

**9.1.4 PIPELINE INSTALLATION, TESTING AND  
DISINFECTION**



## CONTENTS

### 9.1.4 - PIPELINE INSTALLATION, TESTING AND DISINFECTION

	<b>Page</b>
<b>9.1.4.1 PIPE LAYING .....</b>	<b>109</b>
9.1.4.1.1 General Requirements .....	109
9.1.4.1.2 Installation of Pipe and Fittings .....	110
9.1.4.1.3 Thrust and Anchor Blocks .....	116
9.1.4.1.4 Exposed Piping .....	116
<b>9.1.4.2 INSTALLATION OF VALVES, FIRE HYDRANTS &amp; MARKERS.....</b>	<b>117</b>
9.1.4.2.1 General .....	117
9.1.4.2.2 Materials .....	117
9.1.4.2.3 Location of Installation .....	118
9.1.4.2.4 Execution .....	118
9.1.4.2.5 Installation of Marker Posts .....	118
<b>9.1.4.3 TESTING AND DISINFECTION.....</b>	<b>119</b>
9.1.4.3.1 General .....	119
9.1.4.3.2 Colouring Tests for Welding .....	119
9.1.4.3.3 Field Hydrostatic Pressure Test .....	120
9.1.4.3.4 Field Leakage Test .....	120
9.1.4.3.5 Disinfection .....	121
<b>9.1.4.4 PIPE JACKING FOR RAILWAY CROSSING.....</b>	<b>123</b>
9.1.4.4.1 Scope of Work .....	123
9.1.4.4.2 General Requirements .....	123
9.1.4.4.3 Driving Pipe .....	123
9.1.4.4.4 Driving and Arrival Shaft .....	123
9.1.4.4.5 Cutting Edges .....	124
9.1.4.4.6 In-Pit-Based Jacks .....	124
9.1.4.4.7 Installation of Pipe .....	124
9.1.4.4.8 Submittal of Shop Drawings and Reports .....	124

## **9.1.4 PIPELINE INSTALLATION, TESTING AND DISINFECTION**

### **9.1.4.1 PIPE LAYING**

The Contractor shall furnish all labour, materials, equipment and incidentals required to install, test and disinfect water pipelines.

#### **9.1.4.1.1 General Requirements**

All pipe shall be laid to lines and grades shown on the Drawings and to comply with BS 8010 Section 2 "pipe lines on lands: Design Construction and Installation". Only pipes, fittings and accessories which are as specified in Section 9.1.3.2 "Piping Material" shall be used in this work. Loading, transporting and handling shall be done very carefully as described in Section 9.1.3.1. "General", or in conformance with the manufacturer's recommendations.

Pipe end covers and other transit protections fixed by the pipe shall be retain in place except for taking over inspections until the pipes are finally inspected shortly before they are laid.

All pipes, fittings and accessories shall be examined, and no piece which is found to be defective shall be installed.

When pipes and fittings etc are strung adjacent to the pipe trench prior to laying they shall be supported clear of the ground on suitable approved support to prevent damage to their external coating.

Excavation, bedding, backfill shall be done as specified in Section 9.1.1.3 "Trench Excavation" and in this section, all to the satisfaction of the Engineer.

The open ends of the installed pipes shall be plugged with a watertight plug, or other approved means, after the Contractor has finished the installation on each day/night, or when there is no pipe laying in progress. The plug shall be taken off whenever the Contractor is ready for joining pipes. The Engineer reserves the right to order the Contractor to remove any pipe length, which has not been plugged as required to clean the inside of the pipe. Material to be used for plugging shall be approved type that shall adequately protect the pipe from damage, and prevent dirt, debris and water from entering the pipe. The Contractor shall prevent trench water, mud, sand or sewage from entering the pipe during installation.

The type of joint required for each material shall be in accordance with Section 9.1.3.2 "Pipe Material".

All rubber joint rings and gaskets must be stored in a cool damp location in black polythene sacks and shall not be distributed to the trench side until immediately prior to assembly thereof. Rubber gaskets shall be well lubricated prior to fitting.

Care shall be taken during joining the pipes. All pipe fittings shall be checked for defects and cleaned before joining.

Any field cutting of the pipe shall be done only with the approval of the Engineer. The Contractor shall submit to the Engineer for prior approval details of his cutting method, along with types and sizes of pipes to be cut. Any damage to the coating and/or lining shall be immediately repaired. Where cut pipe has been installed without the above prior approval of the Engineer, and the

work is found not to conform to the specifications, the Engineer has the right to order the Contractor to remove that pipe length for rectification. All expenses involved shall be borne by the Contractor.

Each pipe and fitting shall be laid true to alignment, curve and gradient in accordance with the drawing or as directed by the Engineer. The minimum cover and the minimum gradient shall unless otherwise stated not be less than one metre and 1:400 respectively.

The pipes shall be laid to even gradients and sight rails shall be provided for this purposes at intervals not exceeding 50 metres and at changes of direction and grade.

Pipes and fittings suppose to view at culvert or bridge crossings and in manholes or chambers shall be painted in accordance with Section 9.1.7.

The following standards are referred to:

ISO 4482	Asbestos-Cement Coating – Guide for laying
AWWA C203	Coal-Tar Protective Coating and Lining for Steel Water Pipeline – Enamel and Tape-Hot-Applied
AWWA C206	Field Welding of Steel Water Pipe Joints
AWWA C210	Coal-Tar Epoxy Coating System for the Interior and Exterior of Steel Water Pipe
AWWA C600	Standard Specifications for the Installation of Gray and Ductile Cast-Iron Water Mains and Appurtenances
AWWA C603	Standard Specification for the Installation of Asbestos-Cement Pressure Pipe
AWWA Manual M11	Steel Pipe Design and Installation

#### **9.1.4.1.2 Installation of Pipe and Fittings**

##### **(1) Installation of Ductile Iron (DI) Pipe and Fittings**

All pipes and fittings to be used in this work shall be in accordance with Section 9.1.3.2 “Pipe Material”.

All pipes shall be carefully inspected for defects before installation. No pipe or fittings which shows defects excluded by the specification shall be used. Any injury to protective coating of the pipe or fittings shall carefully be repaired before installation.

The Contractor shall, after excavating the trench and preparing the bed for the pipes, furnish all necessary facilities for properly lowering and placing the section of the pipe in trench without damage and shall properly install the pipe. The section of the pipe shall be fitted together correctly and shall be laid true to line and grade in accordance with the bench mark established by the Contractor. The full length of the barrel of the pipe except the socket (bell) or flange shall have a uniform bearing upon the bed of the trench. Suitable excavation shall be made to receive the socket (bell) or flange which shall not bear on the subgrade.

As far as possible, pipe shall be lowered into trench using cranes. No pipe shall be rolled into place for lowering into the trench except over suitable timber planking free from roughness likely to damage any coatings. If the prepared bed is damaged for any reason, the pipe shall be raised and the bed made good before pipe laying is continued.

Whenever the work ceases for any reason, the unfinished end of the pipeline shall be securely closed with a tight fitting plug or cover. The interior of each pipe after being laid shall be thoroughly cleaned.

Any pipe which is not in true alignment both vertical and horizontal, or shows any undue settlement after laying shall be taken up and re-laid correctly by the Contractor at his own expenses when so ordered by the Engineer.

When subsoil water is encountered, it shall be kept below the sockets when joining by pumping or other means. In no case shall pipes and/or fittings be jointed before being lowered into position.

If any damage should occur to any pipes through failure of the Contractor to comply with these conditions, the damage shall be made good at the Contractor's expenses.

When the pipes are specified to be installed with the polyethylene sleeves or tape wrap, the Contractor shall take the necessary care to do it strictly in accordance with the specifications of the manufacturer, using the recommended material, tools and equipment and methods.

If, in the opinion of the Engineer, the sleeves or tape wrap fails to provide the protection to the pipe as intended due to improper material, tools or methods used by the Contractor, he shall replace the sleeves or tape wrap in the affected area as directed by the Engineer, at his own cost.

(i) Concrete Protection of Pipe

When indicated on the drawings or ordered by the Engineer, pipe shall be encased in concrete in accordance with the details shown on the drawings. Such concrete shall not be placed until the joints at each end of the pipe have been completed. Each pipe to be encased shall be supported on at least two purpose made precast concrete blocks of same grade of encasement concrete which shall be left in place and the full width and depth of concrete encasement shall be placed and carefully tamped beneath the pipe followed at once by the addition of the encasing concrete.

(ii) Push In Joints and Restrained (Self Anchored) Joints

Installation shall be in accordance with the manufacturer's recommendations. Sockets and spigots shall be thoroughly cleaned prior to making the joint. Only lubricant recommended by the manufacturer shall be used and it shall be non-toxic. The completed joint shall have a uniform contact by the gasket between the outer surface of the spigot and the rubber ring seat of the socket.

(iii) Flanged Joints

Joints shall be made up square with even pressure upon the gasket and shall be properly water tight. Gaskets shall fit the inside dimension of the pipe accurately so that no surface material projects out into the flow area. The completed joint shall be perfectly aligned. Flanged joints shall be coated including all bolts and nuts with Denso paste and primer, Denso mastic, Denso tape and PVC or polyethylene outer wrapping.

(iv) Slip-on Coupling and Flange Adapters

Coupling and flange adapters which are as specified in Section 9.1.3 shall be used where shown on the drawings approved by the Engineer. Installation shall be in accordance with the manufacturer's recommendations. Gasket seats and gaskets shall be thoroughly cleaned before assembly.

The completed joint shall have uniform contact by the gasket between the outer surface of the spigot and the gasket seat at the socket. Coupling and flange adapters shall be coated including all bolts and nuts with Denso paste and primer, Denso mastic, Denso tape and PVC or polyethylene outer wrapping.

(v) Deflection of Pipeline

Minor changes in direction of pipeline both vertically and horizontally shall be made through deflections at the joints. Such deflections shall not exceed the values given below.

Nominal Diameter (mm)	Maximum Allowable Push-on Joint	Deflection (degree) Mechanical Joint
80 to 200	5.0	5.0
250 to 350	4.0	4.0
400 to 600	3.0	2.5
700 to 900	2.5	2.0
1000 to 1200	2.0	1.5

Joints with deflection shall be installed in accordance with the manufacturer's instruction.

(vi) Cutting of Pipes

Pipe shall be cut using power driven abrasive wheel cutting machine. Acetylene torch and chisel methods will not be permitted in any circumstances. Cut spigot ends shall be beveled to the same dimensions as the normal spigot ended pipe. The edges of the cutter shall be given two coats of approved paint and the internal coating shall be repaired if damaged. The Contractor shall ensure that the diameter at the point of cutting will match the pipe to which it is to be jointed.

(vii) Welding

No site welding work on ductile iron pipe and fittings shall be undertaken without the approval of the Engineer. Where approved, welding work shall be undertaken in accordance with the manufacturer's recommendations.

(viii) Protection of Joints

All buried flange joints, and any un-coated mechanical coupling shall be protected by wrapping with "Denso Paste", "Densyl Mastic", "Densyl Tape" and "PVC Outerwrap" manufactured by Winn and Coales Limited, Denso House, Chapel Road, London, S.E.27 or similar approved materials.

The joints shall be thoroughly cleaned to remove all loose rust and extraneous matter and thoroughly coated with "Denso Paste" over the whole of the joint. A liberal amount of paste should be left around all bolt heads, narrow cavities, etc.

"Densyl Mastic" shall then be applied to cover all bolt heads and nuts to form a triangular fillet against flanges and to fill all gaps and abrupt changes in contour to provide an even contour for wrapping.

"Densyl Tape" shall be applied circumferentially, care being taken to smooth and eliminate any air pockets and to form the tape well into all angles and changes in contour. The tape should be applied with an overlap of at least 25 mm and should extend at least 50 mm on either side of the joint.

Finally an outer wrapping of "PVC Outerwrap" shall be applied with minimum lap of 25 mm to completely cover the "Densyl Tape".

(2) Installation of Steel Pipe (SP) and Fittings

All pipes and fittings to be used in this work shall be in accordance with Section 9.1.3.2 "Pipe Material".

All pipes and fittings shall be handled and installed in accordance with the applicable section of AWWA Manual M11 and the requirements described herein.

At crossings over canals and ditches, the exposed steel pipes and fittings shall be painted with two coats of synthetic red lead primer and one coat of Aluminum paint. The underground steel pipe shall be tied around with synthetic asbestos cloth. Steel sleeve pipe shall be painted with two coats of coal tar epoxy.

The ends of the pipe shall have wooden stiffeners installed inside of the pipe at quarters points and at both ends of the pipe. This blocking shall remain inside the pipe until the pipe has been installed.

When field cutting or mitering of the pipe is required the cutting shall be done by the acceptable cutting machine, leaving a smooth cut at right angles to the axis of the pipe or deflection angle. Cut ends of the pipe shall be beveled with a special tool made for the purpose, and the beveled end shall be exactly the same as the plain end of the pipe as manufactured at the factory.

Steel pipe with plain ends shall be joined together with a flexible coupling as specified in Section 9.1.3.2.2, (2), 2.5 or where shown on the drawings. The Contractor shall make excavation of sufficient width and depth to provide the suitable room for joining the pipes and fittings. The bedding at the joint shall be installed and compacted after the joining has been completed. Where fittings such as bends, tees and blanks are used, all fittings shall be joined with single butt welded joints unless otherwise shown on the drawings.

Any damage to the exterior coating and interior lining shall be repaired in accordance with the manufacturer's recommendations. If, in the opinion of the Engineer, the damage is not properly repaired by the field methods, the Engineer reserves the right to order the Contractor to use the method of repairing that is the same as the manufacturer's procedure. The expenses of repairs shall be borne by the Contractor.

Welded joints shall be butt and weld and in full conformance with AWWA C206. Welders in charge shall have the qualification stipulated in JIS Z3801 or approval equal.

The Contractor shall submit the qualification of the proposed welders for the steel pipe jointing for the approval of the Engineer. The Engineer may request the Contractor to conduct the testing for examination of the capability of the welders. The Contractor shall, when requested by the Engineer make the necessary arrangement for such testing for joint welding at his own cost.

After all field welded joints have been made, and inspected and approved by the Engineer, the joints shall receive the protective coating and lining as specified below.

(i) Coal Tar Enamel Coating (Underground Buried pipe)

All field welded joints in the underground buried pipeline shall be field-coated with coal tar enamel and bonded with double asbestos felt wrap in accordance with BS534, or Appendix A Section A1.2 of AWWA203. The coating system shall be equivalent to the shop-applied coating of the



pipe section and shall be applied across around the outside of the joints. The joints protective coating shall overlap the main body of the shop coating on each side of the field joint to form a continuous coating free from defects. The overlapping length shall be at least 200 mm on each side of the joint.

(ii) Epoxy Painting (Above-ground Exposed Pipe)

All field welded joints in the above-ground exposed pipeline shall be field coated with at least two (2) coats of epoxy resin paint. The first and second coats shall be of minimum coating thickness not less than 40 and 30 microns, respectively. The colour of epoxy paint shall be determined by the Engineer from the sample submitted by the Contractor. The method of field painting shall conform to the paint manufacturer's instruction and recommendations.

Unless otherwise permitted by the Engineer, shop coating and field-painting materials shall be from the same manufacturer.

(iii) Cement Mortar Lining

All field welded joints shall receive field applied cement mortar lining in accordance with AWWA C602. The lining system shall be equivalent to the shop applied lining and shall be applied across the inside of the joints.

Bolts and nuts for mechanical joints, flanged joints and blank flanges shall be given a coat of bituminous paint after the jointing has been completed.

(3). Installation of Unplasticized Polyvinyl Chloride (uPVC) Pipe and Fittings

Careful consideration must be given to the handling and storage of polyvinyl chloride pipe and fittings. The pipe must be stored out of any direct sunlight. Extreme care must be made to prevent any scarring or nicking of the pipe from bearing on sharp objects. Any pipe which has any cut or bruise deeper than 10% of the wall thickness will be rejected and shall not be used in the work. The section of pipe with such a cut shall be reject in its entirety. The pipe shall be stored in such a manner that no direct sunlight is on the pipe but ventilation is provided. Covering the pipe with a tarpaulin shall not be allowed. Stacking shall not exceed 600 mm in height.

In normal ground, pipe shall be bedded in 150 mm depth of granular material as specified in Section 9.1.2. The same material shall be placed alongside the pipe and compacted in 200 mm layers upto the crown of the pipe. Same material shall be placed over the pipe and compacted in two layers, upto a depth of 300 mm.

In other types of ground, additional bedding types shall be used, as shown in relevant typical drawing.

Where uPVC pipes passed under or at the side of culverts they shall be protected by Sleeve pipes as shown on the drawing.

The joints shall be of the push-in type. The socket and spigot of the pipe shall be carefully cleaned before the rubber ring is set in place. The spigot shall then be covered with an approved lubricant and the pipe pushed into the socket. Pushing the pipe into the socket shall be done by barring against the opposite end of the pipe being installed. A wooden block or other suitable device shall be used to prevent any damage to the socket against which the bar is being pressed. No blocking will be allowed under the pipe and it shall bear evenly along its entire length on the bedding material.

Cutting of the pipe shall be kept to a minimum. When cuts are necessary they shall be perpendicular to the axis of the pipe and smooth. Cuts shall be made with tools in conformance with the pipe manufacturer's recommendations. Cut ends shall then be tapered and beveled with a special tool made for that purpose and the beveled end shall be exactly the same as the spigot end of the pipe as manufactured at the factory.

Solvent weld joints for pipes of diameters 90 mm shall be made in strict accordance with the manufacturer's recommendations and utilize only solvents furnished by the manufacturer. In addition it will be necessary to snake the pipe so that on offset from true horizontal alignment of 30 centimeters in 30 meters of laying length will be provided. Care shall be taken to insure that the temperature of both sections of pipe being jointed are the same.

For any diameters other than 90 mm, solvent joints shall be used only after written approval by the Engineer.

For the uPVC pipes of diameters 110 mm and above, caution tapes (warning tapes) shall be installed in the pipe trench, 500 mm above the crest of the pipe.

At uPVC fittings when forming the trust block and anchor blocks a polythene film or equally suitable material membrane to the satisfaction of the Engineer of minimum thickness 2 mm shall be provided to separate the fitting from the concrete of the trust or anchor block.

The warning tape shall be of polythene, and should have performance details applicable to the 100 micron material of "Boddingtons underground warning tapes", or equivalent.

- Minimum ultimate tensile strength at break (longitudinal and transverse) shall be 10MN/m<sup>2</sup> as determined by BS 2782 method 301E.
- Minimum Elongation shall be 300% (Longitudinal) and 350% (Transverse)
- Shall be resistant to chemical attack from the ground conditions with pH ranging from 3.0 to 9.0.

The width of the tape shall be 100mm. Tape shall be blue colour, with the words printed "WATER PIPE LINE BELOW – CAUTION!" on upper side of the tape in black letters, printed in two rows, at an interval of 1m.

#### (4) Installation of Galvanized Steel (GS) Pipe and Fittings

Only pipes, fittings and accessories which are in accordance with the requirement described in Section 9.1.3 "Pipe Material" shall be used in this work. Installation of pipes, fittings and accessories shall be in conformance with the manufacturer's recommendations, or as directed by the Engineer. Gibault or flange joints may be used if necessary.

All threads for screw joints shall be clean, machine cut, and all pipe shall be reamed before erection. Each length of pipes as erected shall be up-ended and rapped to dislodge dirt and scale.

Screwed joint shall be made up with good quality thread compound and applied to the male thread only. After having been set up, a joint must not be backed off unless the joint is completely broken, the threads cleaned, and new compound applied.

No close right and left hand nipples shall be used. All nipples shall be of such length that the correct size of pipe wrench can be used on them when in place.

At crossing over canals or ditches, the pipe shall be laid in accordance with the details and/or construction method specified on the drawings or as directed by the Engineer.

Pipe laid under ditches, shall be in accordance with the details shown on the drawings or as directed by the Engineer. Pipe bedding shall be compacted for the entire length of the pipe good alignment shall be preserved and fittings may be used where necessary.

#### **9.1.4.1.3 Thrust and Anchor Blocks**

- a) Concrete thrust and anchor blocks shall be formed at bends, tees and valves in accordance with the typical sections shown on the drawings or otherwise as directed by the Engineer. The additional excavation shall be made after the bends etc. have been jointed and the concrete shall then be placed with all possible speed. The back of supports and blocks shall abut on to solid ground, all loose material being removed before concreting.
- b) The concrete used for thrust and anchor blocks shall be Grade 15, After placing the concrete shall be kept in view for not less than six hours. No pressure shall be applied in any section of main until the concrete has had at least three day's curing.
- c) At uPVC fittings a polythene film or equally suitable material membrane to the satisfaction of the Engineer shall be provided to separate the fitting from the concrete of the thrust of anchor block .

#### **9.1.4.1.4 Exposed Piping**

The Contractor shall furnish and install sleeves or wall casting for all pipes passing through masonry walls and concrete floors or walls and concrete inserts for hangers and supports as soon as forms are erected and before concrete is poured. Before setting these items, the Contractor shall check all and figures which have a direct bearing on his pipe location and he shall be responsible for the proper location of his pipes during the construction of the structures.

Piping shall be installed to the required lines and grades and as closely as possible to walls, ceilings, columns and other structural parts so as to occupy the minimum of space, and all offsets and fittings required to accomplish this must be furnished. All dimensioned pipes and fittings shall be installed that no stress or strain is created in the lines and associated equipment due to forcing parts into position.

Changes in direction shall be made using proper fittings. Piping shall run parallel and at right angles to walls, unless noted otherwise.

Temporary bracing and supports shall be provided to adequately support the pipe during its installation and care shall be taken in placing piping to prevent damage to the pipelining or pipe coating or to adjacent structures or equipment. All supporting piers and blocking shall be in place before temporary supports and bracing are removed.

Flange piping shall have a sufficient number of couplers and adapters to allow convenient removal of piping.

The Contractor shall furnish and place all inserts for the support of piping installed under this section in masonry and in concrete forms before concrete is placed, unless otherwise permitted.

Systems shall be arranged with low points and drains to arranged with unions or union connections at low points to permit draining. Fill connections shall also be provided on closed systems where required.

Adequate air vents shall be provided at high points in all liquid carrying pipes. All exposed piping shall be rigidly supported by pipe hangers and supports specified hereinafter.

All pipes shall be sound and clean before installation.

In case interference develops between piping and appurtenances, the Engineer will decide which work is to be relocated regardless of which was first installed.

Upon completion of installation and testing, the Contractor shall paint all exposed piping in accordance with the specifications in Section 9.1.6 "Painting".

Where the pipe passes through wall sleeves, the sleeves shall be caulked with sealing compounds recommended by the pipe manufacturer and approved by the Engineer. Sealing compounds shall be applied in accordance with the manufacturer's instructions.

#### **9.1.4.2       INSTALLATION OF VALVES, FIRE HYDRANTS & MARKERS**

##### **9.1.4.2.1      General**

###### **(1)    Scope of Work**

The Contractor shall supply all labour, equipment and material required to install valves, fire hydrants and market posts, and construct valve chamber and surface boxes, as shown on the drawings and as specified herein. This work includes: surface breaking; excavation and backfill; sheeting and bracing; on site forming; supply and installation of pipes, fittings, valves, fire hydrants and appurtenances; supply and installation of miscellaneous metalwork, surface restoration and other work needed to complete the valve boxes.

Most of the components of work for above works are specified in other parts of this Specification. This section consolidates a description of the work required for above works in particular. The Contractor shall consult other parts for further details.

###### **(2)    Submittals**

The Contractor shall prepare and submit a shop drawings for each installation. The shop drawings shall be based on the schematic arrangement shown on the drawings and include the dimensions of piping, appurtenances and other equipment to be installed and shall extend to the limits of the installation shown on the drawings or to the limit of special pipe construction. All supports, clearances and materials to be installed shall be shown.

##### **9.1.4.2.2      Materials**

Cement, aggregate, water, admixture, reinforcing steel, concrete, form work, shall be in accordance with the provision of Section 9.1.2 "Concrete", and the valves, fire hydrants, man holes, surface boxes and appurtenances shall be in accordance with the specifications of Section 9.1.3 "Pipes & Fittings".

#### **9.1.4.2.3 Location of Installation**

##### **(1) Fire Hydrants**

The location of the fire hydrants shall be either under the pedestrian walkway or under the shoulder of the road, but shall not be under the carriageway. The location shall be approved by the Engineer before installation.

##### **(2) Valves**

The location of the valves shall be a sufficient distance away from the road junctions, so that the installation is not adversely affected by future road widening or surfacing by the road maintenance authorities. The Contractor shall obtain the approval of the Engineer before installation.

#### **9.1.4.2.4 Execution**

##### **(1) Underground Utilities Interference**

When underground utilities are shown on the drawings or anticipated to exist near the proposed location of the installation, the Contractor shall excavate test pits to make sure that the existing underground utilities will not interfere with the construction of the structure. On the other hand, if underground utilities are found to be actually existing, proper precautions shall be instituted so as not to disrupt service to the general public.

##### **(2) Manhole Frame and Cover**

Manhole frame shall be set with the top conforming to the grade of the pavement or finished ground surface as indicated on the drawings or as directed by the Engineer. Frames shall be set in full bed of mortar.

##### **(3) Valve Box**

Valve boxes shall be constructed with the top of cover lower by 0.2 m from the grade of the pavement or finished ground surface, or as indicated on the drawings, or as directed by the Engineer. The manhole frame and cover shall be raised with its top conforming to the grade of the pavement or finished ground surface.

#### **9.1.4.2.5 Installation of Marker Posts**

Marker Posts shall be installed at the locations of all valves and meters of the distribution pipe lines and transmission mains and at the location of fire hydrants. The type depth location and diameter of the main shall indicate as specified in the relevant drawing, for the specified sizes of valves and pipe lines. Contractor shall obtain the approval of the engineer regarding the location of marker posts, and also obtain the permission from the relevant authorities for the installation of the marker posts.

### **9.1.4.3 TESTING AND DISINFECTION**

#### **9.1.4.3.1 General**

(1) Scope of Work

The Contractor shall furnish all labour, equipment, materials and metering device required for the pressure and leakage testing and the disinfection of the finished pipelines. The finished pipeline includes the pipes, fittings, valves, fire hydrants and all other appurtenances that are constructed under this Contract. The Contractor shall provide the facilities necessary to convey the water from its sources, as designated by the Engineer, to the place where it is required, and shall install the metering device.

All testing and disinfecting operations shall be done in the presence of the Engineer.

Late delivery of valves will not be allowed to delay testing and commissioning of a pipeline. In such cases the Contractor shall supply and install spool or make up pieces so that testing may proceed. The Contractor shall install valves later in a manner acceptable to the Engineer.

(2) Standard Specification References

The following standard are referred to

AWWA C600 Standard for Installation of Ductile-Iron Water Mains and their Appurtenances

AWWA C601 Standard for Disinfecting Water Mains

(3) Submittals

The Contractor shall submit, as part of his shop drawings, a sketch for each section of pipe to be tested. The sketch shall show the section schematically in profile and shall contain a sequence of operation to be followed during the test such as observations and closing of air-valves, blow-offs and other appurtenances; shall show point of filling, point of pressure observation and test pressure.

#### **9.1.4.3.2 Colouring Tests for Welding**

The colouring test shall be performed at each welding joint on 100 percent in length of joint, and examination on defects or incompleteness shall be executed in accordance with JIS Z2343. When any defect or pin hole is detected by the colouring test, the Contractor shall repair it to the satisfaction of the Engineer and shall repeat the colouring test to confirm that the repair work has been satisfactorily done.

All such tests shall be carried out by the Contractor in the presence of the Engineer. Where necessary, welds shall be repaired in accordance with instruction of the Engineer, at the Contractor's own expense.

The Contractor shall nominate a qualified chief supervisor for field tests of the steel pipe who has the responsibility to perform and to supervise the field tests of steel pipe.

All expenses for the said testing including expenses for equipment, tools, materials, labours, reporting, and any other works related shall be deemed to be included in the rates of pay items for installation of steel pipes.

#### **9.1.4.3.3 Field Hydrostatic Pressure Test**

Hydrostatic pressure test procedure for the pipeline shall be as specified in Section 4.1 of AWWA C600, which shall be not less than 1.5 x the maximum working pressure.

For all pipe sizes, the working pressure shall be of water column based on the elevation of the lowest point in the pipeline under tests, and corrected to the elevation of the test gauge.

All tests shall be conducted on the pipelines in sections after the trench is backfilled, but before pavement restoration. Joints shall be exposed during the test wherever possible.

Before a length of pipeline is tested, each pipeline securely anchored, all thrust and anchor block shall have been constructed.

Maximum length of pressure testing shall be 1 km.

All pipeline shall be thoroughly flushed out with water prior to testing.

The pipeline shall be prepared for testing by closing all valves and hydrants; placing substantial stops and bulkheads at openings, opening air valve assemblies and fitting air release taps at all other high points along the pipeline. These taps shall later be removed after completion of the testing and disinfection and, unless otherwise specified, replaced with permanent plugs.

The pipeline shall be slowly filled with water, allowing all air pockets to be released, until the pipe is completely filled and under working pressure at which condition it should be allowed to stand for 24 hours. Any apparent defects in the pipeline at this stage shall be rectified by the Contractor. To demonstrate that air has been removed the Contractor add a measured amount of water at filling point and measure outflow at remote points of pipe being tested. If remote points of pipeline do not contain convenient points to measure outflow the Contractor shall install taps.

The hydrostatic pressure shall be raised to the test pressure. The duration of the pressure test shall be for a period of two (2) hours. Any defective pipe, fittings, joint, valve or hydrant shall be removed and replaced and the test shall be repeated until satisfactory to the Engineer.

#### **9.1.4.3.4 Field Leakage Test**

Leakage tests procedure for the pipeline shall be as specified in Section 4.2 AWWA C600. The leakage test shall be conducted after the pressure test has been satisfactorily completed. The duration of each leakage test shall be two(2) hours, and during the test the pipeline shall be subjected to the same test pressure stated in the preceding paragraph. The pipeline leakage shall be taken as the amount of water, as measured by the metering device,

Needed to be injected into the line to maintain the test pressure for the two (2) hour leakage test period.

The allowable pipeline leakage shall be less than 2.3 litres per 24 hours per mm-pipe diameter per km-length as presented by the formula below:

$$\frac{Q}{D \times L \times H} \times 24 < 2.3$$

Where:

Q : Amount of leakage in litres  
D : Diameter of pipe in millimeters  
L : Length of pipeline in kilometers  
H : Duration of leakage test in hours

Should any test of pipe laid disclose a leakage greater than the specified above, the Contractor shall locate and repair or replace the defective materials or joint, to the satisfaction of the Engineer. The test shall be repeated until any leakage falls within the permitted allowance.

#### **9.1.4.3.5 Disinfection**

##### **(1) Swabbing**

After the pipelines have been completed and pressure tested satisfactorily in accordance with the relevant Clause then the Contractor shall on the instructions of the Engineer prove any length of pipeline to be free from obstruction.

Proving shall be carried out by means of passing through the pipelines a polyurethane foam swab of approved grade in accordance with the following procedure.

Pipelines shall be proved in sections between entry and exit points. The location of the permanent swabbing points are indicated on the Drawings. Temporary swabbing points shall be provided in the distribution system by insertion of tees and valves which shall be removed after proving and replaced by short lengths of straight pipe.

At the start of the operation the swab shall be introduced at the entry point at the upstream end of the section by means of the tee provided and the isolating valves on branch mains closed.

The isolating valves on either side of the entry point shall be opened sufficiently to flood the entry tee containing the swab and the sluice valve on the entry tee shall then be closed

By opening the isolating valves on either side of the entry point the swab will be free to travel along the pipeline towards the downstream exit point.

The theoretical loss of head between the entry point and the exit point and either end of the section will previously have been determined by the Engineer for a flow of water which will cause the swab to travel through the section at a suitable predetermined velocity. This flow and the corresponding required velocity of the swab will be controlled by throttling of valves at the exit point or at hydrants or washouts.

Washouts or hydrants downstream of swabs shall be controlled so that any rubbish, silt, debris or other extraneous matter may be discharged during the passage of the swab along the pipeline.

Proving of any section shall be repeated as required by the Engineer in the event of the initial or any subsequent operation not being to his satisfaction.

The Contractor shall provide all transport and labor required to prove a pipeline free from obstructions.



Diameters 300 mm and greater:

Visible dirt and debris should have been removed either manually or by the use of cleaning pigs before testing.

After the pipelines have been completed and pressure tested satisfactorily as herein specified the Contractor shall flush out and cleanse the pipelines.

Pipelines shall be cleansed in sections and this shall be carried out by passing polyurethane foam swabs through the pipeline. The swabs shall be to the approval of the Engineer. Water for passing swabs will be made available by the Employer.

Diameters less than 300 mm :

Pipelines shall be cleansed in sections by flushing with portable water, provided by the Employer, for a period of time shall be decided by the Engineer's representative.

Cleansing of any section shall be repeated as required by the Engineer's Representative in the event of the initial or subsequent operation not being to his satisfaction.

The Contractor shall supply all necessary equipment for the cleansing and sterilizing operations, including sufficient swab and swab detectors.

Swabs shall be suitable grade and dimensions appropriate to the pipelines being cleansed and to the approval of the Engineer.

Swabs shall be passed through pipelines at speeds of between 0.2 and 0.4 metres per second to obtain the best cleaning result with the minimum number of passes. Should it be apparent from the debris collected by the swab that damage to the lining has occurred, the Contractor shall be wholly responsible for repairing the lining to the satisfaction of the Engineer's Representative.

The cost of the initial sampling analyses and preparing reports on the bacteriological quality of water shall be borne by the Employer but, in the case of the initial reports being unsatisfactory the cost of any subsequent sampling analyses and preparing reports shall be borne by the Contractor.

## (2) Disinfection

Before being placed into service, or before certification of completion by the Engineer whichever occurs earlier, all new pipelines which will convey the filtered water shall be disinfected with chlorine, and a satisfactory bacteriological analysis of the water certified in accordance with AWWA C601 shall be submitted to the Engineer.

The amount and concentration of chlorine solution applied shall be such as to provide a dosage of not less than 50 mg per litre, introduced into the lines as directed by the Engineer. After a contact period of 24 hours, the chlorine residual at the end of pipeline shall not be less than 25 mg per litre. The system shall then be flushed with clean water until the residual chlorine is not greater than 0.75 mg per litre but not less than 0.25 mg per litre.

The point of application of the chlorination agent is normally at the beginning of the pipeline through a corporation stop insertion on the top of the laid pipe, and the point of withdrawal (normally by blow-off) is at the opposite end of the line.

Should the initial treatment fail to result in the conditions stipulated above, the chlorination procedure shall be repeated until satisfactory results are obtained.

The Contractor shall dispose of the water used in the pipeline testing and disinfecting operations without causing damage to adjacent property.

#### **9.1.4.4 PIPE JACKING FOR RAILWAY CROSSING**

##### **9.1.4.4.1 Scope of Work**

The Contractor shall furnish labour, materials, equipment and incidentals to install the encasement pipe by pipe jacking for railway crossing in accordance with the drawings and as specified herein.

The work shall include supply of driving pipe with jointing materials, and construction of driving and arrival shafts, pipe driving, and incidentals to complete placing of the encasement pipe under the utilities at the locations as indicated on the drawings.

##### **9.1.4.4.2 General Requirements**

Construction method applicable to the pipe driving under this contract shall be open type. Excavation may be done either by manual or by mechanical methods.

Special measures for pipe driving such as ground treatment and/or use of intermediate jacks are not indicated on the drawings but may be incorporated in the driving work by the Contractor. The Contractor's attention is directed to the fact that there will be a large thrusting force required for the pipe driving operation and that the earth behind the driving shaft must safely withstand the thrusting force during the operation. The Contractor shall be responsible to there in force the original soil to obtain sufficient bearing capacity for the jacking force if required, and for this purpose, the Contractor shall carry out additional subsoil investigation as necessary. All expenses due to this improvement shall be the Contractor's responsibility.

Prior to the construction work, the Contractor shall investigate existing subsurface structure as, and utilities located in and around the construction site so as not to damage those facilities during all stages of construction. Before, during and after the driving operation, the Contractor shall make a continuous measurement and record of the level of the existing ground, road surface and railway line.

When the Contractor intends to change his construction method during driving operations, the Engineer's approval shall be required.

The Contractor shall liaise with the Railway Authority throughout the pipe jacking work under the railway lines and comply with all the requirements of the Railway Authority.

##### **9.1.4.4.3 Driving Pipe**

Driving pipe (encasement pipe) shall be steel or ductile iron pipe and the pipe material component and fabrication shall comply with the Specifications in Section 9.1.3.2. Wall thickness shall not be less than that shown on the drawings. Lining and exterior coating will not be required.

##### **9.1.4.4.4 Driving and Arrival Shaft**

Driving shafts shall be sized so that all equipment needed for the driving operation can be reasonably accommodated in the shaft and that placing and jointing of pipe and other works in the shafts can be safely done. Each driving shaft at the bottom shall be provided with dewatering sumps

and pumps to maintain the shaft dry throughout the driving operation. Each driving shaft shall also be equipped with a crane for unloading of pipe and driving equipment and for removal of excavated soil.

Arrival shafts shall be sized so that removal of cutting edges and pipe connections in the shafts can be satisfactorily accomplished. Unless otherwise directed by the Engineer, construction of arrival shafts shall be delayed until driving operation has been nearly finished.

#### **9.1.4.4.5 Cutting Edges**

Irrespective of the construction methods to be used by the Contractor, cutting edges shall be designed to withstand against the required driving force and anticipated earth pressure. Each cutting edge shall be designed to integrate a reasonable number of jacks of controlling of pipe alignment and grade during driving operation.

Cutting edges shall have the same outside diameter as that of the steel encasing cylinder of pipe for driving.

#### **9.1.4.4.6 In-Pit-Based Jacks**

The total number of in-pit-based jacks shall be determined on the basis of jack output equal to 70 percent of the rated jack pressure. The rated pressure of the jack shall not be less than 400 kg/sq.cm and jacking stroke shall not be less than 500 mm.

#### **9.1.4.4.7 Installation of Pipe**

The Contractor shall take all necessary steps to ensure that the casing pipe is driven to the proper alignment and grade.

For steel pipe, method of field welding shall be same as that used for field welding of steel pipe and fittings as specified in Section 9.1.4.1. After the welded joints have been inspected and approved by the Engineer, coating equivalent to the shop applied coating shall be applied across the joints. The ductile iron pipe shall be jointed as shown on the drawings.

The pipes shall be jacked progressively as they are jointed and properly positioned. Thereafter the space between the pipeline and the casing pipe shall be filled with rammed sand or very weak grout that could be removed later if necessary.

#### **9.1.4.4.8 Submittal of Shop Drawings and Reports**

Prior to construction work, the Contractor shall submit to the Engineer shop drawings containing at least the following:

- Results and analyses of soil investigation.
- Construction method and sequence in detail.
- Design calculations to determine the wall thickness of the steel casing pipe.
- Drawings showing full details for dimensions of steel casing pipe for driving including pipe joint and cutting edge.
- Drawings showing full details of driving and arrival shafts.
- List of equipment to be used.

The shop drawings shall be submitted for each railway crossing work. No construction work shall be commenced by the Contractor until the shop drawings have been approved by the Engineer.

