Integration

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Building Services Specification
Volume 2 – Mechanical Services Specification

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1 Heating Systems

1.1 HEAT PUMP PLANT

Each apartment will be provided with a dedicated Air Source Heat Pump (ASHP) to provide all space heating & domestic hot water needs within each apartment. The ASHPs are twinned with pre-plumbed packaged domestic hot water cylinders which include all primary and secondary circulation pumps.

The outdoor units constructed from steel plate and painted are packaged inverter driven air to water heat pump. Insulated condensate lines shall be installed to each unit to discharge over a gulley.

The single unit heat pump is made up of scroll compressor hermetically sealed refrigerant circuits utilising R32 refrigerant. The exchange of heat from refrigerant to water is made through two stainless steel plate heat exchangers linked together in parallel to common flow and return connections. The refrigerant cycle and components are integral to the unit with only flow and return water pipe work connections from the unit.

The air source heat pumps will be installed within the mezzanine plant room, ventilated by a slatted screen with a minimum free area of 70% in accordance with the architect's details. Access for maintenance will be via the vehicular access route and mezzanine plant room. Pipework distributing externally & internally will achieve a thermal conductivity performance of 0.025W/mK or better.

The heat pumps shall use a refrigerant with an Ozone Depletion Potential (ODP) of zero and Global Warming Potential (GWP) of less than 2000.

The heating system will be enabled and controlled by packaged heat pump controls.

The complete installation shall be in accordance with the following:

- BS EN 12828:2012 + A1 - Heating systems in buildings - Design for water-based heating systems
- BS EN 14336:2004 - Heating systems in buildings - Installation and commissioning of water based heating systems
- BS EN 15316- Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies.
- BS EN 14511: 2018 - Air conditioners, liquid chilling packages and heat pumps for space heating and cooling and process chillers, with electrically driven compressors;
- BS EN 12831: 2003 – Heating systems in buildings. Method for calculation of the design heat load.
- BS EN 14336: 2004 - Heating systems in buildings. Installation and commissioning of water based heating systems.
- Building Regulations Approved Documents L Volume 1
- HM Government – Domestic Building Services Compliance Guide, 2013 Edition
- BS EN 378:2016: Refrigerating systems and heat pumps. Safety and environmental requirements. Basic requirements, definitions, classification and selection criteria
- BS EN 14511: Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling
- Manufactures installation and operation recommendations

1.2 LOW TEMPERATURE HOT WATER (LTHW) DISTRIBUTION SYSTEMS

The LTHW heating distribution system will comprise heat-exchangers, circulating pump sets, air / dirt separator, dosing pot, distribution pipework & fittings, isolating valves, strainers, commissioning valves, orifice plates, 'binder' test points, safety valves, spring hangers supports on pipework within plant rooms, resilient pipework supports external to plant rooms, flexible connections to all pumps, key operated drain cocks at all low points, air vents at all high points, thermal insulation, identification etc.

LTHW circuit for each apartment will comprise:

Circuit	LTHW Temperature Flow °C / Return °C	Arrangement	Distribution	Pump Arrangement	Heat Source / Fuel Type
Primary – space heating circuit	58 - 45°C flow / 53 - 40°C	Two pipe return (depending on demand)	Constant flow, Variable temperature.	Duty (1no. single head pump per heat pump)	Centralised air source heat pump

Secondary – space heating circuit	45°C / 40°C	Two pipe	Variable flow, Variable temperature (weather compensated).	Duty (part of packaged system)	Centralised air source heat pump
Primary – domestic hot water circuit	58°C / 53°C	Two pipe	Constant flow, Constant temperature.	Duty (part of packaged system)	Centralised air source heat pump

The Contractor will ensure that isolating valves are provided where necessary, together with stool pieces and flanges or unions, for the isolation of equipment and heating circuits.

The Contractor will employ an expansion specialist to assess the pipework expansion and advise on flexible joints, guides, anchor points etc. The Contractor will confirm in his tender submission that all provisions for pipework expansion have been included and will advise of any structural implications following selection of devices.

Where pipework is installed in plant rooms, it will be protected by aluminium 'hammerclad' protection up to 2m from finished floor level.

1.2.1 Pressurisation Unit and Expansion Vessel

The LTHW systems for each apartment will include a mains water connection for filling & pressurisation of the system. The mains water connections will include double check valves.

Each LTHW system shall include a removable diaphragm type expansion vessel, sized to accommodate expansion of the total volume of water within the system. The expansion vessel will be installed and commissioned in accordance with the manufacturers' recommendations.

The expansion vessel and system pressurisation will be compliant with the current versions (unless dated) of all relevant Building Regulations, Pressure Equipment Regulations, HSE, British Standards and Codes of Practice including but not limited to;

- BS EN 13831: Closed expansion vessels with built-in diaphragm for installation in water
- BS 7074-2: Application, selection and installation of expansion vessels and ancillary equipment for sealed water systems. Code of practice for low and medium temperature hot water heating systems
- *BS EN 12828: Heating systems in buildings. Design for water-based heating systems.*
- BS EN 13076: Devices to prevent pollution by backflow of potable water.
- PED: 2014/68/EU: The pressure Equipment Directive

1.2.2 Magnetic Filter

A magnetic filter shall be installed on the LTHW pipework between the thermal storage cylinder and ASHP within each property for protection of the LTHW system. The filter shall consist of a high strength magnet, an air vent , a drain point and isolation valves on each side of the filter.

The filter shall also allow the means to chemically dose the LTHW system. The unit will be installed at a height that it is convenient and safe to pour chemicals into the filter.

The contractor shall allow sufficient space beneath the drain valve of the filter to place a suitable vessel capable of taking the volume of liquid in the filter. Any liquid drained from the pot should be disposed of safely.

Units to be compliant with The Pressure Equipment Regulations and the Pressure Equipment Directive: 2014/68/EU.

1.2.3 Microbubble Deaerators

The deaerators will be installed in the hottest part of the installation i.e. directly behind the boiler in a heating system/ main return pipe in a cooling system. Installation before the pumps will prevent accumulation of micro bubbles in the pump shaft.

1.3 UNDERFLOOR HEATING SYSTEMS

1.3.1 Wet Underfloor Heating Systems

Wet underfloor Heating (UFH) will be provided in all main living rooms of each apartment.

- The complete UFH system will comprise as a minimum the following components;
- 2 port motorised control valves
- Flow and return manifolds (Number of circuits to be determined by the specialist contractor)

– A proprietary underfloor distribution system (including all necessary components) to suit the proposed floor build up for a suspended floor.

The UFH fixing system and insulation type will be compatible with the floor type/ build up and in accordance with the Architects' requirements.

Edge insulation will be fitted to all walls of the rooms/areas of underfloor heating to provide a barrier against perimeter heat loss and for thermal movement.

The underfloor pipework will be connected to the manifold filled with water and pressurised to check for water tightness. As soon as practical after the installation is completed the floor finish should be applied over the system to the required depth.

Flow to each room will be controlled by 2-port control valves on each manifold to maintain the temperature set point as determined by wall mounted temperature sensors in each room. Temperature sensors will be located in positions agreed with the Architect, away from the external wall, direct sunlight and any other source of heat.

Temperature sensors will also be provided in the floor in each zone. Flow to that zone will be shut-off should the floor temperature rise above a pre-set high temperature limit.

All components up to and including the manifold will be installed in accessible location for maintenance. Suitable provisions will be made for easily filling and venting the UFH pipework.

No pipe joints will be installed below the finished floor.

The UFH pipework will be 20mm outside diameter. The size, batch number and manufacture date will be clearly marked on the pipe at 1m intervals. The pipes will be capable of operating up to 70oC and 10 bar and have an integral oxygen diffusion barrier.

The pipework will be laid uniformly in a continuous loop to achieve a minimum design heating output. The pipework will not be laid in the floor where there are obstacles, services or points of high structural load.

The underfloor heating system and its controls shall be configured to ensure that the rate of change of the floor surface temperature does not exceed 1°C per hour.

Overheating in storage areas should be limited by distributing return pipework through these spaces only and flow pipes via adjacent spaces.

All UFH pipework must be pressure tested for at least 24hours. The testing will be in accordance with BS EN 1264-4 to twice the working pressure or 6barg (whichever is greater) and before screed is applied.

The entire UFH system will be designed, supplied, installed, tested, commissioned and certified by a specialist manufacturer and installer. The specialist will have British Board of Agreement accreditation and be a member of BEAMA Underfloor/ Underfloor Heating Manufacturers Association (UHMA).

The complete UFH system installation will be compliant with the current versions (unless dated) of all relevant Building Regulations, British Standards and Codes of Practice including but not limited to;

– Building Regulations: Approved Documents
– HM Government – Domestic Building Services Compliance Guide
– BS EN 1264: Water based surface embedded heating and cooling systems.
– BSRIA BG 4: 2011: Underfloor heating and cooling
– BSRIA AG 12: 2001: Underfloor Heating Systems
– BS 7671: Requirements for Electrical Installations. IET Wiring Regulations

1.3.2 Electric Underfloor Heating Systems

Electric Underfloor Heating (UFH) will be provided in the apartment bathrooms.

The complete UFH system will comprise as a minimum the following components;

– A proprietary underfloor distribution system (including all necessary components) to suit the proposed floor build up for a suspended floor.
– Edge insulation will be fitted to all walls of the rooms/areas of underfloor heating to provide a barrier against perimeter heat loss and for thermal movement.
– The UFH fixing system and insulation type will be compatible with the floor type/ build up and in accordance with the Architects' requirements.
– Temperature sensors will be located in positions agreed with the Architect, away from the external wall, direct sunlight and any other source of heat.

– Temperature sensors will also be provided in the floor in each zone. Supply to that zone will be shut-off should the floor temperature rise above a pre-set high temperature limit.

Install, terminate and test cable for electric under floor heating in accordance with manufacturer's recommendations.

Ensure installation is protected and monitoring devices connected when screed is laid.

The underfloor heating system and its controls shall be configured to ensure that the rate of change of the floor surface temperature does not exceed 1°C per hour.

– The complete UFH system installation will be compliant with the current versions (unless dated) of all relevant Building Regulations, British Standards and Codes of Practice including but not limited to;
– Building Regulations: Approved Documents
– HM Government – Domestic Building Services Compliance Guide
– BS EN 60079-30-2: 2017 Explosive atmospheres. Electrical resistance trace heating. Application guide for design, installation and maintenance.
– BSRIA BG 4: 2011: Underfloor heating and cooling
– BSRIA AG 12: 2001: Underfloor Heating Systems
– BS 7671: Requirements for Electrical Installations. IET Wiring Regulations

1.4 LTHW SYSTEMS WATER TREATMENT

All works will be undertaken by a specialist contractor including but not limited to;

– Temporary and permanent flushing provisions
– Selection of cleaning, dosing and corrosion inhibitor chemicals compatible with the equipment, all pipework, fittings and components installed.
– Consents from water authority for discharging chemicals and flushing water

Flushing, cleaning and pre-commissioning water treatment will be applied to all LTHW pipework installations.

Facilities will be installed for water treatment to be added through the life of the system. A dosing pot will be installed across the flow and return in order to allow chemicals to be effectively introduced into the system.

A dirt separator will be installed in the primary return before the primary pumps.

The complete water treatment process will be compliant with the current versions (unless dated) of all relevant Building Regulations, local water authority requirements, Water Research Centre, British Standards and Codes of Practice including but not limited to;

– BSRIA BG 29: 2021 - Pre-commission cleaning of pipework systems. 6th edition
– BSRIA BG 50: 2021 – Water treatment for closed heating and cooling systems

2 Ventilation Systems

2.1 MECHANICAL VENTIALTION WITH HEAT RECOVERY

A combined mechanical supply and extract (whole-house) ventilation system will be installed to provide continuous filtered supply and extract ventilation to all apartments.

Purge ventilation for units 1-4 will be via the MVHR system with the system commissioned to achieve 4 air changes in accordance with Building Regulations as per the tender design Purge ventilation for unit 5 will be via operable windows integrated in the façade.

A packaged Mechanical Ventilation with Heat Recovery (MVHR) unit will be installed within a utility cupboard in each apartment.

Thermally insulated intake and exhaust ductwork will extend from the MVHR unit to the façade within each apartment. The ductwork will connect with the façade via a bespoke ductwork plenum (complete with insect mesh) which will be fully sealed to the façade vent. Façade vents will be installed to the architect's drawing details and specification. The contractor will allow for the necessary coordination with the façade contractor to ensure no cold bridging.

Supply ductwork will extend from the MVHR unit to supply ventilation terminals in the living room and bedroom.

Return ductwork will extend from extract terminals in the WC, bathroom, kitchen and utility cupboard.

All ductwork will be PVC, low profile 'Flat duct' type complete with intumescent fire collars/wraps provided wherever the ductwork passes through fire compartments.

Volume control dampers (VCD's) will be provided on all branch ductwork and terminal units to enable system balancing. Access panels will not be provided for future access to VCDs once the building is complete so sufficient time should be made in the programme for creating temporary access to VCDs during the commissioning period.

Where permanent access panels will not be provided for future access to VCDs, sufficient time should be made in the programme for creating temporary access to VCDs during the commissioning period.

The MVHR unit will operate via packaged controls to switch from trickle to boost on activation of a light switch in any of the wet rooms served, or on sensing high humidity in the extract ductwork.

A manual boost switch will also be provided in each kitchen in a position to be agreed with the architect. The boost switch will be engraved with a suitable label or symbol in a format to be agreed with the architect and client.

The sub-contractor will provide all necessary acoustic treatment to meet the acoustic design criteria of this specification including in-duct attenuation, anti-vibration mounts and acoustic treatment/ insulation to prevent break-out noise.

The complete whole house ventilation system will be compliant with the current versions (unless dated) of all relevant Building Regulations, British Standards and Codes of Practice including but not limited to;

- BS EN 13141-1 to 7: Ventilation for Buildings
- BRE: SAP Appendix Q
- BESA DW/154: Specification for Plastics Ductwork

2.2 KITCHEN VENTILATION SYSTEMS

The complete kitchen ventilation requirements will be satisfied by a mechanical system.

Extract from the kitchen will be via an extract canopy hood (complete with primary grease filters) located directly above the cooking equipment to capture cooking odours and grease generated by cooking activities.

The kitchen canopy (complete with grease filters and integral fans) and installation will be by others.

Make-up air to the space will be drawn from the adjacent areas.

Kitchen exhaust fan casings will have a removable airtight impeller inspection and cleaning access door.

The complete whole house ventilation system will be compliant with the current versions (unless dated) of all relevant Building Regulations, British Standards and Codes of Practice including but not limited to;

- Building Regulations: Approved Documents
- HM Government – Domestic Building Services Compliance Guide

- BESA DW/143: A Practical Guide To Ductwork Leakage Testing
- BESA DW/144: Specification for Sheet Metal Ductwork DW/144
- HVCA DW/172: Specification for Kitchen Ventilation Systems

2.3 SMOKE & HEAT EXHAUST SYSTEMS

Natural smoke ventilation will be provided in accordance with the fire strategy to protect the common escape stair from smoke ingress.

A smoke ventilation specialist supplier will be employed to design, supply, install, test and commission the systems. The systems will include all packaged controls, motorised smoke dampers, smoke detectors, heat detectors, fire alarm interfaces and firefighting control panels.

The specialist supplier (Colt International Ltd or equal and approved) will be responsible for the complete design of the systems including all necessary calculations including CFD modelling.

The lobbies to each apartment will be provided with a naturally ventilated smoke shaft with a minimum free area of 1.5m² free area, a minimum internal dimension of 0.85m and an aspect ratio of no more than 2:1. The shaft will extend a minimum of 0.5m above the any building projection within a horizontal distance of 2.0m.

All smoke shafts will extend a minimum of 0.5m above the any building projection within a horizontal distance of 2.0m.

Motorised smoke dampers / Automatic Opening Vents (AOV) will be installed at each floor and at the head of the smoke shafts to provide a minimum free area of 1m².

An AOV providing a minimum free area of 1m² will be located at the top of the common stair. The AOV will operate to the dictates of the smoke detection system within the common corridor on each floor.

On activation of the AOV, the AOVs on the affected floor, at the head of the staircase and at the head of the smoke shaft will open. All remaining AOV's will remain closed, unless over-ridden by the Fire Service during firefighting activities.

The AOVs will be configured so that there is no risk of fall from height.

Maintained power will be provided to all systems by battery back-up.

The complete smoke ventilation system will be compliant with the current versions (unless dated) of all relevant Building Regulations, British Standards and Codes of Practice including but not limited to;

- The fire engineering report produced by Jensen Hughes
- Building regulations Approved Document: Part B
- BS 9991:2015 Fire safety in the design, management and use of residential buildings
- BS 60335 Household and similar electrical appliances. Safety.

3 Domestic Water Systems

3.1 POTABLE COLD WATER SERVICES

A new mains water supply will be provided to serve the 5no. apartments. The new supply will distribute from the street via the existing basement and will rise up to the mezzanine plant room to serve the cold water tank.

The pipework distribution in the basement will include trace heating. All mains & boosted cold water will be thermally insulated throughout the building.

3.1.1 Cold Water Tank

The mains cold water break tanks will be sized to provide a continuous flow rate from the packaged booster pump at peak simultaneous demand.

The water tanks will be constructed from square GRP plates with internal flanges to BS EN 13280 Class A1 for potable water and insulated in accordance with BS 5422: 2009. Internal divisions will be of plated construction from similar materials and thickness to that of the tank walls.

The tank cover will be constructed from bolted ribbed aluminium sheets with readily removable sections for access to ball valves and cleaning access. Covers not capable of supporting the weight of maintenance personnel will be fitted with appropriate warning notices.

Suitable provision will be made for draining and cleaning of the cold-water storage tank. To facilitate this without disruption to the supply, the tank will be divided into two sections. Each section will be provided with insulated man access, float valve chamber, screened vents and overflow.

Access ladders complying with BS 4211 will be provided internally and externally for each compartment. Internal ladders bolts, nuts and washers will be stainless steel. Internal straps, ties and similar fittings will be nylon coated. External ladders will be galvanised steel complete with safety cage and hand rail.

The tank will be fully supported from the structure beneath. The sub-contractor will include for the design, supply and installation of the support/bearer system in accordance with manufacturer's instructions.

Discharge arrangements for overflows and warning pipes will comply with the requirements of the Local Water Supply Authority. Vents, overflow and warning pipes will be fitted with insect screens.

The tank will be installed to facilitate cleaning of the internal and external surfaces and will be thoroughly cleaned prior to testing and commissioning.

- Unless otherwise indicated on the drawings the following will apply:
- Connections will be flanged stools/studded flanged pads or screwed bosses.
- Ball float valves, contents and temperature gauges etc.
- Thermal insulation will be in accordance with the Thermal Insulation, Section of this Specification.
- Site testing and cleaning of tanks will be in accordance with the Commissioning and Testing Section of this Specification.
- Disinfection of tanks and associated connecting services will be in accordance with the Water Treatment and Disinfection Section of this Specification.
- Outflow connections will be taken off the side of each storage compartment.
- Drain connections will where possible be taken off the bottom of each storage compartment.
- Insect screens will be fitted to overflow, warning and vent pipes.
- A dial thermometer will be fitted to each compartment.
- A hydrostatic contents gauge is to be provided for each storage compartment

A packaged monitoring system will be supplied and installed as part of the water tank installation to provide the following:

- High water level alarm
- Low water level alarm
- Overflow alarm
- High water temperature alarm
- Low water temperature alarm

The system will comprise all necessary level and temperature sensors, wiring, control panel and outputs to the building metering and monitoring network.

Connections will be provided for the following sensors in each tank:

- Temperature side boss connection (location in bottom 30% of tank).
- Contents low level, side boss connection (location at the same height as the pump disable float).
- Contents high level, side boss connection (located between the warning pipe and overflow level). Connections will be provided in each tank for the booster pump set low level disable float switch.

All tanks will be designed, manufactured, delivered, installed, tested and commissioned by the manufacturer. Tanks will come complete with necessary bases and supports, internal components, insulation, cover and connection points.

Statutory Requirements and Standards

The complete water storage vessels and tank installation will be compliant with the current versions (unless dated) of all relevant Building Regulations, LPC rules, local water authority requirements, Water Research Centre, NFPA, British Standards and Codes of Practice including but not limited to;

- BS *EN 13280: 2001* - Specification for glass fibre reinforced cisterns of one-piece and sectional construction, for the storage, above ground, of cold water
- BS EN 806: Specifications for installations inside buildings conveying water for human consumption.
- BS 8558: 2011 - Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages. Complementary guidance to BS EN 806.
- Water Supply (Water Fittings) Regulations 1999
- WRAS approval

3.1.2 Cold Water Booster Set

A fully automatic, assembled, tested and self-contained packaged cold-water pressure booster set for potable domestic cold water will be provided.

It will contain all necessary items/equipment for the correct operation of the system. These include;

- Direct coupled pumps as indicated on the Technical Schedules. All pumps will have an electric drive and be capable of isolation and removal.
- The booster set will be mounted on a purpose made pre-fabricated common steel base frame with anti-corrosion finish. The base frame will be mounted on a raised concrete plinth with adequate anti-vibration mounts and flexible couplings to prevent transmission of vibration to the building structure or connected service pipework.
- The pumps shall be connected in parallel with isolating valves on the suction and delivery connections, strainer on the suction connection and non-return valve on the delivery connection only. Pumps will have flanged connections on the supply and suction connections.
- Diaphragm type hydraulic accumulators (to increase pump rest time and reduce hydraulic shock at closed valve) of fabricated steel construction incorporating a butyl rubber diaphragm or removable bag to BS 6144. The internal surfaces shall be coated with epoxy polyester resin or other finish suitable for the application. Vessels shall be charged with nitrogen to the correct system pressure at the commissioning stage.
- Vessel/s shall be sized to limit pump starts to 10 per hour and shall be capable of receiving and discharging the design flow rate between pump starts. The accumulator shall be full flow-through type to avoid stagnant water in drinking applications.
- Pressure switches for each pump and solenoid valve
- System pressure gauge and interconnecting copper pipe work to BS EN 1057
- High- and low-pressure pump cut-out switches.
- Volt-free contacts to relay common fault condition to an external source.
- Motor control panel within a steel cabinet compliant with the latest version of I.E.E Wiring Regulations (BS 7671). The cabinet shall have IP55 protection rating, including main switch, all required fuses, motor protection, anti-condensation heater, switching equipment and multi-pump controller.

Statutory Requirements and Standards

All pumps and booster sets will be compliant with the current versions (unless dated) of all relevant Building Regulations, local water authority requirements, Water Research Centre, British Standards and Codes of Practice including but not limited to;

- BS EN 806: Specifications for installations inside buildings conveying water for human consumption.
- BS 8558: 2011 - Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages. Complementary guidance to BS EN 806.
- Water Supply (Water Fittings) Regulations 1999
- WRAS approval

3.1.3 Water Conditioner

A water conditioning unit will be installed as indicated on the drawings and in accordance with the manufacturers' requirements to inhibit formation of hard scale.

The unit specified is a mechanical (non-powered) type water conditioner with cavitation chambers to create turbulence and pressure changes as the water passes through it.

The unit will contain a large surface area of zinc to promote cathodic protection for pipe work downstream and assist in breaking down existing corrosion leaving a neutral surface which remains protected.

The water conditioning unit (Scale buster) will be manufactured by Goodwater Ltd or equal and approved.

3.1.4 Particle Filter

A particle filter (HydroFIL) manufactured by Hydrotec UK Ltd or equal and approved, will be installed on the incoming mains water supply.

Statutory Requirements and Standards

The water filter will be compliant with the current versions (unless dated) of all relevant Building Regulations, local water authority requirements, Water Research Centre, British Standards and Codes of Practice including but not limited to;

- WRAS Approval
- EMC Directive 2014/130/EU

3.1.5 Metering

Utility meters will be provided to each apartment, installed within the common staircase and accessible via a dedicated riser. Isolating valves will be installed on either side of the meter, and a strainer before the meter. A landlord meter will be installed in the mezzanine plant room. All meters will be installed in accordance with the requirements of the utility company.

3.2 HOT WATER SERVICES

Hot water will be provided within each apartment via local hot water cylinders as described in the following sections of the specification.

3.2.1 Thermostatic Mixing Valves

Technical specifications of all thermostatic mixing valves shall be submitted to the Building Control Officer when requested to demonstrate that the maximum temperature of 43°C cannot be exceeded in operation and that the product will fail-safe (i.e. not discharge water above the maximum temperature).

Valves will be located in accessible locations to facilitate maintenance however valves will not be easily altered by building users.

In-line blending valves and composite thermostatic mixing valves should be compatible with the sources of hot and cold water that serve them.

The contractor shall ensure that the location of any TMV from the hot water outlet it serves should not exceed a total distance of 1m to ensure that hot water is readily available and to minimise the risk of legionella.

Statutory Requirements and Standards

All thermostatic mixing valves will be compliant with the current versions (unless dated) of all relevant Building Regulations, local water authority requirements, Water Research Centre, British Standards and Codes of Practice including but not limited to;

- Building Regulations: Approved Document Part G

- BS EN 1111:2017: Sanitary tapware. Thermostatic mixing valves (PN 10). General technical specification
- BS EN 1287:2017: Sanitary tapware. Low pressure thermostatic mixing valves

3.2.2 Storage Cylinders and Calorifiers

Hot water calorifiers will be provided in each apartment. The calorifiers will be part of a packaged system twinned with an ASHP.

The storage calorifiers installed will be as indicated on the drawings and as specified on the equipment schedules.

A 3rd party domestic hot water return pump will be provided in each apartment, installed within the utility cupboards. The pumps will be as specified on the equipment schedules.

The storage calorifiers will have the following as a minimum;

- Primary LTHW circulation pump
- Secondary LTHW circulation pump for underfloor heating
- Secondary LTHW circulation pump for domestic hot water
- Cylinder mounted control panel (Mitsubishi FTC6 controller or equivalent)
- Isolating valve immediately before the unit
- A 3kW electric immersion heater and thermostat with a switch located outside the utility cupboard. The switch will be complete with an engraved label and a neon indicator.
- Factory fitted 75mm mineral fibre insulation (or other CFC/HCFC free foam plastic insulation)
- Thermostat set to 60°C minimum and wired to the central heating boiler.
- Primary heating surface shall be sized at 20% greater than the design duty, in order to ensure that temperatures are maintained throughout the life of the plant
- Insulation on the first metre of pipework connections to the hot water cylinder. All pipe connections to the vessels will be independently supported and will not impose additional loads on the cylinder.
- Sacrificial anodes and dielectric separation
- Drain cock.
- Expansion vessel.
- PV diverter to maximum energy from the PV panels to the hot water cylinders

Unvented units to be complete with “unvented kits” and pressure regulating valve.

Sufficient clearance will be maintained to allow withdrawal and replacement of heating elements and anodes.

Storage vessels will be orientated to allow all necessary maintenance access. All isolating valves will be fully accessible. Calorifiers to be provided with man access

Safety valve discharge pipes will connect to a drainpipe via a tundish which in turn drains into a local SVP via a waterless trap connection (HepVO or equal and approved) complete with identification labels.

Statutory Requirements and Standards

The storage cylinder and calorifier installation will be compliant with the current versions (unless dated) of all relevant Building Regulations, British Standards, water supply (and fitting) regulations and Codes of Practice including but not limited to;

- Building Regulations: Approved Document Part G
- HM Government: Domestic Building Services Compliance Guide, 2013 Edition
- Water Supply (Water Fittings) Regulations 1999
- BS 853-1:2011: Specification for vessels for use in heating systems. Calorifiers and storage vessels for central heating and hot water supply
- BS 8558:2015: Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages. Complementary guidance to BS EN 806
- BS 7592:2008: Sampling for Legionella bacteria in water systems. Code of practice
- BS 6283:1991: Safety and control devices for use in hot water systems. Specifications for temperature relief valves for pressures from 1 bar to 10 bar

- HSE (L8): The Control of Legionella Bacteria in Water Systems, Approved Code of Practice and Guidance, Third Edition 2000.
- BS 7671:2018 Requirements for Electrical Installations
- CIBSE TM 13:2013: Minimising the Risk of Legionnaires Disease

3.2.3 Waste Water Heat Recovery System

All apartments shall be provided with dedicated hot water heat recovery systems which shall recover heat from the shower waste water as indicated on the tender drawings and the equipment specifications.

The heat recovery systems shall be provided by a specialist and shall allow for a boosted water connection to the system, and a further pipework connection for the preheated water to the shower.

The hot water heat recovery system pipework shall include a double walled copper heat exchanger manufactured in accordance with BS EN 1717

3.2.4 Flow Regulating Devices

Combined flow isolation and regulating valves shall be installed on each draw off point on both hot and cold water systems to provide constant and maximum flow rates at all taps and showers etc.

Valves shall be complete with a range of coloured inserts to suit the required flow rates.

The Sub Contractor shall provide certification to confirm that the systems have been satisfactorily disinfected in accordance with the specification.

3.3 WATER LEAK DETECTION

A leak detection system will be installed on the incoming mains supply to the mezzanine water tank plantroom.

The system will be as manufactured by Envirotech Alarms Ltd or equal and approved.

The performance criteria of the system are as follows:

- Activated with the flow of water passes through the water meter at a flow rate above a pre-set maximum for a pre-set period of time.
- Able to identify different flow and therefore leakage rates, e.g. continuous, high and/or low level, over set time periods.
- Programmable to suite the owner/occupiers' water consumption criteria
- Where applicable, designed to avoid false alarms caused by normal operation of large water-consuming plant.

The systems will be a packaged monitoring system capable of detecting any major water leaks in the coverage area i.e. mains water supply between and within the building and the site boundary. The system will come complete with a local control panel connected to the solenoid valves and linked to the building automatic monitoring system.

The water leak detection system will include the following:

- Local audible and visual alarm (displayed until cable dried and system reset)
- Status indication for each zone
- Alarm mute button
- Full alarm state relays
- 24-hour battery back up
- Indication of mains power failure
- Indication of low battery charge
- Self-test facility

The systems will comprise lengths of leak detection cable, resistant to both corrosion and contamination and capable of drying quickly. The cables will be fixed in position by metal clips or tie wrap pads secured to the base floor by a suitable adhesive. Junction boxes will be installed at the ends of each detector cable and at the zone change points.

All leak detection systems will be monitored by the BMS system and report their status and alarms to the building automatic monitoring system. The controls will incorporate the following:

- Status indication

– Common fault alarm

Installation of leak detection systems will only be carried out after completion of construction work in the coverage areas and after testing and commissioning of all water-based systems has been concluded.

The leak detection system will provide signal to building automatic monitoring system which will control solenoid valves in the cold water main supply and close the solenoid valves in case of leak detection confirmation.

3.4 DOMESTIC SERVICES WATER TREATMENT & DISINFECTION

Disinfection, draining down and flushing will be applied to the following systems:

– Incoming Mains Water

– Potable Water Service

– Domestic Hot Water Service

After completion of works the system will be flushed with mains water. Flow restrictors and filters will be removed, cleaned and reinstated.

All cold and hot water services and cylinders installed under the Works will be disinfected by chlorination (to comply with BS EN 806) or other approved process in accordance with the relevant standards. All necessary equipment will be provided for successful disinfection of the systems.

On conclusion, water samples will be taken from each system for analysis by an independent Public Analyst to confirm water quality.

The Sub-Contractor will only use ultra violet treated water to test, flush and fill any closed water system.

Tanks and cisterns will be filled with clean fresh water pre-treated against bacteriological and microbiological growth. Tanks will be subjected to a similar 24-hour standing leak test, drained and left standing empty for a period of 48 hours and finally filled and subjected to a further standing leak test for 24 hours.

All tests will be successfully completed prior to the application of any thermal insulation.

Sealed tanks and cisterns fitted with an open vent will be filled to the discharge level of the open vent.

Following disinfection, the Sub-Contractor will drain down and thoroughly flush out the systems using clean, untreated mains water to the requirements of the local water authority.

No modifications will be made to the system following disinfection and flushing. Any such modifications will require the whole disinfection and flushing process to be repeated.

All pumps and booster sets will be compliant with the current versions (unless dated) of all relevant Building Regulations, local water authority requirements, Water Research Centre, British Standards and Codes of Practice including but not limited to;

– Water Supply and Water Supply (Water Fittings) Regulations 1999

– WRAS and DWI Approved

– CIBSE TM13: 2013 - Minimising the Risk of Legionnaires Disease

– HSE ACOP L8: 2013 - Legionnaires' disease

– BS EN 806 - Specifications for installations inside buildings conveying water for human consumption

– BS 8558:2015 - Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages,

4 Fire Protection Systems

4.1 DRY RISER

Dry riser will be installed for fire brigade use in the cores of XXXXX with inlet breeching point positioned adjacent to the building entrance.

4.1.1 Dry Riser Inlet Breechings

The inlet breeching shall comprise twin inlets with instantaneous couplings to BS 336 and protecting caps retained on chains. The inlet shall be complete with non-return valve and 25mm drain valve.

The inlet boxes shall be suitable for recessed wall mounting at a height of 400-600mm above ground level in accordance with the Architects' details. Proposals shall be submitted to the Architect for approval prior to ordering.

Inlet breechings shall comply with BS 5041 Part 3.

4.1.2 Dry Riser Landing Valves and Outlet Boxes

Outlets will be located at each floor level within the escape stair and an additional landing valve on the roof.

Landing valves shall be installed 750mm above finished floor level.

Single outlets will be located at each floor level within the escape stair and an additional landing valve on the roof.

Landing valves will be DN65 complete with handwheels of 150mm minimum diameter and marked with 'OPEN' and `SHUT' direction plate. The valve shall be in gunmetal with an instantaneous coupling to BS 336 and a protecting cap with retaining chain. A leather strap and padlock shall be used to secure the valve in a closed position.

Landing valves shall be installed in purpose made outlet boxes complying with BS 5041 Part 4 installed in builder's work recesses in accordance with Architects' details. Boxes shall be steel and fitted with wire glazed doors with spring cylinder locks. The door shall overlap the box architrave and shall be finished in a polyester powder coated paint finish to a RAL colour advised by the Architect. Proposals shall be submitted to the Architect for approval prior to ordering.

Landing valves shall comply with BS 5041 Part 2.

4.1.3 Drain Valves

Drain valves shall be installed at low points on the system where these are below the inlet cabinet drain valve. Drain valves shall be 25mm and comply with BS 5041 Part 3. The drain valve shall be clearly labelled "DRY RISER DRAIN VALVE".

A notice shall be secured in the inlet box stating the location of the system drain valves in accordance with BS 5041 Part 5.

4.1.4 Air Release Valves

A 25mm automatic air release valve shall be installed at the top of the dry riser to assist complete charging and draining of the system. The valve shall be in gunmetal.

Statutory Requirements and Standards

The complete boiler system installation will be compliant with the current versions (unless dated) of all relevant Building Regulations, NFPA, LPC, British Standards and Codes of Practice including but not limited to;

- BS 9990:2015 Non-automatic firefighting systems in buildings
- BS 5041 - Fire hydrant systems equipment
- BS 5306 - Fire protection installations and equipment on premises

4.2 WATER MIST FIRE SUPPRESSION SYSTEMS

The sub-contractor shall employ a specialist company to design, supply and install a water mist fire suppression system suitable for domestic occupancy in accordance with the fire strategy. Each apartment will be provided with a local mist system located at low level in a kitchen cupboard.

The complete sprinkler installation will be carried out by a LPCB certified water mist installer and supervising body who will be responsible for the design, supply and installation of all materials and equipment. The design and installation will comply in all respects to the LPC rules for water mist installations and adopting provisions for life safety.

The entire automatic mist system will be installed using materials suitable for life protection as approved and listed in the current LPC list of approved products and services.

Each system will be directly connected to the metered boosted cold water supply for each apartment. The boosted water supply will branch immediately after entering an apartment, with a dedicated branch pipe serving the water mist suppression system. The branch pipework serving the mist system will include isolating valves, a check valve and a pressure reducing valve (in accordance with the manufacturers requirements). A priority demand valve will be installed on the boosted supply pipework that serves the fixtures & fittings within the apartment. The priority demand valve will be linked and controlled by the mist system to shut off the water supply to the apartment fixtures & fittings during times when the mist system is needed.

The setting out of all nozzles will be confirmed with the architect and interior designer prior to installation. The specialist watermist contractor will produce drawings for review and comment by the architect and interior designer. Appropriate allowance will be made for modifications to be made to these drawings as required to suit the coordination.

The sub-contractor shall submit samples of the proposed nozzles to the architect and interior designer for approval prior to ordering.

The complete design & installation of the water mist suppression system will be by iMist or equal and approved.

Installation methods and materials shall comply with the latest editions of all relevant British Standards and Codes of Practice, in particular:

- BS 8458: 2015 - Fixed Fire Protection Systems – Residential & Domestic Watermist systems: Code of practice for design and installation
- BS EN 12259 - Fixed Firefighting systems – Components for sprinkler & water spray systems
- Loss Prevention Council Board (LPCB) certification requirements

5 Drainage Systems

5.1 ABOVE GROUND FOUL WATER DRAINAGE

Single stack, primary ventilated foul water drainage systems will be provided throughout the building to serve all fixtures & fittings. Primary stacks shall ventilate to atmosphere at roof level as indicated on the tender drawings.

The below ground network will be designed by others and shall be ventilated to atmosphere towards the head of the drainage run as coordinated with the structural engineer.

Every shower / bath in each apartment will comprise a specialist waste water heat recovery drainage system as required by planning. The specialist pipework systems shall be installed as indicated on the tender drawings and shall serve only the showers before connecting onto the nearest main drainage stack (refer to section 3.2.3 for further details).

The full drainage system shall be installed in HDPE or cast iron pipework, complete with acoustic insulation. Vertical drainage stacks will be extended at the full diameter to terminate above roof level in a balloon of the same material. All penetrations through the roof will be weathered. Horizontal offsets of foul drainage pipework shall be installed with 2no. 45 degree bends.

All branch soil and waste pipes to ranges of fittings will have a cleaning eye provided on the pipe in an accessible position immediately adjacent to all sanitary fittings and above the flood level of the fittings to permit the maintenance and rodding of the entire system.

The complete installation will be compliant with the current versions of all relevant British Standards and Codes of Practice including but not limited;

- Building Regulations Approved Documents H & G
- BS EN 12056:2000 parts 1-5 - Gravity Drainage Systems Inside Buildings
- Water Supply and Water Supply (Water Fittings) Regulations 1999

5.1.1 Traps

All waste traps shall have a minimum water seal of 75mm and shall be installed to ensure maintenance of the seal. Traps shall have the following configuration.

Wash Basins	32mm diameter outlet, 75mm seal, two piece white bottle trap with chrome plate finish or as specified in Architect's sanitaryware schedule.
Shower Trays	50mm diameter outlet minimum - to suit the sanitaryware specification, 75mm seal two piece 'P' trap (1)
Baths	40 mm diameter, 50 - 75mm seal two-piece 'P' or 'S' traps PVC - to suit installation.
Sinks	40 mm diameter, 75mm seal two piece 'P' or 'S' traps PVC - to suit installation.
Condensate Drains	Hepworth HEPVO self-sealing waste valve, 32mm diameter.

(1) Larger waste pipe sizes will be required for high flow showers where installed, the sub-contractor shall size all waste pipework to suit the design flow rate as detailed in the Architect's sanitaryware schedule.

5.2 SANITARYWARE

Careful attention shall be given to the assembly, alignment and fixing of sanitary fittings and their supports. All fixings, screws and bolts shall be sheradised or cadmium plated steel.

WC outlets shall be connected to flexible self-sealing, non-translucent Multikwik WC connectors to discharge into the adjacent plain end PVC soil pipe.

WC pans shall be securely fixed to the wall with suitable screws or bolts after drilling and plugging and each fitting shall be free from any rocking movement. Wall mounted pans shall be fixed in accordance with the manufacturer's instructions. The Sub Contractor shall allow for the provision and neat application of sealant joints at abutments with surrounding surfaces, colour to be advised / approved by the Architect prior to application.

Protective coverings shall be left intact until just prior to handover and completion.

5.2.1 Air Admittance Valves

Air Admittance Valves shall be installed as indicated on the Drawings and shall be pipeline size.

Air Admittance Valves shall be installed in adequately ventilated voids and access for periodic inspection and maintenance shall be provided.

Air admittance valves shall be in accordance with the following:

BS EN 12380:2002 - Air admittance valves for drainage systems - Requirements, test methods and evaluation of conformity.

5.3 ABOVE GROUND SURFACE WATER DRAINAGE

New rainwater pipework will be installed to serve the development. 2no. rainwater outlets will be provided for surface water drainage from the main roof of the building, with rainwater pipework distributing internally to the basement to connect to the network in the street. A dedicated rainwater pipe with outlets on each floor will be provided to each winter garden. All internal rainwater pipework shall be thermally insulated.

Rainwater outlets will be proprietary multi-component systems. Guttering systems will come complete with all necessary components (including falls to outlets, offsets, bends, branches, shoes, connections to gullies/drains and support brackets) to provide a fully watertight solution.

All exposed rainwater downpipes, hoppers and fittings shall be new and of the same manufacturer and finish as the roof guttering system in accordance with Architect specification. Samples shall be provided to the Architect for approval and for submission to the local Planning Authority prior to ordering.

The complete installation will be compliant with the current versions of all relevant British Standards and Codes of Practice including but not limited;

- Building Regulations Approved Documents H & G
- BS EN 12056:2000 parts 1-5 - Gravity Drainage Systems Inside Buildings
- Water Supply and Water Supply (Water Fittings) Regulations 1999

6 Automatic Controls

6.1 APARTMENT HEATING & HOT WATER SYSTEMS

Each apartment is served with heating & hot water via a packaged air source heat pump and hot water storage cylinder system. The packaged system shall include a proprietary controls system, such as a Mitsubishi FTC6 controller (or equivalent) which shall monitor and interface with the following as a minimum:

- Packaged primary circulation pump
- 2no. packaged secondary circulation pumps for space heating & domestic hot water circuits
- Air source heat pump
- Immersion heater
- Thermostat for stored domestic hot water
- Temperature sensors for primary & secondary flow & return pipework
- 3rd party room temperature sensors & thermostats (Heatmiser or equivalent)
- Wifi network

Room temperature setpoint adjustment will be via wall mounted thermostats / controllers located in each room. The controllers will be wired to an underfloor heating manifold wiring control centre which will open / close the manifold zone valves and send heating demand signals to the FTC6 controller as required.

Upon receipt of a space heating signal, the FTC6 controller shall enable the air source heat pump, the primary circulation pump and secondary circulation pump for space heating. LTHW for space heating will be generated at the temperatures listed in section 1.2. The FTC6 controller shall monitor the flow & return temperatures included as part of the packaged cylinder and ASHP system. The circulation pumps will be variable speed and will adjust their flowrate according to the flow & return temperatures to maintain a maximum delta T of 5°C.

The ASHP and associated circulation pumps will be disabled by the FTC6 controller when all room temperature setpoints are satisfied.

The hot water storage cylinder will include a thermostat that will monitor the temperature of the stored water to maintain a minimum temperature of 60°C. The thermostat will be linked to the FTC6 controller as part of the packaged system, and will initiate the ASHP, primary circulation pump and secondary circulation pump for DHW if the stored water temperature in the cylinder drops below 60°C. The ASHP and pumps will operate at maximum capacity and will be disabled by the FTC6 controller when the temperature in the cylinder reaches 60°C. A programmable schedule for nightly 'charging' of the hot water cylinders will be available at the FTC6 controller.

If the ASHP and / or associated circulation pumps are not available due to a fault then hot water shall still be available via the immersion heater included as part of the hot water cylinder. Faults shall be raised via the local FTC6 controller mounted to the cylinder.

The FTC6 controller shall include all necessary interlocks between the primary pump and ASHP to ensure flow across the compressor.

In circumstances where there is a simultaneous space heating and domestic hot water demand, the FTC6 controller shall prioritise domestic hot water until the temperature of the cylinder is >60°C.

6.2 APARTMENT MVHR VENTILATION SYSTEMS

The MVHR units in each apartment will operate via packaged controls to switch from trickle to boost on sensing high humidity in the extract ductwork.

A manual boost switch will also be provided in each kitchen in a position to be agreed with the architect. The boost switch will be engraved with a suitable label or symbol in a format to be agreed with the architect and client.

A local wall mounted controller will be provided for each system in an accessible location which will allow programmable schedules to be set and adjusted.

7 Materials & Workmanship

All plant, equipment and materials will comply with the current British and European Standards.

Fire safety provisions will be made for all building services in accordance with relevant sections of BS 9999 and BS 9991.

7.1 PIPEWORK SYSTEMS

7.1.1 Pipe Materials, Joints & Fittings

The pipe and fittings material, installation, method of jointing and fixing and jointing materials will be in accordance with the pipework system manufacturers' recommendations. All items will be inspected before installation and any defective components replaced.

In the case of all domestic hot and cold-water systems that the joint sealants are approved by the Water Research Council for potable water and proofed against bacterial growth. Materials used for these systems will be listed in WRAS 'Water Fittings and Materials Directory'.

All pipework will be kept clean and free from corrosion, rust and internal obstructions. During the works, pipes will be suitably protected, and all open ends will be plugged or capped with proprietary blanking caps to prevent ingress of dirt. Improvised plugs and valves will not be used for capping pipes.

Pipes on site will be stored on stable racks and off the ground. Pipes or fittings with coatings will not be stored in contact with other materials. Items with rubber or compound gaskets/sleeves will be stored away from direct sunlight.

Pipes will be cut square and burrs/irregularities/debris removed from the pipe. Damaged or corroded pipes will not be used.

Pipework will be installed neatly and parallel to the building structure and other pipework except for the required allowance for venting etc. Horizontal drainpipes will be swept in the direction of flow. Any bore reductions in horizontal pipes will be eccentric fittings with level crown/soffit.

All vertical pipes will be plumb. Any bore reductions in vertical pipes will be concentric fittings.

All equipment, components and valves etc., forming the installation will be fully accessible for maintenance, repair or replacement. No pipe joints or change in direction will be permitted within the thickness of walls or floors or positions inaccessible after completion.

Sufficient clear access to every pipe will be maintained without disturbing adjacent pipes, equipment and ducts.

Pipework that is to be subsequently insulated will be spaced to allow 25mm minimum clearance between pipes including any requirements for trace heating.

Jointing material will not protrude/obstruct the bore of the system. Proprietary flexible connectors will be used for WC pan spigots.

All metallic pipework systems will be constructed and installed with appropriate bonding conductors where necessary to provide electrical continuity throughout to comply with the current requirements of the IEE Regulations. A main earth lead will be fitted to each pipework system.

Pipework systems will be suitable for the working temperatures and pressure ratings specified under the commissioning and testing section of this document and in accordance with the following materials and jointing schedule:

System	Pipe Specification	Method of Jointing	Insulation Specification
Heating Water (LTHW) Domestic	Up to DN22 Copper tube to BS EN 1057: 2010	Capillary lead free solder capillary to BS EN 1254 or compression to BS EN 1254	Thermal Insulation BS 5422:2009 Domestic Building Services Compliance Guide, 2013 Edition
Underfloor Heating	Polybutylene (PB) or PEX with EVOH oxygen diffusion barrier layer BS 7291	Continuous pipe throughout	In accordance with manufacturer's requirements

System	Pipe Specification	Method of Jointing	Insulation Specification
Domestic Hot & Cold Water	Copper tube to BS EN 1057: 1996 Materials and fittings will be listed in WRAS 'Water fittings and Materials Directory'	Capillary lead free solder capillary to BS EN 1254 or compression to BS EN 1254	Thermal Insulation to all pipework, with Vapour Barrier to CWS BS 5422: 2009 Domestic Building Services Compliance Guide, 2013 Edition
Incoming Mains Cold Water	Blue Medium Density Polyethylene (MDPE) barrier pipe to BS EN 12201 WRC Approved	Pipes less than DN63 - Compression couplings to BS EN 1254. Pipes greater than DN63 or where inaccessible– Fusion welded couplings. WRAS approved	Thermal Insulation with Vapour Barrier BS 5422: 2009
Waste branches	Grey (white if exposed)ABS pipework to BS EN 1455-1: 2000	Solvent welded with seal ring type expansion joints to BS EN 1455-1:2000	n/a
Foul Drainage	Geberit Black HDPE Soil and Waste Drainage Pipe to BS EN 1519-1:2000	Electro-fusion welding using manufacturer's fittings and tooling to BS EN 1519-1:2000	Acoustic Insulation
Foul Drainage (where exposed)	Socketless cast iron to BS EN 877	Flexible mechanical joints to BS EN 877	
Foul & Surface Water Pumping Main	ABS pressure pipe in compliance with BS 5392 rated at 9 bar (Class C) continuous water pressure at 20°C	At dismantling points compression fittings up to 63 mm diameter to BS EN 1254 Part 2 or BS 2051 Part 1 (b) Flanged to BS EN 1092 Solvent welded.	n/a
	Spigot and socket ductile iron to BS EN 598	Double socket with main iron to flexible joint to BS EN 598	
	Ductile iron to BS EN 598 with flanged ends	Flanged to BS EN 598	
Internal / Concealed Rainwater Drainage	Black UPVC pipework to BS EN 1329-1:2000	Solvent welded with seal ring type expansion joints to BS EN 1329: 2014	Thermal Insulation with Vapour Barrier Acoustic Insulation
	Socket less HDPE	Spigot fittings jointed by butt fusion or with Fusion Welded couplings.	
External / Exposed Rainwater Drainage	Refer to Architects Specification	Refer to Architects Specification	Refer to Architects Specification
Condensate from terminal units	Up to DN75 ABS to BS 5391 PVC to BS 4514	Solvent Weld	
	Copper to BS EN 1057	Compressive type to BS EN 1254-2 or capillary type	
Condensate branch pipework	Grey ABS pipework to BS EN 1455-1: 2000	Solvent welded with seal ring type expansion joints to BS EN 1455-1:2000	Thermal Insulation with Vapour Barrier for first 2m BS 5422: 2009

System	Pipe Specification	Method of Jointing	Insulation Specification
Dry Risers	Medium grade galvanised mild steel tube to BS EN 10255 Landing Valves to BS 5041	Galvanized screwed long radius fittings to BS EN 10242. LPC approved rolled grooved long radius fittings	
Sprinklers, Foam systems	Heavy grade mild steel tube to BS EN 10255	Galvanized screwed long radius fittings to BS EN 10242. LPC approved rolled grooved long radius fittings.	
	Heavy grade galvanised mild steel tube to BS EN 10255	Galvanized screwed long radius fittings to BS EN 10242. LPC approved rolled grooved long radius fittings	

Re-circulating water systems with water temperatures up to 95°C will be steel pipework, unless otherwise stated and will be;

- Screwed joints – Up to and including DN50
- Flanged joints –DN65 and larger
- Grooved ends for mechanical joints

Unless specifically approved push-fit and press-fit systems will not be used.

All materials will be suitable for continuous operation with water quality available and/or refrigerant selected.

All copper tube/pipes will be supplied by a single manufacturer.

Where there is contact between two different types of pipe material e.g. copper and steel, a separating dielectric will be used to prevent any electrolytic reactions.

Flexible joints will be resistant to UV degradation and suitable for system pressures and temperatures. They will mitigate noise and vibration transfer.

7.1.2 Pipework Supports

Pipework supports will be provided as necessary for the stable (prevent sway and offset) and sufficient support of the pipework systems and to allow free movement for expansion and contraction.

Support systems will be graded to required levels for air elimination and drainage.

Sufficient supports will be provided at all equipment and valves to prevent distortion and stress transmission.

All brackets and supports will allow safe access for maintenance and access for removal/replacement of items without the need for total dismantling of the system.

Insulated pipework will be provided with high density rigid foam inserts (with equivalent thermal performance as the insulation) to sustain compression forces. Inserts will be same thickness as the insulation and complete with sealed joints to maintain the vapour barrier.

Rubber lined clips will be used for all domestic cold-water piping. Supports for steel pipework will be ferrous, copper pipework will be non-ferrous or lined (to prevent electrolytic action), chromium plated pipework will be chromium plated.

Pipe supports will be electrically isolated from trace-heated pipework and suitably cross bonded.

7.1.3 Movement & Expansion Joints

Provision will be made for system arrangements to cater for movement from building elements, differential expansion and contraction of the pipework systems. These could be in the form of simple pipe loops or changes in direction where possible. Alternatively, sheathed corrugated bellows or expansion joints can be utilised.

Where expansion joints (c/w internal liners) are used, they will be provided by a specialist manufacturer and will be installed in accordance with their recommendations. Bellows will be capable of more than 12,000 movement cycles without failure.

Pipe guides will be provided on both sides of expansion loops or joints. Guides will be located as recommended by the manufacturer. Where necessary, suitable lubrication will be provided (e.g. sliding type units).

Anchors will be provided of sufficient strength to take up the maximum stresses that could occur as a result of thermal expansion, weight of the charged pipework and the hydraulic pressure acting within the pipe under all normally occurring conditions including hydraulic pressure tests. Anchors will be proprietary units and/or capable of resisting maximum stresses.

Expansion fittings will be of the same material as the pipe with female member anchored/fixed and male member allowed to move.

Calculations for anchor loads, guide and bracket details will be submitted for review prior to install.

7.1.4 Pipe Sleeves

Where pipes pass through walls, floors, and ceilings, the pipes will be enclosed by non-combustible sleeves of the same material as the pipes except PVC and polythene pipework, which will require metal sleeves.

They will be of a size to permit free movement of the pipes, set concentric with the pipe, and will finish flush with the finished face/wall surface.

Where pipes pass through fire-rated elements, extended, non-combustible sleeves or proprietary-sealing systems will be provided which maintain the fire resistance of the element.

Where pipes pass through external building elements, they will be arranged to prevent water penetration. Water protecting sleeves will also be provided in plant rooms, kitchens and areas with waterproof finish.

7.1.5 Pumps

Pumps will be manufactured and tested in accordance with the relevant British Standards and Codes of Practice, in particular BS EN 806, BS EN 60335 2 41 and BS EN 60335 2 51. Pumps will be selected for optimum efficiency.

Potable Water pumps will be WRAS approved.

All pumps will be selected on a pressure/volume operating point to provide stable and efficient operation and lowest possible noise rating for their duty and type.

Pump duties quoted are 'External Static Pressure' losses. The contractor will adjust the pump static pressures to suit the pressure drops of the actual components selected for the system or if changes are made to the pipework distribution. The quoted pump duties include the following commissioning allowances;

- On Flow rates: 10%
- On Head: 15%

These allowances are on top of the calculated design duty to allow for system regulation and additional fittings, unforeseen at the design stage and are not intended as "future spare capacity".

All pumps will have an electric drive and be capable of isolation and removal.

All twin headed pumps shall be supplied with a matching blanking plate to enable the pump to be operated with a single head fitted during maintenance or replacement of standby motor / impeller.

Duty/ Standby pumps will have non-return valves installed on the discharge pipe of each pump.

Impeller shaft speed for circulating pumps will not exceed 1450rpm.

Pumps will be mounted on vibration mounts to meet the noise and vibration criteria.

For variable volume systems, pumps shall be selected with a steep curve in the anticipated range.

Packaged water booster sets for potable domestic cold water will contain all necessary items/equipment (including run/standby pumps and an integral hydraulic accumulator) for the correct operation of the system. Each pump will be controlled by a pressure switch. All booster sets will be provided with low level cut-out switches.

7.1.6 Valves

All necessary valves and cocks will be provided to achieve the following:

- The proper regulation and control of individual systems
- Flow measurement
- The isolation of mains and branches and items of equipment for inspection and maintenance
- The draining and venting of mains and branches and isolated items of equipment.

Valves selected for the works will be compatible with the pipe materials, joints and fittings and will be in accordance with the current version of all relevant British Standards and Codes of Practice.

Safety and pressure relief valves will be positioned as required in the appropriate standards.

7.1.7 Soil & Waste Systems

The installation, method of jointing and fixing shall be in accordance with the pipework system manufacturer's instructions.

All waste pipes shall fall from fittings at the correct gradient to their respective main soil and/or waste stacks or stub wastes. No branch vent pipes to ranges of sanitary fittings shall connect back to the main vent pipe below the level of the respective fittings.

All vent pipes shall discharge to atmosphere away from all windows, openings, or air inlets.

Pipes shall be fixed so that they allow for thermal movement with all expansion couplings anchored preventing movement, with brackets supplied by the pipe system manufacturer.

Flexible joints are to be provided where pipes cross expansion joints.

Solvent welded joints shall be made using the manufacturer's approved cement after cleaning the areas to be joined with the manufacturer's cleaning fluid as required. Seal ring fittings shall be used where necessary to accommodate thermal movement, or the sockets of standard fittings shall be converted to seal ring joints by the addition of a seal ring adapter. Each seal ring shall be lubricated using the manufacturer's lubricant.

All branch soil and waste pipes to ranges of fittings shall have a cleaning eye provided on the pipe in an accessible position immediately adjacent to all sanitary fittings and above the flood level of the fittings to permit the maintenance and rodding of the entire system.

Where SVP/RWP stacks or waste pipes pass through fire-rated elements, extended, non-combustible sleeves or proprietary intumescent sealing systems shall be provided which maintain the fire resistance of the element.

7.1.8 Vents & Drains

Pipework will be graded in the direction of flow to ensure adequate draining and venting.

All accessible high points will have air bottles for collecting trapped air in the system. Extended drain pipes (same size as valve) complete with lock shield valves will be extended to a nearby low level drain. All branch pipes will have automatic air valves located at all high points complete with discharge pipes to suitable drain.

All low points (including those on equipment) of the system will have hose union drain points complete with a cap.

All main risers (LTHW, CHW and cooling water) will have a minimum 300mm long flanged dirt pocket at the base of the riser complete with drain valves and hose union outlets.

Flushing drain valves (see table below) will be provided on all major equipment and appropriate locations (e.g. headers) to aid flushing.

Nominal Pipe size (DN)	Minimum Drain Valve size (DN)
Less than 32	15
32 - 100	20
100 - 300	32

7.1.9 Strainers

Line size strainers will be fitted at inlets of all pumps, heat exchangers and automatic control valves. These will be readily accessible for regular maintenance and isolation for cleaning.

Combined air and dirt separators will be fitted in the hottest part of the system in LTHW systems (20l/s or more) and CHW systems (10l/s) in accordance with manufacturers recommendations. Units will be selected to minimise waterside pressure losses and wastage.

7.1.10 Lubrication

Only mutually compatible lubricants will be used, and all lubrication points will be capped off to prevent dust ingress.

Oil reservoirs serving bearings will be located at the same static pressure.

7.1.11 Equipment Connections

Each item of plant /equipment will have isolating valves (upstream and downstream), regulating valves, by pass, flow measuring device and self-sealing test points. Valves on fire protection systems will be secured in the open/ closed position using straps and padlocks.

Flanged (DN65 and above) or Union (Up to 50DN) joint connectors will be provided at all major plant items and pumps to allow for disconnections and drainage.

Valved Pressure gauges will be installed in the following locations:

- System pressurisation equipment and closed expansion vessels
- Either side of pressure reducing valve sets
- Main pump and boiler headers
- Each boiler
- Either side of each pump (at the same level)
- Either side of evaporators, condensers and cooling towers

All pressure gauges will have an adjustable reference pointer and will be set to the centre under normal operating conditions.

Thermometers will be installed vertically in the following locations:

- Inlet and outlet to chiller evaporators, condensers and cooling towers.
- Flow and return headers to boilers
- Inlets and outlets of heat exchangers
- Domestic hot water storage units
- Common domestic hot water flow

All thermometers will be positioned such that they can be clearly read from floor level.

Self-sealing test points will be provided at the following locations:

- All Heating and cooling coil inlets and outlets (including air handling units)
- All secondary headers
- All main branches of heating and cooling pipework (including mains entering and leaving the plant room).
- Each port of all automatic control valves

Test points will be suitable for both temperature and pressure gauges and re-sealable after repeated use.

7.2 DUCTWORK SYSTEMS

7.2.1 Duct Materials, Joints & Fittings

Duct materials, construction and identification will be to ISO standard sizes and constructed to the recommendations of HVCA DW 144 2016 - 'Specification for Sheet Metal Ductwork'.

A complete air distribution system will be provided with all necessary equipment, ductwork, (isolating, fire, smoke and balancing) dampers, controls, grilles and dampers.

All metallic ductwork systems will be constructed and installed to provide electrical continuity throughout to comply with the requirements of the IEE regulations. Suitable bonding conductors will be provided as necessary to bridge any jointing systems that do not inherently provide the necessary continuity. Damaged galvanised ductwork and all cut edges will be cleaned, prepared and painted with zinc rich paint. Ductwork will be rigid and accurately aligned to prevent noise and vibration.

All external ductwork will be clad with weatherproof ductwork cladding. The contractor will submit details of the proposed cladding for comment by the design team prior to order.

Where ductwork is exposed, longitudinal seams will be aligned. Obstructions and rough surfaces will be avoided on all internal airways. Duct sizes are based on internal clear airway, hence any internal acoustic linings need to be considered. All internal linings will be fixed with continuous contact to prevent fibre transmission or detachment of the lining.

All duct branches will have factory made conical, bell mouth or shoe type take-offs. Square take-offs will not be permitted.

Openings in main ducts will not be larger than the branch duct size.

Perforated rivets will not be used in the manufacture and installation of ductwork. Self-tapping screws will be restricted to site joints in difficult locations. Record of these locations will be provided. All fasteners and fixings will be compatible with the ductwork material.

Adequate ductwork supports will be provided to support equipment locally and prevent duct distortion. Localised reinforcement will be provided for any duct mounted instruments and control items.

Plastic ductwork will comply with DW154. Other than residential projects, plastic ductwork will be limited to specific locations only.

Ducts passing through building elements will be enclosed within purpose made sleeves. Sleeves will be of the same material as the duct and will be packed with non-flammable, fire resistant material to prevent air movement and noise transmission.

Ductwork passing through fire rated walls enclosing a protected escape route will be hot dipped galvanised steel duct securely fixed to the partition wall construction and fire sealed to prevent deformation of the ductwork during a fire condition. This should be achieved by fixing an angle section around the duct with fixings securing the angle section to both sides of the wall the duct is passing through.

Ductwork interfaces to the building fabric will be suitably weather sealed to prevent ingress of water. Access will be maintained where duct components require inspection, cleaning or manual control.

Fume or Vapour containing ducts will be sloped to a drainage point.

Accessible test holes will be provided for airflow measurement, system balancing, testing and commissioning. Test holes will be provided in main and branch ductwork adjacent to all temperature and humidity sensors and agreed prior to installation. Test points will be closed with soft sealing plugs.

Flexible connections will not be used to connect misaligned system components on ductwork sections and will be tightly formed to prevent air leakage. Flexible connections will be limited to 50mm – 250mm in length and remain flexible without strain or distortion.

7.2.2 Plastic Ductwork

Plastic ventilation systems will be installed using PVC ductwork in accordance with HVCA DW 154 2000 - 'Specification for Plastics Ductwork'.

7.2.3 Flexible Ductwork

Flexible duct connections will only be used for connections to main equipment.

Flexible ducts will not exceed 300mm and will be neatly fixed and adequately supported so as to prevent sagging and transfer of weight to adjacent ductwork. The ductwork will be of sufficient rigidity to prevent deformation and/or leakage.

The material used for flexible ductwork will be suitable for the temperatures and air pressures applicable to the system and must comply with the appropriate fire and other statutory regulations for fire resistance and spread of flame.

7.2.4 Fired Rated Ductworks

Fire and smoke rated ductwork together with all associated fittings, accessories, supports, bearers, fixings, sealants, compartment penetration seals and finishes, including proprietary finishes, will be constructed, installed, tested and commissioned to an approved standard and strictly in accordance with the manufacturers' recommendations.

All fire-resisting ductwork will have a fire test certificate. Appropriate test certificates to BS 476-24 covering construction and installation of the selected system will be provided alongside installation drawings for approval by the local Statutory authority and design team.

In the context of this clause 'approved standard' will mean a system of construction and installation which has been independently tested and certified to provide fire protection fully in accordance with the requirements of duct type 'A' or 'B' of BS476-24.

The fire rated installation will provide the required standards of stability, integrity and insulation and will be in accordance with the requirements of BS 9999.

The required standards of stability, integrity and insulation will also apply to any additional components e.g. attenuators incorporated into the 'rated' section of ductwork. Insulation used for fire rated ductwork will be included in the manufacturers test or assessment documents and alternatives will not be acceptable.

Fire resistance of the ductwork will not be less than the fire resistance of the fire compartment that it passes through. Fire resistance ratings will be at least equivalent to the ratings stated in the Plant and Equipment Schedules or as defined on the Drawings. Smoke rated ductworks will be suitable for the smoke temperature/s stated in the Plant and Equipment Schedules or as defined on the Drawings and maintain a minimum cross-sectional area of 90% to BS EN 1366-8.

All testing will have been carried out on the composite system to be offered not as individual components of the construction in isolation.

Finishes applied to fire rated ductwork and associated cladding systems will be suitable for the application, be classified 'Class O' as defined in the Building Regulations and be weather proofed where located externally or otherwise exposed to the atmosphere.

7.2.5 Ductworks Supports

All ductwork systems will be securely held and aligned accordance with DW 144. Support spacing and loading will take into account system components that do not have individual supports e.g. acoustic insulation, cladding, balancing dampers etc.

The supports material, size and strength will be suitable for the ductwork systems, system components, insulation and external conditions. All supports will be external to the insulation and fixings used will not be varied. Wire suspension systems will not be used unless specified.

Hangers or supports exposed to view or humid air will be protected by suitable hot dip galvanising or painting.

Suitable clearances will be provided to enable installation of insulation between ducts and hangers.

7.2.6 Grilles & Diffusers

Final finishes of grilles and diffusers will be powder coated to an RAL colour as agreed with the architect.

All supply diffusers to be complete with plenum boxes with spigot sizes selected to meet the air volume and room noise criteria. Maximum spigot velocity: 2.5m/s.

Throw is based on a terminal velocity of 0.5m/s.

Maximum mean air velocity in occupied zone: Cooling 0.19m/s; Heating 0.16m/s. to comply with category B thermal environment in accordance with BS EN ISO 7730: 2005

All grilles and diffusers shall be supported independently of the ceiling grid. Refer to architect's proposed ceiling details for fixing arrangement.

All grilles and diffusers will be fitted with opposed blade dampers, this shall be fitted either to the grille or fitted to the plenum box spigot – unless otherwise stated.

Plenum boxes will be externally insulated for ductwork carrying conditioned air.

7.2.7 Fans

All fans will be selected on a pressure/volume operating point to provide stable and efficient operation and lowest possible noise rating for their duty and type.

All fans will be 'Type' tested in accordance with BS 848.

The contractor will adjust the above fan static pressures to suit the pressure drops of the actual components selected for the system.

The quoted fan duties include the following commissioning allowances;

- On Flow rates: 10% (L.P. Systems) and 5% (M.P. and H.P. Systems)
- On Head: 20% (L.P. Systems) and 15% (M.P. and H.P. Systems)

These allowances are on top of the calculated design duty to allow for system regulation and additional fittings, unforeseen at the design stage and are not intended as "future spare capacity".

Suitable provisions will be made for inspection, continual maintenance, removal and replacement of internal components including impellers and motors. Suitable protection will be provided to protect casings, impellers and shafts from corrosion. Bearings will be protected from dirt and moisture.

Fans will be mounted on vibration mounts to meet the noise and vibration criteria. Fan casings will be rigidly constructed and braced to prevent drumming and vibrations. Casings will be airtight and manufactured from materials resistant to corrosion in the operating environment.

Externally mounted fans/cowls/bases will be weatherproof and suitable for fixing to the building.

Fan will be statically and dynamically balanced assemblies and suitable for continuous operation. Flexible connections made of fire- resistant material of suitable temperature rating and securely clamped in position will be used to create an airtight connection between the fans and adjacent ductwork.

Fan dampers will close when fans are de-energised. Non-return dampers will be provided in the discharge side for run/standby fan arrangements. Backdraught dampers will come complete with edge seals.

Fans used for smoke ventilation will be of steel construction with fire rated flexible connections to BS EN 12101. Materials used for smoke extract fans and ventilators will not add to the fire risk of the building and will be in accordance with BS 476.

Kitchen exhaust fans will have a minimum motor protection of IP55 and a removable airtight impeller. Tropicalised motors will be provided for fans connected to high humidity environments (e.g. dishwashers).

7.2.8 Air Handling Units

The unit shall be certified or tested at works in accordance with BS EN 1886: 2007 - Ventilation for buildings. Air handling units. Mechanical performance.

The AHU shall be tested on a 'Filter Dirty' condition. Both panel and bag filters will be replaced with new ones following commissioning and before Building regulations Part L Compliance checks.

Unit mechanical performance and air leakage will be in accordance with BS EN 1886.

7.2.9 Balancing & Control Dampers

All dampers will be constructed to DW 144 and will be installed in permanently accessible positions.

Self-closing non-return dampers will be constructed to ensure quiet positive closure.

Balancing dampers will be provided on all duct branches off a main duct to allow satisfactory commissioning of the system.

Dampers will be provided where indicated on the Drawings and as necessary to adjust air flow to achieve the required air distribution throughout the ductwork systems and at the terminals.

Elsewhere single or multi blade dampers will be used with appropriate damper casings. Damper casings will incorporate spigots or flanges to match the connecting ductwork and be constructed to match the pressure classification 'A', 'B' or 'C' of the connecting ductwork. Multi blade dampers will be of the opposed blade type.

Damper blades will be constructed from stainless steel, aluminium or galvanised mild steel to suit the particular construction requirements of the system in which they are installed and be of aerofoil section. For kitchen extract systems, damper blades will be fabricated from stainless steel. Edge and tip seals will be provided, where necessary to avoid noise generation, in systems serving spaces with low ambient noise levels.

On rectangular ductwork with an aspect ratio in excess of 1:3 damper spindles will cross the short dimension.

No single damper blade will exceed 1500mm in length and height. For duct dimensions greater than 1500mm multiple dampers and casings will be used.

Automatic damper actuators will have sufficient torque to open or close the dampers. Unless fitted to the terminal units, position indicators and manual override facilities will also be provided.

7.2.10 Fire & Smoke Dampers

Fire dampers will be installed in all ductwork systems where they penetrate fire compartment walls or fire rated barriers in accordance with BS 9999, unless otherwise stated in the fire strategy. Fire dampers will be rated at least equivalent to the fire barrier in which they are located and in no instance, less than 60 minutes. The rating of fire dampers and framing will be certified by the Joint Fire Research Organisation (UK) or other approved testing Authorities.

Motorised fire and smoke dampers will be installed in all ductwork entering or leaving a protected escape route. The motorised fire and smoke dampers will be interfaced with the fire alarm system and will close automatically on detection of smoke.

Fire dampers will be in accordance with DW 144 with stainless steel blades and casings, tension springs to ensure positive closure and an external mechanical indicator to show damper status. Folding curtain dampers are preferred with the blades out of the air-stream but single blade dampers may be used on ducts less than 200mm on the longest side. In the open position the damper blades will be held outside the air-stream by a replaceable fusible link rated at 72°C. 1 No spare fusible links for each damper will be supplied to the Employer at Handover. Damper assemblies will be made of corrosion resistant material.

The fire dampers will be constructed generally to the same standards of air tightness as the rest of the system. Both the blade/shutter and the fusible link will be accessible through airtight inspection doors located upstream and downstream as necessary to service the damper and fusible link.

Motorised fire and smoke dampers will be installed with the motor and control elements in accessible locations in accordance with the manufacturer's requirements. The control and power cables will be suitable fire rated and interfaced with the building life safety system.

All fire dampers will be tested for satisfactory operation and access and a test record log provided complete with a 'CE' mark to demonstrate compliance with to BS EN 1366-2 and BS EN 13501-3.

The fire dampers will be supplied and installed complete with any fixing framework, tested and commissioned in accordance with manufacturer's recommendations. Dampers will be independently supported and set parallel to wall lines.

In areas PVC ducts are installed where they penetrate fire compartment wall or fire rated barriers a suitable manufacturer approved intumescent fire warp should be fitted. This will comply with BS 9999 and will be confirmed with the fire strategy.

Builders' works openings will be restricted to minimise fire-stopping material around the dampers and maintain the fire integrity of the penetrated element.

Dampers that cannot be accommodated in the thickness of the fire barrier or those located in flexible cavity barriers will be installed in accordance with the manufacturers' recommendations and will conform to their certified details. Suitable frames and brackets will be used to ensure compliance with relevant fire test methods.

Fusible link dampers will be designed to operate at 72°C ±4°C.

7.2.11 Access Openings & Panels

Access openings will be provided into the ductwork systems to facilitate:

- Inspection, adjustment, re-setting and maintenance of all in duct equipment and components including control sensors and devices.
- Thorough cleaning of the airways and installed plant, equipment, components and fittings.

  Access openings, in all ductwork systems shall be in accordance with the following:

- BESA TR/19; 2013 - Internal Cleanliness of Ventilation Systems

Access openings, in all ductwork systems will be in accordance with DW 144 and TR/19 unless otherwise specified by the specialist-cleaning contractor.

The location of access panels will be to facilitate servicing and maintenance of equipment and inspection and cleaning of ductwork. Inspection panels will also be provided adjacent to equipment, turning vanes and base of risers. Access panels will be positioned within 1m of the item to be cleaned.

Access panels, test holes and other components penetrating the duct walls will not be installed on the underside of ducts or within 50mm up the vertical sides

Access panels will be grease tight using a heatproof, airtight gasket and contain minimum projections into the duct.

Access openings in sheet metal ductwork systems will be adequately braced.

All fire and smoke dampers will be provided with access opening to allow manual resetting of the dampers. The base of kitchen extract risers will be provided with an access opening for cleaning and inspection of the trapped drain outlet.

Access panels will be constructed from the same material and same thickness as the ductwork and will employ quick release fasteners (self-tapping screws fixings will not be permitted). Retention devices (e.g. chains) will be provided for all access covers.

Access panels on all insulated ducts will be of the double skin type incorporating a vapour sealed insulation infill matching the thermal insulation specified for the ductwork system.

7.2.12 Attenuators

All attenuators will be designed, constructed and tested by a specialist manufacturer to comply with the design criteria and acoustic specialist requirements. Ductwork system silencers will be provided as indicated on the Drawings and manufactured from the same materials as the ductwork system. Cross talk attenuators will be installed in positions as indicated on drawings.

Attenuators will be constructed with side wall sections constructed from perforated galvanized sheet with mineral wool or glass fibre of a sufficient density to achieve the specified performance and in any case with a minimum density of 48 kg/m3. Only non-flammable adhesives will be used in the construction of attenuators. All insulating materials and coverings will be to Class 0 surface rating of the Building Regulations. Infill material will be inert, inorganic, vermin proof and non-hygroscopic.

The Sub Contractor will be responsible for determining silencer performance against the operating sound levels of the plant and equipment selected for incorporation into the Works to achieve the specified noise ratings. Sizes indicated on the schedules are preliminary for space planning purposes.

Silencers will be purpose made at works and delivered as one-piece units with appropriate flanged connections for attachment to the adjacent ductwork. Silencers will comprise outer casing, acoustic material infill and perforated inner casing. Unless otherwise specified, outer casings will be galvanized sheet metal of thickness and construction of not less than recommended by DW 144 for the size and construction class of the ductwork systems into which it is to be incorporated. Acoustic material will be mineral wool or glass fibre with a suitable scrim type finish. The acoustic material will be inert, rot and vermin-proof, non-hygroscopic and not supporting bacteriological growth. Only non- flammable adhesives will be used in the construction of attenuators. All insulating materials and coverings will be to Class 0 surface rating of the Building Regulations.

Perforated inner facings will be constructed from perforated galvanized sheet metal having at least 30% free area. The perforated metal will protect and retain the acoustic material in position.

Attenuators on the discharge side of flue connections in a flue dilution system will be fabricated from 304 Stainless steel. Where any appliance operates in condensing mode the complete system will be fabricated from stainless steel.

Attenuators for grease laden or saturated atmospheres will incorporate faced or bagged infill of Melinex or equivalent. Facings will be constructed from galvanised expanded metal. Casings and splitter frames will be suitable for the contaminant within the air stream.

Splitters will be constructed with low loss fairings and will be mounted vertically wherever possible. Horizontally mounted splitters will have additional stiffening.

Ends of silencers will be blocked prior to delivery to site to prevent damage and dirt ingress. Silencers will be protected where they are installed in positions exposed to external weather conditions.

Air velocities through clear airways of silencers will not exceed 10 m/s. Silencers will be clearly marked to show the direction of airflow. Insertion loss data in accordance with BS 4718 will be provided for all silencers.

7.2.13 Air Filtration

General ventilation plant/ equipment will be provided with suitable particulate filters suited to the application. Filters could be in the form of individual units or as a bank of filters.

Where panel and bag filters are used, minimum class provided will be Class G4 and F6 respectively. Filters will be provided with appropriate perimeter gaskets to prevent by-pass of air or air leakage.

Airflow onto the filters will be uniform and face velocities (maximum 2.5m/s) selected to optimise performance. Pressure drop across the filters will not exceed 150Pa.

All filters will be fully accessible for inspection, regular maintenance and replacement. Each filter assembly will be provided with an external pressure gauge.

All filters will be made of materials that are not combustible and/or are fire retardant to meet the fire and smoke requirements of BS 9999.

High Efficiency Particulate Air (HEPA) filters will be to BS EN 1822 and consist of pleated glass paper or equivalent medium in a rigidly constructed case.

Where Carbon filters are used, they will be provided with upstream Primary (Class G3) and Secondary (Class F7) filters and downstream (Class F6) filters. Face velocity across carbon filters will be limited to 2m/s. Pressure drop across the filters will not exceed 100Pa.

Carbon filters will be capable of normal operation up to 50oC and 80% RH.

7.2.14 Air Coils

Protection guards will be provided on all air coils fitted on external units.

Minor damages to coil fins will be fixed by combing and major damages will require coil replacement. Pipe connections will terminate minimum 100mm away from the units to allow removal and re-instatement of damaged coils without damage or distortion of adjacent pipework.

Coils will be protected against corrosion internally and externally. Anti-corrosion coatings will be applied to all coils where the risk of corrosion is high.

All coil headers will come complete with air vents and drain cocks to enable full flushing, venting and draining of coils.

All coils will be contained within galvanised steel casings which will be thermally insulated if duct mounted. The coils will extend the full width and height.

Multi-row coils will be staggered in the direction of air flow to maximise heat exchange. Coils will be made of copper tube complete with aluminium fins.

Face velocity across cooling coils will be limited to 2.5m/s where condensation is likely. Where velocities exceed 2.2m/s, eliminator plates designed to prevent water droplet carry over will be provided.

Electric heating coils will have a manual reset thermal cut out and will not exceed 400oC.

Self-tapping screws will not be used.

7.2.15 Heat Recovery

Heat transfer materials will not support growth of fungi, bacteria or mould growth.

Provisions will be made for cleaning heat exchangers and where necessary, trapped condensate drainage provided.

Thermal wheels will comprise a galvanised steel casing containing a matrix of corrosion resistant, alloy material coated with a substance with hygroscopic properties.

All run around coils will be provided with pumps, distribution pipework, ancillaries and expansion facilities to form a fully operational system.

7.2.16 Humidifiers

All humidifiers will be enclosed in air and watertight casings complete with trapped drains extending to the nearest drain.

Humidifiers will be made of materials suitable for cleaning, sterilising and disinfecting with concentrated chemicals.

Air speed across the humidifier will be limited to 2.5m/s.

Steam humidifiers will be designed to only inject dry steam into the airstream. Packaged steam humidifiers will comprise cold-water tank, evaporation chamber, heating elements and integral automatic controls.

7.3 THERMAL INSULATION

7.3.1 General

Thermal insulation materials and thicknesses, and application methods will be in accordance with the current versions of all relevant British Standards and Codes of Practice, in particular;

- BS 5422:2009 - Method for specifying thermal insulating materials for pipes, tanks, vessels, ductwork and equipment operating within the temperature range -40°C to +700°C;
- BS 5970:2012 - Thermal insulation of pipework, ductwork, associated equipment and other industrial installations in the temperature range of -100°C to +870°C;
- BS EN ISO 12241:2008 - Thermal insulation for building equipment and industrial Installations. Calculation rules;
- BS EN 13166:2012+A2: 2016 - Thermal insulation products for buildings. Factory made phenolic foam (PF) products;
- BS EN 13467-13472:2001- Thermal insulating products for building equipment and industrial installations;
- BS 3958 - Thermal Insulating Materials;
- HM Government – Domestic Building Services Compliance Guide, 2013 Edition.
- HM Government – Non-Domestic Building Services Compliance Guide, 2013 Edition.

Thermal insulation will be installed in accordance with the application requirements (i.e. prevention of heat loss, surface temperature control, surface emissivity, prevention of condensation and frost protection) of this specification or TIMSA guidance. Where the insulation thickness is not available, the next nearest larger size will be used.

All thermal insulation will be sourced from a supplier who has ISO 14001 certification to achieve a minimum 'A+' Green Guide rating.

Application	Energy Conservation	Personnel Protection	Frost Protection	Condensation Control
Air Systems				✓
Fresh Air Intake Ductwork, External Louvres and Plenums	✓			✓
Exhaust Air Ductwork, External Louvres and Plenums	✓			✓
Supply Air Ductwork and Plenums	✓			
Extract Air Ductwork and Plenums	✓			
Pipework Systems				
Heating Pipework, Thermal Stores & Heat Exchangers	✓	✓	✓	
Domestic Cold Water Pipework & Storage Tanks			✓	✓
Domestic Hot Water Supply Pipework Systems	✓	✓	✓	
Water Heaters & Storage Cylinders, Heat Exchangers (Hot)	✓	✓	✓	
Internal Rainwater Pipework				✓

7.3.2 Materials

Insulation materials will be applied to achieve full direct contact with the pipework or ductwork to maintain a constant thickness throughout. Joints will be firmly joined and individual sections securely fixed. Where necessary, appropriate mechanical fixings will be used to fix large sections of insulation to ensure long-term full surface contact is maintained. Appropriate cover will be maintained by increasing the insulation thickness over flanged joints, fasteners, connections and other system components.

Insulating materials that contain and/or use CFCs or HCFCs in their manufacture will not be used. Insulating materials will be manufactured using materials with zero ozone depletion potential.

Polystyrene, closed cell nitrite rubber or other material incorporating substances, which in the event of fire generate appreciable quantities of smoke, noxious or toxic fumes will not be used.

Insulation materials will have the relevant certification determined in accordance with EU requirements indicating that fibres are not classified under the CHIP 98 Regulations and EU Directive 97/69/EC.

All thermal insulation systems including insulating materials, surface facings, vapour barriers and other finishes will be classified non-combustible when tested in accordance with BS 476-4.

Surface finishes will be classified 'Class O' when tested to BS 476-6 and BS 476-7.

Supply insulation materials classified as having less than 5% smoke obscuration rating when tested in accordance with BS EN ISO 5659-2.

All insulating materials will be suitable for the maximum service temperature to which they are to be applied.

In proposing insulants, any reduction in thermal performance due to ageing will be taken into account. Insulating materials will maintain their thermal performance for a minimum of the plant design life.

Restrictions on Use

Ensure materials and metals that cause galvanic corrosion are not installed in contact.

Galvanised or zinc coated steel jacketing and accessories will not be used on austenitic stainless steel and austenitic nickel steel/alloy equipment and piping.

Insulated stainless steel surfaces will be protected from the risk of stress corrosion in accordance with the recommendations of BS 5970.

Phenolic insulation will not be used in direct contact with copper pipework where there is a risk of pipework corrosion or on plastic pipework where there is a possibility of a reaction between the pipework and insulation. Where phenolic pipework insulation is used, an adhesively applied inner lining of moisture resistant glass tissue or alternative non-odorous passivating dust suppressant finish will be applied to the phenolic insulation material to prevent the risk of pipework corrosion and reaction. Written confirmation of compliance with this clause will be provided to the design team.

All mineral wool type materials will be fully wrapped with a foil cover and sealed with tape to stop fibre migration. Mineral fibre insulation will not be used in kitchens or food preparation areas.

7.3.3 Adhesives

Comply with recommendations of BS 5970 for insulation bonding adhesives, lagging adhesives and facing and film attachment adhesives.

All surfaces will be cleaned, primed and dry prior to application of any adhesive.

7.3.4 Application of Insulation

Insulation will not be applied until pipes, plant, equipment and ductwork have been satisfactorily tested as specified elsewhere. Attention is drawn to the provisions for painting pipes, plant and equipment prior to the application of insulation as specified elsewhere.

All connections on equipment, vessels and the like will project clear of the finished surface of the insulation to permit the pipework connections to be subsequently disconnected and re-made without disturbing the installation.

Except in the case of cold surfaces insulation applied to plant, equipment, vessels and the like will be neatly cut around all except in the case of cold surfaces manufacturers name and test pressure plates to leave these visible. Where there is a risk of condensation forming the name and test pressure plates will be duplicated and fixed to the finished insulation.

All insulants, facings, coatings and protection will be applied strictly in accordance with the manufacturers instructions.

All joints, corners, edges and overlaps to be neatly finished. Where possible arrange overlaps to fall on the blind side. Ensure overlaps are neat, even and parallel to longitudinal and circumferential joints.

All insulation will be applied to give a smooth, homogeneous and lineable surface. All rigid and semi-rigid sections will be concentric and matched for thickness.

Steps and undulations in the finished surface will not be accepted.

All insulation will fit tight to the surfaces to be covered.

Insulation will be neatly mitred or otherwise finished to terminate at pipeline guide points and supports incorporating rollers and chairs to permit the free movement of the pipework installation, under normal operating conditions, without damage to the installation.

Where insulation is terminated, the ends will be sealed and contained with purpose made end caps.

Where included on systems to be insulated, expansion bellows and joints will be insulated with flexible insulation to match the adjacent pipework insulation and be sized and fixed to permit the free movement of the joint under normal operating conditions without damage to the insulation.

Insulation on pipework and equipment connection flanged joints will be mitred and finished to permit removal of the insulation and flange bolts and fittings or components without disturbing the pipework insulation. On vapour-sealed applications the flanges will be insulated separately to permit removal of the insulation locally to provide access to the flange bolts.

Insulation on vertical pipes and ducts will be securely fixed, reinforced and supported to adequately retain the insulation in position and to avoid compacting.

Individual pipes and items of plant and equipment will be insulated separately. Adjacent units will not be enclosed together. A clearance will be provided between insulated pipes.

All insulation materials and finishes will be installed in accordance with the Manufacturer's Standard Procedures and Recommendations and in accordance with good and proven practice.

All materials will be stored in a suitable manner so as to protect them from damage or deterioration prior to fixing. The use of insulation damaged in any manner whatsoever will not be permitted.

Insulation systems will in all cases avoid direct contact between the surface to be insulated and the insulation finish to obviate hot and cold bridges.

7.3.5 Vapour Barriers

A vapour barrier will be applied to the external surface of the insulation system on 'cold' services to prevent the formation of condensation. Services to be provided with a vapour barrier are as detailed in Schedule 2 in this section of the Specification.

Vapour seals will be inserted at each 10m run of piping and ducting. The seal will be made to the pipe or duct and between adjacent sections of insulation to limit the extent of damage in event of condensation forming on any insulated surface.

The vapour barrier will be continuous including where the systems pass through wall and floor slabs and at supports.

The systems (pipework and ductwork as appropriate) will be insulated from hangers and supports generally as indicated in HVCA Ductwork Specification DW 144. At the point of support, specially prepared blocks of GRP or hard rubber compound will be inserted to which the adjacent insulation will be bonded to maintain the integrity of the vapour barrier.

Where blocks of GRP or hard rubber are provided in sections, the vapour sealant will be applied to the full contact surfaces of the adjacent sections.

Repair immediately any damage to vapour barriers and where such barriers have been applied off site and repair to manufacturer's instructions. Where aluminium sheeting is used for protection, submit proposals for securing sheeting without impairing the integrity of the vapour seal for approval.

In conjunction with the thermal insulation systems specified, the following building services installations will be provided with a continuous vapour barrier.

- Cold Water Supplies
- Chilled water systems throughout including all fittings, pump bodies, valves, flanges, etc.
- Un-heated fresh air ductwork, and exhaust air ductwork where passed through a heat exchanger
- Primary supply air ductwork carrying mechanically cooled air
- Thermally insulated secondary supply air ductwork conveying mechanically cooled air.
- Ductwork carrying extract air from air-conditioned spaces including re-circulation air ductwork.
- Rainwater pipework exposed or concealed in air-conditioned areas including ceiling/floor voids and behind other enclosures/casings.
- Condenser water systems throughout including all fittings, pump bodies, valves, flanges, etc.
- Condensate drainage
- Refrigerant systems throughout including all fittings, valves, etc.

7.3.6 Finishes to Insulation

All surface finishes will be classified 'Class O'.

Finishes will be in accordance with this clause unless otherwise specified in the particular clauses covering specific applications and/or items of plant and equipment.

Particular care will be taken in the application of finishes to ensure that the insulating materials and in particular vapour barriers are not damaged or penetrated. Any damage so caused will be made good to the Consulting Engineer's satisfaction.

All finishes on external insulation exposed to the sun will have a light colour with a minimum albedo of 50%.

7.3.7 Types of Finishes

Type 1	Self-Finish will mean the finish included on the insulating materials and systems specified. (In the absence of any particular specified finish, the insulation will be left self-finish).
Type 2	Polyisobutylene (PIB) Protection Wrap pipework and fittings, ductwork and tanks and vessels with PIB sheeting lapped at every joint by a minimum of 50mm for side laps and 80mm for end laps. Solvent weld joints, support with banding, in accordance with manufacturer's recommendations. At ends of section fit proprietary end caps. Arrange joints to shed water and seal to prevent the ingress of water. For horizontal surfaces the sheeting will be installed to prevent puddling. Where recommended by the manufacturer the sheeting will be bonded to the insulation.
Type 3	For pipework up to 300mm diameter and ductwork up to 500mm wide the sheet thickness will be 0.8mm thick. For pipework up to 1000mm diameter and ductwork up to 1000 m wide the sheet thickness will be 1.0mm thick and for sizes above these 1.2mm thick.
Type 4	Galvanised Sheet Metal on Pipework secure insulation with metal bands at each end of section and at maximum centres of 450 mm. Form sheet metal 1.6 mm thick to fit tightly over the outer circumference of insulation with a longitudinal overlap of at least 50 mm. Secure the outer part of overlap with self tapping screws or rivets at centres of not more than 150 mm. Include provision to accommodate expansion and contraction.

Type 5	For pipes with vapour barrier use metal bands of same material.
Type 6	All joints will be overlapped to shed water and in areas exposed to weather or spillage all joints will be sealed.
Type 7	All bends and fittings will have a matching sheet steel finish, tailored to fit and sealed as appropriate.
Type 8	Galvanised sheet metal on Ductwork, Tanks and Vessels: Form sheet metal to fit tightly over the insulation with longitudinal overlap of at least 40 mm. Secure the outer part of overlap with self tapping screws or rivets at centres of not more than 150 mm.
Type 9	On vapour sealed installations use metal bands of same material
Type 10	Ensure circumferential overlaps are at least 50 mm, secured with self tapping screws or rivets. Make provision to accommodate expansion and contraction at intervals. Ensure all joints are lapped to shed liquids and seal all joints exposed to weather or spillage. Cover all bends and fittings with matching sheet metal, tailored to fit and sealed as appropriate.

7.3.8 Extent of Insulation and Application to Valves, Flanges & Strainers

Type A	Valves, strainers and flanges are to be insulated using oversize sections to the same standard as the adjacent pipework insulation. On vapour sealed systems all joints will be taped in order to maintain the vapour barrier. On hot installations insulation will be supplied in sizes 65mm and above. OR Valve bodies, strainers and flanges are to be insulated with preformed, rigid covers moulded from polyiscyanurate foam retained in place with Velcro straps or similar. Valve covers will be sized so that valve hand wheels and lock shield valve stems project clear. On hot installations insulation will be applied to valves of size 65 mm and above. On vapour sealed services the joints between sections, the cover and adjacent pipework insulation and around valve stems will be sealed with non-setting mastic. On pipework systems exposed to atmosphere pre-formed covers will be painted and a non-setting mastic applied to the valve stem opening and the interface with the weather-proof pipe covering to prevent the ingress of water.
Type B	Valve bodies, expansion bellows, flanges, strainers will be insulated with proprietary muff covers made up with flexible insulation to the same standard as the adjacent pipework insulation to the same standard as the adjacent pipework insulation enclosed in heavy quality glass cloth to match the pipework specification. Muff covers will be secured with non ferrous detachable bands and straps
Type C	Valves, strainers and flanges will be provided with a split casing fabricated from 0.9mm aluminium sheet fitted with spring clips fasteners, filled with insulating of the same thermal performance as insulation on the adjoining pipe. Valve boxes will be designed to facilitate easy access and replacement for maintenance whilst ensuring the integrity of the vapour barrier. On 'hot' installation valve boxes will be sized such that valve wheels and lock shield valves project outside the boxes and remain readily accessible. Where a vapour seal is required valve bodies etc. will be enclosed with an insulating material with all joints taped with 100 mm bright class O aluminium foil tape to maintain the vapour barrier. Where located externally joints between the box and the adjacent pipe insulating material and also around the valve stem will be sealed with a non-setting mastic

7.3.9 Services Installations to be Insulated

For the following table, "□/7/C" reference in boxes would read

✓ – Insulated system

7 – Type 7 insulation finish (Aluminium Sheeting Protection)

C – Valve enclosure type (split case aluminium with spring clip fasteners)

Services to be Insulated	External	Risers	Internal Plantrooms	Exposed (Heated Space)	Exposed (Un-Heated Space)	Concealed (Heated Space)
Tanks & Cisterns	-	-	-	-	-	-
Cold Water (Others)	-	-	-	-	-	-

Sprinkler Storage	-	-	-	-	-	-
Pipework Systems						
LTHW Pipework	✓/3/c	✓/1/b	✓/7/b	✓/7/c	✓/7/c	✓/1/-
Cold Water Pipework	✓/3/c	✓/1/c	✓/7/c	✓/7/c	✓/7/c	✓/1/c
Domestic HWS Pipework	✓/3/-	✓/1/-	✓/7/-	✓/7/-	✓/7/-	✓/1/-
Foul Drainage Stacks (1)	-	-	-	-	-	-
Rainwater Pipes	-	✓/1/-	-	✓/1/-	-	✓/1/-
Wet Sprinklers and Standpipes	-	-	-	-	-	-
Condensate Drainage	✓/3/-	✓/1/-	✓/7/-	✓/7/-	✓/7/-	✓/1/-
Ductwork Systems						
Untreated Fresh Air or Cold Exhaust Air	-	✓/1/-	✓/7/-	✓/7/-	✓/7/-	✓/1/-
Supply Air Heated to Room Temperature	✓/4/-	✓/1/-	✓/7/-	-	✓/7/-	-
Air Extracted from Conditioned Spaces	✓/4/-	✓/1/-	✓/7/-	-	✓/7/-	-
Kitchen Extract	✓/9/-	✓/9/-	✓/9/-	✓/9/-	✓/9/-	✓/9/-
Smoke Extract Air (4)	✓/9/-	✓/9/-	✓/9/-	✓/9/-	✓/9/-	✓/9/-

(1) Foul water drainage stacks routed internally will be insulated to comply with the acoustic requirements of this specification

(2) Primary will mean ductwork between air handling plants and system terminal units e.g. fan coil units, etc.

(3) Secondary will mean ductwork between terminal units and supply air grilles/diffusers

(4) Fire rated ductwork for systems other than Smoke Extract are described elsewhere in the Specification and/or noted on the Detailed Design Drawings.

7.4 PAINTING

Cleaning, preparing and priming all ferrous pipes, supports, brackets and items of equipment will be painted in accordance with this specification. Priming will comprise two coats of non-toxic zinc phosphate and will be applied as the works proceed.

The preparation of surfaces prior to the application of priming coats will be strictly in accordance with the paint manufacturer's recommendations. All dirt, grease, loose rust and other contaminants will be cleaned off.

Where more than one priming coat is specified each coat will be of a different colour.

Any priming coats applied off site which are damaged in transit or off loading, etc will be made good.

The application of undercoats and finishing coats will be by others except where stated below for particular applications or where items are supplied with works final finishes as stated in the relevant clauses of this Specification.

Where necessary, steelwork will be hot-dip galvanised to BS EN ISO1461

All works will be appropriately protected in respect of painting and finishes applied on or off site.

Service	Preparation & Finish
Cut Edges on Galvanized Ductwork	Internal applications: 1 coat etching primer, 1 coat non-toxic zinc phosphate External applications: 1 coat etching primer, 2 coats non-toxic zinc phosphate
Galvanized Ductwork Behind Grilles	All visible ductwork, plenums, etc. behind floor, wall and ceiling grilles to have 1 coat etching primer, 2 coats matt black
Buried Ferrous Pipework	2 coats non-toxic zinc phosphate, 2 coats black bituminous paint to BS 3416 Type 1
Ferrous Pipework, Supports and Brackets Exposed to Atmosphere	Insulated:2 coats non-toxic zinc phosphate Un-insulated: primer as above plus 2 coats black bituminous paint to BS 3416 Type 1
Gas Pipework	2 coats non-toxic zinc phosphate, 2 coats paint yellow gloss.
External Exhaust Ductwork	1 coat etching primer, 2 coats paint to RAL 7024 Matt Finish.

7.5 FIRE, SMOKE & ACOUSTIC SEALING

All building services openings in fire compartments will be fire stopped using proprietary method that maintains the fire and smoke rating of the apartment, performance of the thermal insulation and vapour barrier of the service and acoustic performance of the compartment.

Where piped services pass through fire compartments, they will be provided with short sections of sleeve to allow the structure or barrier to be sealed to the outer sleeve and the penetration appropriately sealed. Pipework fire stopping will comply with appropriate test methods in BS EN 1366-3.

Intumescent pillows will be provided to fill large penetrations and appropriate allowances will be made for the movement of building services.

Small penetrations and gaps will be filled using a proprietary flexible mastic, foam or expanding rubber, rated to suit the integrity of the compartment and tested in accordance with BS EN 1366.

The method will be used for all penetrations including smoke barriers, acoustic barriers and non-fire rated walls and partitions.

Refer to Architects drawings for location of fire, smoke and acoustic barriers.

Certified test data will be provided for all fire stopping methods and materials. All materials used will comply with recommendations of BS 9999.

7.6 IDENTIFICATION & LABELLING

7.6.1 Ductwork Labelling

All ductwork systems will be colour coded and labelled to HVCA Specification DW 144 to identify the type of air contained and direction of flow.

All fire dampers and collars will be clearly identified using white/black/white engraved labels that are securely attached to the dampers/collars.

Colour coding of all ductwork labelling will be in accordance with the current version of BS 4800.

Secondary identification of ductwork will be as follows:

Duct Size	Identification Method
Longest side or diameter < 225mm	Paint colour bands and superimpose legends
Longest side or diameter > 225mm	Apply transfers to identification triangles or triangular plates and superimpose legends

Triangular plates will be equilateral with a minimum side of 150mm. The apex indicating the direction of flow. Legends will be made up of approved transfers applied to colour bands or triangles. Legends will identify the floor and space served, the associated equipment reference and the direction of flow. Text will not be less than 25mm high.

7.6.2 Pipework Labelling

All pipework systems will be identified to indicate service, content and direction of flow in accordance with the current version of BS 1710.

All labelling and identification will be applied following completion of protective and decorative works.

Signage to all fire protection items will be in accordance with the current version of BS ISO 3864.

Primary identification will be by colour bands, 300mm wide to each pipe at least:

- Once in every room or enclosed area
- At intervals not exceeding 3 metres
- At every junction, branch or change in direction
- At every valve or damper
- At every inspection and access position in service shafts, floors, ceilings, etc.
- On both sides of penetrations through building elements
- At each item of equipment

Secondary identification of pipework will be by colour bands, 50mm wide with a superimposed legend clearly identifying circuit (either 'FLOW' or 'RETURN), direction of flow and nominal pipe bore. Legends will be applied to colour bands by transfers of an approved type. Text will not be less than 25mm high.

7.6.3 Plant & Equipment Labelling

All packaged plant and equipment will bear mechanically attached metal nameplates, which state the name of the manufacturer, model number, serial number, date of manufacture, etc.

Additionally, all plant and equipment will be fitted with identification labels in white/black/white traffolyte with black engraved lettering not less than 15mm high. The label descriptions will accurately identify the item to provide a cross reference with the Record Drawings and O&M Manuals (i.e. building reference, equipment type, application, floor level, zone and item number). Labels will be screw fixed with a fixing pattern that allows easy replacement.

Danger labels will be white/red/white traffolyte with lettering in 10mm characters. "Danger 415V" labels will be screw fixed to all equipment containing exposed live parts.

All control devices including sensors, switches and actuators will be labelled to indicate system and function.

7.6.4 Valve Labelling

Except where exposed in occupied areas all valves, cocks, air vents, etc. will be identified by a traffolyte disk engraved with its numerical reference. The reference will accurately identify the item to provide a cross reference with the Record Drawings and O&M Manuals.

The discs will be a minimum of 50mm diameter and 1.5mm thick. The traffolyte will be coloured to suit the primary and secondary identification colours of the associated system. Lettering will be black and not less than 20mm high.

The discs will be secured under the valve wheel nut with a brass link chain. Where valves are covered with valve boxes or muff covers the discs will be fitted so that they are visible.

7.6.5 Hazard Labelling

Warning/ hazard labelling will be provided in accordance with the Health and Safety Executive (HSE) requirements including, but not limited to zones of restricted width or height, prominent and exposed services supports etc.

7.7 SUPPORTS & FIXINGS

All plant and equipment will be supported independently to avoid imposing additional loads on adjacent ductwork or pipework. Independent supports will allow plant removal without adverse impact on adjacent distribution systems.

All support structures and fixings will be compatible with the building construction. Specific fixing methods will not be varied, unless specifically agreed. Fixing to exposed structural steelwork or architectural cladding will only be permitted with the prior approval of the Architect and the Structural Engineer.

All fixings will be resilient and capable of withstanding movements and vibrations e.g. self-locking nuts.

Brackets and proprietary support systems will be neatly cut and finished (i.e. no filings). Suitable paint finish or hot dip galvanising will be applied to all supports. Where brackets are located in a prominent and exposed position, they will be fitted with protective end caps.

Impact of building and service loading deflections will be considered for the supports.

Suitable anti-vibration mounts and resilient supports will be considered where required to achieve the correct natural frequencies and minimise noise and vibration transmission.

Shot fired fixings will not be permitted.

Anchor point fixings will be made with expanding bolts.

Structural and non-structural elements will only be drilled for screw and expanding bolt fixings subject to approval by the Structural Engineer.

7.8 NOISE & VIBRATION

7.8.1 General

All acoustic measurements and testing will be undertaken by a qualified acoustic engineer using a calibrated (with valid certification) Class 1 sound level meter.

7.8.2 Building and Mechanical equipment

All electric motors will be tested at the works under standard conditions to the suitable vibration grade as defined in BS EN 60034-14. Motors with variable speed or multi-speed will achieve the vibration and balance grade for the highest operational speed. The resonant frequency of the vibration isolation system will be lower than any operating speed.

The following machinery will be located on ground bearing slab with a minimum thickness of 150mm and less than 10m span. Installation will not be permitted on suspended floors of steel or timber frame buildings.

- Single cylinder machines greater than 5kW shaft power
- Internal combustion engines greater than 40kW shaft power
- Machines containing compressors greater than 75kW shaft power

All inertia bases will be constructed from reinforced concrete and designed for stressing by the supported machine.

Vibration of building surfaces owing to building services will not be perceptible to occupants in occupied areas. Vibration levels will be in accordance with BS 6472.

Any vibrations of building surfaces at audible frequencies will not result in specified NR levels being exceeded. NR criteria will be defined in accordance with BS 8233. Where NR levels are not specified for standard rooms, CIBSE listed values will be applicable.

The specified noise criteria will be achieved when the building is fully occupied and building services operating at the maximum noise level.

All dynamic equipment will be installed in accordance with the manufacturers' recommendations.

Vibration isolators will be suitable for ambient and contact temperatures at which they operate.

7.8.3 Impellers

Rotating impeller and shaft assemblies of fans, pumps etc. will be balanced to the appropriate grades of ISO 1940-1. Assemblies with variable speed or multi-speed will achieve the vibration and balance grade for the highest operational speed.

Any vibrations resulting from fluid dynamic effects will not be greater than the equivalent permissible vibration caused by an impeller rotating at the same vibration frequency.

7.8.4 Anti-Vibration systems

Isolation systems used will prevent structure borne noise and vibration to maintain the specified NR levels,

The vibration isolation system will be selected to suit the equipment operational environment. The components will be weather-proof, non-rusting, pest and insect proof as necessary.

Levelling screws will be adjusted to design values to enable acceptable deflections of the supported equipment at operating conditions.

The category of isolation will be determined by the room NR requirements. The first 5 ductwork supports on either side of vibration source will be provided with vibration isolators.

Electrical connections to equipment mounted on vibration isolation will be via flexible conduits.

Spring isolators will be constructed from treated steel or steel alloys with a minimum coil diameter of 50mm and manufactured with suitable rubber, neoprene or glass fibre acoustic pads to prevent high frequency transmission. Auxiliary dampers will be provided to prevent excessive movement when machine speeds pass resonant frequencies.

All vibration isolators will be provided with a means of adjustment for deflections to accommodate uneven bases. Adjustment items will be located between the supported machinery and isolators.

'Pad' or 'Mat' type vibration mountings will be cellular, ribbed or studded and normally bonded to the supported surface. Cork mats or pads will not be used.

7.9 CONTROL SYSTEMS

7.9.1 Common Requirements

Automatic Controls will be provided for all equipment to enable correct operation. The controls will be compatible and interfaced if the building management system (if available).

7.9.2 Room Temperature Sensors

Room temperature sensors should be:

- Installed at a height of 1.2m in occupied spaces and at least 500mm from any adjacent walls
- Located in an area representative of the entire control zone in the area it controls
- Hard wired to a central location in the manifold or central boiler location
- Accessible through the internet for remote control

Room temperature sensors should NOT be:

- Exposed to direct solar radiation
- Located near heat sources and air currents generated by ventilation systems or open able windows, external or internal doors
- Located in recesses, alcoves or behind curtains
- Located on external walls, chimney walls or walls concealing hot-water pipes
- Located under lamps or above heat emitters

7.10 MAIN PLANT / EQUIPMENT

All plant and equipment will be correctly accommodated within the specified areas allowing sufficient space for access, full maintenance and withdrawal of any components.

7.10.1 Operating Conditions

All equipment and material will be suitable for the conditions under which they operate and will be installed, tested and commissioned in accordance with the manufacturers' recommendations.

7.10.2 Operating Conditions

National Measurement Office (NMO) approved utility meters will be provided on all incoming utilities. All meters and sub meters will be provided with interfaces to enable remote monitoring via a BMS.

7.10.3 Operating Conditions

Accredited noise data valid for the relevant operating conditions will be presented as octave band sound power levels to illustrate the noise intensity and compliance with the design noise criteria.

7.10.4 Packaged Plant

All packaged plant containing components described within this specification will comply with the relevant section of this specification e.g. fans within air handling units will comply with the 'Fans' section of this specification.

7.10.5 Plant Room Drawings

The following will be hung in each plant room and switch room in an appropriate location agreed with the Consulting Engineer.

- Schematic drawings of main systems/circuits contained within the plant room with plant references, etc.
- Valve schedules showing commissioned settings and normal operating positions
- First aid instructions for treatment of electric shock
- Other items to comply with Statutory Requirements
- Details of emergency operating procedures and emergency contact details from the O&M Manuals.

– Drawings will be contained in rigid frames and surfaces will be protected either by mounting behind glass or by lamination.

7.11 BUILDERSWORK

7.11.1 Services Penetrations

Structural Engineer will be advised of all services penetration in addition to any indicated on the Pricing Drawings. The structure will be marked a minimum of 5 working days before the holes are due to be formed to allow sufficient time for their inspection. No penetrations will be formed without the prior approval of the marked positions by the Structural Engineer.

Builders work drawings will clearly show proposals for direct fixings to structural and non-structural elements and made available for fixings to be built in.

All final penetrations will be identified on the Sub-Contractor's builders work drawings.

7.11.2 Access Platform

All necessary access platforms, stairways and ladders will be provided to enable safe access to plant and equipment.

Access platforms will be galvanised steel and complete with safety hand rail system. The entire system will be compliant with BS EN ISO 14122.

7.11.3 Cavity Barriers

Provision will be made for services passing through cavity barriers without compromising either the barrier or the services. Suitable penetration details must be used where the acoustic and fire performance of the barrier must be maintained.

7.12 ELECTRICAL REQUIREMENTS

7.12.1 Common Requirements

All electrical works associated with mechanical services will be designed, installed, tested and commissioned in accordance with the current version of;

– BS 7671

– Volume 3 – Electrical Specification

– Electrical Specification data sheets

Earth bonding terminals will be provided on all equipment and metal parts bonded together.

All externally located plant will have provisions for lightning protection.

Complete wiring diagrams will be provided and securely located in the electrical compartments of all equipment.

The degree of protection provided by electrical enclosures (IP rating) will be suitable for the conditions in which the equipment is installed and in accordance with BS EN 60529.

The electrical sub-contractor will provide dedicated circuits for the mechanical equipment to be terminated in a local isolator or fused connection unit as means of final isolation for the plant. The mechanical sub-contractor will include for all wiring, trunking and cable tray, outlets etc. from the isolators to the mechanical plant.

7.12.2 Equipment Performance

All Performance ratings of equipment will be based on certified test data.

All motors of mechanical equipment will be mounted on a firm, level base with suitable access space around for routine maintenance and airflow. Suitable allowances will be made for shaft end float and thermal expansion.

Motors will be rated for continuous operation with thermal overload protection and be suitable to operate satisfactorily at ambient temperatures of 10oC to greater than 40oC.

Where available, electronically commutated DC motors will be used for low load applications e.g. terminal units.

Variable speed drives will be designed to prevent harmful currents passing to the motor. They will have the facility to monitor power consumption and record kWh for remote monitoring on the BMS.

Fan and pump bearings will be suitable for the size, speed and arrangement. Bearings will have a minimum life of 40,000 hours. Bearings will be lubricated (grease or oil) and/or sealed in housings protected from dust ingress.

All motors will have an earthing terminal adjacent to the terminal box and four-position cable entry. The motors will have a degree of protection suitable for the application.

Motors will be Totally Enclosed Fan Ventilated (TEFV) type with the fans located on the non-drive end.

8 Commissioning & Testing

8.1 GENERAL

In addition to any specific requirements called for elsewhere in this Specification, the Sub Contractor will be responsible for carrying out site tests, pre-commissioning checks, system cleaning, setting to work, commissioning and testing the installations comprising the Sub-Contract Work.

The Sub Contractor will also ensure that all works tests are properly carried out and subsequently certified.

Calibration certificates will be submitted upon request for all instruments to be used during the commissioning phase. The certificates will bear the equipment serial numbers.

Upon completion of the testing and commissioning the Sub Contractor will submit complete test records to the Consulting Engineer and request for attendance to witness demonstration of the commissioned installations. The demonstrations will include witnessing functional operations and the accuracy of the commissioning test records.

Commissioning and testing will only be undertaken after all systems have been statically completed, certified and operational. This includes;

- Works testing of plant
- Pneumatic and pressure testing of pipework and ductwork systems
- Electrical testing to BS 7671

All systems will be thoroughly cleaned and flushed as part of the pre-commissioning.

All water regulating devices and volume control dampers will be locked in the final position, recorded and permanently marked. Index terminals will be clearly identified on the commissioning sheets.

Air systems will be balanced to minimise noise generation and regulated to tolerances appropriate for the system as defined in CIBSE Commissioning Code A. Water systems will be regulated to tolerance as defined in CIBSE Commissioning Code W.

Flushing and Commissioning of all Building Services systems will be compliant with the current versions of all relevant CIBSE, BSRIA, HVCA, British Standards and Codes of Practice including but not limited to the following;

Subject	Publication Title
Air Systems	- CIBSE Commissioning Code A: Air distribution systems - BSRIA BG 49/2015 Commissioning Air Systems - BSRIA BG 46/2015 Domestic Ventilation Systems - a guide to measuring airflow rates - BESA TR/6 Guide to Good Practice: Site pressure testing of pipework.
Water Systems / Piped Services	- CIBSE Commissioning Code W: Water distribution systems - BSRIA BG 29/2021: Pre-Commission Cleaning of Pipework Systems - BESA TR/20 Part 4, Installation and testing of pipework systems – Hot water service. - BESA TR/20 Part 5, Installation and testing of pipework systems – Cold water service. - BESA TR/20 Part 1, Installation and testing of Low Temperature Hot Water heating pipework systems. - BSRIA BG 50/2021 Water Treatment for Closed Heating and Cooling Systems - BSRIA BG 2/2010: Commissioning Water Systems
Controls	- CIBSE Commissioning Code C: Automatic controls - BSRIA AG 9/2001 Standard specifications for BMS
Smoke Clearance	- BS 7346-8:2013 Components for smoke control systems. Code of practice for planning, design, installation, commissioning and maintenance

8.2 ACTIVITIES PER STAGE

Stage	Requirements	Specific Activities

Construction	The installer will carry out regular progress inspections in the course of installation to ensure that all plant items are in accordance with the design drawings, specifications and where applicable the manufacturers' instructions. Also, installer will ensure correct installation procedures are being followed and standards of installation and site cleanliness are acceptable. During the construction stage of the project, the commissioning team will ensure that the project team produces engineering systems that are physically complete and correct. A process of installation quality verification and static testing should be undertaken to prove the quality and workmanship of the installation, before a certificate is issued to liven services. Static tests include pressure testing of ductwork and pipework. Static completion of a system is achieved when a system is installed in accordance with the specification, is clean and is ready for setting to work. In the case of water systems, this includes flushing, cleaning, filling and venting. The commissioning team will ensure that the installation quality and static completion is satisfactorily demonstrated throughout the monitoring, witnessing and documenting of construction work and static testing.	- Verify technical submittals and installation drawings by physically inspecting the installation on site for all services. - Flush and vent all the mechanical systems - Water pipe hydraulically tested, cleaned and treated. - Ductwork installation pressure tested and cleaned
Commissioning	Carry out functional performance test on the physically complete systems to verify that they perform to the requirements of the design and are fully operational at handover The performance tests include integrated system tests and test required by statutory authorities. The commissioning team will ensure that thorough monitoring, witnessing and documenting activities are undertaken in relation to all system tests, and sign-off of all systems has been achieved. All pipework systems will be fully tested after complete installation of all branch pipework and before being insulated or concealed or equipment fixtures are connected.	- Mechanical Systems pre-performance tests - Water systems balance and volume checks - Ductwork systems air balance and volume checks - Set systems and equipment to work and carry out performance tests - Building automation system proven - All certificates issued to the relevant parties upon satisfactory commissioning
Pre-handover	In the pre-handover stage of the project, the sub-contractor will ensure that the Client's representative clearly understands the engineering systems before they take possession. The sub-contractor will provide the necessary training and familiarisation activities, together with the production of the building logbook and a building users guide. The commissioning team will also check the adequacy of all testing and commissioning records and ensure that they are properly integrated into the project Operating and Maintenance Manuals.	Provide the necessary documents in accordance with Section 1.25 & 1.26, including the following: □ Warranty Documents □ As build documents (operating & maintenance manuals, drawings, schematics etc.) □ Control layout prints and schedules □ Training documents □ Equipment technical manuals □ Testing and Commissioning Certificate Records

8.3 SITE TESTS

Prior notice of all site tests will be made to the Consulting Engineer to enable the opportunity to attend.

Tests will be carried out as the work proceeds but a final test on the whole installation will be carried out on completion. Where tests are failed, works will be rectified, and tests repeated until a pass is achieved.

8.3.1 Piped Services

Hydraulically or pneumatically tested to test pressures specified below for a minimum of 60 minutes, or greater if necessary for all joints to be inspected.

During final witnessing of system balancing ,10% of differential pressure control valves will be functionally demonstrated to show satisfactory operation at part load conditions.

2 port control valves will be driven open automatically to ensure correct seat position is achieved. Pressure control valves (including differential pressure control valves) will be commissioned initially with the system fully open and the pump set to maximum design speed, starting closest to the pump and working towards the index point of the system. Regulating valves will not be adjusted beyond the manufacturers recommendations.

Systems will be proportionally balanced for a normal constant volume system.

Services that cannot be drained (e.g. gas) will have a pneumatic leak test followed by a pneumatic pressure test for a period of 30 minutes.

Soil, waste, vent and rainwater pipework air tested and hydraulically tested in accordance with BS EN 12056.

System	Working Pressure < 3.5 bar	Required Test Pressure (gauge) Working Pressure >3.5 bar
Cold Water Services	6 bar	1.5 x working pressure
Hot Water Services	6 bar	1.5 x working pressure
LTHW Heating	6 bar	1.5 x working pressure
Soil & Vent	38mm(1)	n/a
Waste	38mm (1)	n/a

(1) Air test of positive pressure of at least 38mm water gauge for at least 3 minutes.

A water treatment specialist will undertake work associated with water treatment of all systems including corrosion inhibitors and pH control.

Suitable water and drainage provisions will be available for the fully flushing and cleaning of pipework systems and safe disposal of the contaminated water. Necessary temporary or permanent by-pass loops will be provided to avoid damage to sensitive equipment (e.g. coils) during the flushing process.

Immediately after flushing and cleaning, treated water will be used to fill systems (i.e. water contained within a system for 2 or more hours). Microbial levels will be agreed with the water treatment specialist before a system is filled. Filled systems will be chemically dosed as necessary to prevent corrosion and bacterial growth. Any chemicals used for the purposes of water treatment will be compatible with the installed materials.

Raw mains water will not be used to fill any system at any time. Pipework systems will not be left empty following flushing and cleaning process.

Water samples will be taken for biological analysis by an independent laboratory to confirm compliance with UK Drinking Water Inspectorate Regulations.

8.3.2 Dry Riser Pipework

Pipework will be tested to 10 bar and valves hydraulically tested to 21bar before riser connection.

8.3.3 Wet Riser Pipework

Pipework will be tested to 1.5 x working pressure (closed head) and maintained for 2 hours. Valves will be hydraulically tested to 21bar before riser connection.

Each landing valve will be provided with 1500l/min @ 4bar pressure when three landing valves are operated simultaneously.

8.3.4 Wet Riser Pipework

All pipework will be tested to the required pressure. The test will be maintained for 2 hours without any visible leakages, drop in pressure or addition of additional pressure.

Dry pipework will be tested pneumatically to the working pressure.

Wet pipework will be tested to 1.5 x working pressure or at least 15 bar, whichever is greater.

Any leakages or defects identified during the testing will be rectified and the entire system re-tested (including pump performance tests). A test certificate will be submitted on completion of successful testing.

8.3.5 Gas Pipework

Gas pipework will be isolated from the meters and incoming utility pipe prior to testing.

Pipework will be subjected to a pneumatic leak test of 75mbar or 2x working pressure (whichever is greater) for a period of 30min with no drop-in pressure. All pipework joints will be coated with a soap water solution and visually inspected for any leaks.

For gas installations carry out a pneumatic leak test followed by a pneumatic pressure test in accordance with BESA TR/20 Part 9 and BS EN 12327:2012 procedure.

8.3.6 Safety / Pressure Relief Valves

Checked by hydraulic pressure test at 15% above normal working pressure

8.3.7 Ductworks

Ductwork will be tested in accordance with HVCA DW/144 & DW/154 and leakage testing will be undertaken by a suitably qualified specialist contractor in accordance with Building Regulations and HVCA DW 143 to meet the required low/medium/high pressure requirement. Where ductwork systems fail to meet the leakage requirements, remedial works will be undertaken, and systems re-tested to achieve satisfactory performance.

Displacement ventilation systems will be tested with smoke to prove airflow patterns.

VAV systems will be tested in accordance with BSRIA AG 1/19Fan tracking from Vmin to Vmax will be proven for VAV systems via pitot traverse readings. Minimum fresh air will be measured and proven for VAV systems via pitot traverse readings.

Controlled minimum air flow rates will be demonstrated.

Supply and extract flow rates at each point will be measured and recorded.

8.4 DEMONSTRATIONS & ACCEPTANCE

Demonstrations will include functionality tests and random checks of all systems to prove repeatability of commissioning results including regulation/balancing, switching, control and operation.

The Sub Contractor will be responsible for producing a programme for demonstrations of following systems and approval by the Consulting Engineer.

The systems to be witnessed by the Consulting Engineer shall include but not be limited to:

- Apartment LTHW systems balancing and flow rate demonstration
- Apartment ventilation balancing and flow rate demonstration
- Ventilation system balancing and flow rate demonstration
- Smoke ventilation systems flow rate and functionality testing including fire alarm interfaces
- Fire damper drop tests
- Domestic water system flow and pressure tests at selected fittings
- Domestic hot water temperature demonstration
- Apartment controls systems demonstration

8.5 WITNESSING & INSPECTION BY STATUTORY BODIES

The Sub Contractor will allow for the witnessing of testing as required, any separate testing that may be required by Statutory Authorities and full completed system inspection on the services installation by the following:

- Local Fire Brigade
- Water Supply Authority
- Building Control Department
- Environmental Health Department

– Building Insurers

The Sub Contractor will obtain in writing from the relevant authorities, written confirmation of their acceptance of the installations.

8.6 RECORDS

Upon completion of commissioning and testing the Sub Contractor will assemble all commissioning and testing records. These records will be made available when the commissioned and tested installations are ready for demonstration to the Employer or Consulting Engineer. The records will be supplied in copies of the O&M manuals, the requirements for which are specified elsewhere.

As a minimum, the Sub Contractor will issue the following documents:

– Apartment LTHW systems flow rate balancing certificate
– Apartment ventilation balancing certificates
– Ventilation system balancing certificate
– Smoke ventilation systems commissioning certificate
– Air source heat pump commissioning certificate
– Cold water booster pump commissioning certificate including pressure tests
– Water treatments commissioning certificate including water quality report