

Part IV
Specifications for Utility Works

LA UNION PORT DEVELOPMENT PROJECT

Bidding Documents for Package A : Civil and Building Works

Volume III-A

Specifications Part IV: Utility Works

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SECTION 40100 GENERAL REQUIREMENTS FOR MECHANICAL WORKS

40101 Scope of Works These Works shall cover all requirements that are common to the systems object of the Scope of works of the Mechanical Works:

SECTION 40200	Ventilation and Air-conditioning System
SECTION 40300	Plumbing and Sanitary Appliances
SECTION 40400	Fire Fighting System
SECTION 40500	Water Supply System
SECTION 40600	Wastewater System
SECTION 40700	Fuel Station
SECTION 40800	Elevator
SECTION 40900	Overhead Crane
SECTION 41000	Weighing Bridge
SECTION 41100	Weigh Scale

40102 Contractor Mechanical Design The Contractor shall propose and submit the shop drawings of mechanical systems together with the detailed performance and the design data for the Approval of the Engineer:

- a) Water Storage Tanks
- b) Water Purification System
- c) Service House
- d) Wastewater Treatment Facilities
- e) Fuel Station
- f) Elevator
- g) Overhead Crane
- h) Weighing Bridge
- i) Weigh Scale

In addition of what is specified in the above-mentioned Sections, the Contractor Design shall comply with the related Specifications consigned in SECTION 10400 and SECTION 10800.

40103 Working Information Submissions

40103.1 General
Submittals are required and are specified herein.

40103.2 Material / Color Samples
Plant and Materials shall not be ordered or fabricated until respective submittals have been approved.

40103.3 Certification of Materials

The Contractor shall provide material/color samples for primary materials or finishes or other components as and when requested by the Engineer.

40103.4 Certification of Installation

The Contractor shall submit Certification of materials from Plant or system manufacturers or from independent testing agencies employed by them indicating compliance with requirements of Specifications herein for various items of equipment and system when required by the Engineer.

- a) Required for all mechanical work certifying that entire system in complete safety, functional and compliant with requirements
- b) Prepared by the Contractor or by independent testing agencies regularly providing certification, test and inspection work of types required and as retained by the Contractor.
- c) The Contractor is also required to submit Reports inclusive of information and/or data as specified under the mechanical testing requirements.

40103.5 Test Results

Results of Tests as specified in SECTION 40104.7 shall be submitted in an approved manner in triplicate to the Engineer on completion of all factories and on site tests.

40103.6 Adequacy of Information Submitted

- a) The Engineer reserves the right to determine whether information as furnished by the Contractor is adequate and complete.
- b) The Engineer shall request such additional submissions by the Contractor, as necessary to ensure the satisfactory operation of the various items of equipment and to fulfill the intent of the specifications.

40104 Fabrication/ Construction Requirements

40104.1 Cutting and Repairing

The work shall be carefully laid out in advance, and no cutting of the structure will be permitted. Damage to buildings and technical installations because of cutting for installation shall be repaired by persons skilled in the trade involved, at no additional costs to the trade involved, at no additional costs to the Employer.

- a) Inspection or tests show defects, such defects work or material shall be replaced or repaired work necessary, inspection, and tests shall be repeated.
- b) Repairs shall be made with new materials. No caulking or screwed joints or holes shall be acceptable.

40104.2 Protection of Fixtures, Materials and Equipment

- a) Pipe openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be covered and protected against dirt, water, moisture, sand and chemical or mechanical injury.
- b) Upon completion of all works the fixtures, materials and equipment shall be thoroughly cleaned, adjusted and tested to demonstrate their proper operation to the Engineer.
- c) The Contractor before, during and after installation shall properly and

adequately protect all materials and equipment. Materials and equipment that are damaged as a result of improper and inadequate protection shall not be acceptable for installation in the project.

40104.3 Built-in Inserts, Sleeves and Appurtenances

- a) The Contractor shall provide inserts, sleeves and other appurtenances required to be built-in to concrete or blockwork construction and furnish instruction. Contractor shall provide layout dimensions or templates and other information required for proper installation of work.
- b) All openings for pipes, ducts, and cables and like things through walls and floors shall be sealed with fire resistant material to the installation and approval of the Engineer.

40104.4 Painting

Factory finished items which become damaged shall be restored to original condition, after approval by the Engineer to do so or be replace. All work that has to be field painted shall be free of scale, oil or dirt of any kind.

Color-coding of lines shall be in accordance with the requirements and/or approved standards. Field finishes shall be in accordance with the requirements as specified elsewhere.

40104.5 Prevention of Rust

Where a rust-inhibiting coating or hot-dip galvanizing is specified hereinafter, any protective treatment system currently in use by the manufacturer of the equipment that will pass the following test requirements will be-accepted.

Test Requirements

- a) The coating shall withstand the saltspray fog test in accordance with method 6062 of Federal standard FED-STD-141.
- b) Immediately after the completion of the test the specimen shall show no signs of wrinkling, cracking or loss of adherence and no sings of rust creep age beyond 3 mm on either side of the scratch mark.

40104.6 Access Openings

- a) The Contractor shall provide all access openings required for inspection and maintenance of the installations.
- b) Where openings are necessary in the building construction such as walls, ccilings and floors. Those openings shall have a closure facility designed to match the adjacent surfaces.
- c) Closures shall be removable and replaceable without damage to the adjacent surfaces.

40104.7 Tests

- a) The Contractor shall perform all tests as directed by the Engineer and shall demonstrate the proper operation of all systems. The Contractor shall provide all labor, materials and equipment required for tests.
- b) Defective equipment, materials and workmanship shall be replaced, repaired or corrected by the Contractor, and re-tested and re-demonstrated for proper

- operation at The contractor's expense. Where considered necessary by the Engineer, the Employer may be present at any test.
- c) The Contractor shall carry out tests on individual items of plant and equipment after erection on site in order to confirm their suitability for the intended services. These tests shall include, but not limited to, the following:
- A general inspection to check for correct assembly and quality of workmanship,
 - Overload and protection relay settings,
 - Operation of protective devices,
 - Motor running currents under no load and normal operating conditions,
 - Security of all covers, fittings, conduits, trunking, and cable fixing,
 - Installation of all equipment in accordance with the manufacturer's instructions,
 - Water, oil, and air tightness of all services at or near maximum working pressure or load,
 - Installation in accordance with IEE Regulations,
 - Adequacy, and security of fixing arrangements for machinery and pipe work,
 - Damp- proofing, rust-proofing, and vermin-proofing and where there are any unforeseen flood risks from failure to seal apparatus between plant and building structure,
 - Installation of all protective devices and guards in compliance with industrial safety regulations.
- d) Following the above inspection and tests a 24-hour running test shall be carried out on each machine to prove;
- Correct functioning,
 - Absence of fluid leaks,
 - Correct bearing temperatures,
 - Absence of undue vibration or noise.
- e) During these tests a check on the performance of the plant shall be made to compare its site performance with the official factory tests and to identify any constraints on performance due to site conditions.
- f) Pressure Components
- Any enclosed systems including gas holding components shall be tested for mechanical strength and leakage at a pressure not less than 1.5 times the maximum operating pressure of the system, or the pressure called for in the appropriate standards. Any resulting damage or leakage shall be rectified by the Contractor and the system re-tested at no extra cost to the Employer.
- g) Attendance of Engineers at Factory Inspection and Testing: Engineers will attend at the factory inspection and testing on the Contractor's expense, as follows:

- Equipment: pumps and electrical panels
- Place: manufacture's country
- Number of trips: 2 trips
- Number of Engineers: 2 engineers each
- Period: 10 days

40104.8 Substitution of Materials

The Contractor shall be specifically cautioned to the following minimum considerations which will be reviewed by the Engineer prior to approving any substitute materials, item of equipment or assembly of construction:

- a) Full conformance with architectural and engineering design criteria, design concepts and performance requirements.
- b) Physical dimension requirements to satisfy the space limitations indicated on the Drawings.
- c) Static and dynamic weight limitations
- d) Audible noise level and vibration generation of equipment or assemblies with moving parts.
- e) Interchangeability of parts and components.
- f) Accessibility for preventive maintenance, possible removal and replacement.
- g) Compatibility with other materials, assemblies and components.
- h) Full compliance with all applicable test requirements.
- i) Full compliance with guarantee requirements.

**40105
Pipe Installation**

40105.1 Excavation for Pipe Laying

- a) Pipe trenches shall be excavated in successive stages widths and lengths to be approved by the Engineer. Each stage shall be completed before proceeding to subsequent stages.
- b) Existing surface paving shall be saw cut at edges and carefully demolished without causing excessive overbreak as weakening adjacent remaining work. Surface paving shall be reinstated with new materials to the satisfaction of the Engineer.
- c) Existing landscaping trees, shrubs and sodding shall be carefully removed, set aside, protected, maintained, restored to original position, compacted, watered treated with fertilizer and maintained until new growth is arrived. The Contractor at his own expenses shall replace any dead or dying items occurring up to the end of the Defects Liability Period.
- d) Excavation shall generally be with vertical sides unless otherwise approved by the Engineer.
- e) No excavations with battered sides shall be made in roads, sidewalks, paved areas, or within 10 m of buildings or structures.
- f) Sides of excavations shall be properly supported with the provision of timber planking and strutting or sheet piling.
- g) The width of excavated trench for any size of pipe shall be the minimum required but in no case less than 30cm plus the nominal diameter of pipe for vertical earthwork support.
- h) Over excavation of a trench, due to the error of the Contractor shall be backfilled with concrete Grade C15 or otherwise at the Contractor's expense, as the Engineer may require.
- i) Excavation within 1.5 m of any live pipelines, cables or both encountered while carrying out the Works shall be carried out by hand.
- j) Trenches shall be kept free of all water at all times. The Contractor shall take all necessary precautions to prevent any ground water from entering mains to be used for the conveyance of potable water.
- k) **Working in water:**
The Contractor shall not allow water to lie in any part of the Works unless indicated or directed by the Engineer; water arising from or draining into the works shall be drained or pumped to an approved disposal point. Any drainage sumps shall, where practicable be sited outside the area excavated for the Permanent Works, and shall be refilled with approved material to the level of the underside of the adjacent Permanent Works on completion.
No pipe jointing or associated work shall be carried out under water, unless expressly agreed by the Engineer.
The Contractor shall take all necessary precautions to prevent any adjacent ground from being adversely affected by loss of fines through any dewatering

process.

- l) Where unsuitable material, rock or similar obstructions are encountered at trench invert level, the material shall be removed as required by the Engineer, to a minimum of 150mm below the intended level of the pipes and replaced with selected fill provided to the approval of the Engineer.
- m) The materials excavated from trenches shall be stock piled compactly beside the trench except where in the opinion of the Engineer this would obstruct any vehicular traffic or pedestrians. In such cases the Contractor shall remove excavated material and return it later for backfilling at his own expense.
- n) Trenches shall be temporarily back-filled between working periods to suit operational conditions and as instructed by the Engineer, at the Contractor's expense.
- o) Any trenches and excavations kept open at night, shall have a watchman and be provided with approved type of storm proof lights at each end and at intervals as directed by the Engineer, and if necessary shall be further protected by suitable covering or barricades.
- p) Where hoardings are provided, they shall be adequately constructed and not cause obstruction to any traffic and shall be painted to be conspicuous at all times. The Constructor shall keep hoardings in proper condition

40105.2 Pipe Bedding and Surround

- a) Pipe beds shall be constructed as indicated on the Drawings. Otherwise all pipework shall be bedded on no less than 100 mm compacted thickness of granular bedding material.
- b) Granular bedding and sidefill materials, used to surround a pipe may be selected as-dug trench material or imported granular material in accordance with Tables 47105 - 1 and 2, subject to the approval of the Engineer.
- c) Imported granular materials shall be aggregates conforming to ASTM-C33. The specific approval of the Engineer shall be sought for other materials such as: air-cooled blast furnace slag or sintered pulverised fuel ash.
- d) The following selected as dug materials are not acceptable:
 - Material contaminated with domestic, building or industrial waste, organic and combustible matter, or having high moisture content.
 - Soil containing clay lumps larger than 75 mm or stones larger than those permitted in the Tables.
- e) The bedding shall not contain large particles with sharp edges or particles that

break up when wetted.

- f) The grading should be selected so that it will not permit water passing through it to carry away fine materials or fines from the adjacent soils to infiltrate the bedding or sidefill material. In the later case consideration should be given to the use of filter fabric.
- g) If the main backfill material contains stones greater than the maximum size specified in Tables 1 and 2, the imported granular sidefill material shall be extended to a minimum of 150 mm above the crown of the pipe.
- h) In clays, silts or fine sands and when ordered by the Engineer, one part of free draining sand shall be added to and well mixed with each two parts of the granular material specified above. Alternatively, where approved by the Engineer, the granular material may be 'all-in' gravel mixture of similar size or comprise a layer of coarse sand on the formation covered by granular material as specified.

Table 40105-1: Granular Bedding and Sidefill Materials for Rigid Pipes

Pipe Nominal Bore (DN)	Max. Particle Size (mm)	Class of Bedding	Suitable Materials	
			Imported granular materials	Max. CF value For as-dug granular materials
100	10	S	10 mm nominal single size	0.15
		B		0.30
		F		0.15
		N	Coarse, medium or fine sand	
Over 100 to 150	15	S	10 or 14 mm nominal single size or 14 mm to 5 mm graded	0.15
		B		0.30
		F	0.15	
		N	Coarse, medium or fine sand	
Over 150 to 500	20	S	10, 14 or 20 mm nominal single size or 14 mm to 5 mm graded or 20 mm to 5 mm graded	0.15
		B		0.30
		F		0.15
		N	All-in aggregate or coarse, medium or fine sand	
		B		0.30
		F		0.15
		N	All-in aggregate or coarse, medium or fine sand	

Table 40105-2: Granular Bedding and Sidefill Materials for Flexible Pipes

Pipe Nominal Bore (mm)	Max. Particle Size (mm)	Suitable Materials	
		Imported granular materials	Max. CF value For as-dug granular materials
100	10	10 mm nominal single size	0.15
Over 100 to 150	15	10 or 14 mm nominal single size or 14 mm or 5 mm graded	0.15
Over 150 to 300	20	10, 14 or 20 mm nominal single size or 14 mm to 5 mm graded or 20 mm to 5 mm graded	0.15
Over 300 to 600	20	14, 20 mm nominal single size or 14 mm to 5 mm graded or 20 mm to 5 mm graded	0.15

- i) In all cases the soluble sulphate and chloride content of the granular material shall not exceed 0.5% and 0.06% by weight respectively, and for cementitious pipes the sulphate content should not be greater than 0.3% (expressed as sulphur trioxide) .
- j) The granular material shall be evenly spread over the full width of the formation and lightly hand compacted to a level slightly higher than the level corresponding to the underside of the pipe barrel to allow for settlement of the pipe to the correct level.
- k) For socketed pipes laid on a granular or sand bed, or directly on to a trench bottom, the Final Surface shall be trimmed and levelled to provide even bedding of the pipeline and shall be free from all extraneous matter, stones or other projections that may damage the pipe, pipe coating, or sleeving. Joint holes shall be formed in the bedding material or excavated Final Surface to ensure that each pipe is uniformly supported throughout the length of its barrel and to enable the joint to be made. Recesses for the joints shall be the minimum size required.
- l) Pipes shall be laid on setting blocks only where a concrete bed or cradle is used.
- m) Further granular material shall be placed in the trench, special care being taken to fill under the sides of the pipes to ensure full contact with the barrel of the pipe but leaving the joints exposed for a length of approximately 200 mm on each side of the joint collar or sleeve. The granular material shall then be compacted evenly on both sides and between pipes to an overall thickness as shown on the Drawings, and to provide bedding angle not less than 120 degrees. Where practicable, placing and compaction shall be done in sequence with the removal of the trench supports.

- n) The Contractor shall ensure that the material to the sides of the pipes is adequately compacted.

40105.3 Pipe Laying

- a) All handling, transporting and storage of pipes and pipe fittings shall be in accordance with the manufacturer's recommendations.
- b) No metal tools or heavy objects shall come into contact with the pipes or fittings. Externally coated pipe shall be handled at all times with wide non-abrasive canvas, rubber or leather or other equipment to prevent damage to the coating.
- c) The use of chains, wire slings, or any other handling equipment likely to damage the coating shall not be permitted. The timber or skids used to support the coated pipe prior to lowering into the trench shall be properly padded with sufficient bags stuffed with sand or straw for the purpose of protecting the coating. Alternatively, the pipe may be supported alongside the trench on mounds of sand. Any damage to the protective coating from any cause must be repaired before the pipes are tested.
- d) Laying of pipes in the prepared trench shall be started at the lowest point of a section, proceeding on an upward gradient.
- e) The Contractor is to ensure that all pipework is laid to depth, levels and uniform gradients as indicated on the Drawings. Pipe alignments shall be straight between bends or curves, lengths laid to curves shall only be allowed where shown on Drawings or in accordance with detailed proposals approved by the Engineer.
- f) The Contractor shall submit to the Engineer for approval, his method of the control of pipe laying to the correct levels and alignment.
- g) Pipes shall be laid accurately to the lines and levels shown on the Drawings, within a tolerance of ± 5 mm.
- h) Suitable measures shall be taken to prevent soil or other material from entering pipes. During laying operations, no debris, tools, cloth or other materials shall be placed in the pipe.
- i) A "bung" about 5 mm smaller than the internal diameter of the pipe shall be kept in the pipe at all times pulled forward as the work progresses. When pipe laying is not in progress, including overnight, the open ends of the pipeline shall be blanked off with a temporary watertight fitting approved by the Engineer. The pipe shall be suitably anchored to prevent flotation or other movement before the Works are complete.
- j) **Polyethylene Wrapped Pipes**
Where factory bonded polyethylene coated DI pipes are used in the ground, they shall be laid in accordance with the recommendations of the manufacturer.
If the wrapping is damaged by the Contractor during handling, then he shall carry out repairs using the manufacturer's repair kits in accordance with the manufacturer's recommendations.

For ductile iron pipes wrapped on site, either single or double heavy duty black polyethylene sleeving of not less than 0.25 mm thickness shall be applied as instructed by the Engineer. The sleeving shall be drawn over the pipes during pipe laying. The sleeves over successive pipes shall be carefully lapped and the surplus material folded over the top of the pipe. Ends and overlaps shall be sealed and secured with nylon packaging tape or other approved grease or impregnated bitumen, rubberised or other tape.

- k) All repairs to damaged sleeving shall be carried out with materials and in manner recommended by the pipe manufacturers.

l) Pipes Laid to curves

i. General

Where pipes with flexible joints are to be laid to curves, the deflection at any joint as laid shall not exceed three quarters of the maximum deflection recommended by the manufacturer.

Long radius curves in the pipelines in materials other than of PVC shall be negotiated by joints of one or more pipes.

ii. PVC Pipes

PVC pipes may be curved to a radius not less than 300 times the pipe diameter in sizes up to and including 150mm diameter provided that adequate lateral support is given to the pipe to avoid deflection at the joints.

Pipes shall be jointed with the joints and couplings in compliance with the manufacturer's instructions. Special care shall be taken to ensure absolute cleanliness of the pipe ends and joint component and only recommended lubricants shall be used.

Solvent joints of PVC pipes shall be completed by a method recommended by the manufacturer.

The Contractor shall take all steps necessary to prevent dirty water or other extraneous matter from entering the pipes during or after laying. In the event of an excess of dirty water or extraneous matter entering the pipes the Contractor shall carry out the cleaning as may be directed by the Engineer. No extra payment will be made for such work.

PVC pipes with solvent joints shall be effectively protected from direct sun after they are laid until permission is given for the trenches to be refilled by the Engineer. Subject to such permission trenches shall be refilled without delay at least to the minimum extent required for pressure testing. Final connections at a fix point shall be deferred until the majority of the pipeline has been covered by backfill in order to reduce the effect of expansion and contraction caused by temperature variations.

40105.4 Thrust and Anchor Blocks

- a) In pressure pipelines, except where welded steel pipelines or self anchoring joints are used thrusts from bends, branches and pipelines with gradients in excess of 1 in 6 shall be resisted by concrete thrust blocks cast in contact with undisturbed ground.
- b) Any additional excavation required to accommodate thrust blocks shall be carried out after the bend or branch is in position and the thrust face shall be

- trimmed back to remove all loose or weathered material immediately prior to concreting.
- c) Standard details of permanent thrust blocks and anchor blocks are to be provided as indicated on the drawings and as directed by the Engineer.
 - d) Thrust blocks shall be allowed to develop the required strength before any internal pressure is applied to the pipeline.
 - e) Rapid hardening cement shall not be used in concrete for thrust blocks to plastic pipes.
 - f) Anchoring of curves formed by joining standard straight pipe lengths will not normally be required.
 - g) Welded pipelines shown on the Drawings as having tied couplings and flanges shall require anchor blocks only at the positions specifically noted on the Drawings.
 - h) The Contractor shall establish and maintain temporary thrust restraints to prevent movement of pipelines, fittings and structures. This shall include restraint behind closed valves when pipework is removed.

40105.5 Pipe Work Surrounded by Concrete

- a) Concrete provided as a protection to pipes shall be 20 N/mm² minimum, placed to the required depth in one operation. Concrete protection, bedding and surround shall have attained a minimum 3 day strength before filling commences.
- b) When pipe work is surrounded by concrete at thrust blocks, anchor blocks and road crossings etc., the pipes shall be given the normal external protection and shall be wrapped with at least two layers of waterproof paper to BS 1521, Grade B1F securely fixed with waterproof tape.

40105.6 Pipe Jointing

- a) General

Joints shall be made in accordance with manufacturers' instructions or as specified herein.

Until required, each rubber ring or gasket shall be stored in the dark, free from the deleterious effects of temperature variation, and kept flat without surcharge so as to prevent any part of the rubber being in tension.

No protective cap, disc or other appliance on the end of a pipe or fitting shall be removed permanently until the pipe or fitting which it protects is about to be jointed. Pipes and fittings, including any lining or sheathing, shall be examined for damage.

Pipe jointing surfaces and components shall be cleaned immediately before laying, and kept clean and free from extraneous matter until the joints have been made or assembled.

Care shall be taken to ensure that there is no ingress of grout or other

extraneous material into the joint annulus after the joint has been made.

For push-fit joints only lubricants recommended by the manufacturer shall be used in connection with rubber rings and these lubricants shall not contain any constituent soluble in water conveyed in the pipe. They shall be suitable for the climatic conditions at the Site and shall contain an approved bactericide.

b) Flanged Joints

For flanged joints the gasket shall be fitted smoothly to the flange, and the joint made by tightening the nuts to finger pressure first with the flanges properly aligned. Thereafter the final tightening of the nuts shall be made by gradually and evenly tightening bolts in diametrically opposite positions using only standard spanners of a type approved by the Engineer.

Graphite grease shall be applied to the threads of bolts before joints are made.

Jointing compounds shall not be used when making flanged joints, except to facilitate the making of vertical joints, gaskets may be secured temporarily to one flange face by a minimum quantity of clear rubber solution.

c) Welded Joints in Plastic Pipes

Fusion welded joints in high density and medium density polyethylene pipes shall be made only between pipes having the same physical characteristics. Joints between pipes from different manufacturers shall only be made with the specific approval of the Engineer.

A pipe section containing a completed weld shall achieve the same strength characteristics as the parent pipe.

Bead widths to butt fusion joints shall be as detailed in the manufacturer's literature.

A minimum of 20 minutes shall be allowed to elapse after completion of the joint before the removal of the external bead is permitted. The bead removal shall be carried out using an approved tool specifically designed for the purpose and without damage to the pipe.

Each removed bead shall be marked / labeled and handed to the Engineer.

If, in the opinion of the Engineer, the equipment being used to make the joints is damaged or inadequate to make a satisfactory joint, it shall be replaced to the satisfaction of the Engineer.

Where polyethylene pipework is used the tools and equipment supplied by the Contractor shall be of a type approved for use with polyethylene.

Thermostatically controlled electrically heated tooling shall be used on all polyethylene pipework. Fully automatic butt fusion equipment shall be used on all polyethylene pipes and fittings of 90 mm diameter and larger.

A fitting or an area of pipe that has been through a complete heating cycle shall not be reheated. Where a joint has proved unsuccessful, the section shall be removed to 250 mm either side of the joint and the operation restarted.

The minimum permitted distance between any two fusion joints shall be four times the outside diameter of the pipe being jointed.

The method, time and temperatures laid down by the manufacturer and supplier for pipe jointing shall be rigidly followed. Pipework shall be protected from dust and rain while jointing is in progress.

d) Cement mortar joints

In making yarn and mortar joints for pipes or fittings, the spigot shall be entered into the socket of the last pipe laid until it bears on the back face of the socket, and it shall be centered in the socket. Two turns of tarred yarn shall then be caulked into the back of the socket and cement mortar shall be pressed into the joint to fill the socket and shall be beveled off at 45° from the outside of the socket.

40105.7 Completion of Pipe Surround and Backfilling

- a) After completion of the relevant pipelaying, bedding and protection operations, fill material shall be placed and compacted over the full width of the trench, to a finished thickness of 250 mm above the crown of the pipes. Filling around and over the top of the pipes shall be undertaken with utmost care, special attention being paid around joints to obtain the greatest possible compactness.
- b) The filling material, as necessary shall be screened to exclude stones or other material, which would damage the pipes. Filling shall be placed in layers of not more than 150mm in thickness when compacted. Where mechanical ramming of the filling is employed the machines shall be approved by the Engineer. The Contractor shall ensure that there is sufficient cover over the pipes to obviate damage to them before the mechanical rammer is brought into operation.
- c) Subsequent filling shall then be carried out in compliance with the requirements of Sections 21600 and 21700 of Civil Works.
- d) After the works are successively completed, the Contractor shall dispose of all surplus materials, dirt, and rubbish. He shall restore all disturbed areas to their original conditions.

40105.8 Cutting Pipes

- a) Pipes shall be cut by a method which provides a clean square profile, without splitting or fracturing the pipe wall, and which causes minimal damage to any lining or protective coating. Where necessary, the cut ends of pipes shall be formed to the tapers and chamfers suitable for the type of joint to be used and any protective coatings shall be made good, and the ends sealed before the pipes are laid.
- b) Where ductile pipes are to be cut to form non-standard lengths, the Contractor shall comply with the manufacturer's recommendations in respect of ovality correction, chamfering, grinding and tolerances to the cut spigot end or otherwise made suitable for jointing as recommended by the pipe manufacturer.
- c) Steel pipes shall be cut by an approved method, which provides a clean square cut without separation of the lining from the pipe wall. If wheel cutters are used the burr left after cutting shall be trimmed off by filing or by grinding. A percentage of the pipes ordered shall be supplied 'sized throughout' and these pipes shall be set aside for use in cutting specific lengths.
- d) To prevent damage to ends of pipes exposed to provide access to pressure pipelines for reconditioning purposes, suitable protective collars shall be fitted

to the open ends during all scraping and lining operations.

- e) Or otherwise made suitable for jointing as recommended by the pipe manufacturer.

40105.9 Valve Installation

- a) The location of valves for shall be as shown on the Drawings and / or as directed by the Engineer.
- b) In the case of pressure pipelines no change from a rising to a falling grade shall occur except at air valves, nor any change from falling to rising grade except at washout points.
- c) All below ground valves shall be installed in precast concrete, insitu concrete or brick chambers, which shall have incorporated into the structure a drain to a soakaway or water course as necessary.
- d) Wherever practical valves, air valves, washouts, manholes or any other surface fitting shall be situated close to a boundary feature and behind any fence.
- e) Valves shall be set and jointed to pipe in compliance with all applicable requirements of the manufacturer.
- f) Unless otherwise directed all valves, flow meters, fittings and specials shall be individually supported and their weight shall not be borne by the pipelines, joints or couplings. All supports for valves shall be made of concrete.
- g) All valves shall be set vertically on the mains unless otherwise shown on the /drawings or agreed with the Engineer.
- h) Air valves shall be checked before the main is charged to ensure that the balls and faces are not deformed or split and that there is no dirt or other deleterious materials in the cavities of the body. All air nozzles shall be probed to see that they are clear. No air valves shall be stored before erection in the open in sunlight, or up side down to expose the balls and air cavities.
- i) Washout and scour valves shall where possible, discharge in the direction of natural drainage and at such a distance from the works as to preclude erosion effects. Unless otherwise directed, the controlling valve for a scour shall be installed not more than 1.5 meters from the main pipeline. End of all scours shall be protected from intrusion of animals and other foreign matter by suitable screening securely fixed to the pipe end.
- j) Before each valve is put into service all gear bearings and spindles shall be oiled with approved oil as recommended by the valve manufacturer. Oil baths shall be topped up to the appropriate levels and all grease nipples charged with grease of approved manufacturer. No deleterious matter shall be allowed to come into contact with the working faces and oil sumps shall be maintained clean.

40105.10 Pipelaying Records

The Contractor shall submit daily pipelaying record sheets to the Engineer for approval.

40105.11 Sleeves

Where pipes pass through elements of the building structure, ceiling, partitions, etc., other than water retaining structures, they shall be in all cases enclosed concentrically within purpose made sleeves cut from pipes of the same material one or two sizes larger as may be required to provide reasonable clearance. Such sleeves shall be cut square at the ends, clean and flush with the finished wall and ceiling surfaces. Sleeves shall in no case be used as pipe supports. The free annular space shall be packed with a fire resistant material and shall be finish flush with the sleeve face. The sleeve shall not impede thermal movement of the pipe.

40105.12 Attachment to Structures

- a) Types shall be appropriate for materials and conditions encountered, and as shown, specified or approved by the Engineer.
- b) Sizes shall be adequate for loads and forces involved.
- c) Power actuated type fixing in lieu of removable mechanical fastenings shall not be permitted unless otherwise shown or approved.
- d) Cutting or welding to any structure for support shall be permitted only where shown, specified or approved for specific condition or location.
- e) Supporting pipes or equipment by attaching directly to metal decking shall not be permitted.
- f) Items for attachment to structures shall be hot-dip galvanized or corrosion resistant painted, plated or treated by approved methods.

40105.13 Hangers/Supports

- a) PVC pipes to be suspended on continuous trays or as specified by manufacturer's specifications.
- b) Locknuts shall be provided for each threaded connections on hanger rods.
- c) All hangers, supports and continuous trays shall be capable of resisting forces and stresses developed under full capacity loadings, including dead loads and reaction forces under full operation, and including weight of fluids conveyed and seismic imposed on them. The Engineer shall approve the hangers, supports and trays prior to installation.
- d) Continuous Supports shall be manufacturer's standard prefabricated C type channel, roll formed from steel strip of thickness not less than 2.5 mm, in standard length for minimum splicing shall be provided and shall be complete with matching splice covers, inserts, devices suitable for hanger rods etc., and shall be secured to overhead concrete using hole-in anchors, set through pre-punched holes in C type channel, spaced at not more than 20 centimeters from each end of channel and at not more than 60 centimeters on centers.
- e) The supporting capacity of all hanger assemblies, including connections or fastenings to structures, shall be not less than five times the actual loading capacity resulting from total weight of pipe when filled with water.
- f) Hangers/supports for pipes different than PVC shall be as follows:

Table 40105-3: Separation Between Hangers/Supports for Pipes Different than PVC

Type of Pipe	20 mm and smaller	25 to 40 mm	50 to 80 mm	80 to 100 mm	100 mm and larger
Ductile Iron	-	-	-	3.00 m	4.00 m
Galvanized Iron	1.80 m	2.00 m	3.00 m	4.00 m	
Copper	1.5 m	2.00 m	2.50 m	2.50 m	2.50 m

40105.14 Testing, Disinfections and Flushing of Pipelines:

Pipelines testing shall be carried out as specified in SECTION 40108. Disinfections and Flushing of pipelines shall be performed as specified in SECTION 40109.

40106 Identification

40106.1 Equipment Identification

a) Manufacturer's Identification:

- For each factory fabricated fixture or equipment; fixed behind normally closed door, readily visible and readable when opened.
- Each label or nameplate may be standard with manufacturer, and it shall be non-corrosive and durable, and permanently fixed.
- Labels or nameplates shall state fixture or equipment type, model number, rating, current characteristics etc.

b) Project Identification

- Required for each mechanical equipment in easily visible location, installed horizontal and symmetrically.
- Details and layout shall be submitted for approval prior to ordering or fabrication of signs.

40106.2 Valve Identification

a) Type: Valve Identification shall be round or hexagonal type, solid plastic plate with brass tie wire, permanently stamped or embossed with suitable name or number per approved schedule shall be provided for all control and shut-off valves except faucets and hose bibs.

b) Code System

- Code system shall be developed to provide number/function code, or name system schedule, for all valves requiring tags.
- Submit schedule for approval within 90 days after general material submittals have been approved.
- The Engineer prior to ordering or fabrication of tags shall approve system.

40106.3 Pipe Identification

a) Piping identification system under this Clause shall be worked out by using color legends or pre-printed labels as specified, including flow direction arrows. These arrows shall be clearly visible from floor level.

- b) Piping shall be cleaned and field painted complete prior to applying labels etc.
- c) Apply legend and flow arrow at valve locations, at points where piping enters or leaves walls, partitions, bulkheads, cluster of piping, or similar obstructions, and at about six (6) meters intervals on pipe runs.
- d) Changes in locations and spacing shall be made with approval of the Engineer.
- e) Wherever two (2) or more pipes run parallel, apply printed legend and other markings in the same relative location in either vertical or horizontal alignment, as the case may be.
- f) Paint shall be applied by brush or spray gun in color per schedule uniform throughout, and in hues as approved.
- g) Where pipe marking colors are not easily distinct against background, such as brown on soil pipe, orange on copper tubing, paint neat white or aluminum colored background on the pipe before marking shall be applied.
- h) Pre-printed markings shall be of pressure-sensitive adhesive type cloth labels.
- i) Letter and arrow size shall be as specified in the following Table:

Table 40106-1: Letter and Arrow Size for Identification of Pipes.

Outside diameter of pipe or covering	Size of Stencil letter	Minimum length of Flow Indicating Arrow
20 mm to 40 mm	12 mm	60 mm
50 mm to 100 mm	25 mm	100 mm
125 mm to 175 mm	50 mm	125 mm
200 mm and larger	75 mm	150 mm

**40107
Pipes and
Fitting
Materials**

40107.1 General

Piping materials to be used in the Works shall be as follows:

Table 40107-1: Material of Pipes for Mechanical Works.

System	Pipe Material	Location
Water Supply	Ductile Cast Iron	Out of Port Area
	PVC	Buildings and Port Area
	Galvanized Iron	From Deep Well to Water Storage Tanks
Waste and Sanitary Drainages	PVC	Buildings and Port Area
Indoor Fire Hydrant System	Galvanized Iron	Administration Building
Storm Water	PVC	Buildings

Air Conditioning System	Black Steel	Chilled Water in Administration Building
	PVC	Condensate Water in all Buildings
	Copper	Refrigerant in Mini-split Units in other Buildings

40107.2 Ductile Iron Pipes and Fittings

- a) Pipes shall be in accordance with AWWA C151/A21.51, 150mm and larger Class 50. Fittings shall be in accordance with AWWA C110-111/A21.10-11. The pipe wall thickness shall be as given in Table 10 of ISO 2531.
- b) Joints: For Ductile Iron pipes to be installed below ground joints shall be flexible rubber gasket push-on type. For Ductile Iron pipes to be installed above ground joints shall be rigid flanged type with gasket between flanges. Flanges shall comply with dimensions and drilling details as consigned in ISO 2531.
- c) Linings: Unless otherwise specified, ductile iron pipes and fittings shall have a cement mortar lining and externally protected with Zinc and bitumen coatings, all in accordance with the following specifications:
 - Cement Mortar: The cement mortar lining of ductile iron pipes and fittings shall comply with ISO 4179 and AWWA C104/A21.4.
 - Bitumen Seal Coat: Bitumen seal coating shall be cold applied compound, suitable for tropical climates applied in accordance with the manufacturer's instructions. It shall be suitable for uses in contact with potable water. Normal thickness shall be 0.07 mm unless otherwise specified.
 - Zinc Coating: Zinc coating shall comply with ISO 8179. Zinc spray coating is the preferred method for pipes in the range of 80 mm to 800 mm diameter and the mass of sprayed metal shall not be less than 130 g/m² as described in Clause 5.2 of ISO 8179. If zinc rich paint coating is provided the zinc rich paint shall contain at least 90% of zinc in the dry film.
 - Damaged areas of coating shall be repainted on site after removing any remaining loose coating and wire brushing any rusted areas of pipe
- d) Polyethylene Sleeving: Unless ductile iron pipes are supplied with a factory bonded polyethylene coating, either single or double heavy duty black polyethylene sleeving of not less than 0.25 mm thickness shall be applied as instructed by the Engineer. Where polyethylene sleeving is specified to be applied in addition to bitumen coating it shall comply with ISO 8180.

40107.3 Polyvinyl Chloride (PVC) Pipes and Fittings

- a) Standards:
 - Pipes less than 100mm shall be in compliance with ASTM D2241 and 10 kg/cm² rated, larger than 100mm shall comply with AWWA C900 and 10 kg/cm² rated.
 - Fittings for use with PVC pipes shall comply with ASTM D2466.
- b) Manufacture of PVC Pipes

The Contractor shall regularly submit to the Engineer copies of certificates of

tests carried out for quality control during manufacture of pipes and fittings. Such certificates shall state that each item supplied has been tested to satisfaction of the following quality Tests Standards:

- Humidity contents in Resins: ASTM D-3030.
- PVC Compounds Fusion: ASTM D-2538.
- Physical Dimensions: ASTM D-2122
- Anhidric Acetone Immersion: ASTM D-2152
- Impact Resistance: ASTM D-2444, D-4495, and F-794
- Collapsing: ASTM D-1785, D-2241, D-3034 and F-794
- Short Term Failure Pressure: ASTM D-1599
- Long Term sustained pressure: ASTM D-1598
- External Load Resistance: ASTM D-2412
- Oven heating: ASTM F-1057
- Pressure test for solvent
cement: ASTM D-2564

c) **Fittings**

The dimensions of fittings shall be as indicated on the Drawings. Where no dimensions are given, they shall be at the option of the manufacturer and to the approval of the Engineer.

Detail drawings of all fittings and special appurtenances shall be submitted by the Contractor to the Engineer for his approval before the commencement of manufacture.

d) **Joints: PVC pipes' joints shall be:**

- Caulked Elastomeric Gasket, in accordance with ASTM D-3139, D-3212.
- Solvent Cement, in accordance with ASTM D-2564, D-2855.
- Flange Adapters, cast iron, in accordance with ANSI B16.1 Class 125.

40107.4 Galvanized Iron Pipes and Fittings

- a) Standards: All galvanized iron pipes and fittings shall conform to ANSI/ASTM A120-79
- b) Pipes: shall be thread end and supplied in full length of six meters. The screw threads in all pipes and fittings shall comply with ISO Metric Screw Threads.
- c) Joints: all joints shall be threaded socket type designed to have the same properties and strength as the pipe.

40107.5 Black Steel and Copper Pipes

Black steel and copper pipes shall be used in Air Conditioning System as specified in SECTION 40200.

**40108
Testing for
Pipelines**

40108.1 General

Except where otherwise specified pipelines and pipe work shall be subjected to hydrostatic testing in the presence of the Engineer. Testing shall be carried out in

two stages:

- a) Test of sections as construction proceeds;
- b) Final test of the whole of the pipe work or pipeline on completion.

The Contractor shall supply all plant, equipment, fittings etc. including water/gas, necessary for the hydraulic and low-pressure air tests. He shall submit to the Engineer, well in advance of the time for tests, details of his proposals for transporting the test water from the point of supply at the inlet works to the pipeline to be tested. No connections to the pipeline or pipe work that would involve cutting, tapping or otherwise permanently altering the Permanent works, will be allowed.

Test gauges shall be of approved manufacture having dials at least 200mm diameter, graduated such that the test pressure is at least 75% of the gauge reading. If necessary different gauges shall be supplied for different pipeline sections. Two gauges of each type shall be provided for the sole use of the Engineer and shall remain in the Engineer's possession for the duration of the contract.

All gauges shall be dead weight tested and proved at the commencement of use and at regular intervals thereafter as required by the Engineer.

The Contractor's arrangements for testing shall include a suitable means of quick installation and removal of the engineer's gauges during testing.

40108.2 Hydrostatic Testing for Pressure Pipelines

- a) Contractor shall provide all equipment necessary for tests.
- b) Couplings and fittings shall not be backfilled prior to test. Couplings and fittings shall be braced to prevent movement during testing. Other portions of pipeline shall be backfilled prior to test so no movement can occur when the line is under pressure.
- c) All thrust blocks shall be allowed to cure for forty-eight hours, minimum, and prior to testing.
- d) All pipelines shall be flushed.
- e) All temporary supports, blocking and plugs, necessary to run the test shall be furnished by the Contractor and removed after testing by him.
- f) Each section of the pipeline or pipe work to be tested shall be capped or blanked off at each end and securely strutted or restrained to withstand the considerable forces which will be exerted when the test pressure is applied.
- g) Testing against closed valves will not be permitted. Hydrants, washout valves and isolation valves shall be fitted with blank flanges and these together with in-line valves shall be left open. Air valves already fitted shall be permitted to function during the test. The air valve manufacture's confirmation shall be obtained that the valves are capable of withstanding the test pressure involved.
- h) All air should be expelled from the pipeline during filling and again before making the pressure test.
- i) Each section shall be tested at a minimum of 10.5 kg/cm² at the point of

lowest elevation in the section for a period of four hours.

- j) Maximum allowable overall leakage for a test section shall be:
- $$L=(N)(D)(P) \frac{1}{2}/18000$$
- L= Allowable leakage, in liters per hour
N=Number of joints in the test section
D=Nominal diameter of pipe, in millimeters
P=Pressure during test, in kg/cm²
- k) Any visible leakage at joints shall be repaired and the test shall be repeated.
- l) If overall leakage is above maximum allowable, the pipeline shall be repaired and the test repeated.
- m) The procedure shall be continued until leakage is within the allowable specified.

40108.3 Hydrostatic Test for Gravity Pipelines.

- a) All sections of the gravity pipeline shall be subjected to testing.
- b) Test sections shall be considered from manhole to manhole, or manhole to cleanout for line ends. All laterals shall be included. Laterals entering manholes shall be tested separately.
- c) The Contractor shall supply all test equipment required
- d) The sections to be tested shall be plugged with a watertight stopper and all joints shall be left exposed during tests.
- e) Procedure:
- Provide standpipe extending 3.0 meters above highest point in the test section. Fill standpipe to top with potable water. No subsidence in the standpipe during four continuous hours is acceptable.
 - Determine the source of leakage and repair the defective pipe section or sections by removing, replacing, and relaying the pipe, or by installing a maximum of one manufactured full circle repair clamp per pipe section.
 - Repair and retest the section until a passing test is obtained. Repair and retesting of sections shall be done at no additional cost to the Employer.
- f) The sectional hydraulic test shall be carried out after the pipeline or pipe work section to be tested has been laid, jointed and backfilled to a depth of at least 300 mm above the crown of the pipe but leaving the joints exposed. The sections to be tested shall be approved by the Engineer.

40109 Disinfections and Flushing of Pipelines

After the new pipeline and appurtenances have been successfully pressure and leakage tested, the Contractor shall disinfect and flush the pipelines. This work will be done to the satisfaction of and under the supervision of the Engineer and be in general accordance with AWWA C 602, "Standard Procedure for Disinfecting Water Mains" except the tablet method described in AWWA Section 7.3 and 7.3.1 shall not be used. The method of chlorine application shall be first to flush all dirty or discolored water from the lines, and then introduce chlorine in approved dosages

through a tap at one end, while water is being drawn at the other end of the line, until even distribution of the chlorine is obtained. The chlorine solution shall remain in the pipe line for about 24 hours. At the end of this 24 hours period the treated water shall contain no less than 25 mg/l chlorine throughout the length of the pipeline.

The Contractor shall provide all necessary apparatus, chemicals, materials, and labor for disinfecting the pipeline and shall make the required taps for this purpose. All expenses involved shall be borne by the Contractor.

Upon completion of disinfecting and when the main has been flushed, bacteriological tests shall be made in accordance with the standard specified above. If the bacteriological tests indicate positive results the disinfecting procedure shall be repeated until no positive results occur. A recognized authority shall do the bacteriological sampling. The Contractor shall furnish all apparatus and equipment required for disinfecting.