

**REPUBLIC OF LEBANON
COUNCIL FOR DEVELOPMENT AND RECONSTRUCTION**

**Lebanese Emergency Assistant Project (LEAP)
Rehabilitation of Shelters (Public Schools)**

Batch 3: Lot 1, Lot 2, Lot 3 and Lot 4

in the Cazas of:

- 1. Baalbek**
- 2. Zahle**
- 3. West Bekaa & Rachaya**
- 4. Baabda, Aley, Chouf, Saida, Sour & Marjeyoun**

**VOLUME 2
SPECIFICATIONS**

**Part 2
Mechanical Works**

May 2026



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Consulting — Engineers



VOLUME 2
SPECIFICATIONS

Part 2
Mechanical Works

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CHAPTER ONE

GENERAL TECHNICAL REQUIREMENTS



1.0 GENERAL TECHNICAL REQUIREMENTS

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CHAPTER ONE

GENERAL TECHNICAL REQUIREMENTS

1. SCOPE, REGULATIONS AND STANDARDS

Specification Scope

This Specification covers the supply, installation and testing of all necessary equipment required for the complete Mechanical and Ventilation Services as described in the attached Contract Documents and incorporates standard descriptions for equipment and the installation to be provided under this Contract. The clauses shall be read in conjunction with the accompanying General Conditions of Contract, Scope of Works document, Schedules and Drawings.

The words 'as indicated', 'where indicated', 'unless otherwise indicated', refer to requirements identified elsewhere in the documents issued in connection with the Contract, e.g. on a drawing, in the specification or in a schedule.

The extent of the work shall comprise the system engineering, the whole labour and materials required to form a complete installation, together with such tests, adjustments and commissioning as prescribed in subsequent clauses and otherwise as may be required in order to provide an effective working installation to the satisfaction of the Engineer.

The words 'complete installation' in the foregoing clause shall mean not only the major items of plant and equipment covered by this Specification, but all the incidental sundry components that are required for the complete execution of the works; also for the proper operation of the installation, together with associated labour charges, whether or not these sundry components are mentioned in detail in the tender documents issued in connection with the Contract.

The Contractor shall comply with the latest applicable Standards of the followings:

- 1) ASME, American Society of Mechanical Engineers.
- 2) ASHRAE, American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.
- 3) ANSI, American National Standards Institute.
- 4) CIBSE, Chartered Institute Of Building Services Engineers.
- 5) ASTM, American Society of Testing Materials.
- 6) AMCA, Air Moving and Conditioning Association.
- 7) NEMA, National Electrical Manufactureres Association.
- 8) NFPA, National Fire Protection Association.
- 9) BS, British Standards
- 10) ASPE, American Society of Plumbing Engineers.
- 11) DIN Deutsches Institut Für Normung
- 12) FM, Factory Mutual.
- 13) IBR, Institute of Boiler and Radiator Manufacturers
- 14) ISO, International Standardization Organisation.



Compliance with Regulations

The work shall comply with all relevant stringent statutory instruments and regulations, applicable to local codes and regulations, at the date of construction and in particular with the following:-

The requirements of the Local Authority Planning Department, District Surveyor or equivalent.

The requirements of the Local Fire Officer. The
Local Water Authority Regulations.

All installations and materials used for the works shall be carried out and provided in full compliance with the appropriate Specifications or Codes of Practice issued by the above mentioned institutions.

Alternatively the installations and materials may be carried out and provided to other equivalent internationally recognized standards provided the standards are acceptable to the Engineer and the relevant local Authorities.

2. INSTALLATION GENERAL

General

The Contractor shall allow in his Tender for all labour, materials, tools, plant and equipment required to supply, deliver and erect all equipment, pipework, fittings, etc., described in this Specification and indicated on the drawings to form a complete working facility including tests and commissioning. This shall mean not only the main items of plant and equipment but also all incidental sundry components with their labour charges necessary for the complete execution of the works.

The Contractor shall ensure that his work is installed in the correct sequence. The Contractor shall be responsible for ensuring that all sections of the work and all materials are compatible with one another. The Contractor shall check and ensure that all of the equipment and works offered by him will fit into the space provided in the building(s) including the limited entry through doorways and into ducts.

Operating Conditions

All equipment will be required to operate successfully in the climatic conditions prevailing in the locality. Equipment, even if normally operating in air conditioned spaces, may be required to operate at times when the air conditioning system is not being used. Under such conditions all equipment must operate satisfactorily and still have a working life comparable with that expected from top quality equipment operating in more temperate conditions.

Workmanship and Materials

Materials and workmanship generally shall be of the highest standard and the Specification shall be closely adhered to. Materials shall be brand new bearing stamped ratings as required.

Where materials or equipment are not described in detail they shall be of the best quality available and shall comply with the appropriate Standards. The Contractor shall, if required, submit drawings or samples of such materials or equipment to the Engineer for his approval before use on the Contract works.

Samples of Workmanship

The Contractor shall provide the following samples of workmanship for the approval of the Engineer:-

Samples of pipework.

The samples shall be submitted to the Engineer as soon as possible after the order for the work has been placed so that the subsequent delivery of the associated equipment will not be delayed. No orders shall be placed until the Engineer has approved the samples.

All samples shall be correctly labelled and forwarded to the Engineer's office or to the site as directed by the Engineer. At least 14 days shall be allowed for approval of samples by the Engineer.

Unless otherwise stated, approved samples shall be retained on site by the Engineer, who will reject all such materials, which do not correspond with the approved samples. Rejected materials shall be removed from the site immediately.

Where the Engineer carries out an inspection of materials before they leave the manufacturer's premises prior to being delivered to the site, the Engineer shall be at liberty to reject any such materials after delivery should he consider them to be in any way unsatisfactory notwithstanding the preliminary inspection and tests at the manufacturer's premises.

The Contract shall include for the cost of remedial work or tests and inspections necessary due to unsatisfactory material and/or equipment.

3. NOISE AND VIBRATION CONTROL

Anti-Vibration Mountings

All equipment containing moving parts generating noise and vibration shall be mounted upon specially designed vibration isolators. All service connections to such equipment shall include customised flexible connectors and shall be installed in such a way as to prevent transmission of noise and vibration to the structure, other areas of the building or to other items of equipment.

Where required, mountings shall be provided with a positioning or restraining device, which will prevent the equipment position changing if its load changes, for example, during draining down of the equipment, or other maintenance.

Mounting selection should allow for any eccentric load distribution or torque reaction, so that the design deflection is achieved on all mountings under operating conditions.

4. INSPECTION, TESTING AND COMMISSIONING

General

All the works provided as part of this contract shall be inspected, tested, regulated and commissioned in accordance with all relevant Standards, Specifications and Codes of Practice and the details given in the specification and/or as indicated on the drawings, to the entire satisfaction of the Engineer.

All installations shall be inspected and tested in sections as the work proceeds and on completion as composite systems and it shall be noted that the Engineer may require to inspect or test any equipment during manufacture at the manufacturers works. All necessary arrangements shall be made as part of this contract.

All tests shall be arranged in co-operation with the Engineer and the Engineer and other interested parties shall be given seven (7) days notice in writing of the time, location and nature of the test to be performed. No test shall be considered valid unless the Engineer is present.

All necessary skilled and unskilled labour shall be provided for attendance duties during the test (including pre and post test activities) and the test medium shall be provided and subsequently disposed of except where specifically stated otherwise.

Any defects occurring at any time during the test duration shall be made good and a complete re-test shall be carried out, all at no cost to the contract.



Where failure during a test, inspection or commissioning process results in damage to the building fabric and/or any services or requires subsequent builderswork in connection to be carried out, then the remedial work shall be carried out at no cost to the contract.

Where valve and flange boxes and access covers and de-mountable ceilings need to be removed and replaced during the commissioning of the works, these shall be removed, protected from damage and replaced in good order by the Contractor.

The Contractor shall arrange a progressive regulation testing and balancing programme to achieve the Date of Completion of the Contract Works.

During the Commissioning Period the Contractor will hold commissioning meetings, which will be attended by the Engineer. The Senior representative of the Contractor's site and Management staff shall attend the meetings which will be held at fortnightly intervals.

The meetings may continue after issue of the 'Taking Over Certificate' for as long as necessary to deal properly with any outstanding works and defects in the Contract Works.

All representatives present during inspection, testing and commissioning shall be fully conversant with the system concerned and the method of system and instrument operation. Manufacturers or specialist contractors representatives shall attend where specifically indicated elsewhere in the Specification or where necessary to ensure full service and co-operation is available to the Engineer to enable the works to be tested and commissioned in accordance with the requirements of the Specification.

All necessary precautions shall be taken to safeguard against frost damage during inspection, testing or commissioning. Any damage so caused shall be made good at no cost to the contract.

All tests shall last for the minimum time period stated or for a longer period if necessary to ensure all sections have been fully examined as required by the test.

All performance tests shall be carried out initially prior to the Engineer being requested to witness the tests and thereby avoid unnecessary re-tests being required.

Provision of Test Points:

The Bills of Quantities do not separately enumerate test point in pipework and ductwork installations. These are deemed to be included in the pipework or ductwork installation. The Contractor shall allow sufficient points for the correct and complete regulation, testing, and commissioning of the installations. All test points shall be indicated on the Working and Record Drawings.



All test points shall be provided which are necessary to carry out the specified tests and commissioning requirements including facilities for temperature, pressure, pressure drop, volume flow, and other relevant conditions to be measured. Such points shall be fitted with removable plugs, flanges or other approved devices appropriate to the service concerned. Permanent test or reading points shall be provided only where specified elsewhere.

Provision of Regulating Valves and Dampers:

Balancing valves and dampers shall be included on every main, branch and sub circuit to facilitate system commissioning. All such devices shall be identified on the Working drawings and submitted for approval.

Testing of Soil, Waste, Vent and Rainwater Pipework

All works which are to be concealed shall be tested before being finally enclosed, a final test shall be made upon completion for soundness and performance strictly in accordance with the British Standard 5572 for Sanitary Pipework, or equivalent and shall be to the entire satisfaction of the Engineer.

Cleaning and Flushing Out of System

Prior to setting systems to work all systems shall be thoroughly cleaned and pipework systems shall be flushed out.

Water installations shall be flushed out using cold water at maximum mains pressure.

Steam and gas installations shall be thoroughly scavenged with steam or compressed air.

During the cleaning process the flow shall be interrupted occasionally to dislodge debris.

Tanks and vessels shall be similarly cleaned.

Water services for domestic use shall then be chemically cleaned by Chlorine treatment as described elsewhere, tested and set to work to comply fully with the UK Department of Health Code of Practice on the Control of Legionellae, and any other recognised recommendations to prevent the development of legionellae bacteria.

All cleaning and flushing out operations shall be conducted in the presence of the Engineer.

Following the cleaning and flushing out operations a signed certificate shall be provided confirming that the systems have been adequately and satisfactorily flushed through and cleaned. This certificate shall be countersigned by the Engineer and forwarded to the Engineer. No commissioning whatsoever shall take place until the Contractor has received written acknowledgement of receipt of this certificate from the Engineer.

Commissioning of Services

All systems shall be filled with the working fluid, vented as necessary, and brought to operating conditions and the flows then regulated to the design values.

The balancing and testing of systems to verify performance of the engineering systems shall be carried out by a team of experienced specialist Balancing and Testing Engineers who shall be responsible to the Contractor for the complete balancing and testing of all systems and the production of a complete log of all tests including any comments they may wish to make for improving the performance of the installations.

Following regulation and balancing procedures all plant systems shall be put into operation and examined to ensure that the installations are operating correctly.

5. HANDOVER PROCEDURES AND DOCUMENTATION

Operation and Maintenance Instruction Manuals

Three copies of a manual, (or series of manuals if required by the extent of the installations) shall be provided 1 month prior to the anticipated completion date of the contract and shall contain complete operational and maintenance instructions for the various installations.

The purpose of the manuals is to:-

- (a) Familiarise maintenance staff with the overall philosophy of the project.
- (b) Describe the Mechanical and Public Health Services systems and their inter-relation with other systems.
- (c) Act as central point of reference and as such, to contain specific references to Record Drawings and Vendors/ Manufacturers literature to enable the reader to easily locate further information.
- (d) Give all the specific information and instructions including safety information, to enable an operator, of technician level, to manually start and run each system at Local Control Station and from any Central Monitoring Control Station included in the Contract. This shall also include procedures for start-up of systems after an emergency shutdown.



- (e) To give details of action to be taken by operators in event of fire, plant malfunction or alarm condition occurring.
- (f) Provide information and warnings necessary to ensure the health and safety of the general public together with operating and maintenance staff.

The manual(s) shall be agreed in draft form with the Engineer and shall be primarily sub-divided into (a) instructions relevant to items of plant or equipment and (b) instructions relevant to complete systems.

The plant and equipment section shall contain the manufacturers printed maintenance and operator's instructions relevant only to the particular item of equipment concerned. General catalogues will not be acceptable.

The section dealing with complete systems shall be sub-divided into each service with a ready means of reference and detailed index. The function and manner of operation of each system shall be clearly described together with illustration and line diagrams in schematic form showing the location and function of control valves, items of equipment and which spaces or areas are served by these items. The colour coding and identification systems employed shall be explained, and a full lubrication schedule for all lubricated items of plant and equipment shall be included.

Operation and Maintenance charts shall be included for each plantroom area and shall provide essential information and reference data for daily running checks together with weekly, monthly and annual maintenance procedures.

Where more than one system can be shown on a single chart without loss of clarity this will be acceptable. Complex systems must be shown on individual charts.

A special section shall be included in the manual for dealing with fault finding routines and emergency procedures in case of plant or system malfunction.

All equipment shall be scheduled in the document including a complete valve schedule with all items identified in accordance with the plant reference provided on the item of plant or equipment and the as-installed drawings.

A complete itemised list of essential and secondary spares together with the manufacturers ordering reference numbers shall be provided. A list of plant manufacturers names, addresses and telephone numbers shall also be included.

The Operation and Maintenance manual(s) shall include copies of all manufacturers works test certificates for plant items such as heat generating plant, heat exchangers, calorifiers, refrigeration machines, tanks, vessels, motors, fans, pumps, controls, electrical and other like equipment. In the case of fans and pumps copies of the manufacturers characteristic curves for the actual unit fitted shall be supplied.

Labels and Identification

All valves controlling mains and sub-circuits shall be provided with a treffolyte label not less than 75mm x 50mm x 1.6mm thick with a reference number clearly engraved and coloured red. Labels shall be securely fixed to the valve body, handle or spindle in a position where they can be easily read.

The numbers on the valve labels shall refer to those on the "as installed" drawings and valve charts.

All items of plant, motor starters and isolators shall be labelled with their corresponding plant reference engraved on a treffolyte label securely fixed to the item in a prominent position. The plant reference shall correspond to that indicated on the "as installed" drawings and plant schedules in the operation and maintenance manuals.

In addition items of plant such as fans, pumps, calorifiers, etc. shall bear a metal label fixed by the manufacturer giving the makers name, date of manufacture and manufacturer's serial number, test and working pressures, duty, kW, phasing, hertz, speeds, BS number, etc. as appropriate to the item of plant such that its origins and details may be easily traced at a later date.

Schedule of Outstanding Items and Defects

Until the installation is finally taken over as complete, the Contractor shall be responsible for any necessary protection of the installation and electrical safety requirements.

On the completion of the Contract an inspection of the installation will be made by the Engineer. During the inspection a schedule of outstanding items or defects will be provided by the Engineer.

All items included in this Schedule shall be attended to within fourteen days of the date of the inspection.

Certificate of Practical Completion

When the Contractor has demonstrated to the Engineer and to the Engineer's complete satisfaction that the works are operating as intended within the design limits and tolerances of the manufactured items, then the Engineer will issue a Certificate of Practical Completion subject to the clearance of any outstanding items or defects within 14 days of the date of the Certificate and the responsibility for the operation of the plant will pass from the Contractor to the Employer or as otherwise agreed with the Engineer.

This Certificate will not be authorised until all items in this clause have been cleared to the Engineer's satisfaction.



Responsibility During Period of Maintenance

The Contractor shall include for making checks of the Thermal Environment in the building when occupied and in use by the Client and for making normal adjustments to the commissioning and testing settings to tune the installations to the actual building usage.

The Contractor shall include for making checks of the water flow capacities on domestic water services in buildings when occupied and used by the Client and for making normal adjustments to the commissioning settings to tune the installation to the actual building usage.

Testing of Plant Capacity and Efficiency

A heating test shall be carried out under maximum load and design conditions to check the actual plant capacity as supplied and installed. Where possible, thermal efficiency checks shall be made. These tests shall be carried out during the year following practical completion.

Adjustments During Course of Period of Maintenance

The Contractor shall include for making a further visit to the site before the end of the Period of Maintenance to check over and, if necessary, re-adjust the system.

Certificate of Making Good Defects

The Contractor shall carry out a thorough detailed examination of the installations between the eleventh and twelfth month of the defects liability period and shall put right any outstanding works or defects that might have occurred under the Defects Liability Period in the Conditions of Contract.

On completion of such works, and agreement that the requirements of the Conditions of Contract and Specification have been met, the Engineer will recommend to the Architect that a Certificate of Making Good Defects can be issued.

6. RE-MODELLING

Contractor, at Contractor's expense, will be responsible for any items not included in bid, but are shown on plans or specified in the General Specifications or required by local codes and ordinances.

In order to do so the contractor shall inspect all the existing mechanical prior to pricing. All work to conform to all applicable codes. Contractor shall provide all necessary Mechanical works, maintenance, cleaning, relocation or removing, testing & commissioning for the existing Mechanical system to ensure properly working system. Work performed under this section shall result in complete and updated plumbing systems. All material, labor, equipment, and other items to complete the plumbing system as outlined in Bid Document shall be furnished.

All plumbing work, whether existing and to be kept, or new installation performed under this contract SHALL BE INSPECTED, tested, and approved by the Consultant.

Cutting, patching, and cleaning shall be done as necessary by the contractor performing the work; however, special permission shall be obtained from the Consultant before cutting structural members of finished construction.

The plumbing contractor shall clean away all debris caused by his work at the close of each work day, and upon completion of the job.

A salvaged plumbing fixture and upon approval by the Engineer, shall be handed to the Owner representative.

Upon removal of old fixtures, contractor shall inspect all cleats, supports, and floor joists to assure a solid and secure installation. If unforeseen repair or replacement is needed, contractor shall notify the Engineer.

The contractor shall further determine if a change in the location of any plumbing fixture and/or pipes is necessary for proper functional replacement of the unit, and to meet codes.

Repair All Existing Supply lines.

Furnish and install all labor and materials necessary to repair all existing supply lines in and under structure. All work to conform to local plumbing code. Examine all supply lines in and under structure for proper operation. Replace all galvanized.

Repair All Existing Drain lines.

Furnish and install all labor and materials necessary to restore all drain lines in and under structure to good condition (no leaks and fast positive drainage and venting) in accordance with the Code. Care to be taken to not damage any plumbing fixture or other pipes.

Reseat Toilet

Remove toilet and old seating gasket. Clean area and reseat toilet with new wax seal. Make all connections and leave free of any leaks. Installation shall meet all local plumbing codes. If Contractor shall uncover a lead flange once toilet is removed, the Contractor shall notify the Engineer for a decision on whether the flange should be replaced.

Toilet

Replace existing toilet with new first quality vitreous china toilet. Installation shall be complete with new toilet seat and all required plumbing connections. Plumbing equipment and materials and workmanship shall comply with local codes and as per the other sections of this Specification.

Color and style of fixture to be selected as per the specification.

Replace Flush Mechanism

Remove deteriorated flushing unit and install a suitable adaptable unit. All new seals to be installed with new unit. After replacement, unit shall function properly with moderate pressure and completely shut-off when optimum water level is reached.

Repair Faucet

Repair existing defective faucet(s) as set forth in Bid Document. Restore to a watertight condition in accordance with code. Any replacement handles or equipment shall conform to original style as closely as possible. Contractor shall take all necessary precautions to prevent tool scarring or damage to fixture or other accessories. Work shall include replacement of all worn internal components. Final result shall be a faucet that operates easily with no leaks or drips.

Drains, Wastes, Vents, Traps

Furnish and install all required drains, wastes, vents, and traps. Installation shall meet all local plumbing codes. Stack shall extend through roof and be made waterproof. Repair all scarring. When a new plumbing fixture is installed, or an existing fixture is relocated, all work shall conform to local plumbing code. Snake drain lines - where called for in the work write-up a professional contractor shall be used to snake the entire sewer system including all clean outs, roof vents and yard line to the street.

Kitchen Sink

Furnish and install double well, stainless steel sink with sound dampening. Replace all waste to the wall including baskets strainers. Work shall include removal and reinstallation of all items not replaced in the Bid Document.



Vanity/Lavatory/Faucet Top

Remove existing vanity and lavatory. Repair/replace wall surface as needed. Size shall be as specified. Include new supply and waste lines to wall. Unit shall be complete with vented drains, proper traps, cutoffs and washer less faucets.

Replace Existing Drain

Furnish and install all labor and materials to replace existing drain. If existing drain is not vented, provisions shall be made to vent the replacement drain. Size and slope shall conform to the current plumbing code.

Replace Existing Supply Lines

Furnish and install all labor and materials necessary to replace supply lines as indicated in the Bid Document. Piping with all necessary fittings, hangers, supports, and all accessories needed to run piping in a workmanlike manner in conformance with the plumbing code.

Sump Pump

Furnish and install all labor and materials necessary to install sump pump as specified in Bid Document. Pit shall be located at lowest corner of basement. Materials included are sump pump pit, rigid outflow pipe, and electric hook-up. Drainage from sump pump shall not be connected to the sanitary sewer. All work shall conform to local codes in particular if the repair of the existing pumps is required.

Floor Drain Cover

Furnish and install new floor drain cover on existing drain. Cover should fit snugly.

Demolition

Where required, demolition shall be performed without damage to adjacent existing work. All existing fixtures, equipment and piping which have been removed or disconnected by the contractor shall become the property of this contractor and shall be removed from the site at his expense. All remaining lines that are not to be reused shall be deactivated and properly capped and plugged in basement or crawl space areas.

When concrete is removed in a basement floor for access to underground pipes, concrete shall be replaced.



CHAPTER TWO **BELOW GROUND DRAINAGE**



2.0 BELOW GROUND DRAINAGE

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CHAPTER TWO **BELOW GROUND DRAINAGE**

1. GENERAL PREAMBLE

Description of Works

The belowground drainage shall comprise a separate system of drainage as described herein.

Where drainage is located beneath the building ground floor slab the pipe work shall be suspended from the underside of the concrete slab, where located externally pipe work shall be below ground installed in trenches as described.

Scope of Work

The Contractor shall carry out all works described in these documents strictly in accordance with this Specification, relevant Standards and Codes of Practice and the requirements of the Local Authority.

Connect the foul drainage installation to the Local Authority Foul Sewer, at a point external to the site, as indicated on the site layout plan.

Connect the surface water drainage installation to discharge into the drainage system, if it exists, at a point external to the site, as indicated on the site layout plan.

Co-ordinate the works with the Local Authority in accordance with the building programme and ensure the least inconvenience to the site or surrounding areas.

Strictly adhere to the materials described within this Specification.

Do not commence the drainage works until all materials are delivered to site.

Drainage Termination (Internal)

The underground drainage installation shall in general terminate at Lowest Floor Slab Level.

Where drainage pipe work is indicated as passing through a structural retaining wall connecting to a suspended pipe work installation include the suspended pipe work to form part of the drainage works and terminate at the Floor Slab level immediately above the point of entry through the retaining wall.



Drainage Termination (External)

The drainage installation shall terminate at and include the connections to the Local Authority Sewer.

Drainage By-Laws and Regulations

The Contractor shall state which standards are to be used and submit a copy of the relevant International Standards to the Architect/ Engineer or his appointed representative at the commencement of the contract.

Notification for Inspection

Give a minimum of 24 hours' written notice to the Architect/Engineer or his appointed representative for the purpose of inspection and measurement whenever sections of:-

- a) Setting out is completed;
- b) Excavations are completed;
- c) Concrete and/or granular beds are laid;
- d) Drainage installed ready for testing;
- e) Compaction/Backfill is to be carried out;
- f) Sewer connections are complete;
- g) Final testing/commissioning;
- h) Simultaneous discharge test.

No further work shall be carried out until each stage of the work has been inspected approved and signed off.

Existing Drain/Sewers/Manholes

Check invert levels of all existing drains, sewers, or manholes before laying new drains, notify the Architect/Engineer or his appointed representative if the declared invert levels are found to be inaccurate.

Where it is necessary to cut into any live drain within the boundary of the site carry out the works causing the minimum disruption to the existing drainage system while the connection is being made.

Check existing drains crossing the area of the site operations, ensure they do not serve other buildings outside the site boundary and either remove and plug off at manholes, or divert clear of the works as directed by the Architect/Engineer or his appointed representative.

Check all drains to be abandoned and record the locations on drawings before filling is carried out.



The Contractor shall indemnify the Employer against all risks connected with any existing pipe mains, drains, sewers and the safety thereof and for all damage caused to them through, or in consequence of, site operations during the construction of the works.

Local Water Authority Sewers

Obtain written consent from the Local Authority before cutting into any Public Sewer.

Confirm to the Local Authority the requirements for the sewer connections, giving size, line, level, and location and establish a programme for the work to be carried out, make necessary arrangements for traffic diversions, road closure order, and any other requirements to comply with the programme.

Drainage, Water, Electric, Telephone Supply Authorities

Give information regarding the line and level of these services and co-operate with the Local Authority, Water, Electricity and Telecommunications Authorities, or any other authorized firms to enable them to provide and lay mains, cables, sewer connections etc., along routes on or adjacent to the site without any undue delays or interruption.

No claim will be allowed for any delay or interference which may be occasioned by this work.

Ensure the various authorities or companies lay their mains in the given positions and/or make provision to enable them to do so at a later date without disturbing the structure of carriageways and/or paved areas, supply drawings showing the runs and positions of such mains to be included as part of the contract.

Ensure supply authorities, companies and/or their agents properly consolidate and reinstate all trenches and other excavations opened by them to ensure the safety of the persons passing adjacent to or within the area of site operations.

On-Site Drainage, Sewers /Water Mains, Electric/Telephone Cables etc.

Take all precautions to avoid damage to water, drains, sewers, culverts, telegraph, telephone or electric cables, ducts or other apparatus that may be met in the course of excavation, together with any walls, buildings or other properties adjacent to the area of operations. Maintain and protect during the progress of the works.



When any water mains, drains, cables etc., are encountered, inform the Architect/Engineer or his appointed representative and obtain information as to the necessary supports or protective measures which may be necessary in accordance with the requirements of the respective Authority or Company, including approval to any permanent works that may have to be put in hand for the purpose of support, protection or deviation.

The cost of providing temporary supports, protection of pipes, drain cables, etc., shall be included and measured as part of the Contract.

If the Architect/Engineer or his appointed representative on inspection of any existing pipes, drains, cables etc., considers that they are in a condition requiring repair, renewal, deviation or other work to maintain their efficiency, and such work not being considered due to any damage caused by site operations, he shall request remedial works be carried out to make good any such damage.

Invert Levels

Invert levels are generally given at all main points of intersection and changes of direction determine all intermediate levels as required by calculating the gradients between given invert levels.

Setting Out

Where the drainage works are to connect directly to a soil, waste or rainwater system the Contractor shall be responsible for:-

- (a) Checking all dimensions with his Plumbing Sub-contractor to ensure that all connections relate accurately to his "Sanitary Pipe work Installation Drawings";
- (b) Ensuring all dimensions relate correctly to the site setting out and building dimensions shown on the latest Architect/Structural Engineers drawings; and
- (c) Relating to the specified sanitary fittings dimensions shown on the Architects Sanitary Fitting Schedule.

Report any uncertainty as to the accuracy of the dimensions or tolerances before the works are carried out, check the drawings and all associated details in sufficient time to enable any adjustments to be made and necessary instructions to be issued. Unless sufficient time is given no claim for delay will be considered.

2. MATERIALS

General

Provide all pipe work, fittings and materials to the entire satisfaction of the Architect/Engineer or his appointed representative in accordance with British Standard Specification or equivalent International Standard.

Standards

EN1401 UPVC Pipes & Fittings for below ground gravity drainage & sewerage.

OR APPROVED EQUAL to European norm i.e. Din, NF, American Standards
...Etc.

All materials or article required to comply with a shall incorporate the stamp of the registered certification "kite mark" of the Standard Institution, or alternatively, copies of test certificates shall be furnished by the suppliers or manufacturer indicating compliance with the relevant Standard.

Manhole/Inspection Covers and Frames

Covers and frames shall be either solid or recessed top as described and conform to the following requirements:-

Grade B - Medium Ductile Iron covers and frames shall withstand a test load of 250kN used in areas subject to a wheel load of up to 5.00 tones with non-rocking covers and/or machined faces.

Pre-Cast Concrete Manholes

Shall conform to BS.5911, or equivalent be "Kite Marked" and consist of concrete aggregate chamber rings incorporating "Ogee" joints. Manholes exceeding 1.800m. in depth shall have either a reinforced concrete reducing slab, or a straight back taper with pre-cast concrete shaft rings.

The rings shall have rebate joint for watertight construction.

Provide a pre-cast reinforced concrete cover slab with clear opening to suit the specified manhole cover.

The opening in the concrete cover slab shall be set over galvanized step irons cast into the concrete manhole rings by the manufacturer.

The chamber rings shall be set on an "in situ" concrete base slab incorporating the main drainage channel, and branch drain connections.

Submersible Sewage Pumps

Supply and install submersible sewage pumps where shown on the drawings and of indicated capacities and heads.

The pump and motor housing form a compact integral unit and shall be of the completely submersible type. The motor shall be cooled by the fluid in the sump.

The pump/motor housing shall be complete with:

- Lifting Yoke
- Electrical terminal board, and submersible electric flexible cable between pump motor and control unit.
- Ball bearings good for three years continuous operation
- Stainless steel shaft with precision ground finish.
- Stator, cast iron stator housing and class F stator insulation.
- Rotor.
- Statically and dynamically balanced non-clog impeller with a minimum passage cross-section of 2 ½" (65mm).
- Cast iron pump.
- Base and Stainer.
- Tungsten carbide shaft seals to withstand heavily contaminated liquid.
- Gate valve and check valve at pump discharge.

The wet well housing the pump/motor assembly shall be complete with the following accessories:

- Grouting-in cast iron frame with cast iron cover plate and upper guide rail bracket.
- Cable holder to collect power cables and permit adjustment of height of level regulators.
- Discharge connection with lower guide rail bracket.
- Automatic control unit with level regulator to start and stop the pumps automatically. The contronunit shall also alternate the operaof the pumpsto equalize their operating time. In case of failure of one pump; the control unit shall initiate an alarm and automatically start the other pump.

A high level floats, when reached shall automatically initiate an alarm.

The level regulators (float switches) shall be of polypropylene housing with eccentrically positioned lead weight, mercury switch and 13 meters waterproof cable.

The control unit shall be complete with circuit breakers, starters and indicating lights.

3. WORKMANSHIP

Setting Out

Before laying new drains check existing datum reference points, invert levels, and positions of existing drains, sewers, inspection chambers and manholes with the levels indicated on the Contract Drawings, and relate to building foundations, piles or other features to which the works are related.

The checking of any setting-out, line or level by the Architect/ Engineering of his appointed representative shall not in any way relieve the contractor of his responsibility for the correctness thereof.

Connections to Sewers

Make arrangements to connect new drains to existing sewers to the satisfaction of the Local Authority.

Excavation

Carry out all excavation work arranging to visit site and to judge the extent of works, and site/ground conditions, check information on site reports, trial pits, borehole reports and establish ground conditions and strata.

Main excavation of drain trenches on any section of the works shall not be commenced until a full supply of pipes, fittings and materials is available for completing that section.

Clear the working area of all vegetation, rubbish, debris, contaminated earth, concrete, tarmac etc., and include for excavation in whatever type of soil is encountered.

Where top soil is to be replaced over backfilled trenches allow for removal and place clear of the main excavated material. Replace in a single layer at completion of the backfill operation and leave proud to allow for settlement.

Carry out in open cut all excavations to the lines and levels having a minimum size to permit accurate setting out, and installation of the works, including trench sheeting, efficient refilling of voids with approved material, all placed and compacted in accordance with this specification.



Formation of Excavations

Excavate immediately before laying bedding or pipe work.

Remove mud, rock projections, boulders and hard spot. Replace where necessary with approved filling material well consolidated, local soft spots to be stabilized by tamping in bedding material.

Excavations taken out to a greater depth than necessary shall be filled to the required levels with concrete or granular bedding material as directed by the Architect/Engineer or his appointed representative. The cost of additional fill material shall be deemed to be included in the rates of excavation.

The bottoms of all excavations, trenches and headings shall be inspected and approved by the Architect/Engineer or his appointed representative before any concrete or granular bedding is deposited or pipes laid.

Where a true trench formation is required and this cannot be achieved by excavation, a true trench formation shall be achieved using filled bagging or alternatively filled concrete blocks to give a trench profile as described in the Excavation clauses of this specification.

Transport of Spoil

Vehicles and containers used to transport excavated materials from site shall be constructed and loaded to avoid spillage, level all loads before commencement of journey.

Any spillage that occurs outside the boundary of the site shall be cleaned away at the end of each working day.

Laying Drainage Pipe work - General

All pipe materials including concrete, granular material for bedding and surround to be in accordance with the Materials Specification of this document. All pipes, fittings and associated materials to be installed strictly in accordance with the manufacturer's recommendations and technical installation manuals.

Check all pipes and fittings, and test for soundness. Do not use damaged pipe work or fittings in the work.

Cut all pipes square and clean, using approved pipe cutting apparatus or chain cutters.

Road Gully Construction

Construct 150mm thick concrete base and set gully pot truly level, making allowance for finished levels, thickness of grating and frame, and two courses of engineering brick.

Manholes/Inspection Chambers General

Construct all main drainage lines, channels, step irons, benching and branch connections in the specified pipe work and materials with all branch connections discharging in the direction of flow.

Set the concrete cover slab to suit the completion of the surround levels, adjust as necessary, and make allowance for the thickness of the cover and frame and the required courses of engineering bricks for level adjustment.

The depth of the main open channel shall not be less than half the diameter of the main drain line unless otherwise indicated on the Contract Drawings, use vitrified clay channels on pipes up to and including 300mm diameter and joint in sand/cement mortar 1:2.

Where level invert channels and branch connections are required use level invert branch vitrified clay channels or form in situ granolithic concrete 1:1 trowelled to formation and smooth finish.

On branch channel bends up to an included 150mm diameter install three quarter section curved bends in the direction of flow set to discharge over the main channel invert joint in sand/cement mortar 1:2 and form benching.

On branch channel bends over 150mm diameter form in in situ concrete as part of the benching and finish in 25mm thickness granolithic concrete 1:1 trowelled smooth and curved in the direction of flow.

When installing the main drainage line the channels or chambers within the manholes/inspection chambers must be installed at the same time to give continuity of line and to ensure the correct setting of branch connections.

Build galvanized step iron into manhole/inspection chamber walls as work proceeds at 300mm horizontal and 300mm vertical centres directly above the benching as shown on the Contract Drawings, carried up to and within 225mm of the cover and channel benching.

Fix covers and frames in position, bed all frames in sand/cement mortar 1:3 maintaining cover level with surrounding areas, providing an angled fillet to hold frame square to the brick base where covers are located in temporary positions held secure with angled filled and rest to suit final finishes.

Keep all covers in their respective frames at all times to prevent rocking and deformation of frame.



Set light duty frames with covers in position to prevent distortion of the frame.

Fill recessed pattern covers with suitable material to match surrounding areas, the infill material to be well consolidated and tamped, all finished truly level with smooth trowelled finish to paved areas, smooth recessed for filed finish, and tamped finish to rough textured surface.

Pre-Cast Concrete Manhole Construction

Refer to "Manholes/Inspection Chambers General" for description of all associated works.

Construct the pre-cast concrete rings on an "in situ" reinforced concrete base slab to the thickness and profile shown on the Contract Drawings.

Place the rings in position on the base slab set over the main drainage pipeline, channels, branch connections, etc., all set truly level and vertical.

Construct the "in situ" concrete base up to a level of 150mm above the crown of the main drainage line to the profile shown on the Contract Drawings, and form a level base to receive the manhole rings.

Set pre-cast concrete manhole rings on a sand/cement mortar bed 1:2 on the concrete base all set level and firm for placing additional rings.

Ensure all joints are liberally provided with sand/cement mortar 1:2 before lowering sections into position, and neatly strike off joints on the inside of the chamber, filling any voids as work proceeds. Make good any lifting holes.

Make all watertight construction joints in accordance with manufacturer's recommendations and technical installation manuals. Neatly strike off joints on the inside of the chamber, filling any voids as work proceeds, and make good any lifting holes.

When placing pre-cast concrete manhole rings ensure the step irons are aligned vertically and at 300mm horizontal pitch, set over the benching, and in line with any access shafts, pre-cast concrete cover slabs and manhole cover.

Where pre-cast concrete manhole rings are to be supplied without step irons, build in a galvanized mild steel access ladder in the location indicated on the Contract Drawings, complete with all bolt fixings.

When all pre-cast concrete manhole rings, access shafts, cover slabs etc. have been set in position, using sectional fiber glass manhole shuttering, completely surround the manhole rings in 150mm in situ concrete well compacted.

Set pre-cast concrete cover slab in position with the opening in line with the step irons laid on a sand/cement mortar 1:2 bed, all set truly level, filling any voids in the bedding and flush point on the inside of the manhole wall as work proceeds.

Allow concrete work to set hard before back-filling the voids between the concrete surround and side of the excavation.

Concrete Block Manhole Construction

Refer to Manholes/Inspection Chamber General for description of all associated works.

Construct manholes in concrete blocks on an in situ reinforced concrete base with blocks set in bond with no straight joints using sand/cement mortar 1:3, building in galvanized step irons as work proceeds.

Fill hollow blocks with concrete and compact well before construction.

Completely fill all beds and vertical joints with mortar, and cut and flush point as work proceeds.

Backfilling General

Backfilling to trenches shall not be carried out until all interim tests have been successfully concluded.

Backfill adjacent to foundation in accordance with the details shown on the Contract Drawings.

Do not fill void between side of excavation and pre-cast concrete manhole walls until seven days after concrete has been poured and set hard.

Where excavated material is unsuitable for backfilling, suitable material shall be imported to comply with the requirements of this specification and the Engineer's requirements.

4. TESTING

Testing & Inspection

Test all drainage works to obtain the approval of the Local Authority, Architect/Engineer or his appointed representative and generally the following requirements.

Give a minimum of 24 hours' notice to the Architect/Engineer or his appointed representative when interim and final tests are to be carried out to give him/her the opportunity to observe tests.

Keep a record of all tests duly signed, and hand a copy to the Architect/Engineer or his appointed representative for retention.



Any works having previously passed any tests will not relieve the Contractor of his obligations when any further defects are shown during final tests, or appear during the maintenance period. Any defects shall be located and rectified, and the system retested in accordance with this section of the specification and as directed by the Architect/Engineer or his appointed representative.

Ensure all sections of the drainage system are completely clear of obstructions, builder's debris, silt, etc. before interim and final tests are carried out on each section of the installation, all drains to be cored through using apparatus to suit the diameter of the pipe.

Provide all facilities, equipment, clean water, appliances and materials for interim and final testing, and arrange to place in position any branch connections, tubes and plugs when and where required. Seal off and remove all equipment during and after tests.

Testing Underground Manholes/Chambers

Test all chambers for water tightness. Keeping external faces clear of backfill for inspection until approved, temporary seal all pipe connections within the chamber and fill with water up to 1.500m above the crown of the pipe allowing time for absorption. Allow adding water before starting the test, and maintain water level for 30 minutes without adding further water. Any manhole/chamber failing the test shall be re-constructed until a satisfactory test result can be achieved.

Record Drawings

The Contractor shall keep a record of any changes to pipe work location or adjustments to levels during the course of the contract and prepare upon completion Record Drawings/Schedules equal to the Contract Drawings.

The Contractor shall keep a record of any changes to pipe work location or adjustments to levels during the course of the contract, and upon completion hand to the Architect/Engineer to enable him to prepare record drawings.

Handover

Thoroughly clean and flush out the entire drainage installation and clean out silt and debris from drainage gullies etc. before handover.

Give a minimum of 24 hours' notice when tests are to be carried out and provide sufficient personnel to carry out the flushing operation of the various appliances.

Hand to the Architect/Engineer or his appointed representative, copies of the "As Fitted" drainage record drawings.



CHAPTER THREE

SANITARY WASTE & RAINWATER PIPEWORK INSTALLATION



3.0 SANITARY, WASTE AND RAINWATER PIPEWORK INSTALLATION

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1. General Preamble
2. Materials
3. Pipework Materials
4. Pipework Installation
5. Waste Installation
6. Approved Manufacturers



CHAPTER THREE

SANITARY, WASTE AND RAINWATER PIPEWORK INSTALLATION

1. GENERAL PREAMBLE

Scope of Work

Soil, Waste, Vent and Rainwater Installations.
Waste Installations.
All Overflows Pipes.

Sanitary Fittings

Shall include the following:-

Order, take delivery, store, and protect during the course of the contract all sanitary ware including fixtures and fittings all in accordance with the sanitary fitting specification and standard.

Allow for fixing and protecting all sanitary ware, fixtures and fittings as indicated, all strictly in accordance with the manufacturers' recommendations.

All pipework and fittings used in the hot and cold water service installations shall be as specified herein.

Allow for all overflows and warning pipes where indicated on the drawings using pipework and fittings specified herein.

2. MATERIALS

General

All pipework, fixtures and fittings shall comply strictly in accordance with the relevant International Standard Specification.



Standards

Where a British Standard and/or Code of Practice is quoted in this Specification, refer to the latest published standard and any subsequent amendments.

British Standard Institution documents referred to in this Specification are:-

BS.4514	Unplasticized PVC soil and ventilating pipe, fittings and accessories or approved equal EN.
BS.5254	Polypropylene waste pipes and fittings (external diameter 34.6 mm, 41.0 mm and 54.1 mm) or approved equal EN.
BS.5255	Plastics waste pipe and fittings or approved equal EN.
BS.3943	Plastics waste traps or approved equal EN.
BS.2494	Materials for elastomeric joint rings for pipework and pipelines or approved equal EN.

British Standard Code of Practice referred to in this Specification are:-

BS.CP.5572	Sanitary Pipework or approved equal EN.
BS.6367	Drainage of Roofs and Paved Areas or approved equal EN.

Building Standards and Regulations

All pipework and fittings shall be installed strictly in accordance with Local Authority Regulations or equivalent.

Termination

The installation shall be deemed to terminate at the buried drain connections.

3. PIPEWORK MATERIALS

Main Soil Waste and Rain Water

<u>Pipe Size</u>	<u>Material</u>
110mm, 160mm 200mm 300mm	- UPVC (EN – 1401)

Main Soil, Waste Rain Water and Vent Pipework shall be deemed to include horizontal pipework underground drainage.



Branch Soil, Waste and Vent Pipes

<u>Pipe Size</u>	<u>Material</u>
- 50mm	- UPVC (DIN. 19531)
- 82mm 110mm 160mm 200mm	- UPVC(BS.4514)+(EN.1329)

Branch Soil, Waste and Vent Pipework shall be deemed to include for all vertical and/or horizontal pipework between the connection to drain or main soil, waste and vent stack, and the terminal connections to the Sanitary appliance or fitting.

All soil and waste pipe work discharging from sump pits shall be cast iron.

Rainwater Pipes

<u>Material</u>	<u>Pipe Size</u>
UPVC (BS.4514) + (EN.1329)	□□□80 - □□□110 - □□200

General Requirement

There shall be no deviation from the details indicated on the drawings, any alterations to the design intent without prior approval shall be restored to the original design at no extra cost to the contract unless it is proven that the original design cannot be accommodated.

The entire installation shall be carried out to the satisfaction of the Architect/Engineer or his appointed representative.

4. PIPEWORK INSTALLATION

General

All pipework shall be installed truly vertical or if horizontal to the gradient dictated by the design.

All bends and offsets shall be kept to the minimum number and if required be of a wide sweep pattern.

All pipework shall be cut clean and square with the axis of the pipe with all sharp edges and/or burrs removed before installation.

Should any blockage occur within the system caused by general negligence or abuse pipework shall be removed and the system thoroughly cleaned out at no extra cost to the contract.



Pipework Fixtures and Fittings

All pipework fixtures and fittings shall be installed using the correct fixtures and fixing procedures including support brackets to suit the specified materials, and hold pipework secure.

All bracket and support fixings shall be in accordance with the details shown on the coded detail drawings.

UPVC Pipework and Fittings

Shall comply to British Standard 4514 bear the British Standard Kite Mark, or equivalent and shall be installed strictly in accordance with manufacturers recommendations.

All pipework shall be supplied in plain ended lengths.

The pipe and fittings shall be to colour grey, British Standard 5252 with the exception of water closet connections which shall be coloured white where exposed to view.

Method of jointing shall be a combination of solvent welding using the manufacturer's approved solvent cement, with seal ring fittings used where necessary to accommodate thermal movement. The sockets of standard fittings shall be converted to incorporate a rubber seal ring where required.

UPVC Pipework Installation

All pipework shall be installed to accommodate thermal movement, flexible joints shall be incorporated at all fixed points and changes of direction with a secure fixing bracket located in the retention groove moulded on the socket of the fitting.

Waste boss connections when fitted to the pipes shall consist of two parts with inner and outer flanges, solvent welded as a complete unit with inbuilt gradients of 1 1/4o. Where it is not possible to gain access to the bore of the soil pipe self- locking bosses with integral clamping devices shall be used providing the mating surfaces are suitable for and used with solvent weld cement.

Access shall be provided to gain entry into all pipework either by means of an integrally moulded door in an access fitting with external fitted rubber seal and secured with two galvanised bolts and nuts, or alternatively a two piece clamp type door fitted into the pipe run.

Where WC connections are to be fixed in a range a single manifold branch shall be used comprising a single branch with a standard WC connector welded together, up to six WCs may be connected on either side of the soil stack using the available left or right hand fittings as required.



The correct angle and type of fitting to suit the application shall be as described in the manufacturers Product Handbook.

The system shall be installed strictly in accordance with the Product Handbook complying with the recommendations of BS.4940.

UPVC Pipe Supports

UPVC pipe supports shall be made of mild steel with galvanised or PVC protective coating, supplied to suit the specified pipework and fittings and have a two position fixing suitable for either acting as a pipe support allowing thermal movement, or alternatively as a clamp fit on a fitting creating a fixed point. For optimum fit on pipe supports UPVC spacing pieces shall be used.

Maximum intervals between pipe supports shall be:-

Pipe Size	38 mm	42 mm	50 mm	75 mm	100mm
Horizontal	0.5 m	0.5 m	0.6 m	0.9 m	0.9m
Vertical	1.2 m	1.2 m	1.2 m	1.8 m	1.8m

Pipework shall be fixed truly vertical with all horizontal runs laid to gradients in accordance with British Standard 5572 and in any event not less than 18mm/m unless otherwise instructed.

The pipework shall be fixed to the fabric of the building in accordance with BS CP 5572.

5. WASTE INSTALLATION

Access Fittings

All fittings shall give full width access into the bore of the pipe and located as indicated on the drawings.

Access Location (General)

Access points shall be provided to give full access to all sections of installation at the locations indicated on the drawings, to enable section testing and efficient maintenance operations to be carried out and to enable every section of Soil, Waste or Rainwater Pipework to be rodded, tested, inspected and to enable the easy removable of objects or debris from the system.

Roof Vent Fittings

All vent pipes passing through the roof shall be fitted with a connector suitable for a weatherproof seal and to ensure a completely watertight arrangement.

The pipe shall terminate 450mm above finished roof level with a section of spigot end and vent cage, complete with a weathering shroud to enclose the waterproof finish.

WC's Connectors

Pipework connections to WC's shall be flexible self-sealing connectors incorporating multiple plastic and rubber seal gaskets. The connector shall incorporate outward facing rubber seals and plastic fins for insertion into the pipe, and an internal rubber seal with plastic shroud for connection to the WC pan.

The Connectors shall suit the specified pipe materials.

Storage of Pipework and Fixtures and Fittings

All pipework fixtures and fittings including jointing materials shall be stored within a clean dry storage area protected from extreme temperatures and where applicable in accordance with manufacturers recommendations.

UPVC

All pipework fittings, gaskets, and solvents shall be stored to avoid direct exposure to sunlight, and extreme temperature conditions.

Pipework shall be stored on level ground free from stones or sharp objects either on timber bearers 75mm wide and not greater than 1 metre centres and stacked neatly not more than 1 metre high, or alternatively stored in loose racks with side support not greater than 1.5 metres apart.

All fittings, gaskets and solvents shall be stored within a well ventilated cool compartment, and retain in plastic bags and storage containers until ready for installation.

Pipe Sleeves

Where pipes pass through walls, or floors tubular pipe sleeves of non- combustible material shall be provided of sufficient size to permit the free passage of the pipe through the sleeve to ensure the pipe neither touches the sleeve nor the building structure.

All pipe sleeves shall be set in the walls, or floors before plastering or screeding is completed.

All sleeves shall be suitable for the pipe on which they are to be fitted and shall extend the full thickness of the division through which the pipe is to pass, after installation the gap between pipe and sleeve shall be "fire stopped" with suitable non-combustible caulking compound.

Where UPVC pipework passes through walls or floors a fire sleeve shall be provided tested in accordance with BS.476 comprising of a metal clad flanged sleeve with fire resistant filler rings in accordance with the detailed drawings.

Rainwater Roof Outlets (Roof Drain)

All rainwater outlets shall be cleaned to the satisfaction of the Engineer / Architect suitable for the specified pipe material.

Floor Gullies (Floor Drain)

Floor gullies and channel gratings shall be supplied and installed as required within public bathrooms and toilet areas and playgrounds. Where these are of a quality finish they shall be suitably protected until completion of the contract.

Where traps are suspended they shall have weight support lugs cast on with suitable bracket fixing back to the structure.

FCO : Floor clean out – 20 cm x 20 cm Chrome Plated, Ø 110mm Bottom outlet

FD-01: Floor drain – 20 cm x 20 cm Chrome Plated, Ø 80mm Side outlet

CHD-01: Channel floor drain – 20 cm wide Nickel bronze heavy duty grating cover, Bottom outlet (for excavation of channels, refer to Chapter 2, Below Ground Drainage).

Waste Connections to Mechanical Services Plant

Waste and/or overflow connections from, pump glands, etc, shall discharge into a tundish and connect to drain via a trap connection or alternatively discharge over a trapped floor gully, but on no account connect to a soil pipe.

Overflows/Warning Pipes and Sanitary Fittings

All overflows and/or warning pipes shall be installed strictly in accordance with the Water Authority Bylaws/Regulations including any subsequent amendments, and the detailed drawings.



Depending on the location, the overflows and/or warning pipes shall discharge in the following locations and as indicated on the drawings.

- a) External to the building
- b) Over a Sanitary Fitting
- c) Over the floor

Testing, Flushing Out and Cleaning of Soil, Waste, Vent and Rainwater Pipes

All pipework to be concealed shall be tested before being enclosed, a final test shall be made upon completion for soundness and performance strictly in accordance with the British Standard 5572, and include a simultaneous discharge test.

At completion of the installation all plugs shall be removed and the entire system flushed and rodded through.

6. APPROVED MANUFACTURERS

UPVC

- a. Redi
- b. Nicoll

or approved equal.

FB & JB

- a. Zurn
- b. Wade
- c. Josam

or approved equal.



CHAPTER FOUR **PIPED SYSTEMS (LIQUIDS)**



4.0 PIPED SYSTEMS (LIQUIDS)

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4. Valves and cocks
5. Pipework ancillaries
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7. Water storage tanks
8. Solar Water Heating System



CHAPTER FOUR **PIPED SYSTEMS (LIQUIDS)**

1. GENERAL

This section of the Specification shall apply to the following pipework installations:-
Domestic Hot and Cold Water (including distilled and cold and hot soft water) And as
a supplement to the following sections:-
Soil, Waste and Rainwater

Demarcations

The Domestic Hot and Cold-water service installation shall include final connections between isolation stop-cocks or valves serving sanitary appliances or equipment and the appliances/equipment being served.

2. PIPEWORK INSTALLATION (GENERAL)

Mild Steel

All tubes shall be of uniform thickness within the manufacturing tolerances as stated in the appropriate British Standard and shall have a concentric bore throughout.

All pipework shall be free from rust and without any signs of scaling, pitting or weathering to the satisfaction of the Engineer.

All pipework shall be supplied with varnished finish and each length must have at least one coloured identification band when delivered.

When screwed pipes are required they shall be supplied with at least one socket for each length fitted and threads not fitted with sockets shall be fitted with protectors during transit.

All branches off mains shall be of the easy sweep type, where the size of the branch off the main is outside the range of branch bends available; the branch shall be formed from piping carefully formed to an easy sweep.



Gradients and Erection of Pipework

Pipework shall be graded to ensure adequate draining and venting and wherever possible be self-venting. Draining and venting facilities as detailed in this Specification shall be fitted at all low and high points respectively and wherever else necessary to ensure that all sections and subsidiary sections can be drained and no air locks can form.

The gradients shall be in the direction of flow and shall be appropriate to the service as follows unless otherwise stated on the drawings:-

<u>Service</u>	<u>Gradient</u>
All services	1 in 250

Pipework shall generally be set around all pipes and columns and shall follow the contours of the building whether so indicated or not.

Bare piping shall be erected so that there is 75 mm clear below it to the finished floor level and at least 25 mm to the finished wall face.

Insulated piping shall have sufficient clearance for the proper application of the insulating material. The finished surface of any covering shall be at least 25 mm from walls etc. Clearance between adjacent insulated pipes shall be at least 25 mm.

All pipework valves, fittings and equipment forming the piping installation shall be erected so that it can be dismantled and is accessible for repair and replacement.

Pipe and Services Supports

All pipework shall be supported by means of clips, hangers etc., or in the manner and positions indicated at intervals not exceeding the following:-

Nominal Bore	<u>Steel</u> Interval (Metre)	
	Vert.	Horiz.
15mm	2.4	1.8
20mm	3.0	2.4
25mm	3.0	2.4
32mm	3.0	2.4
40mm	3.7	2.4
50mm	3.7	2.4
65mm	4.6	3.0
80mm	4.6	3.0
100mm	4.6	3.0
125mm	5.5	3.7
150mm	5.5	4.5
and over	6.0	6.0



Care should be taken with the design and installation of supports for A.B.S., pipework, which shall be designed in accordance with the manufacturer's recommendations but shall not be greater spacings than the following table:-

Pipework O/D	UPVC Maximum Horizontal Support Distance m
15	1.0
20	1.0
25	1.0
32	1.1
40	1.1
50	1.2
63	1.4
75	1.6
110	1.9
125	1.9
160	2.1
200	2.5

In the event of two or more pipes being carried by a single support the spacing shall be for the short intervals. No more than two pipes may be supported from a single drop rod support. Double hanging of pipes with unequal expansion movement due to different service temperatures shall not be permitted.

All supports for mild steel pipes and fittings shall be ferrous as indicated and/or specified herein.

Metal pipe clips on plastic pipework shall be free of sharp edges likely to damage the pipe.

Valve supports shall be provided for all large diameter valves in plastic pipework to ensure that distortion of the pipework does not occur.

It shall be the responsibility of the Contractor to ensure that all supports are adequate, firmly and truly fixed, and that they do not transmit vibration.

The Contractor shall provide and install all fixings to the structure or cast in support channels where appropriate to carry the brackets, clips, hangers, etc., for the various services.

The Contractor shall provide all necessary steelwork for the support of the Services in vertical risers at the required intervals, which shall be detailed on drawings and submitted for approval. The drawing shall show full details of all steelwork sizes and fixings and shall show the imposed load from each service.

All pipework shall be supported by substantial brackets, hangers, or clips to the approval of the Engineer. The layout of piping shall take into account expansion and contraction, particularly at ends of runs where changes of direction occur. Main walls or partition walls etc., where pipes pass through sleeves shall not be considered as pipe supports.

Supports for insulated pipes on cold-water service shall be arranged so that there is no penetration by metal of the pipe insulation. In addition precautions must be taken to preserve an unfractured vapour-proof skin at these joints. Two half sections of high density phenolic foam (120 kg/m³) to fit the pipes and of correct thickness to suit the insulation shall be used at all support positions. The joints between the high-density phenolic foam and the insulation shall be chamfered and trowelled in with a mastic compound.

In exposed areas and where metalclad pipework insulation finish is provided the vapour barrier shall be over the band clip to ensure a concealed and straight line finish appearance.

When rested upon fixed supports, freedom of longitudinal movement must be provided.

Pipe Sleeves and Puddle Sleeves

Where pipes pass through walls, floors, footings and waterproof membranes, the Contractor shall include in his price pipe sleeves.

The inside diameter of sleeves shall not be less than 15 mm larger than the outside diameter of the pipe except where pipes pass through bearing walls or footings where sleeves shall be sized to allow for structural movement and 15 mm clearance from the outside diameter of the pipe.

The diameter of the sleeves for cold-water pipework shall be such that adequate clearance between the pipe and the sleeve will enable the insulation to be carried through the sleeve.

Sleeves shall protrude not less than 2 mm and not more than 4 mm proud of the finished surface.

Flushing of Pipework Systems

Prior to the chemical cleaning or treatment of any pipework system the entire system, sectionally or as whole, shall be subjected to a full bore rapid flush to ensure the complete removal of any loose foreign material. This shall also apply to pipework systems where chemical cleaning is not called for.

The Contractor shall also be responsible for providing temporary fill and drain points on each system and for making whatever temporary arrangements that may be necessary to have adequate raw water available at the fill points and for the removal of flushing water from the drain points.



Approved Manufacturers

Galvanized Steel Supports for Pipes

- a. Flamco
- b. Walraven
- c. Mupro
- d. Erico

or approved equal.

3. PIPEWORK SERVICE MATERIALS

Polypropylene (PPR) Pipes and Fittings

A. Polypropylene pipe shall conform to the following requirements:

- ✓ Polypropylene pipes shall be made of polypropylene, a copolymer RANDOM, Beta PPR with enhanced crystalline structure, Class-2 (S-3.2; SDR-7.4) for embedded domestic cold and hot water pipes applications. Beta PPR with Aluminum layer for exposed and embedded heating pipes, and for exposed cold and hot water pipes application conforming to EN ISO 15874 or approved equal International Standards (DIN, ASTM,) for polypropylene pipes.
- ✓ Polypropylene pipe: ASTM F 2389, pipe pressure rating shall comply with temperature and pressure ratings per the plumbing code requirement for the applicable service (water distribution, water service).
- ✓ Fittings shall have same material and quality as pipes and according to EN ISO 15874.
- ✓ Polypropylene Fittings: ASTM F 2389, socket fusion, butt fusion, electrofusion, or fusion outlet fittings shall be used for fusion weld joints between pipe and fittings.
- ✓ Mechanical Fittings and transition fittings shall be used where transitions are made to other piping materials or to valves and appurtenances.
- ✓ Polypropylene pipe shall not be threaded. Threaded transition fittings per ASTM F 2389 shall be used where a threaded connection is required.

B. Polypropylene – Random Copolymer

- ✓ Polypropylene – Random Copolymer (PP-R) used for the manufacture of pipes shall confirm to the requirements of IS 10951 and IS 10910.
- ✓ The specified base density shall be between 900 Kg/m³ and 910 Kg/m³ (both inclusive) when determined at 27°C according to procedure prescribed in IS 13360 (Part 3/Sec 1).
- ✓ The MFR of the material shall be ≤0.5 g/10min when tested at 230°C with nominal load of 2.16 Kg as determined by method prescribed in IS 13360 (Part 4/Sec1). The MFR of the material shall also be within ± 20percent of the value declared by the manufacturer.
- ✓ The resin shall be mixed with sufficient quantity of colour master batches. The colour master batch description shall be uniform throughout the pipe surface.
- ✓ Outer Layer (Optional)

The base resin used for outer layer compounds shall be a base resin certified by the supplier to be compatible to the PPR resin/master batch that is used to produce the pipes.

Coloured outer layer compound shall be UV stabilized with minimum of 0.2 percent of a hindered amine light stabilizer (HALS).

- ✓ Anti-oxidant

The percentage of anti-oxidant used shall not be more than 0.3 percent by mass of finished resin. The anti-oxidant used shall be physiologically harmless and shall be selected from the list given in IS 10909.

4. VALVES AND COCKS**General**

All valves and cocks shall be generally as described and of first class quality.

All castings shall be clean close-grained metal free from rough projections. Unless otherwise specified valves of 50 mm nominal bore and under shall have female ends screwed to BS 21 and valves 65 mm nominal bore and over shall have flanged ends.



Screwed valves shall have heavy hexagon reinforcements at openings, threads of ample length and heavy shoulders to prevent over entry to pipes. Flanged valves shall have the flanges flat faced on valves 50 mm and below and raised face on valves 65 mm and above and of thickness conforming to the appropriate Specifications and drilled.

All valves must have the maker's name or trade mark cast or heavily stamped or rolled on. Valves not bearing these distinguishing marks will be rejected.

Each valve must be made easy to operate before being installed.

Regulating and isolating valves shall be fitted to permit proper isolation and regulation of plant and primary and secondary mains.

All mains shall be provided with isolation valves at the point of entry or exit.

All valves shall be suitable for the fluid carried and the temperatures, test and working pressures of the system in which they are installed.

Where flanged ends are specified, the flanges shall be of the type and nominal pressure rating as specified in the 'Flanged Pipework Jointing' clause in this Section of the Specification.

Isolating Valves to Hot and Cold Water Services

(i) General

Isolating valves shall be installed in the locations shown on the drawings and on connections to single groups of wash-hand basins or wc's, on the draw-off connections to individual sinks and on connections to equipment.

(ii) Mains Water Services

Isolating valves on pipework size 54 mm and below shall be stopcocks of the screw down pattern gunmetal construction in accordance with BS 1010 with pinned jumper and gunmetal or brass spindle with crutch head and union connection.

Alternatively isolating valves where used internally shall be full way lever operated quarter turn spherical ball valves manufactured from dezincification resistant bronze, polished balls and PTFE seats. Ends shall be compression to BS864 Part 2 and the valve shall be suitable for working pressure up to 16 bar.

Servicing valves up to and including 22mm to be the spherical plug type manufactured to BS6675 with compression ends to BS864 and shall be chromium plated.



Valves above 54 mm shall be cast iron, with inside screw, wedge gate valves manufactured in accordance with BS 5163 Class 2, having flanged ends and provided with wheel head assembly unless otherwise noted on the drawings.

Alternatively valves above 54mm shall be butterfly valves to BS5155, lever operation, suitable for pressures up to 16 bar. Valves shall be approved for use on potable water services.

(iii) Cold Water Services

Full way gate pattern valves 54 mm diameter and below shall be bronze or gunmetal construction in accordance with BS 5154 solid wedge disc, non-rising stem, and having either integral solder ring capillary ring union ends, or compression ring joints in accordance with BS 864 Part 2.

Alternatively isolating valves where used internally shall be full way lever operated quarter turn spherical ball valves manufactured from dezincification resistant bronze, polished balls and PTFE seats. Ends shall be compression to BS864 Part 2 and the valve shall be suitable for working pressure up to 16 bar.

(iv) Hot Water Services

Full way gate pattern valves 54 mm diameter and below shall be bronze or gunmetal construction in accordance with BS 5154 solid wedge disc, non-rising stem, and having either integral solder ring capillary ring union ends, or compression ring joints in accordance with BS 864 Part 2.

Alternatively isolating valves where used internally shall be full way lever operated quarter turn spherical ball valves manufactured from dezincification resistant bronze, polished balls and PTFE seats. Ends shall be compression to BS864 Part 2 and the valve shall be suitable for working pressure up to 16 bar.

(v) Fitting Isolation Valves

Isolation valves to individual fittings shall be full port in-line spherical plug ball type of bronze or nickel construction, to BS 6675 with operating lever and compression ring joints in accordance with BS864 Part 2.

Ball Float Valves

Unless otherwise specified ball valves shall be of bronze or gunmetal construction manufactured in accordance with BS 1212, Part 1 and having a bronze or gunmetal seat, lever and plastic float conforming to BS 2456.



Where required ball valves of the delayed action type shall be provided generally as above and complete with hydraulic delay subsidiary tank and bottom float. Galvanised mild steel supports shall be provided to the valve manufacturers recommendations.

The ball valves shall be suitable for the particular pressure requirements at the point of discharge.

Hose Union Bib Taps

Hose Union Bib Taps shall be of the screw down pattern, gunmetal construction manufactured in accordance with BS 1010 and be complete with a bib hose union connection.

The bib taps shall have a polished finish and be complete with a polished brass dust bonnet.

Drain Cocks and Drain Valves

Drain cocks shall be fitted on all low points and on the 'dead' side of all isolating valves and cocks.

Other than on HTHW drain cocks where in exposed positions in rooms shall be of the bronze draining tap type to BS 2879 Type A with screwed end and lockshield dustcap. Elsewhere they shall be of the bronze gland cock type with hose union.

Drain cocks where used on hot, cold and mains water services shall be of the pattern that can be readily rewashered and that are suitable for 1.5 times the system working pressure.

Safety Valves

Safety valves shall be of the enclosed spring loaded type complying with BS 6759 and of size not less than that required for the equipment specified. The safety valve shall be arranged vertically and attached directly to the equipment shell.

The safety valves shall have a padlock and key. Unless otherwise specified safety valve set pressure shall be:-

1.1 x working pressure

The setting shall not exceed the design pressure of the equipment.

Safety valves up to 50 mm n.b. shall have screwed connections, bronze body, cadmium plated steel spring with high tensile brass adjusting screw and locknut suitable for a maximum working pressure of 24 bar.



Approved Manufacturers

- a. Crane
- b. Nibco
- c. Hattarsley
- d. Serseg

or approved equal.

5. PIPEWORK ANCILLARIES

Flow Commissioning Sets

Flow Commissioning Sets shall be provided on all main, branch and sub-circuits throughout the heating and chilled water pipework installations to enable satisfactory commissioning of hydraulic circuits. The sets shall comprise a measuring orifice ring with pressure tapplings, fitted complete with valve. This valve shall be a double regulating valve in accordance with the appropriate Service Specification, located in the return pipe.

Orifice ring fittings 50 mm and below shall have gunmetal body castings with screwed ends to BS 21 and comply with BS 1400. Orifice ring fittings 65 mm and above shall have cast iron flangeless bodies with notches for pipe alignment fitted with stainless steel orifice plates and gunmetal retaining bushes.

Pressure tapplings shall be the brass body mechanical self-sealing type with screwed blanking caps.

For flow rates below 0.04 litres/s low flow or ultra low flow sets shall be provided, appropriate to the low flow rate condition.

Water Strainers

Strainers shall be located at inlets to control valve arrangements and pump sets and generally as detailed on the drawings.

The strainer shall be simplex or duplex as indicated on the drawings.



Each strainer shall be provided complete with a stainless steel strainer screen as follows:-

<u>Application</u>	<u>Perforation Size mm</u>
In pipework 15mm to 50mm nominal bore and on inlets to all control valves.	0.8
In pipework 65mm to 100mm nominal bore.	1.2
In pipework 125mm nominal bore and above.	1.6

Cold Water Applications, HWS and LTHW:

Strainers up to 50 mm shall be "Y" type of bronze or gunmetal construction in accordance with BS 5154 screwed ends to BS 21.

Pressure Gauges

Pressure gauges shall be 100 mm and 150 mm diameter as specified, aluminium alloy cased with chromium bezel Bourdon Type BS 1780, Part 2 and shall be with plain glass front, concentric pointer and red line at the working pressure scaled in bars.

The range, unless otherwise stated shall be a maximum of one and a half times the working pressure. The tubes shall be of brass construction and removable, and the outlet screwed BSPT.

Temperature Gauges and Wells

Dial type temperature gauges with aluminium alloy cases black painted with chromium bezel shall be fitted in the positions as indicated. Each dial type gauge shall be of mercury in steel type having a nominal dial size of 150 mm.

All gauges shall have a white dial with black numbering and shall be calibrated to cover the operating temperature range plus 30°C on DHWS and cold water.

Water Meters

Water meters shall be provided on the incoming water main and shall be located within an accessible position so as to facilitate easy reading and maintenance.

Meters for use on pipework over 40 mm diameter shall be of the in-line Helical Vane type with graphite iron body to BS 2789 1973 420/12, polypropylene rotor, stainless steel bearings, and shall be provided with flanged connections to BS 4504.

Each meter shall be provided with a suitable pulsed output suitable for connection to a central control and monitoring system.

All counters shall read in cubic meters.

All meters in exposed positions shall be suitable for the prevailing temperature conditions without loss of performance or accuracy.

Air Release LTHW, HWS, Oil

Air vents shall be fitted at all high points. Pipework which requires venting shall be fitted with 6 mm air cocks on air bottles. Air bottles shall be formed from 150 mm length of tube of equal bore to the pipe which is being vented, with 6 mm pipe welded into the top and taken to a low level accessible position unless otherwise specified and fitted with 6 mm lockshield needle valve. The discharge from the needle valve shall be piped to a convenient position for discharge into a container.

In addition, vent points on oil lines shall be provided with a mild steel receptacle hooked onto the piping and arranged to collect oil drips.

Automatic Air Vents

Automatic air vents shall be installed in accessible positions and shall be of aluminium bronze construction with brass spindle nickel alloy valve and seat, brass float and integral lockshield isolating valve. In all cases the air vent shall be preceded by a lockshield pattern stop valve and the discharge from the air vent shall be 10 mm copper pipe. Automatic air vents shall be provided on each service, with the exception of HTHW and MTHW, at the highest point of the service within each plant area and on each vertical distribution riser.

Discharge pipes shall be collected over a covered tundish and the outlet piped to the nearest drain gully. Discharge pipes shall be labelled according to the service.



6. HOT WATER STORAGE TANK

6.1 Electrical Water Heater

Supply and install electric water heaters whenever shown on the drawings of capacities as indicated on the drawings.

Each electric water heater shall be of the cylindrical storage type constructed of heavy gauge steel with white enamel finish and glass lining from inside.

Heater shall have polyurethane foam insulation wall between the outer casing and the glass lining all around top and bottom of cylinder. Heater shall be suitable for a working pressure of 100 psi (690 Kpa).

Each electric water heater shall be complete with the following:

- Fast acting surface mounted thermostat for automatic temperature control.
- Factory installed sensitive high limit energy cut-off (for safety to prevent overheating) present at 210 °F (99 °C).
- Electric element of 1500 watt capacity and smaller as indicated on the drawings. Element shall be constructed of highest quality resistant wire sheathed in mineral filling and the whole encased in a copper tube and subjected to a high voltage test.

The water Supply System shall consist of piping, valves, automatic controls, tanks, electric water heaters, and all equipment as hereinafter specified and shown on the Drawings.

6.2 Heat Exchangers And Calorifiers

Supply and install Heat exchangers whenever shown on the drawings of capacities as indicated on the drawings.

Each water heat exchanger shall be of the cylindrical storage type constructed of copper / copper heating coil

Heater shall have polyurethane foam insulation wall between the outer and inner casing of cylinder. Heater shall be suitable for a working pressure of 100 psi (690 Kpa).

Each water heat exchanger shall be complete with the following:

- Fast acting surface mounted thermostat for automatic temperature control.
- Factory installed sensitive high limit energy cut-off (for safety to prevent overheating) present at 210 °F (99 °C).

The water Supply System shall consist of piping, valves, pumps, automatic controls, tanks, water heat exchanger, and all equipment as hereinafter specified and shown on the Drawings.

Approved Manufacturers

- a. Rheem
- b. Buderus
- c. Aristan

or approved equal.

7. WATER STORAGE TANKS**Polyethylene Water Tank (s)**

Polyethylene water tank(s) shall be of the size and shapes as indicated on the drawings.

All elements of the tank(s) and their appurtenances shall be designed to withstand all conditions of the intended service without undue stress or deflection. The design shall take into account the stressed caused by the contents of the tank. The minimum allowable thickness of any portion of the tank(s) and their appurtenances shall be 7 mm, which shall be increased as necessary to provide adequate strength and shall be fully insulated to minimize heat gain.

The tank(s) shall be provided with reinforced threaded openings for all pipe connections and float switches indicated on the Drawings.

The top of tank(s) shall be equipped with a removable cover. The cover shall have a whole cur for the fill.

Interior and exterior surfaces shall have a relatively smooth texture.

8. SOLAR WATER HEATING SYSTEM

The Solar System set shall be a compact system comprising of 6 solar collectors and all the components necessary for having domestic hot water at the required temperature.

Solar Collector

Flat solar collector (6 Nos., 2152 x 1252) with single copper pipe coil, covered with 50mm thickness polyurethane foam and enveloped by a PVC jacket finished with RAC color. Maximum working pressure is 8 bars and maximum temperature is 95°C.



Solar stainless steel cylinder 100 lits (3 Nos. for each apartment and comprises of a coil primary circuit and an enameled secondary circuit protected by a magnesium anode with anode status indicator.

Circulation pump (P-HWR-01) complete with built-in overload protection motor. Solar controller programmable controls, solar collector temperature closed expansion tank and cylinder temperature.

Hot Water Storage Cylinder

Solar stainless steel cylinder comprises of enameled shell protected by a magnesium anode with anode status indicator.



CHAPTER FIVE

GENERAL BOILER PLANT



5.0 GENERAL BOILER PLANT

TABLE OF CONTENTS

1. General
2. Products
3. Execution
4. Fuel Oil System



CHAPTER FIVE **GENERAL BOILER PLANT**

1. GENERAL

Related Work

- Pipe and pipe fittings.
- Valves.
- Pumps.
- Control & Instrumentation.
- Testing and Commissioning.

System Description

A. General

1. Provide and install where indicated on the drawings sealed expansion unit for each separate heating system.
2. This section of the Specification covers the supply, installation, testing and commissioning of boiler plant and all associated ancillaries necessary to generate the required heat at a central source for onward distribution to terminal equipment.

References

Refer to individual materials for specified standards.

Submittals

A. Product Data

Descriptive literature for each of the actual proposed equipment to be used including:

- a. Capacity
- b. Operating Pressure Ranges
- c. Pressure Losses



- d. Fluid Flows
- e. Test Reports
- f. Certificates of Approval
- g. Operation and Maintenance Data
- h. Any other Technical Data

B. Shop Drawings

Shop Drawings for each of the actual proposed equipment shall include the following:

- a. Working or Manufacturing Drawings.
- b. Calculations.
- c. Installation Details.
- d. Connections by other services.
- e. Wiring and Control Diagrams.
- f. Accessories Available indicating those included.
- g. System Diagrams.

2. PRODUCTS

Materials

The pipe work shall be as specified in Chapter 4. Seamless black steel, schedule 40, ASTM A53 Grade B.

Valves shall be as specified in Chapter 4.
Insulation shall be as specified in Chapter 11.

Heating Pumps

Supply and install whenever shown on the drawings hot water circulators of the centrifugal in line type directly coupled to an electric motor suitable for handling hot water at 200° F (93° C).

Circulators shall be horizontal or vertical all bronze with stainless steel and watertight mechanical seals. Motor shall be sleeve type bearing drip proof with built in automatic over load protection.

Circulators shall be complete with switch pilot light and electric wiring adjustable immersion type thermostat shall be furnished and installed for each pump to start and stop the pump motor and maintain its thermostat setting.



Aluminum Radiator

- ✓ The contractor shall supply and install aluminum radiators of capacity as indicated on the drawings.
- ✓ Each radiator shall be of sectional type
- ✓ Each radiator shall be complete with the following:
 - Supply valve
 - Manual air vent
 - Manual flow adjusting bronze elbow
 - Wall brackets
- ✓ Each radiator shall have two coats of finishing paint over the base paint.

Boilers

A. Cast Iron Hot Water Heating Boiler

Type: cast iron, sectional type, design for firing by forced draught burner, with pressurized combustion chamber. It is to be factory assembled, sealed and hydrostatically tested to 10 bars for a operating pressure of 6 bars at 100° C.

Combustion Chamber: to be water cooled by being completely surrounded with water. It is not to require firebrick or refractory except at limited locations such as on rear wall and at bottom if front of burner to evaporate oil drippings from burner nozzle.

Boiler Section: high grade cast iron ribbed to provide continuous path for combustion gases for best efficiency of heat transfer. Boiler to have integrally cast supporting legs to permit it to rest directly on concrete support with uniform distribution of load throughout length. Boiler to be assembled with steel tie rods and nuts and externally sealed with special high temperature mastic for complete gas tightness.

Access doors: cast iron cleanout doors to be provide on front section to permit easy access to internal combustion gas passages hinged cast iron burner mounting door to be provided for full access to combustion chamber. Doors to be sealed gas-tight with asbestos rope gaskets, stud bolts and brass nuts.

Burner Mounting door to be fitted with thick; steel front plate for securing burner, supplied undrilled and provided with internal frame to support factory supplied refractory. Hole for burner nozzle to be formed in refractory. Door to have pyrex observation port with cover for inspecting flame condition.

Boiler shall be supplied with motorized air damper installed on boiler chimney and interlocked with the boiler.



Accessories: boiler to have cast iron real smoke hood with horizontal smoke outlet fitted to boiler with asbestos rope gasket to ensure permanent gas-tight seal. Necessary threaded connections to be integrally cast with boiler sections for boiler fill, boiler drain, altitude gauge, thermometer and two thermostats. Connections to be plugged at factory.

Accessories: the following are to be packed separately for field installation: all-around fiber glass insulated heavy gauge sheet steel jacket, sectionalized for fitting to boiler without removal of door fittings or pipe connections, cast iron flanged outlet and return headers with steel counter flanges, gaskets, bolts and nuts, brass separable socket wells for insertion of thermometer and thermostat bulbs into boilers and decorative control panel designed for fitting on boiler.

Maintenance equipment: boiler to be provided complete with set of cleaning brushes with handle, special tools required for maintenance and installation, gun for application of sealing mastic and recommended quantity of sealing mastic in sealed containers required for field sealing of joints.

B. Oil Fired Boiler (Cast Iron)

Boiler Construction

Boiler shall be of the steel type rated for 88.5 psi (610 kpa). each boiler shall be complete with the following:

- Automatic, high pressure, gun-type burner suitable for light oil No. 2 atomization.
- Fuel oil solenoid valve.
- Burner Plate.
- Insulated and enameled steel jacket and fire bricks.
- 4mm. thick steel breaching with 2" (50mm) insulation, connecting the boiler with the chimney.
- Draft control damper.
- Thermometer.
- Pressure gauge.
- Aquastat.



- Pyrostat or photocell.
- Safety relief valve.
- Electric control panel complete with switches and pilot lights and all electrical wiring.

The Aquastat shall control burner operation to maintain water leaving the boiler at 180°F (82 °C) and the Pyrostat or the photocell shall monitor burner operation and stop it in the event of flame failure or if combustion does not take place.

Burner

Burner shall be of the fully automatic mechanical pressure atomizing type; factory assembled and fire tested.

Burner shall be suitable for burning diesel fuel No. 2. It shall be complete with the following components and accessories.

- Oil burning nozzles.
- Ignition transformer and ignition electrodes.
- Fuel oil pump of the rotary type, directly connected to the blower motor.
- Blower.
- Blower and oil pump motor auto-starter.

Controls

Burner shall be automatically controlled by an aquastat actuated by the outgoing boiler water temperature.

In addition to the aquastat, the burner shall be controlled by the following safety devices.

High limit thermostat, for protection against high water temperature. Pyrostat to provide for a shutdown of the burner in the event that combustion does not take place.

Audible alarm shall be provided in case of malfunctioning of the boiler.

Boiler Stacks and Insulation

Boiler stacks must be carefully sized for the total simultaneous capacity of the plant and other fuel fired devices in order to maintain reasonable flue gas velocities for the fuel being burned, the firing equipment and the available draft.

Field fabricated stacks are to be of 2.5 mm. (No. 12 U.S. gauge) black iron welded construction, insulated with 50 mm. (2 in.) of hydrous calcium silicate (asbestos free), all joints cemented. Exposed sections are to be covered with an aluminum jacket. The stack must be self-supporting, with an air space between it and the enclosing shaft wall.

Insulation shall be of Rockwool (120kg/m³) 100 mm thick with aluminum sheet metal jacket 0.8 mm thick as described for heating water pipes in Mechanical Rooms

C. Boiler Control Panel & Electricals

A fully factory prewired, tested and mounted boiler electrical panel shall be installed at the front end or side of boiler.

The control panel shall be fully enclosed, hinged, dust-proof. The control panel shall be of the PLC type fully programmable. The cascade operation of the two boilers shall be fully automatic, with the first boiler with the main controller being the master and the second boiler being the slave with a PCB. The connection between the two boilers shall be using a bus cable.

All sensors shall be connected to the main control panel. The system shall include the following sensors:

- Outside temperature sensor.
- Indoor temperature sensor with automatic mode, night mode or off mode.
- Aquastat sensors.
- Supply water temperature sensor.

The control panel shall include:

- A step-down control transformer.
- Control and power fuses.
- All relays and transformers.
- A blower motor starter with overloads and auxiliary contracts.
- A oil pump motor starter with overloads and auxiliary contracts.
- The flame safeguard and programming relay complete: Base.
- Chassis and modules as outlined elsewhere.
- Terminal strips, numbered for easy tracing of wiring, complete with all hardware.



All wires running out of the panel shall be installed within metallic conduits and terminated at the punched holes to the panel sides, with the required hardware as per IEC code.

Refer to division 16, section for wiring recommendations shall stay on until the failure condition has been corrected.

The control panel shall be able to be programmed for a full week. It shall take also night or day mode in addition to weekend mode.

The reading of the outside temperature sensor shall regulate the supply water temperature to meet the required load and comfort.

D. Boiler & Burner Manufacturers:

Obtain unit from one of the following: De

Dietrich (France)

Buderus (Germany)

Chemical Feeder Pot

The unit shall be of a quality construction with dished ends for safe operation at pressure and shall be supplied complete with all valves and funnels all factory assembled. The feeder unit shall be supplied with a stand and shall be pressure tested with a certificate from the factory.

Chemical feeder pot shall be similar to Houseman dosage pots or approved equal.

Expansion Tank

Provide compression tank (expansion tank) as shown on the drawings, constructed for 930 Kpa working pressure, stamped with "U" symbol and supplied with National Board from U-1 denoting compliance with ASME boiler and pressure vessel code or any equivalent European standards. Provide fittings and connections to related equipment in accordance with tanks manufacturer's recommendations. Tank shall be insulated externally. Insulation shall be same type used for exposed ductwork, specified hereinbefore. Tank diaphragm shall withstand 10 deg. C up to 120° suitable for heating water systems.

Refer to drawings for tank support.

Heating Water Treatment

Contractor shall assign a chemical specialist to execute all chemical treatment works subject to the approval of the Engineer.



The scope of work for the chemical treatment specialist is as follows:

1. Chemical Supply
2. Supervision of treatment program applied
3. Water analysis and recommendations.

The mechanical contractor shall make sure that the following are completed and handed over to the engineer prior to commencement of water treatment works:

1. System is electromechanical operating.
2. System is tested and pressurized for leaks.
3. System to be cleaned should be final and any new loops to be connected should be separately.
4. Drain points should be provided and sufficient for quick system draining.
5. Make-up water supply should match with system volume.

3. EXECUTION

General Installation

A. Piping

The piping shall be installed generally as described and as shown on the drawings for heating water.

Install thermometers in piping system adjacent to the heat exchanger inlet and outlet secondary connections.

Install strainers in water piping a head of all pumps, automatic modulating valves, and heating coils.

Provide balancing valves and pressure gage cocks in all returns from three way valve bypass loops to balance the system.

Balancing valves shall be required on the return of each branch main to balance the system.

Provide flexible connections at the inlet and outlet to all major equipment which require vibration isolation.

- B. General: Except as otherwise indicated, install heating plant work, including components and controls required for boiler operation, in accordance with boiler manufacturer's instructions, and, with recognized industry practices, to ensure that boiler equipment complies With requirements and serves intended purposes.



- C. Locate boilers in general position indicated in relation to other work.
Position boilers with sufficient clearance for normal service and maintenance, including clearance for cleaning and replacement of tubes and clearance for component replacement.
- D. Paint damaged and abraded factory finish with touch-up paint matching factory finish.

Examination of Related Work

Observe installation of other work (related and connected to boiler work) and after completion check for inadequacies and protect operation and performance of boiler work to suit boiler manufacturer's requirements and to the Royal Commission's satisfaction and approval, do not start boiler work until inadequacies have been corrected in a manner acceptable to the Engineer.

Field Quality Control

Manufacturer's Supervision: Boiler manufacturer shall supervise field assembly (if any) and installation of boiler work, with a factory-trained technical service representative, for a minimum of 2 working days, plus one additional day for each boiler unit in excess of one. Prepare manufacturer's written report of installation.

Boiler Start-Up

General: Except as otherwise indicated, start-up boiler in accordance with boiler manufacturer's instructions.

Sustained Operation: Do not place boiler in sustained operation prior to initial balancing of mechanical systems affected by boiler operation. Refer to requirements of Division 15 sections for testing, adjusting, and balancing.

Cooperate with other trades of other work during the testing, adjusting, balancing and start-up of mechanical systems

Testing

General: Except as otherwise indicated, test boiler as directed by the Engineer.



4. FUEL OIL SYSTEM

GENERAL

System Description

- A. This Section covers:
 - 1. The daily services tanks constructed of steel
 - 2. Underground main fuel tanks.
 - 3. The oil feed pumps and piping circuits.

Quality Assurance

- A. Manufacturers Qualifications
 - 1. The manufacturer must be experienced in the manufacture of the type and size of tank using the materials specified and shall be approved.

References

- A. Refer to individual materials for specified standards.
- B. American Petroleum Institute (API)
 - 1. API - 650 Fabrication of Oil Tanks.

Submittals

- A. Product Data
 - 1. Descriptive literature for each of the actual proposed equipment to be used including:
 - a. Capacity.
 - b. Test Reports.
 - c. Certificates of Approval.
 - d. Operating and Maintenance Data.
 - e. Any other Technical Data.



B. Shop Drawings

1. Shop drawings for each of the actual proposed equipment shall include the following:
 - a. Working or Manufacturing Drawings.
 - b. Calculations.
 - c. Installation Details.
 - d. Connections by Other Services.
 - e. Wiring Diagrams.
 - f. Accessories Available Indicating Those Included.
 - g. System Diagrams.

PRODUCTS

Pipes And Tubes

- A. Refer to Part 3 Article “ Piping Applications” for identification of system where pipe and tube materials specified below are used.
- B. Steel pipe: ASTM A53, Schedule 40, Seamless type, Grade B, black, with beveled ends.

Pipes And Tubes Fittings

- A. Refer to Part 3 Article “ Piping Applications” for identification of system where pipe and tube fitting materials specified below are used.
- B. Malleable-iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threads according to ASME B1.20.1.
- C. Steel Fittings: ASTM A 234/A 234M, welded, for welded joints.

Oil Safety Valves:

UL-listed for flammable or volatile liquids, 1725 kPa maximum working pressure, 288 deg C maximum operation temperature. Include ASTM B 61 bronze body, bronze bases and discs, and field adjustable cadmium- plated carbon steel springs, factory set at 20 percent above operating pressure. End connections have inside threads according to ASME B1.20.1.



Oil Tanks

A. General

1. Fuel oil storage tanks shall be provided where located on the drawings with capacities as scheduled.

B. Storage Tank (Horizontal Mounting)

- Tank shall be constructed of 4 mm. thick welded black steel sheet metal to the capacities indicated on the Drawings.
- Tank shall be tested for leaks before installation and shall be painted with two coats of red lead oxide or approved equal, and two coats black bituminous paint.
- Tank shall be mounted on a concrete pad and shall be equipped with the following:
 - * Manhole and manhole cover, air tight.
 - * Protected oil level indicator fixed to the tank.
 - * Fill and vent pipes.
 - * Gate valves as shown on drawings.
 - * Overflow, drain and supply lines.

C. Fuel Oil Strainers

Y-pattern, full size of connecting piping. Include Type 304 stainless steel screens with 1.2 mm perforations.

1. Pressure Rating: 860 kPa (125 psig) minimum steam working pressure.
2. Size 65 mm and Smaller: Bronze body, with female threaded ends.
3. Sizes 80 mm and Larger: Cast-iron body, with flanged ends.
4. Screwed screen retainer with centered blow-down and pipe plug.



D. Level Switches in Fuel Tank

Level switches installed in daily fuel oil tank all on one stem to operate solenoid valve shall be of the type suitable for fuel oil with four level switches as indicated on drawings. Mounting and stem material shall be of brass, float shall be of polysulfone or polypropylene. Switches shall give signal for:

- Low level alarm
- Low level open valve.
- High level close valve.
- High level alarm.

Grip rings shall be of copper and collar of brass Stem size shall be 5/16 inches diameters of the adjustable type with length suitable for day tank height.

Level switch shall be UL listed, Thomas products LTD level and flow switches mode 4000 or approved equal.

Low level switch and high level switch in underground fuel tank shall be as described above but shall give low level signal BMS and high level signal to give alarm that tank is over filled with fuel oil by tanker and a signal to BMS.

Flame Arrestor

Flame arrestor shall be installed at end of fuel oil vent pipes and shall consist of a series of sturdy round discs mounted on a durable collar casing.

Flame arrestor shall be constructed of light weight cast aluminum collar, weather hood and flame arrestor plates. Flame arrestors shall be UL listed with quality assurance from factory before shipment.

Flame arrestor shall be Protectoseal Model No 6670 or approved equal.

Pressurization and Expansion Units

HWS Expansion Vessels

Expansion vessels shall be constructed of mild steel generally in accordance with BS 4814 and BS 5169 and as per ASME section VII Div. 1.

Each vessel shall be provided with a removable, heavy duty Butyl rubber bladder, removes easily for inspection and maintenance.



Each vessel shall be suitable for the working pressure of the system and shall be provided with a charging valve connections and feed connection to the system. The vessels shall be suitable for the total water content of the various systems.

EXECUTION

Piping Applications

- A. Aboveground Piping, Sizes 50 mm and smaller: Steel pipe, malleable- iron fittings, and threaded joints.

Pipe Installations

- A. Install strainers on the supply side of each control valve, pressure regulating valve, oil burner connection, and elsewhere as indicated. Install 20 mm pipe nipple and ball valve in blow-down connection of strainers 50 mm and larger. Use same size nipple and valve as blow-off connection of strainer.

Hanger and Support Installation

- A. Refer to Division 15 Section “Hangers & Supports” for hanger and support devices.
- B. Install hangers for horizontal piping with following maximum spacing and minimum rod sizes:

Nominal Pipe Size (Millimeters)	Steel Pipe Max. Span (Meters)	Min. Rod Diameter (Millimeters)
15 & smaller	2.1	2.1
20	2.1	2.1
25	2.1	2.1

- Support vertical steel pipe at each floor and at spacing not greater than 4.6m.

Valve Installations

- A. Install valves in accessible locations, protected from physical damage. Tag valves with a metal tag attached with a metal chain indicating the piping systems supplied.



- B. Install gate valves at each branch connection to supply mains and elsewhere as indicated.
- C. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage.

Terminal Equipment Connections

- A. Sediment raps: Install a “T” fitting with the bottom outlet plugged or capped as close to the inlet of the oil burning appliance as practical. Drip leg shall be a minimum of 3 pipe diameter in length.

Field Quality Control

- A. Test fuel oil piping according to NFPA 31. Remark leaking joints and connections using new materials.
- B. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

Demonstration

- A. Train Owner's maintenance personal on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventive maintenance.
- B. Review data in Operating and Maintenance Manuals. Refer to Division 1 Section “Project Closeout”.
- C. Schedule training with Owner with at least 7 days advance notice

Commissioning

- A. Before activating system perform these steps:
 - 1- Open valves to full open position and close bypass valves.
 - 2- Remove and clean strainer screens.
 - 3- Check pump for proper direction of rotation.
 - 4- Fill oil storage tank with proper fuel type.
 - 5- Check operating controls of fuel burner units.
 - 6- Check operation at automatic bypass valves.
 - 7- Check and set operating temperature controls on oil heaters.



CHAPTER SIX **VENTILATION**



6.0 VENTILATION

TABLE OF CONTENTS

1. Ductwork
2. Ductwork ancillaries
3. Dampers and terminal units
4. Inlet and outlet terminals
5. Fans



CHAPTER SIX **VENTILATION**

1. DUCTWORK

1.1 General

All site measurements for manufacture and installation co-ordination of ductwork shall be taken by the Contractor.

Ducts shall be anchored securely to the structure in an approved manner and shall be installed so as to be completely free from vibration under all conditions of operation.

1.2 Construction of Sheet Metal Ductwork

Supply and install all ductwork as shown on the drawings and specified therein. Ducts shall be constructed of galvanized steel sheets conforming to ASTM A 526-71, galvanized by the hot-dip process coating designation G90 or approved equivalent standard. Minimum weight of zinc coating (total on both sides) 275 g/m².

Ductwork shall be installed in accordance with ASHRAE or SMACNA requirements for low pressure ducts.

Ductwork galvanized after manufacture shall be of adequate thickness to avoid undue distortion during the galvanizing process. All ductwork shall be to the approval of the Engineer.

The ductwork shall be manufactured without longitudinal joints at the bottom and suitable gaskets shall be provided at flanges to prevent leakage of condensation. The ductwork shall be installed with a fall back to the dishwasher or grease filters as applicable. Access doors shall be provided for inspection and cleaning at 3 meters intervals and at each change in direction. Where restricted space dictates that these access panels must be mounted on the bottom face of the duct an internal lip shall be incorporated to minimize the risk of spillage. The access panels shall be provided with suitable gaskets.

Sheet metal ducts shall be properly braced and reinforced with steel angles or other structural members approved by the Engineer all in accordance with ASHRAE & SMACNA requirements. Unless otherwise required, the internal ends of all slip joints shall be installed in the direction of flow.



2. DUCTWORK ANCILLARIES

2.1 Flexible Connectors

2.1.1 General

Flexible connectors shall be included in the price on ductwork crossing building movement joints on all fan and air handling plant ducting connections including fan coil units and grille/diffuser plenum boxes to provide isolation. Metal ducts shall be arranged so that there is a clear gap of not less than 100 mm or greater than 200mm where necessary between the ends of the ducts and the fan spigots, and the ducts shall be supported either side of the connector to ensure the alignment of the duct and/or fan spigots.

Flexible connectors shall be hemmed and seamed as appropriate and formed to a section to suit the dimensions of the duct or fan connection.

The flexible connections shall be made from non-inflammable and rot resistant approved material with a surface spread of flame of Class '0' as defined in BS 476 Part 7 in ceiling voids and Class '1' to BS 476 Part 7 in plantrooms. The material shall be of adequate thickness to give a minimum of noise reduction of 12 dB at 125 Hz.

2.1.2 Sheet Metal Ducting

Angle iron welded flange frames shall be secured to the ends of the flexibles by riveting through the inside flange of the angle iron and using a flat mild steel backing strap on the outside of the flexible. Mating flanges shall be provided unless otherwise specified on the adjacent ductwork or fan connection.

In rectangular ductwork other than fan connections with the longest side less than 450 mm the flexible may be riveted direct to the ductwork using a flat mild steel backing strap or when approved a four piece bolted band clip provided that angle iron stiffeners are fitted to the ductwork.

In circular ductwork other than on fan connections and ductwork over 900 mm diameter mating flanges may be omitted and flexibles secured with a worm driven draw up band clip provided that angle iron stiffening rings are fitted to the ductwork.

3. DAMPERS AND TERMINAL UNITS

3.1 Fire Dampers

Sheet Metal Ductwork

Fire dampers and duct access panels shall be provided wherever ductwork penetrates a fire barrier.

Fire dampers shall be stainless steel curtain dampers comprising a continuous series of folded interlocked blades contained within, and arranged to close the opening of a surrounding frame.

The damper blades when set shall fold up out of the airstream.

The damper blades shall be of not less than 0.7 mm stainless steel strip type 430 to BS 1449. All blades shall be shaped on both edges to form a continuous interlocking hinge extending the full length of the blade to ensure correctness of action, each blade incorporating two Vee formed ribs along each blade length for maximum strength.

The blade assembly shall be fixed to the damper framework by the first blade being secured flat to the inside face of one side of the outer frame.

The damper casing shall be of rolled section so shaped as to provide two 25.4 mm internal flanges spaced at not more than 78 mm apart. This frame shall be airtight and of not less than 1.59 mm strip mill cold reduced sheet continuously hot dipped galvanized to BS 2989, Group 2, Class B.

All welded edges and joints shall be protected with zinc chromate primer or zinc rich paint.

Spring tempered 0.25 mm stainless steel type 301S21 to BS 1449 side gasketing shall be inserted between the blade end and damper casing to provide an increased blade edge seal to reduce the passage of smoke and combustible gases.

The blades shall be held open by a purpose made straight bar type fusible link, locking into two stainless steel cam latch assemblies or similar.

This link assembly, combined with a ramp blade release toggle fitted to the leading blade of each fire damper assembly, shall allow the fire damper to be tested and reset from either side of the damper when installed. The fusible link shall be rated 72°C unless otherwise specified.

The unit shall include indication that the damper is closed.

The dampers shall be clearly marked "bottom of unit" to assist correct installation.

All dampers shall be closed by two constant tension coil band springs exerting a pull of not less than 35N, and shall be capable of completely closing against the normal in duct air flow total pressure. These springs shall be stainless steel 17/7PH or type 304S31 to BS 1449 and not less than 19 mm wide by 0.3 mm thick.

The coiled end of the spring shall be retained around a stainless steel pivot fixed to a catch plate in such a way that it will not become dislodged from the pivot by side movement.

3.2 Constant Volume Dampers

The Contractor shall supply and install as indicated in the Scope of Works constant volume controllers designed to maintain a constant downstream duct pressure regardless of fluctuating upstream pressures.

The controller shall be system operated with mechanical constant volume action factory preset to the required air volume.

The volume tolerance shall be $\pm 5\%$ with a pressure variation of 700 Pa.

The constant volume control damper shall be manufactured from galvanized steel in circular construction with damping by air bellows and a stainless steel control spring. The blade spindle shall be mounted in ball bearings. The control damper shall be suitable for connection to circular ductwork. It shall be possible to site adjust the volume setting.

Each supply unit shall be provided complete with a downstream LTHW reheater battery and with outlet attenuation to achieve the relevant required room noise level, all as a composite proprietary constant volume terminal unit.

3.3 Hand Operated Volume Control Dampers

3.3.1 Sheet Metal Ductwork

Galvanized steel aerofoil opposed blade control dampers shall be installed on systems without constant volume dampers to ensure the ventilation systems can be properly balanced. The use of opposed blade dampers behind diffusers to balance ductwork branches will not be permitted. A separate branch ductwork damper shall be provided and the diffuser damper used only for fine-tuning of the flow to the room. Blades shall be of a low profile and aspect ratio for lowest possible turbulences, air resistance and noise. The blade size shall be such as will permit site withdrawal of the complete damper regardless of damper blade position.

Volume control dampers shall be provided on every main duct, branch duct and sub-branch in accordance with the C.I.B.S.E. COMMISSIONING CODE.

Damper control shall be via finely toothed precision moulded nylon gears and bearings, which shall be completely out of the air stream. The gearing shall have a 4:1 ratio to give minimum torque during operation.

All moving parts shall be enclosed in a galvanized sheet steel dustproof control box and be complete with visual blade position indicator, operating and locking assembly.

The damper casing shall be of slimline airtight dustproof double skin construction of high rigidity and maximum strength. The outer frame shall be manufactured from roll formed 1.6 mm galvanized steel and the inner frame from 1.0 mm. The outer frame shall have continuously welded corners and integral peripheral flanges pre-punched with elongated holes for ease of duct attachment and height adjustment. The external damper casing surface area shall have only one penetration of drive shaft to simplify insulation where required.

In large ducts where a multiple assembly is required the dampers shall be arranged so that control shall be from one central control.

In circular low velocity (not exceeding 7.5 m/s) ductwork dampers shall be as specified above and fitted with rectangular to circular masking plates. The air leakage past the damper shall not exceed 5% when in the fully closed position at a static pressure equal to the maximum static pressure in the system.

All volume control dampers shall be supplied with duct access panels as specified.

3.4 Back Pressure Dampers

Backpressure dampers shall be of the automatic self-operating type and constructed in a galvanized mild steel frame with flanged connections drilled for installation in the ductwork system. The blades shall be coupled together and shall be constructed from aluminium on stainless steel shafts with bronze bearings and neoprene seals.

4. INLET AND OUTLET TERMINALS

4.1 Grilles

The Contractor shall select and locate the grilles and diffusers and coordinate them into the architectural reflected ceiling plans where applicable.

During construction the Contractor shall co-ordinate the location and fixing of the grilles and diffusers with the ceiling installations. The Contractor shall site measure and agree with the Engineer the final dimensions of all grilles and diffusers before manufacture.



4.2 Louvers

Intake and discharge louvers in the face of the building will be provided as part of the Mechanical Contract and are therefore included in the Scope of the Mechanical Services. All louvers shall be of aluminum construction, weather proof and complete with bird screens.

Acoustic louvers, silencers etc. shall be installed as indicated on the drawings. All louvers will be painted to match the buildings facia.

Approved Manufacturers

- a. KBE
- b. Trox
- c. Titus

or approved equal.

5. FANS

5.1 General

The Contractor shall supply and install in accordance with this Specification, fan and motor assemblies as detailed in the Schedules of Equipment and as indicated on the drawings.

Fan unit performance curves derived in accordance with BS 848 shall be supplied showing volume, static pressure, maximum absorbed kW and static efficiency with the unit operating condition clearly marked. These details shall be issued to the Engineer for approval prior to the fans being installed.

A sound spectrum for each fan and motor assembly derived in accordance with BS 848 shall be supplied to the Engineer before manufacture, but under no circumstances shall the sound power level exceed that given in the Schedule of Equipment.

Additional attenuation is specified in the Schedules to meet specific noise criteria for fan systems. Where fans are supplied having different sound spectrum or ductwork is modified, the attenuator insertion losses shall be adjusted to ensure design noise criteria are maintained.

The fan motors shall comply with the relevant clauses on Electric Motors set down elsewhere in this Specification.

Unless otherwise specified or detailed each fan assembly shall be installed on a 150 mm concrete base and shall be isolated from the structure by anti-vibration mountings in accordance with the relevant clauses of this Specification.

The complete fan assembly shall be primed and painted in a colour to be agreed with the Engineer and in accordance with the relevant section of this Specification relating to painting.

Each fan shall be isolated from the ductwork installation by flexible connections complying with the relevant clauses set down elsewhere in this Specification.

5.2 Axial Flow Fans

Axial flow fan impellers shall be of the multi-blade type dynamically balanced with blades of 'aerofoil section' constructed from aluminum alloy.

The casings shall be of the long type of heavy gauge mild steel having flanges at both ends and hot dipped galvanized to BS 729 after manufacture.

The casings shall be provided with bolted inspection doors and an external weatherproof terminal box.

The impellers shall be direct driven by motors of totally enclosed continuously rated 3-phase type with ball bearings and extended grease point. The impellers shall be capable of giving fan total efficiency of not less than 75%.

Purpose made feet shall be provided on the fan casing for supporting the fans. The fan speed shall not exceed 24 rps (1440 rpm).

Each axial flow fan shall be supported by means of a strong rolled steel angle or channel frame from the steelwork, wall or floors as necessary.

5.3 Approved Manufacturers

- a. Penn
- b. Woods
- c. Ventaxia
- d. Kanaflakt
- e. Greenheck
- f. Acme

or approved equal.



CHAPTER SEVEN

FIRE PROTECTION



7.0 FIRE PROTECTION

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1. General
2. Products



CHAPTER SEVEN **FIRE PROTECTION**

PART 1.0 – GENERAL

1.1 DESCRIPTION

This section of the specifications includes the furnishing and installation of fire extinguisher.

PART 2.0 - PRODUCTS

2.1 PORTABLE FIRE EXTINGUISHERS

Portable fire extinguishers shall be provided to the types specified, and at locations as shown on the drawings. Standard portable fire extinguishers are 10 pound (4.54 kilogram) ABC dry chemical units with a UL rating of 4A-60BC. A 20 pound (9.07 kilogram) BC dry chemical unit shall be located adjacent to each cooking line. Carbon dioxide extinguishers shall be provided for all electrical equipment areas.

Portable extinguishers shall be located within combined hose rack cabinets where shown, or attached to walls with purpose made brackets. Extinguishers with a gross weight of forty (40) pounds (18.14 kilograms) or less, may be installed in a position where the top of the extinguisher is no more than 5 feet (1.53 metres) above the floor. Extinguishers with a gross weight in excess of forty (40) pounds (18.14 kilograms) shall be installed such that the top of the extinguisher is no more than 42" (1070mm) above the floor.

2.2 APPROVED MANUFACTURERS

- a. Kiddi
- b. ABC
- c. Fridhom

or approved equal.



CHAPTER NINE

PLUMBING FIXTURES



CHAPTER NINE

PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Lavatories.
 - 2. Sinks.
 - 3. Water closets.
 - 4. Shower tray.
 - 5. Self close taps.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted plumbing fixtures.
- B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For plumbing fixtures and faucets to include in emergency, operation, and operation and maintenance manuals.



1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Faucet Washers and O-Rings: Equal to **10** percent of amount of each type and size installed.
 2. Faucet Cartridges and O-Rings: Equal to **5** percent of amount of each type and size installed.
 3. Flushometer-Tank Repair Kits: Equal to **5** percent of amount of each type installed, but no fewer than **two** of each type.
 4. Toilet Seats: Equal to **5** percent of amount of each type installed.

PART 2 - PRODUCTS

2.1 LAVATORIES

- A. Lavatory - Type LAV-1 (toilets): As specified including mixer 0.5gpm @ 60 psi rated aerator complete with the following trim and accessories or approved equal:
- ☐ 32 mm chrome waste fitting, Grohe 28940
 - ☐ 32 mm chrome plated bottle trap with adjustable inlet pipe, wall tube and wall flange,
 - ☐ Grohe No. 28920 15 mm angle valve with 300 mm long chrome plated copper tube, blue index, Grohe No. 22958
 - ☐ 15 mm angle valve with 300 mm long chrome plated copper tube, red index, Grohe No. 22940.
- B. Lavatory - Type LAV-2 (disabled toilet): As specified including basin sensor mixer 0.5gpm @ 60 psi rated aerator complete with the following trim and accessories or approved equal:
- ☐ 32 mm chrome waste fitting, Grohe 28940
 - ☐ 32 mm chrome plated bottle trap with adjustable inlet pipe, wall tube and wall flange
 - ☐ Grohe No. 28920 15 mm angle valve with 300 mm long chrome plated copper tube, blue index, Grohe No. 22958
 - ☐ 15mm angle valve with 300 mm long chrome plated copper tube, red index, Grohe No. 22940
- C. Lavatory - Type LAV-3 (children): As specified including self close mixer 0.5gpm @ 60 psi rated aerator complete with the following trim and accessories or approved equal:
- ☐ 32 mm chrome waste fitting, Grohe 28940
 - ☐ 32 mm chrome plated bottle trap with adjustable inlet pipe, wall tube and wall flange
 - ☐ Grohe No. 28920 15 mm angle valve with 300 mm long chrome plated copper tube, blue index, Grohe No. 22958
 - ☐ 15 mm angle valve with 300 mm long chrome plated copper tube, red index, Grohe No. 22940.

- D. Lavatory - Type LAV-4 (toilets): As specified including self close mixer 0.5gpm @ 60 psi rated aerator complete with the following trim and accessories or approved equal:
- ☐ 32 mm chrome waste fitting, Grohe 28940
 - ☐ 32 mm chrome plated bottle trap with adjustable inlet pipe, wall tube and wall flange,
 - ☐ Grohe No. 28920 15 mm angle valve with 300 mm long chrome plated copper tube, blue index, Grohe No. 22958
 - ☐ 15 mm angle valve with 300 mm long chrome plated copper tube, red index, Grohe No. 22940.

2.2 SINKS

- A. Kitchen Sink - Type KS-1: Refer to architectural BOQ & Specifications.

Under counter Kitchen Sink is to be supplied complete with the following trim and accessories as manufactured by Grohe, or approved equal:

50 mm sink waste with stainless steel grating One 50 x 50 x 40 mm outlet pipe 40 x 40 mm Tubular P-trap with extension pipe and flange

40 mm round nuts

Supply inlets DN 15 brass pipe or copper tubing

Supply shutoff valves DN 15 gate, globe or angle valves. Washer less ceramic disc valve.

Kitchen Faucet as specified: One stainless steel detachable overflow

- B. Laboratory Sink - Type LS: Sink and faucet as selected and specified by specialist, complete with the following trim and accessories or approved equal:

32 mm chrome waste fitting, Grohe 28940

32 mm chrome plated bottle trap with adjustable inlet pipe, wall tube and wall flange, Grohe No. 28920 15 mm angle valve with 300 mm long chrome plated copper tube, blue index, Grohe No. 22958

15 mm angle valve with 300 mm long chrome plated copper tube, red index, Grohe No. 22940.

- C. Service Sink - Type S: Sink and faucet as selected and specified by specialist, complete with the following trim and accessories or approved equal:

32 mm chrome waste fitting, Grohe 28940

32 mm chrome plated bottle trap with adjustable inlet pipe, wall tube and wall flange, Grohe No. 28920 15 mm angle valve with 300 mm long chrome plated copper tube, blue index, Grohe No. 22958

15 mm angle valve with 300 mm long chrome plated copper tube, red index, Grohe No. 22940.

2.3 WATER CLOSETS

- A. Water Closet - Type EWC-1 (toilets): As specified including solid plastic seat and cover, flush valve, complete with the following trim and accessories, or approved equal:
- Plastic bottom hinges, rubber washers and plastic screws and nuts,
- 15 mm angle valve with 300 mm long chrome plated copper tube, blue index, Grohe No. 22960
- B. Water Closet - Type EWC-2 (disabled): As specified, including solid plastic seat and cover, flush valve, complete with the following trim and accessories, or approved equal:
- Plastic bottom hinges, rubber washers and plastic screws and nuts, Grab Bars 2 No. Bobrick B 5806x24
- 15 mm angle valve with 300 mm long chrome plated copper tube, blue index, Grohe No. 22960
- C. Water Closet - Type EWC-3 (Children): As specified, including solid plastic seat and cover, flush valve, complete with the following trim and accessories, or approved equal:
- Plastic bottom hinges, rubber washers and plastic screws and nuts,
- 15 mm angle valve with 300 mm long chrome plated copper tube, blue index, Grohe No. 22960

2.4 SHOWER - Type SH

Shower receptacle shall be white enameled fireclay of the tray type 800x800x110mm,

Shower shall be complete with the following:

1 ½ " unslotted strainer, waste face of the shower tray adjacent to the waste shall be unglazed, stainless steel straight grab rail, single lever bath and shower mixer with handshower flexible hose and fixed support, chrome plated.

2.5 SELF CLOSE TAPS

Faucet shall be self-closing wall-mounted or fixed on LAV body, push button and adjustable fitted on the pan as provided by others.

It shall include an integrated aerator, chrome finish complete with flow regulator, vandal proof and wall plate.

1¼" drain shall be provided with chrome plated trap and connected to the drain UPVC pipe. The number of faucets shall be as shown on the drawings.



PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing-fixture installation.
- B. Examine walls, floors, cabinets, and counters for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install plumbing fixtures level and plumb according to roughing-in drawings.
- B. Install floor-mounted water closets on closet flange attachments to drainage piping.
- C. Install counter-mounting fixtures in and attached to casework.
- D. Install pedestal lavatories on pedestals and secured to wood blocking in wall.
- E. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
 - 1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Comply with valve requirements specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- F. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.
- G. Install toilet seats on water closets.
- H. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- I. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes unless otherwise indicated.
- J. Install disposer in outlet of each sink indicated to have a disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.
- K. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible **lavatories and sinks**. Comply with requirements in Division 22 Section "Plumbing Piping Insulation."



- L. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep- pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Division 22 Section "Escutcheons for Plumbing Piping."
- M. Seal joints between plumbing fixtures, counters, floors, and walls using sanitary-type, one- part, mildew- resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Division 07 Section "Joint Sealants."

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Division 22 Section "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Division 22 Section "Sanitary Waste and Vent Piping."
- D. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible **lavatories and sinks**. Comply with requirements in Division 22 Section "Plumbing Piping Insulation."

3.4 ADJUSTING

- A. Operate and adjust plumbing fixtures and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

- A. After completing installation of plumbing fixtures, inspect and repair damaged finishes.
- B. Clean plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed plumbing fixtures and fittings.
- D. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Employer.



CHAPTER TEN

THERMAL INSULATION



10.0 THERMAL INSULATION

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Products



CHAPTER TEN **THERMAL INSULATION**

PRODUCTS

1. PIPEWORK THERMAL INSULATION (Type A)

A. Material

1. Thermal insulating material shall be made from long, fine fiber glass, Rockwool, free from short or coarse fibers, bonded with a temperature resistant binder and formed into a cylindrical or semi-cylindrical rigid pipe sections with aluminum foil facing as described in duct insulation of thickness as specified below with a thermal conductivity of not greater than $0.05\text{W/m}^2\text{C}$. Insulation exposed on roof tank and in Mechanical Rooms shall have a density of 96kg/m^3 . Insulation in false ceiling voids and shafts shall have a density of 64kg/m^3 .

2. Thickness of Insulation

DOMESTIC HOT WATER SUPPLY AND HEATING WATER PIPES

NOM-BORE MM	THICKNESS MM
15-32	25
40-100	30
125	40
150 & above	50

3. The insulation shall have an alkalinity of between PH6.0 and PH10.0. Then insulation shall not include substances which will promote corrosive attack on the services with which it is to be in contact. The insulation shall also be free from objectionable odour at the temperature at which it is to be used, unable to encourage pests or support the growth of fungi, or suffer deterioration under the specific conditions of use or as a result of contact with moisture due to thickness, uniformity of thickness and internal diameter from manufacturer's standards dimension are as follows:

Thickness: $\pm 3\text{ mm}$

Uniformity of thickness The local thickness at any point shall not differ from the average thickness by more than 3 mm.

Internal Diameter: $-0+1.5$ or 1%, whichever is the greater.

Pipe Fittings Insulation

- ✓ Where hangers are installed on the pipe covered with insulation, the entire hanger up to the rod shall be insulated.
- ✓ Where insulated piping is subject to movement and supported on rollers and chairs, or sliding plate brackets, steel protection saddles shall be provided.
- ✓ All insulated pipework not supported as described in Section 15060 but subject to movement, shall be provided with protection shields at all hanger locations. Shields shall be No. 10 gauge galvanized iron extending on each side of the hanger for a distance equal to the diameter of the insulation and shall be provided with cork pad support.
- ✓ Insulate valves, strainers, fittings and flanges with identical material, density, thickness and finish as the pipe insulation. Use premoulded material where available, otherwise use shaped block segments wired on with all edges filled with insulating cement or filler.
- ✓ Insulate strainers to permit removal of the basket without disturbing the insulation of the strainer body.

2. PIPEWORK THERMAL INSULATION (TYPE B)

This type of insulation shall apply to domestic hot water system under tiles or in walls.

Pipes shall be insulated with rubber type insulation Armaflex 19 mm thick. Insulation shall be closed cell tubing with finished skin, chemical and oil resistant with minimum water absorption. Insulation shall stand extremes temperatures ranging from 40°C to 120°C. Inner tubing insulation diameter shall be equal to outer utility pipe diameter. Rubber insulation shall be wrapped with 2 layers of PVC tape.

Insulation density shall be 0.111 Gms/m³ with thermal conductivity K value at 40°C mean temperature 0.041 W/M-K insulation shall be self extinguishing.

Insulation shall be ASTM approved similar to Gulf – O – Flex or approved equal.

3. APPROVED MANUFACTURERS

Johns – Manville	(USA)
Armstrong	(France)
Fiberglass Limited	(UK)
Isotoprack	(Turkey)
ST. Goban	(France)
Al Fujairah Rockwool Factory	(U.A.E.)
Knauf Insulation	(USA)



CHAPTER ELEVEN

GAS SERVICES



CHAPTER ELEVEN **GAS SERVICES**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Butane and propane cylinder and piping

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.
- C. Wiring diagrams for medical gas systems and tanks. Differentiate between manufacturer- installed and field-installed wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and testing agency.
- B. Seismic Qualification Certificates: For **gas manifolds and gas cylinders**, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Material Certificates: Signed by Installer certifying that medical gas piping materials comply with requirements in NFPA 99 for positive-pressure medical gas systems.
- D. Brazing certificates.



- E. Certificates of Shop Inspection and Data Report for Bulk Gas Storage Tanks: As required by ASME Boiler and Pressure Vessel Code.
- F. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For medical gas piping specialties to include in emergency, operation, and maintenance manuals. Refer to Division 1 requirements.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Shape-Memory-Metal Coupling Joints: An authorized representative who is trained and approved by manufacturer.
- B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the medical gas piping testing indicated,, and that is acceptable to authorities having jurisdiction.
- C. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Comply with NFPA 99 for gas piping materials.
- B. Copper Gas Tube: ASTM B 819, Type K and Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service; or according to CGA G-4.1 for oxygen service. Include standard color marking in green for Type K tube and blue for Type L tube.
- C. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type that has been manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
- D. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.



- E. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.
 - 1. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8- inch (3.2-mm) maximum thickness, full-face type.
 - 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.
- F. Shape-Memory-Metal Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
 - a. AeroFit, Inc.
 - b. Smart Tap, Inc.
 - 2. Description: Cryogenic compression fitting made of nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G- 4.1.
- G. PVC Pipe: ASTM D 1785, Schedule 40.
- H. PVC Fittings: ASTM D 2466, Schedule 40; socket type.

2.2 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.
- B. Threaded-Joint Tape: PTFE.
- C. Solvent Cement for Joining PVC Piping: ASTM D 2564. Include primer complying with ASTM F 656.

2.3 VALVES AND VALVE BOXES

- A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
- B. Zone-Valve Box Assemblies: Box with medical gas valves, tube extensions, and gages.
 - 1. Zone-Valve Boxes:
 - a. Steel Box with Stainless-Steel Cover:
 - 1) Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
 - a) BeaconMedaes.
 - b) Tri-Tech Medical.



- b. Description: Formed steel box with cover, anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
 - 1) Interior Finish: Factory-applied white enamel.
 - 2) Cover Plate: **Aluminum** with frangible or removable windows.
 - 3) Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

C. Ball Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
 - a. Amico Corporation.
 - b. BeaconMedaes.
 - c. Conbraco Industries, Inc – Appollo Valves.
 - d. Marwin Valve; a division of Richards Industries.
 - e. NIBCO INC. Tri-Tech Medical Inc.
- 2. Standard: MSS SP-110.
- 3. Description: Three-piece body, brass or bronze.
- 4. Pressure Rating: 300 psig (2070 kPa) minimum.
- 5. Ball: Full-port, chrome-plated brass.
- 6. Seats: PTFE or TFE.
- 7. Handle: Lever type with locking device.
- 8. Stem: Blowout proof with PTFE or TFE seal.
- 9. Ends: manufacturer-installed ASTM B 819, copper-tube extensions with pressure gage on one copper-tube extension
- 10. Enclosure: Weatherproof hinged locking cover with caption similar to "Emergency Low-Pressure Gaseous Oxygen Inlet."
- 11. Inlet: Manufacturer-installed, NPS 1 or NPS 1-1/4 (DN 25 or DN 32), ASTM B 819, copper tubing with NPS 1 (DN 25) minimum ball valve.
- 12. Safety Valve: Bronze-body pressure relief valve set at 75 or 80 psig (520 or 550 kPa).
- 13. Instrumentation: Pressure gage.

D. Safety Valves:

- 1. Bronze body.
- 2. ASME-construction, poppet, pressure-relief type.
- 3. Settings to match system requirements.

E. Pressure Regulators:

- 1. Bronze body and trim.
- 2. Spring-loaded, diaphragm-operated, relieving type.
- 3. Manual pressure-setting adjustment.
- 4. Rated for 250-psig (1725-kPa) minimum inlet pressure.
- 5. Capable of controlling delivered gas pressure within 0.5 psig for each 10-psig (5.0 kPa for each 100-kPa) inlet pressure.



2.4 GAS MANIFOLDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:
 - 1. Acme Cryogenics.
 - 2. Allied Healthcare Products Inc.; Chemetron Division.
 - 3. Amico Corporation.
 - 4. BeaconMedaes.
 - 5. Ohio Medical Corporation.
 - 6. Tri-Tech Medical Inc.
- B. Comply with NFPA 99 for high-pressure medical gas cylinders.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Central Control-Panel Unit:
 - 1. Weatherproof cabinet.
 - 2. Supply and delivery pressure gages.
 - 3. Electrical alarm-system connections and transformer.
 - 4. Indicator lights or devices.
 - 5. Manifold connection.
 - 6. Pressure changeover switch.
 - 7. Line-pressure regulator.
 - 8. Shutoff valves.
 - 9. Safety valve.
- E. Manifold and Headers:
 - 1. Duplex, nonferrous-metal header for number of cylinders indicated, divided into two equal banks.
 - 2. Designed for **2000-psig (13.8-MPa)** minimum inlet pressure.
 - 3. Cylinder-bank headers with inlet (pigtail) connections complying with CGA V-1.
 - 4. Individual inlet check valves, shutoff valve, pressure regulator, check valve, and pressure gage.
- F. Operation: Automatic, pressure-switch-activated changeover from one cylinder bank to the other when first bank becomes exhausted, without line-pressure fluctuation or resetting of regulators and without supply interruption by shutoff of either cylinder-bank header.
- G. Mounting: **Wall with mounting brackets for manifold control cabinet and headers**
- H. Label manifold control unit with permanent label identifying medical gas type and system operating pressure.
- I. Propane/ Butane Cylinders: Number and type of medical gas cylinders required for complete manifold systems.



2.5 GAS CYLINDER STORAGE RACKS

- A. Wall Storage Racks: Fabricate racks with chain restraints for upright cylinders as indicated or provide equivalent manufactured wall racks.
- B. Freestanding Storage Racks: Fabricate racks as indicated or provide equivalent manufactured storage racks.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of gas piping.
Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Comply with NFPA 99 for installation of gas piping.
- C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- F. Install piping adjacent to equipment and specialties to allow service and maintenance.
- G. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications specified in "Piping Schedule" Article unless otherwise indicated.
- H. Install piping to permit valve servicing.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and for branch connections.
- K. Install medical gas piping to medical gas service connections specified in this Section, to medical gas service connections in equipment specified in this Section, and to equipment specified in other Sections requiring medical gas service.
- L. Install exterior, buried medical gas piping in protective conduit fabricated with PVC pipe and fittings. Do not extend conduit through foundation wall.



- M. Piping Restraint Installation: Install seismic restraints on piping. Comply with requirements for seismic- restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- N. Install medical gas service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- O. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.
- P. Install unions in copper tubing adjacent to each valve and at final connection to each specialty and piece of equipment.
- Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.2 VALVE INSTALLATION

- A. Install shutoff valve at each connection to gas laboratory equipment and specialties.
- B. Install check valves to maintain correct direction of gas flow from laboratory and healthcare gas supplies.
- C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- D. Install zone valves and gages in valve boxes. Arrange valves so largest valve is lowest. Rotate valves to angle that prevents closure of cover when valve is in closed position.
- E. Install pressure regulators on gas piping where reduced pressure is required.
- F. Install emergency oxygen connection with pressure relief valve and full-size discharge piping to outside, with check valve downstream from pressure relief valve, and with ball valve and check valve in supply main from bulk oxygen storage tank.

3.3 JOINT CONSTRUCTION

- A. Ream ends of PVC pipes and remove burrs.
- B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- C. Threaded Joints: Apply appropriate tape to external pipe threads.



- D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" chapter. Continuously purge joint with oil-free, dry nitrogen during brazing.
- E. Shape-Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of shape-memory-metal coupling joints.
- F. Solvent-Cemented Joints: Clean and dry joining surfaces. Join PVC pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. Apply primer and join according to ASME B31.9 and ASTM D 2672 for solvent-cemented joints.

3.4 GAS SERVICE COMPONENT INSTALLATION

- A. Assemble ceiling columns and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.
- B. Assemble ceiling-hose assemblies and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.
- C. Install gas manifolds on concrete base anchored to substrate.
- D. Install gas cylinders and connect to manifold piping.
- E. Install gas manifolds with seismic restraints.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.
- B. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.
- C. Vertical Piping: MSS Type 8 or Type 42, clamps.
- D. Individual, Straight, Horizontal Piping Runs:
 - 1. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel, clevis hangers.
 - 2. Longer Than 100 Feet (30 m): MSS Type 43, adjustable, roller hangers.
- E. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.
- F. Base of Vertical Piping: MSS Type 52, spring hangers.
- G. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.



- H. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch- (10-mm-) minimum rods.
- I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10- mm) rod.
 - 3. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
 - 4. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
- J. Install supports for vertical copper tubing every 10 feet (3 m).

3.6 IDENTIFICATION

- A. Install identifying labels and devices for specialty gas piping, valves, and specialties. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment."

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Piping Testing Coordination: Perform tests, inspections, verifications, and certification of medical gas piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical vacuum piping systems.
 - 2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
 - a. Initial blowdown.
 - b. Initial pressure test.
 - c. Cross-connection test.
 - d. Piping purge test.
 - e. Standing pressure test for positive-pressure medical gas piping.
 - f. Standing pressure test for vacuum systems.
 - g. Repair leaks and retest until no leaks exist.
 - 3. System Verification: Perform the following tests and inspections according to NFPA 99, ASSE Standard #6020, and ASSE Standard #6030:
 - a. Standing pressure test.
 - b. Individual-pressurization or pressure-differential cross-connection test.
 - c. Valve test.
 - d. Master and area alarm tests.
 - e. Piping purge test.
 - f. Piping particulate test.
 - g. Piping purity test.
 - h. Final tie-in test.
 - i. Operational pressure test.
 - j. Medical gas concentration test.
 - k. Medical air purity test.



- l. Verify correct labeling of equipment and components.
 - m. Verify medical gas supply sources.
 - 4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
 - a. Inspections performed.
 - b. Procedures, materials, and gases used.
 - c. Test methods used.
 - d. Results of tests.
 - C. Remove and replace components that do not pass tests and inspections and retest as specified above.
 - D. Prepare test and inspection reports.

3.8 FIELD QUALITY CONTROL FOR LABORATORY GAS

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. System Clearing: Purge medical gas piping using oil-free, dry nitrogen after installing piping but before installing service outlets, alarms, and gages.
 - 2. Piping Leak Tests for Specialty Gas Piping: Test new and modified parts of existing piping. Cap and fill specialty gas piping with oil-free, dry nitrogen to pressure of **50 psig (345 kPa)** above system operating pressure, but not less than **150 psig (1035 kPa)**. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
 - 3. Standing-Pressure Test: Install assembled system components after testing individual systems as specified above. Subject systems to 24-hour standing-pressure test at 20 percent above normal line pressure, but not less than **455 kPa (66 psig)**.
 - 4. Repair leaks and retest until no leaks exist.
 - 5. Inspect specialty gas regulators for proper operation.
- C. Remove and replace components that do not pass tests and inspections and retest as specified above.
- D. Prepare test and inspection reports.

3.9 PROTECTION

- A. Protect tubing from damage.
- B. Retain sealing plugs in tubing, fittings, and specialties until installation.
- C. Clean tubing not properly sealed, and where sealing is damaged, according to "Preparation" Article.



3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Employer's maintenance personnel in procedures for alarm system startup and shutdown, and to adjust, operate, and maintain medical gas piping systems and bulk gas storage tanks.
 - 1. Schedule at least four (4) hours of training.

3.11 PIPING SCHEDULE

- A. Connect new tubing to existing tubing with memory-metal couplings.
- B. Gas: Type L, copper tube; wrought-copper fittings; and brazed joints.
- C. Protective Conduit: PVC pipe, PVC fittings, and solvent-cemented joints.

3.12 VALVE SCHEDULE

- A. Shutoff Valves: Ball valve with manufacturer-installed ASTM B 819, copper-tube extensions.
- B. Zone Valves: Ball valve with manufacturer-installed ASTM B 819, copper-tube extensions with pressure gage on one copper-tube extension.