SECTION 15291

HVAC THERMAL INSULATION

PART 1 GENERAL

1.01 SCOPE OF SECTION

A. This technical specification establishes the type and quality of materials and the standard of workmanship to be used in the supply and application of thermal insulation for HVAC items.

1.02 WORK INCLUDED

A. The work includes the provision of all labour, materials and the performance of all operations in connection with the supply and application of thermal insulation as specified herein and where referred to on the Drawings.

B. Coordination : The Contractor shall be responsible for the full coordination of the work of all trades.

1.03 QUALITY ASSURANCE

A. Manufacturers : Firms regularly engaged in the manufacture of thermal insulation materials whose products have been in satisfactory use for a similar application for not less than 10 years.

B. Installer : Firms regularly engaged and qualified in the application of thermal insulation materials with at least 5 years successful installation experience on projects of a similar nature.

C. No thermal insulation shall be applied to pipework and ductwork services until the installations have been inspected by the Engineer and tested in accordance with the relevant sections of this specification.

1.04 APPLICABLE CODES AND STANDARDS

A. The thermal insulation products and all associated materials shall comply with the latest relevant British Standards in all respects.

B. The following are the most commonly used and relevant British Standards associated with thermal insulation products and associated material. However, the Contractor shall ensure that all applicable British Standards are complied with whether listed here or not.

BS 476 Part 4	:	Non-combustibility Test for Materials.
BS 476 Part 7	:	Method for Classification of the Surface Spread of Flame of Products

BS 476 Part 20: Method for Determination of the Fire Resistance of Elements of Construction.

BS 1485 : Specification for Zinc Coated Hexagonal Steel Wire Netting.

BS 3958 Part 3: Metal Mesh Faced Man-made Mineral Fibre Mattresses.

BS 3958 Part 4: Bonded Preformed Man-made Mineral Fibre Pipe Sections.

BS 3958 Part 5: Specification for Bonded Man-made Mineral Fibre Slabs.

BS 5422 : Specification for the use of Thermal Insulation Materials.

BS 5970 : Code of Practice for Thermal Insulation of Pipework and Equipment.

1.05 SUBMITTALS

A. Drawings refer to 15010

B. Products: Full manufacturers data confirming type and composition of all products including thermal characteristics.

C. Sample - Section of insulated duct
- Section of insulated pipe

both showing detail of resilient spacer at bracket location.

1.06 OPERATION AND MAINTENANCE DATA

A. Comply with 15010

1.07 WARRANTY

A. Provide 12 months warranty in accordance with contract conditions.

PART 2 PRODUCTS

2.01 GENERAL

A. For general applications the thermal insulation materials shall be made from materials which will not burn, but materials which are not entirely non-combustible may be accepted if they have self-extinguishing characteristics, the total mass of combustible materials is small and combustion does not produce dense smoke or toxic fumes. All material finishes shall conform to spread of

flame classification class O. Such materials shall only be used with the prior permission of the Engineer.

B. Insulation shall be rotproof, odourless, non-hyroscopic, shall not sustain vermin and shall not contribute to metal corrosion. Any finishes (or coverings) used shall not deteriorate with age or the effects of solar heat.

C. Thermal insulation materials and their finishes shall be asbestos free and be suitable for continuous use throughout the range of operating temperatures and within the environment indicated.

D. All insulating materials and associated products, sealants, tapes, adhesives, securing bands and protective cladding shall be as specified or equal and approved.

2.02 DUCTWORK INSULATION

A. Thermal insulation of rectangular ductwork shall be rigid mineral fibre slab consisting of long fine fibres (free from short and coarse fibres) bonded with a temperature resistant resin. The density shall be a minimum of 48 Kg/m^3.

B. Thermal insulation of circular ductwork shall be flexible mineral fibre material consisting of long fine fibres (free from shot and coarse fibres) made up in mat form. The density shall be a minimum of 32 Kg/m^3.

C. Thermal insulation on ductwork etc. inside buildings generally shall be at least 25mm thick where its declared value of thermal conductivity at the relevant temperature is equal to or less than 0.04 W/m deg. C or at least 38mm thick where the declared value of thermal conductivity is between 0.04 and 0.06 W/m deg. C. In the open air, in plant rooms and in large unconditioned open areas of buildings, the thermal insulation shall be at least 50mm thick where the thermal conductivity is less than or equal to 0.04 W/m deg. C or at least 63mm thick where the thermal conductivity is between 0.04 and 0.06 W/m deg. C.

For ductwork carrying chilled air, the insulation shall cover the flanges either by means of flange boxes or by increasing the general thickness of insulation to give at least 6mm cover at the flanges.

D. All ductwork thermal insulation shall be complete with a reinforced aluminium foil applied to one side during the manufacturing process.

E. Where integral or surface reinforcement is called for, or required in connection with insulation materials, it shall be one or other of the following:

i. Galvanised wire netting of not less than 0.914mm. diameter and 22mm mesh size.

ii. Galvanised wire, either 0.914mm diameter spirally wound at approximately 75mm pitch or 1.219mm diameter when used in single strands at right angles to the axis of duct (or pipe).

iii. Aluminium bands 20mm wide by 0.51mm thick, with galvanised wire end loops.

iv. Aluminium or galvanised steel edge reinforcement strips secured to the insulation with adhesive.

F. Where there is a requirement to prevent noise transmission through the walls of the ductwork, either in the form of noise break-out prior to an attenuator, noise break-in on the attenuated side, acoustic insulation shall be applied to the external surface of the ductwork. The acoustic insulation shall be of an approved noise control barrier of mineral fibre with a minimum density of 48 Kg/m^3. The acoustic insulation shall be at least 50mm thick and the thermal conductivity less than or equal to 0.04 W/m ^oC.

G. Where there is a requirement to internally line the ductwork to attenuate airborne noise the acoustic lining material shall be of an approved noise control barrier of mineral fibre faced to prevent fragmentation with a minimum density of 48 Kg/m^3. The acoustic lining shall be at least 50mm thick and the thermal conductivity less than or equal to 0.04 W/m ^oC.

2.03 PLANT AND PIPEWORK INSULATION

A. Thermal insulation shall be pre-formed rigid sections or slabs, the basic material consisting of the following:

* Rockwool mineral fibre (density 110-160 Kg/m^3).

* Thermal conductivity 0.040 w/m deg C.

The insulation shall be manufactured from long stranded mineral fibres, resin bonded to form sections having uniform density and high compressibility. The preformed rigid insulation outside surface shall be smooth, unbroken, uniform, concentric and firm.

B. Pipework insulation shall be high density rigid resin bonded preformed rockwool mineral fibre sections of the thickness specified. The insulation shall comprise of two half sections with a factory applied reinforced aluminium foil covering hinging the two half mating sections for ease of installation. The covering shall have a 50mm side overlap of reinforced aluminium foil to enable the outside surface to be completely sealed.

C. Where thermal insulation of plant is required the insulation shall be preformed rigid sections or slab. The material shall consist of long fine fibres (free from shot and coarse fibres) bonded with a temperature resistant resin. The density shall be a minimum of 48 Kg/m^3 and the surface shall have a factory applied reinforced aluminium foil finish.

D. Thickness of insulation shall be determined in accordance with the following tables for the appropriate medium and the declared value of thermal conductivity of the insulation material at the relevant temperature.

When selecting the insulation thermal conductivity, the space available for the installation shall be thoroughly examined to ensure that the resultant thickness can be accommodated.

TABLE 1

THICKNESS OF INSULATION FOR CHILLED WATER AND CONDENSATE DRAINAGE PIPEWORK

DECLARED THERMAL CONDUCTIVITY W/m deg.C	
PIPEWORK WITHIN CONDITIONED SPACES	
SIZE OF TUBE (mm)	UP TO 0.040 W/m deg C Minimum Thickness of Insulation (mm)
15 to 20	32
25 to 50	38
65 to 300	50
Flat Surfaces	50

TABLE 2

THICKNESS OF INSULATION FOR CHILLED WATER AND CONDENSATE DRAINAGE PIPEWORK

DECLARED THERMAL CONDUCTIVITY W/m deg.C	
PIPEWORK WITHIN UNCONDITIONED SPACES, PLANT ROOMS AND OPEN AIR	
SIZE OF TUBE (mm)	UP TO 0.040 W/m deg. C Minimum Thickness of Insulation (mm)
15 to 20	38
25 to 50	50
65 to 100	63
125 to 300	75
Flat Surfaces	50

2.04 REFRIGERATION PIPEWORK INSULATION

A. Thermal insulation shall be preformed un-slit foamed Class 1 plastic material to suit the size of the pipe. The vapour barrier shall be an integral part of the material. The insulation shall have a thermal conductivity of 0.0375 W/m^{o}C and shall be satisfactory for a temperature range of 0^{o}C to 104^{o}C without deformation or deterioration. The minimum thickness of the insulation shall be 25mm.

PART 3 EXECUTION

3.01 STORAGE

A. All thermal insulation materials shall be stored in their original packaging in such a manner as to prevent the ingress of dust or moisture. The height of the packages shall be restricted to prevent any deformation of preformed rigid sections.

B. Flat sheet and rolled metal materials used for protective claddings shall be stored away from the ground surface, adequately covered and protected in a manner to prevent damage to the materials.

C. All storage areas shall have adequate lighting to allow for the inspection of all materials.

D. Refer to 01600

3.02 FIXINGS

A. All mechanical fixings (rivets, screws) shall be as recommended by the manufacturer of the material being fixed. All mechanical fixings, sealants, tapes and adhesives shall be entirely suitable for the medium that they are being applied to and the application shall be fully in accordance with the manufacturers recommendations.

3.03 DUCTWORK INSULATION

A. Thermal insulation to ductwork shall be carried out neatly and to a high grade quality by skilled workers experienced in the trade, and strictly in accordance with this Specification. No thermal insulation shall be applied to any ductwork prior to completion of any air leakage testing that may be required and only then after a full inspection and approval by the Engineer.

B. Thermal insulation shall be applied to all supply and return ductwork carrying conditioned air through unconditioned areas including plantrooms. Thermal insulation shall not be installed on the sections of return air ductwork covered with fire resistant cladding.

Supply ductwork carrying conditioned air through conditioned areas shall be insulated, whereas return ductwork passing through conditioned areas shall not be insulated unless otherwise stated.

All ductwork exposed to the atmosphere shall be insulated. All ductwork in plant rooms shall be insulated except return ductwork covered with fire resistant cladding.

C. All rectangular ductwork shall be insulated with rigid slab, cut to fit so that the top and bottom pieces overlap the sides, bonded to the ductwork with adhesive applied in 100mm bands at 300mm intervals. On ductwork where the width exceeds 900mm, stickpins shall be used on the underside and sides to prevent any excessive sagging.

D. All circular ductwork shall be insulated with mineral fibre mat bonded to the ductwork with adhesive applied in 100 mm bands at 300 mm intervals.

E. All joints in the thermal insulation shall be fully sealed to maintain a continuous vapour barrier throughout by the use of 75 mm wide aluminium tape.

F. Load bearing inserts of hardwood or phenolic foam complete with factory applied vapour seal shall be used at support positions. The inserts shall be of the same thickness as the insulating material and cut such that 50 mm protrudes either side of the support. The rigid slab shall be butt jointed to the insert and the joint fully sealed with 75 mm wide aluminium tape to maintain the vapour seal. The vapour seal shall not be pierced or fouled by the supports, and shall be continuous.

G. All insulation on ductwork carrying conditioned air shall have a continuous vapour seal.

H. The insulation on ductwork exposed to view and within plantrooms shall be clad totally in an aluminium stucco finish cladding 0.8mm thick with folded corners and held in place by means of rivets or self tapping screws. All joints shall be sealed with a non-setting sealing compound.

J. All ductwork exposed to the outside atmosphere shall be insulated and clad as for plant rooms.

K. Where ductwork passes through masonry walls, floors and roofs a sheet metal sleeve shall be installed and the gap, equal to the insulation thickness, shall be packed with a load bearing insert with integral vapour seal. The thermal insulation shall be butt jointed to the insert and the joint sealed by the use of 75 mm wide aluminium tape. All openings through external walls and roofs shall be fitted with a flashing fixed to ensure water will not enter the insulated space between the ductwork and the cladding.

L. Where the insulation is 50 mm thick or more (except for insulation which is sprayed or moulded in situ) the insulation shall be fixed in two layers with joints staggered. For air heaters using media at high temperature the thermal insulation material shall be suitable for use at those temperatures.

M. All joints, surfaces, edges and overlaps shall be neatly finished and where possible overlaps shall be arranged on the `blind' side. Overlaps shall be even and parallel to the circumferential and longitudinal joints. Insulation shall be neatly shaped around flanged joints, access openings etc., irregular joints, surfaces, edges and overlaps will not be accepted by the Engineer in any circumstances.

Until final acceptance of the installation by the Engineer, the Contractor shall make good any damage to insulation at his own expense, so that the installation is handed over in a perfect conditioned.

N. Where an acoustic lining to ductwork is specified, it shall be fitted in the workshop. Before manufacture, confirmation shall be obtained that the dimensions of the duct allow for the thickness of the lining.

Duct surfaces must be thoroughly clean and the lining fixed by an approved type of adhesive applied over the whole of the area to be lined. In addition, fasteners must be used at 450mm maximum centres, and not more than 75mm from joints, corners, breaks etc. with washers or caps to hold the lining. Metal mesh may be called for by the Engineer as an additional precaution against displacement or break-up of the lining.

The lining must be applied so as to provide abutment at joints and edges, with continuity of facing material. For protection prior to erection, the edges of the lining shall be sealed or enclosed by a light metal section mechanically fastened to the duct.

O. All attenuators and diffuser plenums shall be insulated and vapour sealed to the same specification as the ductwork connecting to them except diffuser plenum boxes specified as having internal acoustic/thermal insulation.

3.04 PLANT AND PIPEWORK INSULATION

A. Thermal insulation to pipework shall be carried out by specialists and strictly in accordance with this Specification. No thermal insulation shall be applied to pipework prior to witnessing of the pipework pressure test and only then after a full inspection and approval by the Engineer.

B. Thermal insulation shall be applied to the following:-

(i) External distributing mains and fittings above ground and in ducts, chases and trenches including all valve bodies and flanges.

(ii) Buried pipework shall have special forms of insulation as indicated.

(iii) All condensate drainage pipework to prevent shedding of condensation.

Insulation shall fit closely on pipework and other surfaces without gaps between.

C. All sections of the insulation shall be of the correct size and made for the type and grade of piping to which it is fitted and shall form a tight fit on the pipework after application of adhesive and lapping.

D. Each pre-formed rigid insulation section shall be butt jointed to the next, the point being fully sealed with 75 mm wide aluminium tape. The preformed sections on domestic hot and cold water services shall be secured hard to the bracket where inserts are not used. The reinforced aluminium side overlap shall be sealed with a suitable adhesive or 75 mm wide aluminium tape. Outer coverings shall not come into contact with pipework and attachments.

E. Each section of pre-formed insulation shall be secured to the pipe by one of the following means:

* Circumferential tie wires each formed from three turns of wire not less than 1 mm thick, spaced not more than 450 mm apart.

* Circumferential bands of non-ferrous metal, plastic fibre or adhesive sheet.

* Rigid insulation applied to cylinders and flat surfaces shall be secured with non-ferrous metal or plastic fixings.

F. The insulation on pipework concealed from view within buildings will not require further protective cladding.

G. Insulation on pipework exposed to view and within plantrooms and external to the building shall be clad fully in a pre-formed aluminium stucco finish cladding 0.8 mm thick held in place by means of rivets or self tapping screws. All joints shall be sealed with a non-setting sealing compound. The Contractor shall take extreme care to ensure that the application of the metal cladding does not destroy the continuity of the vapour barrier.

H. Valves, flanges and specialties shall be fitted with insulated removable boxes formed in 0.8mm thick aluminium stucco cladding.

I. At all instrument points or tappings on pipework or ductwork the insulation shall be cut away and the edges neatly finished and sealed as for adjacent finishes allowing access for the instrument.

3.05 REFRIGERATION PIPEWORK INSULATION

A. The suction line from the evaporator to the compressor shall be insulated with foamed plastic as specified previously and shall be protected by a vapour barrier which shall not be broken between joints of sectional material or at discontinuities of valves or brackets.

B. Where possible the insulation shall be sleeved on the pipes before they are fitted. At all junctions, elbows, valves, and the like, it shall be carefully cut and fitted to the method recommended by the manufacturer.

C. All open edges, joints and the like, shall be sealed with an adhesive as recommended by the insulation manufacturer.

3.06 PROTECTION

A. The Contractor shall take all necessary measures to protect the works during construction. Any damaged sections of insulation shall be completely cut out and replaced with a new section. The vapour seal shall be repaired to ensure continuity.

All damaged sections shall be replaced at the Contractor's expense until the system is accepted and finally handed over.

END OF SECTION 15291

SECTION 15325

FIRE PROTECTION SYSTEMS AND EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF SECTION

A. This technical Specification establishes the quality of materials and workmanship to be used in the supply and installation of the Fire Protection systems and equipment used internally within buildings.

1.02 WORK INCLUDED

A. Provisions of all labour, materials and the performance of all operations in connection with the installation and testing fire protection and fire fighting systems within buildings as specified herein and shown on the drawings.

B. Coordination: The Contractor shall be responsible for proper coordination of the work of all trades and shall provide clear drawings where necessary.

1.03 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in the manufacture of fire fighting and fire protection systems and equipment fittings whose products have been in satisfactory use in similar service for not less than 10 years.

B. Installer: Qualified with at least 5 years of successful installation experience on projects with fire fighting and fire protection schemes and equipment similar to that required for this project.

1.04 APPLICABLE CODES AND STANDARDS

A. The Fire Protection systems and equipment shall comply fully with the latest relevant National Fire Protection Association standards in all respects.

B. The following are the most commonly used NFPA Standards associated with Fire Protection systems. However, the contractor shall ensure that all applicable NFPA Standards are complied with, whether listed here or not.

NFPA 1 - Fire Prevention Code.

NFPA 10 - Standard for Portable Fire Extinguishers.

NFPA 78 - Lightning Protection code.

1.05 SUBMITTALS

A. Drawings - refer to Section 15010

B. Products - submit full manufacturers data for every item.

1.06 OPERATION AND MAINTENANCE DATA

A. Comply with Section 15010.

1.07 WARRANTY

A. Provide 12 month warranty in accordance with contract conditions.

PART 2 PRODUCTS

2.01 GENERAL DESCRIPTION

A. All materials, equipment and procedures associated with the Fire Protection Systems shall be in accordance with NFPA requirements.

B. Where operating or warning instructions are provided or specified they shall be clearly denoted in Arabic and English.

C. The Contractor shall supply original authenticated certificates for each type of material or equipment, confirming the standard they have been manufactured and tested to.

2.02 PORTABLE FIRE EXTINGUISHERS

A. Portable Fire Extinguishers shall be of the type indicated on the drawings and specified herein.

B. The fire extinguishers shall conform to the requirements of NFPA 10 for design standard and performance with the classes of fire as defined in that standard and this Specification.

C. Classes

Class A Fire involving solid materials, usually of an organic nature such as wood, cloth, paper, rubber and many plastics.

Class B Fires involving flammable liquids, oils, greases, tars, oil based paints, lacquers and flammable gases.

Class C Fires involving energized electrical equipment where the electrical non-conductivity of the extinguishing media is of importance.

D. Multi-purpose dry powder (chemical)-Class A.B. and C fires. Multi-purpose dry powder extinguishers shall be ammonium phosphate, stored pressure type with steel cylinders, braided PVC or black reinforced rubber discharge hose and nozzle and pressure gauge. Suitable carrying handles shall be incorporated in the extinguisher body or the control mechanism moulding. Extinguishers shall be hermetically seated to prevent moisture contaminating the powder.

E. Carbon Dioxide (CO_2) - Class B and C fires. Carbon Dioxide extinguishers shall have steel cylinders and be complete with swivel horn or hose and horn applicator.

F. Water (H2O) - Class 'A' fires water extinguishers shall be stored pressure type with steel cylinders, braided PVC or black reinforced rubber discharge hose and nozzle and pressure gauge. Suitable carrying handles shall be incorporated in the exitinguisher body or the control mechanism moulding.

G. Foam - Class A and B fires. Foam extinguishers shall be of the stored pressure type with steel cylinders, braided PVC or black reinforced rubber discharge hose and nozzle and pressure gauge. Suitable carrying handles shall be in corporated in the extinguisher body or control mechanism moulding.

H. Special Features

All portable extinguishers shall be wall bracket mounted as shown on the drawings. Wall mounted units shall be supplied complete with purpose made wall brackets, and the Contractor will secure these to the building structure so that the installed height of each extinguisher conforms to the NFPA Standard 10 Clause 1-6.9 relative to its gross weight. Where floor standing units are provided these shall be fitted with integral steel skirts such that the extinguisher body itself does not rest on the floor. Specific extinguisher requirements are shown on the drawings.

All types of extinguisher shall be fitted with a locking pin arrangement to prevent accidental discharges, the safety pins being secured to the unit by a chain or wire cable to prevent loss.

I. Design, Deployment and Capacity

The extinguisher designs shall be such as to facilitate inspection, cleaning, repair and replacement, and be simple and reliable when in use under operational (or training) conditions.

The mounting requirement for extinguishers shall be as shown on the Drawings. The Contractor shall not deviate from this requirement or other aspect of the specification without the permission of the Engineer.

The locations, type of extinguishant and capacity of fire extinguishers are shown on the relevant Drawings. The capacity of each unit specified is the minimum quantity of extinguishant required at the location indicated. The Contractor may supply slightly larger sizes to that specified where the Specification does not

coincide with a particular supplier's production standard extinguisher. If the nearest standard deviates considerably from the Specification the Contractor shall obtain the approval of the Engineer before placing his order.

J. Extinguisher Marking

All extinguishers shall carry in English and Arabic clear and concise operating instructions and warnings against use on fires for which the extinguishant is not suitable, or any other warnings of which the operator must take heed. The extinguisher class suitability and warnings may take the form of pictorial labels as depicted in the NFPA Standard 10.

The following information shall also be clearly marked on the body of each unit:

1. The name of the manufacturer.
2. Instructions for regular periodic checking of the units for operational serviceability.

K. Portable Fire Extinguishers - Types and Sizes

1. Multi-purpose dry powder complete with wall bracket.

Capacity	6Kg	10Kg
Range & discharge	5-7m	5-7m
Duration of discharge	13 secs	20secs
Blocked nozzle pressure at 20°C	13 bar	13 bar

2. Carbon Dioxie

Capacity	3 kg	5 kg	6 kg
Minimum range of discharge	3 m	5 m	3 m
Duration of discharge	17 secs.	15 secs.	17 secs.
Working pressure at 20°C	50 bar	50 bar	50 bar

3. Foam

Capacity	6 L	9 L
Minimum range of discharge	4 m	4 m
Duration of discharge	28 secs.	40 secs.
Working pressure at 20 C	12.5 bar	12.5 bar

4. Water

Capacity	10 L
Minimum range of discharge	6 m
Duration of discharge	65 secs.
Working pressure at 20 C	12.5 bar

PART 3 EXECUTION

3.01 STORAGE

A. Fire extinguishers and fire blankets shall be covered in protective packaging and stored in a well lit container. Fire extinguishers in particular, shall be secured to prevent damage resulting from falling and in no instance shall they be subject to temperatures in excess of 50°C for to direct sunlight.

3.02 GENERAL INSTALLATION

A. All items shall be installed in the locations indicated on the drawings and strictly in accordance with the manufacturer's instructions.

B. The installation shall comply fully with all applicable standards and codes listed in Part 1.04.

C. Fire extinguishers and fire blankets shall be securely fixed with approved fixings in a position offering unobstructed access.

END OF SECTION 15325

SECTION 15410

PLUMBING PIPING

PART 1 GENERAL

1.01 SCOPE OF SECTION

A. This technical Specification establishes the minimum requirements for the equipment to be incorporated into the above ground Soil, Waste and rainwater and hot and cold water services plumbing pipework.

It also establishes the quality of materials and workmanship to be used in the supply and installation of the systems.

1.02 WORK INCLUDED

A. Provision of all labour, materials and the performance of all operations necessary for the supply and installation of pipework and fittings of the soil and waste systems as specified herein and as detailed on the Drawings.

B. Coordination: The Contractor shall ensure that the soil and waste systems are fully compatible with all trades, particularly those of the Civil, Mechanical and Electrical services, for successful installation and operation.

C. Submittals: The Contractor shall submit to the Engineer for review and approval, all calculations and drawings for the equipment proposed and associated builders works to show that the plant as installed will meet all the specified criteria.

No works shall commence on the site until the design has received the approval of the Engineer.

1.03 QUALITY ASSURANCE

A. Manufacturers: The contractor shall only propose the use of materials produced by firms who have been regularly engaged in the manufacture of plumbing pipework systems and whose products have proved satisfactory in similar service for not less than 10 years.

B. Installer: Firms proposed for the installation of the plumbing pipework systems shall have been regularly engaged for at least 5 years in the installation of plants of a similar type, quality and scope as is required for this project.

1.04 APPLICABLE CODES AND STANDARDS

A. The plumbing pipework shall comply fully with the latest relevant British and Saudi Arabian Standards in all respects.

B. The following are the most commonly used and relevant British and Jordanian Standards associated with Soil and Waste Systems. However the Contractor shall ensure that all applicable British and Jordanian Standards are complied with, whether listed here or not.

BS: 3380 - Wastes (excluding skeleton sink wastes) and bath overflows. In conjunction with BS 2779, 3643 and 5572.

BS: 3505 - Specification for uPVC pressure pipes.

BS: 3943 - Plastic waste traps. In conjunction with BS 2779 and 3380.

BS: 3974 - (Part 1 & 2) Pipe supports.

BS: 4118 - Glossary of sanitation terms.

BS: 4514 - Unplasticized PVC soil and ventilating pipes, fittings and accessories.

BS: 4576 - Unplasticized PVC rain water goods. In conjunction with BS 2494 Part 2, 4514.

BS: 4660 - Unplasticized PVC underground drain pipe and fittings. In conjunction with BS 2494, 5955 and CP312.

BS: 5255 - Plastic waste pipe and fittings. In conjunction with BS 21, 2494, 2779 and 4515.

BS 5911 - Plain and reinforced concrete pipes and fittings.

BS 843 - Thermal-storage electric water heaters. In conjunction with BS 3456, Sections 2.21, 2.7 an 3.9 and 3999 Part 2.

BS 1010 - Specification for drains off taps and stop valves for water services.

BS 2494 - Elastomeric joint rings for pipework and pipelines. In conjunction with BS 1179, 3502, 3574, 4250, and 4947.

BS 2779 - Pipe threads. for tubes and fittings where pressure-tight joints are not made on the threads

BS 3284 - Polythene pipe (type 50) for cold water services. In conjunction with BS 21 and 5556.

BS 3505 - uPVC pressure pipes for cold potable water. In conjunction with BS 21 and CP 312.

BS 3605 - Seamless and welded austenitic stainless steel pipes and tubes for pressure purposes. In conjunction with BS 3600.

BS 3955 - Electrical controls for household and similar general purposes

BS 3974 - Pipe supports.
Part 1 & 2

BS 4346 - Joints and fittings for use with uPVC pressure pipes. In conjunction with BS 3505, 3506, 4576, 4660, 5481 and 6209.

BS 4368 - Compression coupling for tubes. In conjunction with BS 1706, 2051, 2779, 2871, 3601, 3602, 3605, 3643, 4368 and Din 2353.

BS 5114 - Performance requirements for joints and compression fittings for use with polyethylene pipes. In conjunction with BS 1972, 1973,2494 and 3284.

BS 5433 - Underground stop valves for water services. In conjunction with BS 21,61,864, 1972, 3284, 3885 and 5728 Part 1 and 2.

BS 6281 - Devices without moving parts for the prevention of contamination of water by backflow. In conjunction with BS 864, 2779, 2872, 4504, 5412 and 5413.

BS 1387 - Galvanised steel medium and heavy duty.

BS 6675 - Servicing valves (copper alloy) for water services. In conjunction with BS 864, 1400, 2871, 2872 and 2874.

BS 6700 - Design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages.

BS: 5481 - Unplasticized PVC pipes and fittings for gravity sewers. In conjunction with BS 2494, 4660 and CP 312.

BS: 5572 - Sanitary pipework. In conjunction BS 416, 437, 1188, 1387, 1710, 1973, 2871, 3506, 3868, 4118, 4514, 5254, 5255, CP3.

BS: 6283 - Safety devices for use in hot water systems. In conjunction with BS 864, 2056, 2779, 2872, 2874, 3075, 3457, 4504, 5412 and 5413.

BS: 8000 - Part B Section 3 - Above ground drainage

BS: 6367 - Drainage of roofs and paved areas

In addition to the above standards the works shall be in accordance with all local bye-laws, local municipality requirements and the manufacturers recommendations.

1.05 SUBMITTALS

A. Drawings - refer to Section 15010

B. Products - submit full manufacturers data for every item.

1.06 OPERATION AND MAINTENANCE DATA

A. Comply with Section 15010.

1.07 WARRANTY

A. Provide 12 month warranty in accordance with contract conditions.

PART 2 PRODUCTS

2.01 SOIL WASTE AND RAINWATER PIPEWORK

A. Pipework and fittings

1. All main soil, waste and rainwater stack pipes shall be installed in UPVC.

B. Vent / antisiphon pipework

1. All vent and antisiphon pipework pipes shall be installed in UPVC pipework .

2. The jointing of the pipework and fittings shall be by the use of solvent weld sockets and shall be carried out in full compliance with the manufacturer's recommendations.

3. Expansion joints and pipe support brackets shall be installed in accordance with the manufacturer's recommendations and BSCP312.

4. Sleeves shall be provided where pipes pass through walls or floors to allow free axial movement of the pipes. Sleeves shall be of a material compatible with the pipes they protect, non combustible and two pipe sizes larger than the pipe being protected and packed with mineral .

5. Where such pipes pass through fire compartment walls, floors or ceiling cavity barriers the pipes shall be installed with fire sleeves.

C. PVC branch soil waste and vent pipework

1. The soil, waste and vent pipework shall be UPVC TO BS4514.

2. The soil waste and vent pipework shall have solvent joints in general, with expansion joints where specified.

3. All pipework shall be adequately supported at the centers indicated in Table 13 of BS5572. All PVC pipework shall be supportering with extensioexpanding ragbolt fixings in the brickwork. Where the brackets are to be used as anchor points they will be made to grip the pipe by means of a rubber sleeve, and must support the pipe with additional studding and back plates to the duct wall. All horizontal waste pipework shall be supported on the manufacturer's screw-to-wall brackets.

4. All waste pipes shall fall from fittings to their respective main soil pipe so as to be self draining. Branch vent pipes shall rise towards their respective main vent pipe so as to be self venting.

5. All branch waste pipes to a range of fittings shall have an access provided on the pipe in an accessible position at the end of the run. All traps shall be adequately ventilated in order that the seal may be maintained.

6. Water closets shall be connected by flexible self sealing w.c. "Multikwik" connector, and shall be discharged into adjacent soil pipe.

D. PVC traps

1. All basins shall be provided with an appropriately sized PVC bottle trap to BS3934.

2. All sinks, etc, and other mechanical and specialist items of equipment, shall be provided with an appropriately sized white PVC "P" or "S" trap to BS3943 (unless such specialist item of equipment is supplied with its own integral trap).

3. Traps to be chrome plated where exposed to view, and in these situations a chrome plated cover plate shall be provided to mask the penetration of the waste pipe through the duct wall or structure. Approval shall be obtained from the local Public Health Authority of all types of traps that are intended for installation. All traps shall have a 75 mm water seal.

2.02. POTABLE COLD WATER SERVICES

A. PIPEWORK AND FITTINGS

1. Pipes:

   a. XLPE Pipes to JS 1021, 1022, 1023 / 1995 and matching fitting for Domestic cold water from water manifolds to Sanitary Fixtures.

   b. Galvanized Steel seam welded Pipes to BS 1387 medium weight and fitting to BS 21 for main Pipes and Booster Pumps installation.

B. SYSTEM DESCRIPTION

1. This section relates to the installation of potable cold water systems at all facilities.

2. Incoming pipeline from the municipality water mains shall be provided with a water meter located in an area free of wheeled access, but positioned to enable the meter to be read without entering the building served by the metered connection. The loction shall be as shown on drawings.

3. Internal Potable Water Installation:

   i. All cold water supply piping inside the building shall be made of XLPE unless other wise indicated on relevant drawings. The piping layouts are as indicated on the drawings.

   ii. Potable water supply is provided for all uses.

C. PIPEWORK SUPPORTS

Pipework supports and hangers will comply with Section 15511.

D. Thermal insulation shall comply with Section 15450.

PART 3 EXECUTION

3.01 SOIL WASTE AND RAINWATER PIPEWORK

A. Workmanship

1. Materials and workmanship to be of best quality and executed in accordance with the Specification, drawings and manufacturers recommendations.

2. Where any pipe is required to be shortened it shall be cut off square and cleanly with an approved pipe-cutting machine.

3. Where special joints or jointing materials are shown for pipes of any materials, they shall be of an approved type and manufacture, and the joint shall be made in accordance with the manufacturer's instructions, or as directed.

4. Responsibility shall be assumed to identify and install all necessary expansion couplings and fire sleeves throughout the installations.

5. All plant, pipes and fittings etc shall be thoroughly cleaned of all foreign matter before installation. Each section of the installation shall be clean and free from any obstructions whatsoever before proceeding with the next section of the installation.

6. All vertical soil, waste and vent pipes are to have access doors provided on each floor, above flood level of fittings served. Access to be provided in ducts to sanitary services. All vent pipes are to terminate 300 mm above roof level, with suitable weathering slate apron and vent cowl or copper wire balloon.

7. Flexible joints are to be provided wherever pipes cross expansion joints.

8. All soil, waste, vent and rainwater pipes shall be the size and positions indicated on the drawings to take the discharge from the branch waste and vent pipes, sanitary fittings and equipment adjacent thereto.

9. On completion the whole of the work is to be handed over in a sound and clean condition. In the event of any pipe being fractured from any cause whatsoever after having been (to all appearances) properly installed, responsibility shall be assumed in every instance and any such defective pipes shall be replaced for approval.

10. All pipework shall be erected to present a neat and orderly appearance, arranged parallel to or at right-angles to the structural members of the buildings, giving maximum headroom and shall not obstruct windows or doorways. Pipes shall bend round piers, projections and into recesses forming part of the structural works whether so indicated on the drawings or not. Pipework shall be erected such that there is a minimum clearance of 75 mm to finished floor level and a minimum clearance of 25 mm to finished wall faces.

11. Slopes of drainage system (gravity) shall be a minimum of:
    Foulwater - 1%
    Drain and rainwater pipes - 1%

B. The discharge pipework shall be so installed as to minimize the risk of blockage. Access covers and/or rodding eyes are to be positioned such as to enable maintenance equipment to be inserted into the system(s) to permit cleaning or clearing of all sections of the system(s).

The pipework system and fittings are to be installed so that broken or defective parts can be easily removed and replaced.

The discharge pipework shall ensure that there is no leakage of contaminated water or foul air into any building.

C. The work shall be set out and responsibility assumed for the accuracy of the same, and the position of all fittings shall be approved by the Employer's representative. When first setting to any work, consideration must be given to the work of other trades.

D. Responsibility shall be assumed for leaving all unfinished works in a safe conditions during the progress of the works.

All materials & equipment are to be installed and protected in such manner as to be adequately covered against damage and deterioration, and during the execution of the work the open ends of all pipework shall be temporarily plugged off by means of blank ends and compression caps respectively.

E. Vent pipe roof termination

1. Discharge stacks complete with domicil cages shall terminate not less than 300 mm above the roof, 900 mm above and not less than 3000 mm, measured horizontally from any window or air conditioner.

2. Where the stack passes through floors, ceilings and roofs, the openings are to be perfectly sealed-off by proprietary fittings. They shall terminate with neoprene aluminium weathering slate, weathering collar; and a balloon grating on 180° bend.

F. Connection to sanitary fittings

All outlets shall be trapped and provided with accessible and adequate means of removal and cleaning. The traps shall be designed to be self-cleaning all surfaces and joints are to be smooth.

1. All traps with outlets for pipes up to and including 50 mm shall have a minimum water seal of 75 mm.

2. Traps with outlets for pipes of over 50 mm shall have a minimum water seal of 50 mm.

The waste pipes to the various sanitary fittings shall be of the following sizes:

Wash basins	32 mm diameter
W.C's	100 mm diameter
Shower bath tray	50 mm diameter
Floor gullies	75 mm diameter
Sink	40 mm diameter
unit tubular tray	50 mm diameter

G. Self siphonage tests

The contractor shall undertake tests for self-siphonage and induced siphonage in branch discharge pipes by fitting each appliance to over flowing and then discharging by removing the plugs and discharging the W.C(s) at the upstream end of the discharge pipe. All seals are to remain in the traps.

The numbers of sanitary appliances to be discharged for this performance test are enumerated below:

Type of Use	Number of appliances of each kind on the stack	Number of appliances to be discharged simultaneously		
		9 litres WC	Wash basin	Kitchen sink
Domestic	1 to 9 24 to 24	1 1	1 1	1 2
Congested	1 to 24 5 to 9 10 to 13 14 to 26 27 to 39 40 to 50	1 1 2 2 3 3	1 2 2 3 4 5	

H. Testing and commissioning

1. All tests requested by Local Municipality or engineer on the entire installation shall be carried out, and all necessary appliance and equipment for this purpose shall be supplied.

2. Provision shall be made to carry out any test requested at any time during the progress of the works or after their completion.

3. Whilst phased testing may be carried out (which may or may not have been witnessed) it will be required to demonstrate the watertightness, alignment, and level and cleanliness of the whole installation seven days prior to the installation.

4. This requirement will be discharged by the applying a full running water test to the whole installation as described below and by the drawing through of a drain profile which will be provided to the required detail.

5. All tests shall be carried out in the presence of the Employer's representative, and seven days notice shall be given readiness to test any section of the installation. Test Certificates shall be submitted to the person witnessing the test, for their signature of approval, to the effect that the system satisfies the requirements of this Specification.

6. All sections of works must be pretested to satisfy that the system will pass the required test, prior to carrying out the main test.

7. The Test Certificate shall be required to be completed for all sections of the installation.

8. After erection and immediately prior to sealing in, all rainwater, main soil, waste, vent and branch soil, waste pipes, shall be checked throughout for obstructions and finally tested for soundness.

9. The above ground sanitation and rainwater pipe installation shall be subjected to two air tests, one of 75 mm water gauge for a minimum period of 15 minutes prior to connection of sanitary fittings and building in of pipework, and a second air test on completion of the system with all traps and WC's connected when the test pressure shall be 45 mm water gauge for a minimum period of 15 minutes. Water test according to Jordanian codes may be used as an alternative.

10. At start of testing sanitation and Rainwater Pipework shall be checked for alignment and stability; mechanical joints shall be re-torqued where necessary.

11. Access doors shall be removed, felt washers greased and doors replaced.

12. The whole system shall be rodded through with an appropriately sized disc type plus the allowance shall also be made for testing to the Local Authority requirements and for carrying out separate and independent tests if required.

13. The provision shall also be made for obtaining an acceptance test certificate form the Local Authority on completion of the works. The test for the Local Authority shall be allowed for as an addition to the tests required under this specification.

3.02. POTABLE COLD WATER SERVICES PIPEWORK

A. Product handling

1. All products shall be delivered in manufacturer's original protective packaging. All products shall be inspected at time of delivery for damage and for compliance with Specifications. Any products that are found to be damaged or not in accordance with the Specifications shall immediately be repaired or removed from the site and replaced. Repairs shall not be undertaken before the Engineer's review of Contractor's proposed action.

2. All products shall be handled and stored as recommended by the manufacturer to prevent damage and deterioration. The Contractor shall supply handling equipment such as lifting beams, reinforced canvas slings, protective padding, struts, cradles, etc., required to handle the products without damaging hardware or linings and coatings.

3. Products shall be protected against damage and the ambient conditions both during transport, site storage and immediately up to the time products are installed. Precautions shall be taken to protect the product from mechanical damage and the effect of sunlight heat, until the backfilling operations have been completed. All site storage areas shall be shaded.

B. Installation of pipework

1. Pipework from the water meter to the inside of the buildings where running below ground level shall be galvanized steel pipes (class B) and the distribution within Toilet, shall be XLPE pipes.

   Joints in buried pipework shall be kept to the absolute minimum. Marker tapes shall be laid 150 mm above the pipework. If valves are required, they are to be in a valve chamber with the surface box lettered to indicated what service is below them.

2. The underground pipework shall be laid in 200 mm of sand or stone free bedding material and wherever possible in straight lines to uniform gradients. The clearance between the pipework and footings of the buildings is not to be less than 200 mm. If less, the pipes shall be installed in a flexible sleeve.

3. All pipework shall run vertically or at an inclination of 1° to the horizontal to enable the whole system to be drained off either through the system or through a valve discharging externally with an air gap to prevent contamination by backflow. When the pipework is drained down, air is to be allowed into the system to prevent failure or damage to the hot water cylinder. A manual air inlet value shall be fitted to the high point in the system to achieve this.

4. Where pipes are run in walls, floors, etc., all pipework shall be insulated.

5. All pipework shall be erected to present a neat and orderly appearance, arranged parallel to or at right-angles to the structural members of the buildings, giving maximum headroom and shall not obstruct windows or doorways. Pipes shall bend round piers, projections and into recesses forming part of the structural works whether so indicated on the drawings or not. Pipework shall be erected such that there is a minimum clearance of 75 mm to the finished floor level and at least 25 mm to the finished wall faces.

6. All fittings shall, as far as practicable, be the same size as the tubes and pipes connected to them. Bushed outlets will only be accepted if the required outlet size of a fitting is not of standard manufacturer. Eccentric bushings and square tees shall be used where concentric bushing and pitcher tees might cause air to be trapped in the system. Elsewhere square tees shall be confined to dead-leg branches of domestic hot water supply systems and on cold-water branches to fitting or ranges of fittings.

7. Elbows shall be used, where practicable, in preference to bends Square elbows will not be permitted.

8. Pipework shall follow the contours of walls and shall be graded to ensure venting and draining. The clearance between pipework (or the insulation) and the wall and any other fixtures shall be not less than 20 mm.

9. Purpose-made sets or springs may be used where it is necessary to deviate from a straight run.

10. Sets or springs in tubes of 50 mm size and above shall be fire-made and tubes shall remain circular after setting.

11. Eccentric reducing sockets shall be used where changes of bore are made in runs of nominally horizontal pipework to facilitate air venting and draining.

12. Tubes shall be reamed after cutting and shall be free from burrs, rust scale and other defects and shall be thoroughly cleaned before erection. Open ends left during the progress of work shall be temporally closed with purpose-made metal or plastic plugs or caps, or blank metal flanges.

13. Where pipe passes through walls, ceilings, shall be provided. Pipe passing through flooring shall be provided with approved type floor and ceiling plates fastened securely to the pipe. The sleeves to be of the same metal as the pipe.

14. All entry and exit holes to or from a building for pipework services shall be sealed and plugged. For service conditions below 60°C the sealant shall be mastic compound, Above this temperature it shall be

silicon rubber. Where the pipework enters the building through a large hole or duct, a mild steel blanking plate not less than 6 mm thick shall be built into the walls of the hole or duct. The service pipes shall pass through clearance sockets welded to the plate and the space between pipe exterior and socket interior shall be sealed and plugged.

15. All pipes shall be secured by copper or copper alloy clips or brackets to allow for thermal movement and support at spacings not exceeding 300 mm for copper pipes up to 38 mm diameter and 40 cms for those up to 75 mm diameter.

16. Pipework of 75 mm size and larger subject to expansion and contraction and hung from supports shall be suspended on swivel hangers unless otherwise agreed.

17. Hangers for horizontal pipework shall be supported in accordance with the requirements of Section 15412 support, Hangers and Brackets.

18. Piping that is insulated shall be secured by clips that allow sufficient space behind the back of the pipe for the pipe insulation to be properly installed.

19. All pipework shall be installed so that the vertical distance between the discharge point and overflow level of the receiving appliance shall not be less than 25 mm for taps and/or fittings up to and including 20 mm and 70 mm for those over 20 mm to prevent contamination as result of backflow of water.

20. A 15 mm diameter washout pipe, discharging outside the building will be provided at ground floor level to drain the system. The top of the outlet is to be in excess of 70 mm from the ground or receiver.

B. Storage

1. All pipework shall be stored on purpose made pipe racks of welded construction and of sufficient strength to support the entire weight of the materials without any noticeable deformation. The racks shall be such that all pipework is clear of the ground.

2. Pipework fittings shall be stored within a well-lit container made compartmented racks or shelves. The fittings shall be separated by means of their type and size and laid out in an orderly manner for ease of identification.

C. System testing

1. The Contractor shall ensure that all pipework is watertight to the satisfaction of the Engineer and shall supply all pressure gauges, meters, hoses, pumps and other temporary supports, equipment and manpower necessary for carrying out pressure tests.

2. The Contractor shall, during testing, check the satisfactory operation of each valve installed under the Contract.

3. Before filling or pressure testing is started the Contractor shall re-check pipes and valves for cleanliness and shall re-check the operation of valves. The open ends of the pipes shall normally be stopped off by blank flanges or capped ends additionally secured where necessary by temporary struts and wedges.

4. Potable water system shall be tested with water to 1.5 times the normal system working pressure or 6 bar whichever is greater while uncovered but adequately anchored. The testing shall be carried out in sections if necessary. If a section should fail the test, the Contractor shall trace and repair all leaks and defects and retest the section before any further pipes or section of adjacent pipework are laid.

5. The system shall be filled with potable water and all air expelled. After the system has been completely filled, the pressure shall be steadily and gradually increased until the testpressure hasbeen reached. if any loss is recorded, repairs shall be made and the test re-run.

6. Written records of every test clearly identifying the tested system together with time of test and name of testing Engineer in tabulated format shall be submitted for review by the Engineer upon completion of the test.

D. Flushing and disinfection

1. Potable water pipelines shall be flushed with potable water after completion of pressure testing and before introducing disinfection.

2. Liquid chlorine, calcium hypochlorite shall be used for disinfection. Where chlorine is used, it shall be introduced only in conjunction with proper equipment and under the supervision of qualified personnel familiar with the physiological, chemical and physical properties of liquid chlorine and who are suitably trained and equipped for dealing with any emergency which may arise from it's use.

3. Potable water from a suitable source shall be injected with flow control at a constant and measured rate. The water shall receive a dosage of chlorine fed at a measured rate to ensure chlorine concentration in the water entering the pipe is maintained at a minimum of 50 mg/1. The chlorine residual shall be measured at regular intervals to ensure that the required chlorine concentration is maintained.

4. During the application of chlorine, valves shall be manipulated to prevent the treatment dosage from flowing back into the line supplying the water. Chlorine application shall continue until the entire pipeline is filled with chlorine solution.

5. After 24 hours retention, the chlorinated water shall be flushed out with potable water, until the chlorine concentration in the water leaving the pipeline does not exceed 21 mg/1. Chlorine residual determination shall be made to ascertain that the heavily chlorinated water has been removed from the pipeline.

6. Flushing water shall be discharged only to sites or into conduits. Discharges which cause damage, create nuisance or health hazard, or interfere with the work of others will not be permitted.

END OF SECTION 15410