



TENDER NO. TCML/MGD/WS/2019/03

**TENDER FOR THE PROPOSED
CONSTRUCTION AND INSTALLATION OF FIRE
TANK AND HYDRANTS**

**Volume 2
Specification**

JUNE, 2019

CLIENT:

TATA CHEMICALS MAGADI LIMITED

P.O. BOX 1-00205

THE HEAD OF PROCUREMENT

TATA CHEMICALS MAGADI LTD.

P.O. BOX 1-00205



TATA CHEMICALS MAGADI

TECHNICAL SPECIFICATIONS

Wherever reference is made in the Contract to specific standards and codes to be met by the goods and materials to be furnished, and work performed or tested, the provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise expressly stated in the Contract. Where such standards and codes are national, or relate to a particular country or region, other authoritative standards that ensure a substantially equal or higher quality than the standards and codes specified will be accepted subject to the Client Engineer's prior review and written consent. Differences between the standards specified and the proposed alternative standards shall be fully described in writing by the Contractor and submitted to the Client Engineer at least 28 days prior to the date when the Contractor desires the Client Engineer's consent. In the event the Client Engineer determines that such proposed deviations do not ensure substantially equal or higher quality, the Contractor shall comply with the standards specified in the documents.

Provision of equipments material and labour

The contractor shall provide all equipments, transport consumable materials and labour necessary for the satisfactory completion of the works in compliance with the specifications herein. The Client Engineer reserves the right to inspect plant and materials prior to contractor selection, and may reject plant or material that in his/her opinion is substandard or inappropriate. The contractor shall provide full descriptions of all plants to be deployed for these works. The contractor shall present method statements describing in detail the proposed approach to work.

The contractor shall provide summary detail of the experience of key personnel to be deployed for these works.

Occupation of site

The employer will provide land on which the works shall be constructed. The contractor shall be given possession of such parts of the site that he requires for activities related to construction works including storage of raw materials, equipment and setting up of camp during the period of contract provided his operation does not interfere with the daily activities of the employer.

The Contractor shall not enter upon or occupy with men, tools, equipment and materials any land other than the land or right of way provided by the employer

Diligent performance

The contractor shall at all times perform the Works diligently and in accordance with sound professional practice. He/she shall not proceed from one stage of works to another without the express permission of the Client Engineer

Decisions regarding Temporary halt, discontinuing of any element or part of any element of these works, or abandonment of these works, shall be discussed jointly between the contractor and the Client Engineer before any further actions are authorized by the Engineer. The Client Engineer's decision shall be final.

The Engineer will require a written submission justifying any steps taken by the successful bidder taken without the Client Engineer's approval. An unsatisfactory explanation shall lead to non-payment for works undertaken without prior agreement, and may be included for consideration as liquidated Damages.

Drawings

The project drawings shall comprise

- a) The drawings attached to tender documents
- b) Such other drawings and/or sketches as are issued from time to time by the Client representative to deal with design modifications in response to on-site conditions.

Record drawing

As the work proceeds the Contractor shall mark up 'As Built' details on a set of prints of the contract Drawings modified to portray the works as actually constructed and issue to the Client Engineer for approval within 7 days of completion of the works covered by each drawing.

Level datum

The Client representative will establish on site temporary benchmark and will assign a value to it. The Contractor shall establish and maintain such additional benchmarks as are necessary; the form of such benchmarks shall be approved by the Client Engineer.

Contractor's staff, communication, offices etc**General**

The contractor shall advise the Client representative at which of his offices any notices may be served in accordance with the conditions of contract.

Language of correspondence and records

All communication from contractor to the Client and the client representative shall be in English language.

All site books, time sheets, records, notes drawings, documents, specifications etc. shall be in English language

Contractor's duty staff & offices

At least one responsible senior representative of the contractor shall be immediately available at all times and he shall be on site during normal working hours.

To such representative shall be delegated full authority to confer with Client Engineer and to take all steps and to issue all those instructions which may be required in an emergency to ensure the safety of all personnel of the works and of all the Employer's and other property on the site and in the immediate vicinity thereof. The Client Engineer may from time to time at his discretion after taking into consideration all the prevailing conditions allow some relaxation of this clause but such relaxation shall be made only with his written permission and subject to any special conditions which he may then require.

If deemed necessary and upon request by the Client, the contractor shall provide and maintain at the site, offices for the use of representative and to which written instructions by the Client Engineer can be delivered. Any instructions delivered to such offices shall be deemed to have been delivered to the contractor.

Public Relations

The contractor shall designate within his site organization competent staff whose responsibility shall be to ensure good relations.

The location of all yards, stores, workshops, offices, etc. shall be agreed beforehand with the Client Engineer and shall be such as to avoid obstruction and nuisance to public and/or the client.

The contractor shall provide and maintain at or near the site suitable and sufficient shelters, mess rooms, washrooms, latrines etc. as are necessary and customary, to the satisfaction of the Client Engineer Client Engineer and in accordance with the law and regulations of the relevant authorities.

Accommodation for workmen

Where the contractor wishes to construct camp to accommodate his labour, the following requirements shall be adhered to and shall also be subject to the requirement made by the area administration or any local Authority.

Demolition of contractor's temporary structures

The Client Engineer may at any time before the end of the period of maintenance give the contractor notice in writing to demolish and remove those buildings and works which are no longer required, whereupon the title to such buildings and works and materials connected therewith shall revert to the contractor. After the demolition and removal of building and works as required by the Client Engineer and contractor shall level, clear, restore and make good the sites and surrounding ground and fill in and compact all latrines, drains, pits and similar works leaving the satisfaction of the Client Engineer.

First aid outfits

The contractors shall provide and maintain in an easily accessible place at the site of the works adequate first aid outfits for the whole duration of the contract, to the satisfaction of the Client Engineer. The contractor shall have available at all times a suitable vehicle for conveyance of the sick or injured people to hospital.

Protective clothing

The contractor shall provide all protective or any other special clothing or equipment for his employees that may be necessary.

Inspection by Client Engineer during period of defects liability

The Client Engineer will give the contractor due notice of his intention to carry out any inspection during the period of Defects Liability and the contractor shall hereupon arrange for a responsible representative to be present at the times and dates named by the Client Engineer. This representative shall render all necessary assistance and take note all matters and things to which his attention is directed by the Client Engineer.

Advertisement

No advertisements shall be placed on any boarding or scaffolding erected for any purpose connected with the contract without the written permission of the Client Engineer.

Site Investigations

- a. Ground levels shown on the drawings are believed to be correct. Should the contractor consider the levels shown to be inaccurate he must draw the attention of the Client Engineer to the discrepancy before interfering with the existing ground.
- b. The Contractor must make such site investigations as he thinks fit and satisfy him/her as to the nature of the ground and availability of materials.

Work Programme

The contractor shall submit a work programme showing the sequence and timing of the various stages in the execution of the works as per the conditions of contract.

Facilities for the Client Engineer

In need be and upon request by the client, the Contractor shall provide for the Client Engineer or his representative:

- a. Such instruments as are necessary to enable the Client Engineer to check the setting out and make such inspections as he may deem necessary.
- b. Such labour and assistance as may be required.

- c. Any facilities necessary to enable the Engineer to take samples
- d. Provide a temporary site office during the contract period.

Testing facilities

- (i) The Contractor shall provide laboratory facilities on site suitable for carrying out tests as shown:-
- (ii) Concrete
 - Slump
 - Crushing strength
- (iii) Aggregates
 - Particle Size
 - Impurities

Should the contractor so wish he may make arrangements for the necessary tests to be carried out by a Laboratory to be approved by the Client Engineer?

Water supply

The contractor will arrange to provide water for use in the camps and on the works. The Contractor must provide any treatment necessary to ensure it is suitable for use as in accordance to health regulations.

Electrical supply

The Contractor must provide his own source of electricity if he so requires.

Security

The Contractor will be responsible for the security of the Works and of site installations during the Contract period. He must provide such fencing, watching & lighting as he deems necessary.

Description of the materials and workmanship

The following apply to all sections hereafter.

a) Materials

Materials, commodities, components and equipment are to be new and unused unless otherwise specified. Handle, store, fix and protect all commodities with care to ensure that they are in perfect condition when incorporated into the work and handed over on completion.

b) Manufacturer's recommendation

Handle, store and fix every commodity strictly in accordance with the printed or written recommendations of the manufacturer and/or supplier. Supply the Client Engineer with copies of the manufacturer's recommendations. Inform the Client Engineer if the manufacturer's recommendations conflict with any other specified requirements, and obtain his instructions before proceeding.

c) Standards

Where commodities or workmanship are specified by reference to Kenya Bureau of Standards (K.S.), or British Standards (B.S.) or Codes of Practice (C.P.) or International (I.S.O.), or other standards, such standards are deemed to be the latest published at the time of tendering. The Contractor will be deemed to have read and understood the standards specified, and no claim for want of knowledge will be allowed. The substitution of commodities or standards of

workmanship complying with other standards may be allowed at the discretion of the Client Engineer, but application for permission for such substitution must be made in writing in sufficient time to allow adequate investigation. Obtain Certificates of Compliance with standards and supply to the Client Engineer on request.

d) **Local conditions**

All materials, commodities, components and equipment must be suitable for use in tropical climates.

Samples

The Contractor shall submit to the Client Engineer samples of materials to be used in the works, the samples must be fairly representative of the bulk to be supplied. Samples should be subject to relevant tests before submission and Test Certificates should accompany the samples.

Clearing site on completion

The site, including borrow pits and spoil dumps shall be carefully tidied up on completion, and shaped to avoid ponding, holes, and dangerous slopes. The borrow pits and spoil dumps must be covered with topsoil neatly trimmed and the whole site left in a tidy and satisfactory condition.

PRESSED STEEL TANK

PRESSED STEEL TANK**TABLE OF CONTENTS PRESSED STEEL TANK**

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TECHNICAL SPECIFICATION FOR PRESSED STEEL TANK

1 TESTING OF WATER-RETAINING STRUCTURES

Water retaining structures shall be tested for the water tightness at appropriate stages or on completion. They shall be filled with water in stages and held at each water level for such lengths of time as required by the Engineer. Should leakage occur at any stage, the water shall be drawn off and the defects remedied. The procedure shall be continued and finally the structure shall be allowed to remain full for 7 days. At the expiration of this period, the level of the surface of the water shall be recorded and further measurements made at intervals of 24-hours for 7 days. The structure shall be deemed to be watertight if the total drop in surface level does not exceed 10 mm in 7 days. For open structures, additional allowance shall be made for evaporation. If the structure does not satisfy the condition of the test and the daily drop in water level is decreasing, the period of test may be extended for a further 7 days, and if the specified limit is then reached, the structure may be considered as satisfactory.

The Contractor shall provide a hook gauge to measure variations in water level during the tests.

The testing shall be carried out before the excavations are backfilled and embankments placed.

The Contractor shall be solely responsible for the water tightness of the structure and any remedial measures necessary.

2 CLEANING AND STERILIZING OF WATER-RETAINING STRUCTURES

The inside of all water-retaining structures and all interior pipework and fittings, shall be thoroughly cleaned and washed to remove all contamination and the water from these operations removed by squeezing and drained away.

The inside of water-retaining structures shall be filled to overflow level with water containing 50 parts per million of chlorine and left for at least 24-hours. They shall then be drained and refilled with clean water from which samples and analyses shall be taken as instructed by the Engineer. If the results of the analyses are unsatisfactory, the sterilizing process and refilling and sampling shall be repeated until the results of the test are satisfactory.

The provision of all necessary water, labour and materials for carrying out the foregoing operations, shall be included in the Contractor's rates and prices. The cost of sampling, testing and the reports on the bacteriological quality of the water will be borne by the Employer, provided the results of the tests are satisfactory, otherwise the cost of such sampling, testing and reporting shall be borne by the Contractor.

3 STRUCTURAL STEEL

All structural steel work shall be of mild steel confirming to SSRN 905. All sections shall be at least equivalent to those shown in SSRN 913.

Ends of beams and joints, etc. shall be cut to exact lengths true and square and shall be cleaned of burrs or rough edges. Drilled or punched holes shall not be greater than 1/16" more than the bolt diameter and they shall be cleaned of burrs and rough edges. Punching of holes shall be allowed for plates thinner than 8 mm.

Prices for all mild steel shall include for removing all rust and mild scale and applying one coat of red lead or other approved priming paint to all surfaces before vising. Following erection, all structural steel not galvanised shall receive three coats of lead paint and be finished in an approved colour.

4 BOLTS, NUTS AND WASHERS

Bolts, nuts and washers shall conform to SSRN 914 threaded to SSRN 923. Washers shall be to SSRN 925 except that the outside diameter shall be at least 2.5 x the bolt diameter. Tapered washers shall be supplied where required.

Where specifically called for, nuts, bolts and washers shall be electroplated. For below ground environments including chambers, the electroplating shall be to SSRN 922. Elsewhere it shall be to SSRN 921.

5 HOT DIP GALVANIZING

All hot dip galvanizing shall conform to SSRN 903.

6 HANDRAIL

Hand railing shall be designed and manufactured in accordance with SSRN 848. It shall consist of 38 mm diameter galvanised steel sections of tubing to SSRN 203, screwed at each end. The sections shall be joined by 38 mm diameter galvanised steel equal crosses, equal tees or short radius 900 bends where appropriate, such that the top rail shall be 1 metre and the lower rail 0.5 metre above the concrete slab, and the spacing between standards shall be 2 metres maximum. A 38 mm diameter galvanised steel flange shall be screwed to the base of each standard and drilled for four 20 mm diameter, 100 mm long mild steel rag bolts which shall be welded on platform.

All hand railing components shall be galvanised after cutting, screwing and drilling and shall be supplied complete with all bolts, nuts, washers and other fixings necessary to complete the installation

7 CHEQUERED PLATE FLOORING

Chequered plate flooring shall be of mild steel and manufactured with diamond chequering or other non-slip pattern. The plates shall be of sufficient thickness not to bend or spring in ordinary usage and shall be fitted evenly and truly into steel angle frames or curbing with suitable attachments for building into concrete flooring.

8 CHEMICAL WATERPROOFING OF CONCRETE

Should it become necessary or if indicated in the Bills of Quantities or directed by the Engineer, the Contractor shall apply a concrete waterproofing chemical to concrete surfaces. For surfaces in contact with potable water, such a chemical shall have been certified as suitable for use in potable water retaining structures by competent and internationally recognised authorities.

Products acceptable include waterproofing chemicals consisting of rapid hardening Portland cement, oven-dried quartz sand and active inorganic chemicals of a type that upon application to a concrete surface a crystal chain reaction starts as the active chemical ingredients react with the free lime and water in the concrete capillaries resulting in the formation of insoluble crystals which drive out the surplus capillary water ensuring a permanently water tight concrete but which however at the same time allow the concrete to breath.

9 NEW PRESSED STEEL RESERVOIRS

Construction and Fittings

Pressed steel reservoirs shall be constructed of pressed galvanised mild steel panels and in accordance with SSRN 909. They shall be externally flanged. The tanks shall be complete with all necessary stays, cleats, bolts, nuts, washers and jointing compound. Pipework and pipe connections shall be provided as shown on the Drawings.

Tanks that have a Central Division wall shall have this of similar construction to the external walls of the tanks and shall effectively divide the tank into two separate reservoirs which can be used independently.

For roof covers, weatherproof covers shall be provided. These shall be complete with all stiffeners, and supports, with pressed steel gable fillers where necessary, and with all necessary stays, cleats, bolts, nuts, washers and jointing compound. The connection between roof and walls shall be weatherproof.

Each tank, (or compartment in the case of tanks with Central Division walls) shall be equipped with an access manhole, 2 fresh air ventilators, internal and external access ladders, peripheral platform, a float indicator, a valve box with access manhole, and a float valve.

Galvanizing

For new panels galvanising shall be carried out at the manufacturer's works and shall be in general conformity with SSRN 903. Re-usable existing panels shall be re-galvanised at an approved nominated subcontractor's works. Periodical inspection by the Engineer will be undertaken to confirm that the procedure followed for re-galvanising and the final quality of re-galvanised panels is satisfactory. Where painting is required, refer to Clause 14.

Fittings

a) Access Manholes

Each tank or compartment shall have one access manhole to permit inspection of the tank internally. In addition, one manhole may be located on top of the valve box in order to permit inspection of the ball valve without entering the reservoir. Manholes shall be of appropriate size and/or the same size as existing ones (for refurbished tanks) and shall be equipped with a hinged lid, which shall be provided with a means of locking into position (with a padlock) on a thick gasket of felt or bitumen.

b) Access Ladders

Internal and external access ladders shall be mild steel galvanised and shall be provided adjacent to access manholes. External ladders shall be fitted with a safety cage and intermediate landing platform.

Ladders shall be designed and manufactured in accordance with SSRN 847. They shall be of mild steel with 25 mm solid rungs at 250 mm centres. The stringers shall be 65 mm x 20 mm, 400 mm apart, turned over at top and bottom and drilled for 12 mm dia rag bolts. Stays shall be 75 mm x 10 mm, length to suit, bent to shape and drilled for 12 mm dia rag bolts, and shall be of such length that will give a minimum clearance of 200 mm behind the rungs. Finish to ladders and stays shall be galvanised to SSRN 903 unless otherwise directed by the Engineer or shown on the Drawings.

c) Fresh Air Ventilators

Two fresh air ventilators shall be fixed to the roof of each compartment. They shall be cowled to prevent rain from entering and fully mosquito-proofed with fine meshed gauze all fixed to the satisfaction of the Engineer.

d) Float Level Indicator

Float level indicators shall be attached to the side of each compartment with vitreous enamelled scales graduated at intervals of 0.5 metres and clearly marked in indelible paint. Pointer and float shall be connected by a steel cable. Guides for the cable shall be provided to prevent snagging or fouling of cable travel.

e) Valve box

Valve boxes shall be provided to maximise the capacity of the reservoirs where float valves are to be fitted.

Testing, Sterilising and Flushing

a) Testing

After refurbishment and/or erection and before testing the Contractor shall ensure that the tank is cleaned internally and ensure that no foreign matter is present. Where applicable each compartment shall be tested by being filled with clean cold water and left for twenty four hours. Throughout the test period there shall be no visible leakage and no measurable drop in water level in the compartment. In the case of reservoirs with central division walls each compartment shall be tested separately and not concurrently.

b) Sterilising

Tanks shall be sterilised by filling them with potable water containing 50 mg/l of chlorine and permitting them to stand 4 hours when full. Thereafter the residual chlorine shall be measured. If no residual is found the process must be repeated. Chlorine shall be added to the test water in a manner approved by the Engineer.

c) Flushing

None of the water used for testing or sterilizing shall be released for consumption but all shall be discarded via the scour to drain. Tanks and pipes shall be thoroughly flushed with potable water after sterilization.

Supporting Steel Structures

Elevated reservoirs shall be supported on structural steel towers of height as indicated on the relevant drawing or in the Bills of Quantities. These towers shall be designed by the Nominated Sub-contractor and approved by the Engineer prior to fabrication. They shall be designed in accordance with SSRN 863. The design shall cater for all vertical and horizontal loads including those imposed by wind forces and seismic disturbances.

The towers shall be provided with all necessary beams, adequate cross bracing, bolts, cleats, base plates and holding down bolts. The tower shall be provided with an adequate valve operating platform one metre wide. These platforms shall be of open steel flooring with 20 mm diameter tubular handrails and angle iron handrail stands, and shall be provided with toe-boards.

The Nominated Sub-contractor shall provide two sets of properly dimensioned working drawings showing sizes of all principle tower members and maximum and minimum stanchion loads together with two sets of supporting detailed calculations for approval by the Engineer before fabrication. All damage to paintwork during the course of erection shall be repaired. The final painting of the tower etc. shall comprise two coats of suitable primer and two coats of a thixotropic, aluminium pigmented, bitumen based barrier coating paint.

Foundations

Concrete pad foundations for the towers shall be designed by the Nominated Sub-contractor and approved by the Engineer prior to erection. The nominated Sub-contractor shall provide, for approval, two sets of properly detailed calculations supporting the designs. These drawings shall also show details and position of holding down bolts.

Lightning Protection

Where present lightning protection is found inadequate or obsolete, the water tower structures are to be re-earthed so that the maximum resistance to earth is 10 ohms. At a position at the base of the tower a test clamp shall be fitted and from this test clamp a copper strip 25 mm x 3.2 mm shall be installed to the earth rod. The earth rod shall consist of a 12 mm dia. hard drawn copper rod approx. 2.5 metres long. The head of the earth rod shall be located in a concrete inspection pit, complete with cover.

Pipes and Pipework Fittings

Where required by the Engineer or shown on Drawings each tank or each compartment shall be fitted with inlet, outlet, overflow and scour pipework.

All overflow pipes shall be mosquito proofed with fine meshed gauge fitted covering the pipe opening inside the reservoir, fixed with galvanised wire tightly bound or otherwise to the satisfaction of the Engineer.

All pipes and fittings shall be flanged ductile iron or steel and shall comply with the specification for pipes and fittings contained elsewhere in this specification. Suitably designed pipework supports shall be provided in order to minimise pipeline stresses. After erection all pipework shall be painted externally with two coats of a suitable primer and two coats of a thixotropic aluminium based barrier coating paint.

10 GEOMEMBRANE LINING TO WATER RESERVOIRS

If indicated in the bills of quantities, any geomembrane lining shall be suitable for potable water, and comprise an ultra - violet light resistant high density polyethylene (HDPE) to SSRN 307, suitable for on site fusion/extrusion welding. It shall be provided in seam free rolls of at least 7 m width, and of thickness not less than 500 micrometres, and breaking strength not less than 180 N/25 mm. When used to line compacted earth or sand, it shall be underlain by an appropriate geotextile layer. It shall be provided rolled on hollow cores of diameter not less than 150 cm, and each roll shall be provided with slings to assist handling on site. The length of rolls shall be such that only longitudinal welds between rolls are required. In situ jointing shall be undertaken by a person or persons well experienced in the technique and approved by the manufacturer. The Contractor will have specified both the proposed manufacturer, and provided full details of laying and jointing techniques, complete with examples of previous similar usage in a tropical environment. The material manufacturer shall have a locally based agent of technically proven capability.

11 FLOATING COVERS TO WATER RESERVOIRS

Any cover shall be of chlorosulphonated polyethylene, or other similar and approved geomembrane, mechanically fixed at the edges, and provided with floats. It shall be self draining under gravity and capable of being suspended on pre - positioned stainless steel wire ropes allowing access when empty for inspection, cleaning etc. It shall be provided to site in rolls and appropriately jointed together on site. In situ jointing shall be undertaken by a person or persons well experienced in the technique and approved by the manufacturer. The Contractor will have specified both the proposed manufacturer, and provided full details of the material, its thickness and properties and of the laying and jointing techniques, complete with examples of previous similar usage in a tropical environment. The material manufacturer shall have a locally based agent of technically proven capability.

12 PAINTING OF METALWORK

All work shall be carried out in accordance with SSRN 900, 908 and 917, as appropriate.

All paints shall be obtained from an approved manufacturer, and applied strictly in accordance with the manufacturer's instructions. The source of supply shall not be altered without the Engineer's approval. The colour of the paints used shall be to the Engineer's approval and where possible alternate coats shall be of different shades.

Where blast cleaning is specified prior to painting, the cleaned surfaces shall conform to First Quality finish to SSRN 933.

All preparation and painting shall be carried out under dry conditions and on completely clean and dry surfaces.

All preparation and painting at manufacturer's works shall be carried out under cover at a controlled ambient temperature in the range 15 to 21 degrees C. Site painting shall not proceed when the ambient temperature falls below 10 degrees C.

Where surfaces are joined during fabrication, they shall be brought together while the final protective coat is still wet.

After welding and fabrication, all weld areas shall be thoroughly cleaned and touched up as specified with the appropriate priming system.

Coatings and paints used for all structures, including tanks, pipes, valves, flow meters, fittings etc., which are in contact with potable water shall be non-toxic, and shall not foster microbiological growth or give rise to taste, odour, turbidity or discoloration of the water with which they are, or could be in contact.

The Engineer reserves the right to inspect all work prior to painting, and reasonable access shall be given for such inspection at any stage of the work.

13 SITE PAINTING

Equipment or plant that has to be refurbished on site shall be manually cleaned to the in compliance with SSRN 900, 908 and/or 917 as appropriate.

The protective system shall then, where possible conform to the requirements of Section 2.3 hereof. Any deviation shall be indicated in the appropriate schedule of Part 4.

14 TYPES OF PAINT PROTECTION

TYPE A (Hot Dip Galvanized)

- (a) Blast clean to first quality finish to SSRN 933.
- (b) Hot-dip galvanized to give a minimum coating weight of 610 g/m² in accordance with SSRN 903.

Finish dry film thickness shall both be less than 85 microns for metals in interiors of buildings and normally dry condition, and 140 microns for other conditions.

NOTE:

All fastenings including bolts, for use with materials having a Type A finish shall be sterilized in accordance with SSRN 934.

TYPE B (Zinc Rich 2-Pack Epoxy Primer And Heavy Duty Epoxy Coal Tar)

- (a) Blast clean to First Quality finish to SSRN 933.
- (b) Within 2 hours of blast cleaning apply by airless spray one coat of 2-pack zinc rich epoxy primer, to a finished dry film thickness of not less than 50 microns.
- (c) Apply by airless spray one coat of 2-pack zinc epoxy primer as in (b) above to a finished thickness of not less than 100 microns.
- (d) Apply by airless spray two coats of high build epoxy coal tar, to a final finished dry film thickness of not less than 350 microns.

TYPE C

As type B above but with sufficient number of coats in (d) to give a final finished dry film thickness of not less than 450 microns.

TYPE D (2-Pack Zinc Rich Epoxy Paint)

- (a) Blast clean to First Quality finish to SSRN 933.
- (b) Within 2 hours of blast cleaning apply by airless spray one coat of 2-pack zinc rich epoxy primer all as in Type B part (b) above.
- (c) Apply two coats of 2-pack zinc rich epoxy high build matt finish dry film thickness of not less than 300 microns.
- (d) Apply final coat of 2-pack epoxy gloss finish of approved shade to produce a total finished minimum dry film thickness of 350 microns.

Application shall be by airless spray and a minimum of 16 hours shall be allowed between coats.

TYPE E (Epoxy Paint)

- (a) Blast clean to First Quality finish to SSRN 933.
- (b) Within 2 hours of blast cleaning, apply by airless spray one coat of high build 2-pack cold cure epoxy resin primer to give a finished dry film thickness of 125 microns.
- (c) After a period of not less than 8 hours from the first coat ('b' above), a finish coat of high build pure epoxy shall be applied by airless spray to give a total dry film thickness of not less than 350 microns.

TYPE F (Epoxy Primer And Chlorinated Rubber Paint)

- (a) Blast clean to First Quality finish to SSRN 933.
- (b) Within 2 hours of blast cleaning, apply by airless spray one coat of 2-pack zinc rich epoxy primer to give a finished dry film thickness of 50 microns.
- (c) Apply 2 coats of 2-pack zinc epoxy high build to a matt finished dry film thickness of 300 microns.
- (d) Apply one coat of chlorinated rubber paint of approved shade to a gloss finished dry film total thickness of not less than 350 microns.

TYPE G (Chlorinated Rubber Paint) - Brush Application

- (a) Blast clean to First Quality finish to SSRN 933.
- (b) Apply 2 coats of chlorinated rubber paint primer to give a finished dry film thickness of 100 microns.
- (c) Apply 2 coats of chlorinated rubber based high build undercoat to give a finished dry film thickness of 220 microns.
- (d) Apply 2 coats of chlorinated rubber base gloss finish of approved shade to give a total dry film thickness of 280 microns.

TYPE H (Chlorinated Rubber Paint) - Airless Spray Application

- (a) Blast clean to First Quality finish to SSRN 933.
- (b) Apply 2 coats of chlorinated rubber based high build primer to give a finished film thickness of 150 microns.
- (c) Apply 2 coats of chlorinated rubber based high build semi-gloss finish of approved shade to give a total dry film thickness of 300 microns.

TYPE J (Lead Primer And Epoxy Paint)

- (a) Blast clean First Quality finish to SSRN 933.
- (b) Within 2 hours of blast cleaning apply one coat of 2-pack epoxy metallic lead primer to give a finished dry film thickness of 50 microns.
- (c) Apply 2 coats of 2-pack epoxy micaceous iron oxide undercoat to give a total dry film thickness of 150 microns.
- (d) Apply one coat of 2-pack epoxy gloss finish of approved shade to give a total dry film thickness of not less than 180 microns.

TYPE K (Lead Primer And Epoxy Paint For Galvanized Metal)

- (a) Thoroughly clean and degrease.
- (b) Apply one coat of 2-pack epoxy metallic lead primer to give a finished dry film thickness of 50 microns.

- (c) Apply one coat of 2-pack epoxy micaceous iron ore undercoat to give a finished dry film thickness of 120 microns.
- (d) Apply one coat of 2-pack epoxy gloss finish of approved shade to give a total dry film thickness of not less than 155 microns.

TYPE L (Bitumen Coating)

- (a) Blast clean to First Quality finish to SSRN 933 or pickle in hot dilute sulphuric acid.
- (b) After thorough washing, phosphate coating by immersion in a bath of hot dilute phosphoric acid.
- (c) Application of one coat of primer to SSRN 908.
- (d) Hot dip bitumen/bitumen coating applied to give a smooth lining having a minimum dry film thickness of not less than 300 microns.

TYPE M (Electro-zinc Plated And Stove Enamelled)

- (a) Blast clean to First Quality finish to SSRN 933 or pickling in hot dilute sulphuric acid.
- (b) After thorough washing, phosphate coating by immersion in a bath of hot dilute phosphoric acid.
- (c) Electro zinc plated.
- (d) Apply stoved zinc based epoxy primer (incorporating suitable pigments to act as acid scavengers and counteract the formation of adhesion destroying compounds).
- (e) Finishing coat(s) of stoved alkyd enamel to give a high standard of gloss finish of approved shade, and of not less than 150 microns dry film thickness.

TYPE N (Clean And Degrease)

Thoroughly clean using hand, and/or power tools where available, to remove all mill scale, rust and grease.

TYPE P (Lead Primer)

- (a) Blast clean to First Quality finish to SSRN 933.
- (b) Within 2 hours of blast cleaning apply by brush two coats of metallic lead primer to a finished thickness of not less than 100 microns.

TYPE Q (Bitumen Enamel Or Coal Tar Enamel Wrappings)

Apply bitumen enamel wrapping or coal tar enamel wrapping in accordance with SSRN 214.

TYPE R (Sealed Sprayed Aluminium Coating)

- (a) Blast clean to First Quality finish to SSRN 933.
Surface preparation shall be in accordance with to SSRN 900.
- (b) Apply suitable primer.
- (c) Apply sprayed - aluminium coating to give a finished dry film thickness of not less than 150 microns.
- (d) Apply suitable pre-treatment primer (e.g. Two-pack polyvinyl butyral or Two-pack polyvinyl butyral/phenolic, containing not less than 85% by weight of zinc tetroxychromate pigment).

- (e) Apply suitable sealer e.g. (Blend of vinyl chloride/acetate copolymers, or Two-pack phenolic binder or Two-pack epoxy or Two-pack polyurethane).

TYPE S (Sealed Sprayed Zinc Coating)

- (a) As in (a) type R.
 (b) As in (b) type R.
 (c) As in (c) type R but using sprayed zinc coating to give a finished dry film thickness of not less than 175 microns.
 (d) As in (d) type R.
 (e) Apply suitable sealer e.g. silicone resin containing not less than 95% by weight of aluminium pigment.

TYPE T (Decorative Painting)

Decorative paint (when specified) shall be compatible with the final finish paint or coating.

The final shade shall be as recommended by the Engineer.

The film thickness of decorative paint shall not be included in the total dry film thickness specified.

15 PAINTING SYSTEMS FOR METALWORK

The applications shall be to the approval of the Engineer but generally in accordance with the schedule below.

Item	Application	Type
1.	All steel ladders, staircases, guardrails, guardrail stands, safety cages, open steel flooring, small bore pipework and steel conduit. All small metalwork such as pipe supports, steel flooring supports and safety chains.	A
2.	All steelwork, castings and other metal surfaces which are immersed in water (non-potable water), sewage, and other effluents, or in contact with liquid or subject to splashing, or buried in the ground.	C
3.	All steel, ductile and cast iron pipes, valves, flow meters and fittings 75 mm diameter and larger, used for the conveyance of sewage and other effluents as in 2 above.	B
4.	All steelwork, castings, pipes, valves flow meters and other surfaces which are exposed (exterior) and frequently damp or wet.	B
5.	As 4 above but in interior of building and normally dry.	D or F
6.	All steel pipes laid underground.	Q
7.	All valves, penstocks, flow meters, tanks and fittings which are in contact with potable water.	E, F or H
8.	Potable water pumping plant installed inside pumping station-normally dry condition.	
	(a) <u>Suction and delivery pipes</u> Internal protection External protection	L E, F or H
	(b) <u>Valves</u> Internal protection External protection	E or L E, F or H

Item	Application	Type
	(c) <u>Pumping Casing</u> Internal protection External protection	E or L E,F or H
	(d) <u>Flow meter (body)</u> Internal protection External protection	E,F or L E,F or H
	(e) <u>Extension shaft and couplings</u>	E,F or H
	(f) <u>Pump motor casing and support steelwork</u>	E, F or H
9.	Screw pumps (screws and shafts) used for potable water.	E or H
10.	Filter internals (potable water)	A
11.	Over painting of galvanized items (not in contact with potable water)	J
12.	Switchboard, multi-motor control panels and other similar enclosures.	M
13.	Metal cable trays, conduits and fixings	A
14.	Section of pipe to be built into concrete.	N
15.	All steelwork and castings in contact with potable water	A, D, E, F or H

16 REPAIR OF DAMAGED PAINTWORK COATINGS

Any damage to the protective coating shall be made good as soon as possible, and shall not be left until the time of general finish painting. Damaged areas shall be cleaned down to bright metal by power wire brushing or sanding and feathered off to the surrounding area. A new protective system approved by the Engineer shall then be applied generally following the requirements of the system originally applied, modified if necessary to comply with the recommendations of the manufacturer of the protective materials used.

17 METALWORK SURFACE PREPARATION PRIOR TO PAINTING

Surface preparation shall conform generally to SSRN 900, 903 or 917 as appropriate, together with any additional preparation recommended by the paint manufacturer, and/or approved by the Engineer.

Prior to painting, protective coatings shall be thoroughly cleaned, degreased, and washed with clean water.

Where steelwork has been delivered with zinc rich epoxy primer and has been allowed to weather, the primed surface shall be washed with clean water to remove zinc salts and allowed to dry.

18 SITE PAINTING DURING ERECTION OF METALWORK

Site connections shall be given a second coat and be brought together wet. Where the finishing paint has been subject to damage during transit or erection, the areas affected shall be cleaned, repaired, and re-painted generally following the requirements of the system originally applied.

19 PAINTING OF STEEL TANKS AND TOWER SUPPORTS

(a) General

This clause shall be read in conjunction with the following sub-clauses described above, Cl. 14 "Painting of Metalwork", Cl. 617 "Repair of damaged paintwork coatings", Cl. 618 "Metalwork surface preparation prior to painting", Cl. 619 "Site painting during erection of metalwork"

(b) Painting internal tank surfaces with bitumen based paints

Internal surfaces of panel tanks shall be prepared by power brushing to remove all rust, scales and loose paint to the approval of the Engineer. Sand blasting shall not be allowed for tank panel unless if directed otherwise by the Engineer. On the prepared surface 2 coats of a bitumen based paint such as a single component, liquid coating, based on a blend of bitumen and solvents e.g. "Igol A" or a thixotropic high build fast drying bituminous coating e.g. "Intex No. 1", shall be applied in strict accordance with the manufacturer's specifications.

(c) Painting surfaces with epoxy paints

The surfaces shall be prepared as indicated in the Bill of Quantities. For steel hand rails, walkways, stairs and steel sections, this shall involve mechanical brushing. Sand blasting shall not be allowed for tank panels unless if directed otherwise by the Engineer. On the prepared surface 2 coats of an epoxy paint (a 2-component, solvent-free coating material based on epoxy resins) e.g. "Sikaguard 63", shall be applied according to the manufacturer's instructions.

(d) Painting of steel tower frames with aluminium paint

Removal of soil deposits at the base of tower shall be done prior to cleaning entire surfaces including corners and edges, ladder, platforms etc. by wirebrushing mechanically to the satisfaction of the Engineer. Alternatively surfaces may be prepared by blast cleaning to remove all rust and loose paint. Cleaned surfaces shall be painted with 2 coats of a suitable primer such as red oxide primer followed by 2 coats of an approved bituminous aluminium paint according to the manufacturer's instructions.

(e) Painting surfaces with oil-based gloss paint

Surfaces shall be cleaned by mechanical wire-brushing. Where surfaces are buried the material should be excavated and the surface cleaned using water and brush and after the surface is dry it shall be cleaned of all rust and loose paint by power-brushing. Cleaned surfaces shall then be painted with 2 coats of a suitable primer such as red oxide followed by 2 coats of an approved oil based gloss paint. The final shade shall be as recommended by the Engineer.

20 INSULATION OF DISSIMILAR METALS

Where dissimilar metals are likely to be in contact with each other a suitable insulating barrier shall be incorporated to prevent galvanic action occurring. This shall be to the approval of the Engineer.

21 EXPANDING RAWL BOLTS

These Bolts shall be expanding type and be made of stainless steel. Drilled or punched holes shall not be greater than 1.5 mm more than the bolt diameter and the depth shall be sized to suit the length of the bolt. The holes shall be cleaned of any loose material and rough edges before the bolts are fitted. Washers shall be at least 2.5 x the bolt diameter. Washers should be fitted under each bolt head.

CONCRETE WORKS

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CONCRETE WORKS

1 GENERAL

(a) Code of practice

All workmanship, materials, tests and performances in connection with the reinforced concrete work are to be in conformity with the latest edition of British Standard Code of Practice (B.S. 8110 for "Structural Use of Concrete") where not inconsistent with these specifications.

(b) Contractor's plant

Not less than 30 days prior to the installation of the Contractor's plant and equipment for processing, handling, transporting, storing and proportioning ingredients, and for mixing, transporting and placing concrete, the Contractor shall submit drawings for approval by the Client Engineer, showing proposed general plant arrangements, together with a general description of the equipment he proposes to use.

After completion of installation, the operation of the plant and equipment shall be subject to the approval of the Client Engineer.

2 MATERIALS

Cement

Cement, unless otherwise specified, shall be Portland cement of the Blue Triangle brand, or Bamburi Portland Cement brand, Mombasa cement brand or any other brand which comply with the requirements of B.S.12 and is approved by the Client Engineer. The cement shall not contain reactive volcanic ash (of not more than 10% of total weight) and the quantity of insoluble residue permitted in B.S. 12 may be exceeded. A manufacturer's Certificate of Test in accordance with B.S. shall be supplied for each consignment delivered to site.

Should the Contractor require using cement of the rapid hardening variety, he shall obtain the approval of the Client Engineer and also obtain any instructions regarding the modifications to the preambles caused thereby. Any additional cost that may be caused by the use of the rapid hardening cement shall be at the Contractor's expense.

Cement may be delivered to site either in bags or in bulk. If delivered in bags, each bag shall be properly sealed and marked with the manufacturer's name and on the site is to be stored in a weather-proof shed of adequate dimensions with a raised floor. Each consignment shall be kept separate and marked so that it may be used in the sequence in which it was received. Any bag found to contain cement which has set or partly set shall be completely discarded and not used in the Works. Bags shall not be stored more than 1500 mm in height.

If delivered in bulk the cement shall be stored in a weather-proof silo either provided by the cement supplier or by the Contractor, but in either case the silo shall be to the approval of the Engineer.

Aggregates

The aggregates shall conform to the requirements of B.S. 882 and the sources and all types of all aggregates are to be approved in all respects by the Client

Engineer before work commences.

The grading of aggregates shall be one within the limits set out in B.S. 882 and as later specified and the grading, once approved, shall be adhered to throughout the Works and not varied without the approval of the Client Engineer. Fine aggregate shall be clean, coarse, siliceous sand of good, sharp, hard quality and shall be free from lumps of stone, earth, loam, dust, salt, organic matter and any other deleterious substances. It shall be graded within the limits set out in zone 1 or 2 of B.S. 882.

Coarse aggregate shall be good, hard, clean approved black trap or similar stone, free from dust, decomposed stone, clay, earthy matter, foreign substances or friable thin elongated or laminated pieces. It shall be graded within the limits of Table 1 of B.S. 882 for its respective nominal size.

If in the opinion of the Client Engineer the aggregate meets the above requirements, but is dirty or adulterated in any manner it shall be screened and/or washed with clean water if he so directs at the Contractor's expense.

Aggregates shall be delivered to the site in their prescribed sizes or grading and shall be stockpiled on paved areas or boarded platforms in separate units to avoid intermixing.

Fine aggregate

Fine aggregate shall be sand free from impurities and complying with British Standard No. 882. Grading zone 2 of Table 2.

Coarse aggregate

Coarse aggregate shall be hard crushed rock free from impurities and complying with British Standard No. 882 "graded aggregate" 20 mm to 5 mm nominal size as Table 1.

Water

Water for concrete shall be free from impurities, complying with BS 3148

Hardcore

Hardcore for filling under floors shall be good, hard stone ballast or quarry waste, to the approval of the Client Engineer, broken to pass through not greater than a 150 mm ring or to be 75% of the finished thickness of the layers being compacted, whichever is the lesser. Hardcore shall be free from all weeds, roots, vegetable soil, clay, black cotton soil or other unstable materials.

It shall be graded with smaller stones and fine materials to give a dense compact mass after consolidation. Sufficient fine material shall be added to each layer to give gradation of material as necessary to obtain a solid compact mass after rolling. Hardcore filling is to be laid in layers each of a consolidated thickness not exceeding 250 mm. Each layer shall be compacted by at least 8 passes of a 10-tonne smooth-wheeled roller or a 2-tonne vibrating roller until all movement ceases. Sufficient water is to be added to obtain maximum compaction to the Client Engineer's approval. To each layer a 25 mm thick layer of sand complying with the specification of fine aggregate for concrete shall be spread over the surface and forced into the hardcore by the use of a vibrating roller weighing not

less than 2 tones. This operation should be carried out when the materials are dry and repeated whilst the sand is well watered. Should all the sand be absorbed the Client Engineer may require a further layer to be applied and the process repeated.

The top surface of the hardcore shall be levelled or graded to fall as required, and shall then be blinded with a layer of similar material broken to 25 mm gauge and finished with a 10-tonne smooth-wheeled roller. The surface so obtained shall be to the Engineer's approval.

Compacted hardcore

The sub-grade shall be compacted by a smooth-wheeled roller of 8 to 10 tonnes weight or the vibrating roller of minimum 1300 Kg., or other approved plant. The number of coverage shall be at least 10 and there shall be a 50% overlap of successive coverage. If so instructed by the Engineer, water shall be added during compaction to obtain optimum water content. Filling shall be compacted as above but in maximum 200 mm deep layers.

Sand

The sand shall be as described for fine aggregate but that for plastering shall be light in colour and well graded to a suitable fineness in accordance with the nature of work in order to obtain the finish directed.

3 FINISHES

General

The Contractor will be required from an early stage in the contract to prepare samples, for the approval of the Client Engineer, of the various concrete finishes specified hereafter. Samples are to be prepared using the same materials and the same methods of construction, compaction, curing, etc. as the Contractor proposes to use for executing the full quantity of the work. A record of the mix, water content, method of compaction, any additives used, etc., is to be kept for each sample prepared. When the Client Engineer has approved a sample it will be kept on site in an approved location. The finishes in construction will be expected to be up to a standard equal to the approved sample. Consistency in cement colour, and the colour, grading and quality of aggregates must be maintained in all finished concrete work.

Mortars

Cement mortar shall consist of one part of Portland cement to three parts sand by volume. The cement/lime mortar shall consist of one part of Portland cement, one part of lime and six parts of sand by volume.

The ingredients of mortar shall be measured in proper gauge boxes on a boarded platform, the ingredients being thoroughly mixed dry, and again whilst adding water. In the case of cement/lime mortar, sand and lime shall be mixed first and then the cement added.

All mortar is to be thoroughly mixed to a uniform consistency with only sufficient water to obtain a plastic condition suitable for towelling. No mortar that has commenced to set is to be used or re-mixed for use.

Tamped finish

Areas so specified shall be finished at the time of casting with a tamped finish to the Engineer's approval produced by an edge board. Board marks are to be made to a true pattern and will generally be at right angles to the traffic flow. Haphazard or diagonal tamping will not be accepted.

Fair face

Fair face surfaces shall be clean, smooth, even, true to form, line and level, and free from all board marks, joint marks, and honey combing, pitting, and other blemishes. Forms are to be provided with a smooth lining of plywood, steel, or other approved material which will achieve the required finish without any general rubbing down. Rubbing down will only be permitted to remove any projecting fins at corners or joints.

Fine face

Fine face surfaces shall be for Fair face above, but to a higher standard obtained from forms provided with an impervious sheet lining of metal or plastics faced plywood in large panels arranged in an approved pattern. Rubbing down shall only be permitted after an inspection by the Client Engineer. The finished surfaces shall be capable of receiving a painted finish.

Chisel-dressed finish

Chisel-dressed finish is to be carried out on any grade of concrete but not until it is at least 30 days old. The surfaces are to be fully chisel-dressed to remove a maximum of 12 mm (average 9 mm) of the surface by shearing and exposing the aggregate without excessive cracking of the surrounding matrix. Arises of columns, beams, etc., are pre-formed fair face with timber fillets set in the formwork and care must be taken in working up to these to preserve a clean line.

For vertical surfaces of walls and columns particular care must be taken to remove all sharp projections. For beam soffits this requirement is not necessary. All surfaces requiring this treatment are to have margins chisel-dressed by hand for a minimum width of 75 mm commencing from the fillet edge. Thereafter, mechanical chisel-dressing may be used, but the Contractor must ensure that a uniform texture and even plane surface is achieved. The use of sharply pointed steel tools for both hand and mechanical chisel-dressing is essential. Upon completion the surfaces are to be thoroughly wire brushed and washed down.

Protection of finishes

Wherever possible, in-situ exposed concrete finishes should be commenced at the highest level and worked progressively down the building. Precaution shall be taken to avoid staining or discoloration of previously finished concrete faces by leakage of grout from newly placed concrete. The Contractor shall, during all stages of construction, adequately protect all concrete finishes from Damage by leaking grout, knocking, paint stains, falling plaster, etc. In cases of balustrade walls to staircases and members where Damage is otherwise likely, concrete finishes shall be protected by cladding with timber, Celotex, or other approved sheeting. All Sub-contractors shall be informed accordingly on the precautions to be taken.

4 BLINDING

All blinding concrete to be 1:3:6, or as otherwise instructed by the Client Engineer in writing.

5 FORMWORK

The method and system of formwork which the Contractor proposes to use shall be approved of by the Client Engineer before construction commences. Formwork shall be substantially and rigidly constructed of timber or steel or pre-cast concrete or other approved material.

All timber for formwork shall be good, sound, clean, sawn, well-seasoned timber, free from warps and loose knots and of scantings sufficiently strong for their purpose.

Construction of formwork

All formwork shall be of sufficient thickness and with joints close enough to prevent undue leakage of liquid from the concrete and fixed to proper alignment, level and plumb and supported on sufficiently strong bearers, shores, braces, plates etc. properly held together by bolts or other fastenings to prevent displacement, vibration or movement by the weight of materials, men and plant on same and so wedged and clamped as to permit easing and removal of the formwork without jarring the concrete. Where formwork is supported on previously constructed portions of the reinforced concrete structural frame, the Contractor shall by consultation with the Client Engineer ensure that the supporting concrete is capable of carrying the load and/or sufficiently propped from lower floors or portions of the frame to permit the load to be temporarily carried during construction.

Soffits shall be erected with an upward camber of 5 mm for each 5 meters of horizontal span or as directed by the Client Engineer.

Great care shall be taken to make and maintain all joints in the formwork as tight as possible, to prevent the leakage of grout during vibration. All faulty joints shall be caulked to the Client Engineer's approval before concreting. The formwork shall be sufficiently rigid to ensure that no distortion or bulging occurs under the effects of vibration. If at any time the formwork is insufficiently rigid or in any way defective the Contractor shall strengthen or improve such formwork as the Client Engineer may direct.

The Contractor's attention is drawn to the various surface textures and applied finishes required and the faces of formwork next to the concrete must be of such material and construction and be sufficiently true to provide a concrete surface which will in each particular case permit the specified surface treatment or applied finish.

All surfaces which will be in contact with concrete shall be oiled or greased to prevent adhesion of mortar. Oil or grease shall be of a non-staining mineral type applied as a thin film before the reinforcement is placed. Surplus moisture shall be removed from the forms prior to placing of the concrete.

Temporary openings shall be provided at the base of columns, wall and beam forms and at any other points where necessary to facilitate cleaning and

inspection immediately before the pouring of concrete. Before the concrete is placed the shuttering shall be trued-up and any water accumulated therein shall be removed. All sawdust, nails, chips and other debris shall be washed out or otherwise removed from within the formwork. The reinforcement shall then be inspected for accuracy of fixing. Immediately before placing the concrete the formwork shall be well wetted and inspection openings shall be closed. The erection, easing, striking and removing of all formwork must be done under the personal supervision of a competent foreman, and any Damage occurring through faulty formwork or its incorrect removal shall be made good by the Contractor at his own expense.

After removal of formwork, all projections, fins etc., on the concrete surface shall be chipped off, and made good to the requirements of the Client Engineer. Any voids or honeycombing shall be treated as described in "Faulty Concrete".

Stripping formwork

All formwork shall be removed without undue vibration or shock and without Damage to the concrete. No formwork shall be removed without the prior consent of the Engineer and the minimum periods that shall elapse between the placing of the concrete and the striking of the formwork will be as follows:

Beam sides, wall and columns	2 days
Slab Soffits (props left under)	3 days
Beam Soffits	7 days
Removal of props (partly subject to 7 days Concrete cube strength being satisfactory) to:	

Slabs	10 days
Beams	14 days
Cantilevered Beams and Slabs	28 days

If the Contractor wishes to take advantage of the shorter stripping times permitted for beams and slab soffits when props are left in place, he must so design his formwork that sufficient props are agreed with the Client Engineer can remain in their original positions without being moved in any way until the expiry of the minimum time for removal of props. Stripping and re-propping will not be permitted.

The above times may be reduced in certain circumstances, at the discretion of the Engineer provided an approved method is adopted at the Contractor's expense to ensure that the required concrete strength is attained before the forms are stripped.

Solid strips in composite slabs shall be considered as beams. The tops of retaining walls shall be adequately supported with stout raking props at intervals required by the Engineer. These props are not to be removed until 7 days after casting of the floor slab is over.

Supporting props to wall and beam soffits

When directed by the Client Engineer, supporting props to wall and beam soffits are to be left in position until the completion of the whole of the reinforced concrete structure. The props are to be to the approval of the Engineer and the Contractor must submit the suggested method of propping to the Engineer prior to removal of formwork to the relevant surfaces.

6 CONCRETE MIXES

Concrete to be used shall be of the classes specified in "Ministry of Works standard Specification" Section 17.

Class	Nominal mix	Trial Strength in N/mm ²		Where used in this Contract
		7 day	28 day	
15	1:3:6	13	19.5	Surround to pipes
25	1:2:4	25	32.5	Spillway lining, walls

Concrete mixing and placing

The concrete shall be mixed only in approved power-driven mixers of a type and capacity suitable for the work, and in any event not smaller than 0.04/0.28 cubic meter capacity. The mixer shall be equipped with an accurate water measuring device. All materials shall be thoroughly mixed dry before water is added and the mixing of each batch shall continue for a period of not less than two minutes after the water has been added and until there is a uniform distribution of the materials and the mass is uniform in colour.

The entire contents of the mixed drum shall be discharged before recharging. The volume of mixed material shall not exceed the rated capacity of the mixer. Whenever the mixer is started, 10% extra cement shall be added to the first batch and no extra payment will be made on this account.

As a check on concrete consistency slump tests may be carried out and shall be in accordance with B.S. 1881. The Contractor shall provide the necessary apparatus and carry out such tests as are required. The slump of the concrete made with the specified water content, using dry materials, shall be determined and the water to be added under wet conditions shall be so reduced as to give approximately the same slump.

The concrete shall be mixed as near to the place where it is required as is practicable, and only as much as is required for a specified section of the work shall be mixed at one time, such sections being commenced and finished in one operation without delay. All concrete must be efficiently handled and used in the Works within twenty (20) minutes of mixing. It shall be discarded from the mixer direct either into receptacles or barrows and shall be distributed by approved means which do not cause separation or otherwise impair the quality of the concrete. Approved mechanical means of handling will be encouraged, but the use of chutes for placing concrete is subject to prior approval of the Client Engineer.

Concrete shall be placed from a height not exceeding 1,500 mm directly into its

permanent position and shall not be worked along the shutters to that position. Unless otherwise approved, concrete shall be placed in a single operation to the full thickness of slabs, beams, and similar members, and shall be placed in horizontal layers not exceeding 1,500 mm deep in the walls and similar members.

Concrete in columns may be placed to a height of 4 meters with careful placing and vibration and satisfactory results. Where the height of the column exceeds 4 meters suitable openings must be left in the shutters so that this maximum lift is not exceeded.

Concrete shall be placed continuously until completion of the part of the work between construction joints as specified hereinafter or of a part of the approved extent. At the completion of a specified or approved part a construction joint of the form and in the positions hereinafter specified shall be made. If stopping of concrete be unavoidable elsewhere, a construction joint shall be made where the work is stopped. A record of all such joints shall be made by the Contractor and a copy supplied to the Client Engineer.

Any accumulation of set concrete on the reinforcement shall be removed by wire brushing before further concrete is placed. The Contractor shall provide runways for concreting to the satisfaction of the Client Engineer. Under no circumstances will the runways be allowed to rest on the reinforcement. Care shall be taken that the concrete is not disturbed or subjected to vibrations and shocks during the setting period. Mixing machines, platforms and barrows shall be clean before commencing mixing and be cleaned on every cessation of work. Where concrete is laid on hardcore or other absorbent materials, the base shall be suitable and sufficiently wetted before the concrete is deposited.

Works cube tests

Work cubes are to be made at intervals as required by the Client Engineer in accordance with C.P. 114, and the Contractor shall provide a continuous record of the concrete work. The cubes shall be made in approved 150 mm moulds in strict accordance with the Code of Practice. Three cubes shall be made on each occasion. Each cube shall be marked with a distinguishing number (numbers) to run consecutively and the date, and a record shall be kept on site giving the following particulars:-

- a) Cube No.
- b) Date made
- c) Location in work
- d) 7-Day Test, Date, Strength
- e) 28-Day Test, Date, Strength

Cubes shall be forwarded, carriage paid, to an approved Testing Authority, in time to be tested two at 7 days and the remaining one at the discretion of the Client Engineer. No cube shall be dispatched within three days of casting. Copies of all Works Cube Tests shall be forwarded to the Client Engineer and one shall be retained on site. If the strengths required above are not attained and maintained during the carrying out of the contract, the Contractor will be required to increase the proportion of cement and/or substitute better aggregates so as to give

concrete which does comply with the requirements of the contract. The Contractor may be required to remove and replace at his own cost any concrete which fails to attain the required strength as ascertained by Works Cube Tests.

7 COMPACTION

At all times during which the concrete is being placed, the Contractor shall provide adequate trained and experienced labour to ensure that the concrete is compacted in the forms to the satisfaction of the Client Engineer. Concrete shall not be placed at a rate greater than will permit satisfactory compaction or to a depth greater than 400 mm before it is compacted.

During and immediately after placing, the concrete shall be thoroughly compacted by means of continuous tamping, spading, slicing and vibration. Vibration is required for all concrete of classes 40, 35, 25, and 20. Care shall be taken to fill every part of the forms, to work the concrete under and around the reinforcement without displacing it to avoid disturbing recently placed concrete which has begun to set. Any water accumulating on the surface of newly placed concrete shall be removed and no further concrete shall be placed thereon until such water is removed.

Internal vibrators shall be of a frequency not less than 7000 cycles per minute and shall have a rotating eccentric weight of at least 0.05 Kg. with an eccentricity of not more than 12 mm. Such vibrators shall visibly affect the concrete within a radius of 250 mm from the vibrator. Internal vibrators shall not be inserted between layers of reinforcement less than one and one half times the diameter of the vibrators apart. Contact between the vibrators and reinforcement, and vibrators and formwork shall be avoided. Internal vibrators shall be inserted vertically into the concrete at not more than 500 mm centres and shall be moved constantly from place to place. No internal vibrator shall be permitted to remain in any one position for more than ten seconds and it shall be withdrawn very slowly from the concrete.

In consolidating each layer of concrete the vibrating head shall be allowed to penetrate and re-vibrate the concrete in the upper portion of the underlying layer. In the area where newly placed concrete in each layer joins previously placed concrete more than usual vibration shall be performed, the vibrator penetrating deeply at close intervals along these contacts. Layers of concrete shall not be placed until layers previously placed have been vibrated thoroughly as specified. Vibrators shall not be used to move concrete from place to place in the formwork.

At least one internal vibrator shall be of the high frequency, low amplitude type applied with the principal direction of vibration in the horizontal plane. They shall be attached directly to the forms at no more than 1200 mm centres. In addition to internal and external vibration the upper surface of suspended floor slabs shall be levelled by tamping or vibrating to receive finishes. Vibrating elements shall be of the low frequency high amplitude type operating at a speed of not less than 3000 r.p.m.

Curing and protection

Care must be taken that no concrete is allowed to become prematurely dry and the fresh concrete must be carefully protected, within two hours of placing, from rain, sun and wind by means of Hessian sacking, polythene sheeting, or other

approved means. This protective layer and the concrete itself must be kept continuously wet for at least 7 days after the concrete has been placed. The contractor will be required to provide complete coverage of all fresh concrete for a period of 7 days. Hessian or polythene sheeting shall be in the maximum widths obtainable and shall be secured against wind. The Contractor will not be permitted to use old cement bags, Hessian or other materials in small pieces.

Concrete in foundations and other underground work shall be protected from admixture with falling earth during and after placing. Traffic or loading must not be allowed on the concrete until the concrete is sufficiently matured, and in no case shall traffic or loading be of such magnitude as to cause deflection or other movement in the formwork or Damage to the concrete members. Where directed by the Client Engineer props may be required to be left in position under slabs and other members for greater periods than those specified hereafter.

Faulty concrete

Any concrete which fails to comply with these specifications, or which shows signs of setting before it is placed shall be taken out and removed from site. Where concrete is found to be defective after it has set, the concrete shall be cut out and replaced in accordance with the Client Engineer's instructions. On no account shall any faulty, honeycombed, or otherwise defective concrete be repaired or patched until the Client Engineer has made an inspection and issued instructions for the repair. The whole cost whatsoever, which might be occasioned by the need to remove faulty concrete, shall be borne by the Contractor.

Pre-cast units

Pre-cast reinforced concrete slabs to be made to sizes as shown in the Drawings. Slabs to be cast with Grade 25 concrete in approved formwork, suitably vibrated and cured for 28 days before use.

8 REINFORCEMENT

Material

Reinforcement shall be as specified by the Client Engineer.

Bending and placing reinforcement

Reinforcement shall be cleaned before placing and secured with space blocks in the correct position. It shall be bound with suitable wire and have such cover as shown on the drawings.

Strength of reinforcement

Characteristic strengths of reinforcement are as given in B.S. 4449, 4461, and 4483. Refer to 503.

Rod reinforcement

The steel reinforcement shall comply with the latest requirements of the following British Standards:-

Hot Rolled bars for the Reinforcement of concrete to B.S. 4449 (metric units)

Cold worked steel for the reinforcement of concrete to B.S. 4461 (metric units)

The Contractor will be required to submit a test certificate of the rolling. Reinforcement shall be stored on racks above ground level. All reinforcement shall be free from loose mill scale or rust, grease, paint or other substances likely to reduce the bond between the steel and the concrete.

9 BRC

The BRC should be electrically cross-welded steel wire mesh reinforcement to B.S. 4483: 1969, or as directed by the Client Engineer, and of the size and weight specified in the Drawings.

The fabric shall be free from scale, dust, rust, grease or other substance likely to reduce the bond between the steel and the concrete and shall be laid with a minimum 300 mm laps and bound with No. 18 S.W.G. annealed iron wire.

Fixing reinforcement

Reinforcement shall be accurately bent to the shapes and dimensions shown on the Drawings and in accordance with B.S. 4466 (1969). Reinforcement must be cut and bent cold and no welded joints will be permitted, unless so detailed. Reinforcement shall be accurately placed as shown on the Drawings, and before and during concreting, shall be secured against displacement by using No. 18 S.W.G. annealed binding wire or suitable clips at intersections, and shall be supported by concrete or metal supports, spacers or metal hangers to ensure the correct position. No concreting shall be commenced until the Client Engineer has inspected the reinforcement in position and until his approval has been obtained and Contractor has given two clear days' notice of intention to concrete.

The Contractor is responsible for maintaining the reinforcement in its correct position, according to the drawings, before and during concreting. During concreting, a competent steel fixer must be in attendance to adjust and correct the position of any reinforcement which may be displaced. The vibrators are not to come into contact with the reinforcement.

Position and correctness of reinforcement

Irrespective of whether any inspection and/or approval of the fixing of the reinforcement has been carried out as in C above, it shall be the Contractor's sole responsibility to ensure that the reinforcement complies with the details on the Drawings and is fixed exactly in the positions shown therein and in the positions to give the prescribed cover. The Contractor will be held entirely responsible for any failure or defect in any portion of the reinforced concrete structure and including any consequent delay, claims, third party claims. etc., where it is shown that the reinforcement has been incorrectly positioned or is incorrect in size or quantity with respect to the detailed Drawings.

Concrete cover to reinforcement

Unless otherwise directed, the concrete cover to rod reinforcement over main bars in any face shall be:-

Foundations against blinding	50 mm
Strip foundations	40 mm
Columns/Floor slab	40 mm

Beams

25 mm

Projecting reinforcement

Where reinforcement projects from a concreted section of the structure and this reinforcement is expected to remain exposed for some time, it is to be coated with a cement grout to prevent rust staining on the finished concrete. This grout is to be brushed off the reinforcement prior to the continuation of concreting.

Fixtures

No openings, chases, holes or other voids shall be formed in the concrete without the prior approval of the Client Engineer. Details of any fixtures to be permanently built into the concrete including the proposed position of all electrical conduits 25 mm and over in diameter shall be submitted to the Client Engineer for his approval before being placed.

Chases, holes, etc., in concrete

The Contractor shall be responsible for the co-ordination with the Electrical and other Sub-Contractors for incorporating electrical conduits, pipes, fixing blocks, chases and holes in concrete members as required and must ensure that adequate notice is given to such Sub-Contractors informing them when concrete members incorporating the above are to be poured. The Contractor shall submit full details of these items to the Engineer for approval before the work is put in hand. All fixing blocks, chases, holes, etc., to be left in the concrete shall be accurately set out and cast with the concrete. Unless otherwise instructed by the Client Engineer, all electrical conduit to be positioned within the reinforced concrete shall be fixed inside the steel cages of beams and columns and between the top and bottom steel layers in the slabs and similar members.

The proposed position of all electrical conduits 25 mm and over in diameter which are to be enclose in the concrete shall be shown accurately on a plan to be submitted to the Engineer, whose approval shall be obtained before any such conduit is placed.

PIPEWORKS

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PIPEWORK

THERMOPLASTIC PIPES DURING MANUFACTURE, SUPPLY, INSTALLATION, COMMISSIONING & TESTING

1 MATERIALS AND STANDARDS, UNPLASTICISED PVC PIPES AND JOINTS

PVC pipes and fittings shall be manufactured and installed in accordance to SSRN 300 and SSRN 301. Preference shall be given to PVCu pipes that are not stabilised by lead, tin or other heavy metals. However, where they are then tested in accordance with SSRN 305, and SSRN 301 (c) they must produce acceptable results.

Other related standards for pipes and joints of PVCu are given in SSRN 304 and SSRN 310,311 and SSRN 312. For laying, jointing and pressure testing they shall conform to the relevant sections of SSRN 302, and for quality control to SSRN 305 (c) and SSRN 313 (b) They shall be transported, laid, jointed and backfilled in accordance with the manufacturers written instructions except where this specification is more rigorous in which case this shall be followed.

To ensure that the Employer benefits from superior materials with enhanced useful life, at all times, latest and updated standards and procedures for design and installation shall be used and adopted but governed by cost effectiveness. In the same context the Contractor may provide, with the approval of the Engineer, superior materials using other standards not listed here provided that they do not affect costs or programme and that they can demonstrate the superiority of the materials through tests and guarantee certifications.

All PVCu joints shall be of the spigot and integral socket type whilst solvent weld joints or joints with adhesives are not permitted. Fittings for use with PVCu pipes shall be either of steel or ductile iron and shall have socketed joints, save that injection moulded plastic bends and tees will be permitted with the approval of the Engineer. Aluminium alloy fittings are not permitted.

“Bulking up” with Chalk or use of any rework material during manufacture of PVCu pipes is however strictly forbidden and the Manufacturer shall provide certification to this effect.

The Contractor shall supply pipeline materials to the pressure classes referred to on the Drawings and in the Bills of Quantities, which classes are design and NOT solely hydraulic pressure classes. In all cases minimum cover shall be 900 mm and the bedding shall be restricted to S1, save that S2 bedding may be used with the approval of the Engineer, but only if he is fully satisfied with the Contractors initial performance in regards to excavation, embedment, compaction and backfilling.

The maximum allowable deflection after laying of thermoplastic pipes shall be 2% at a joint.

Where specific design is carried out during construction, the equivalent pressure rating shall be calculated taking into consideration: the operating and test pressures, surges if applicable, external pressures, PVCu pipe strength characteristics, temperature, soil conditions, trench width, depth, appropriate traffic loads and impact fatigue.

Minimum pressure ratings and cover for PVCu pipes shall be as follows:

Nom. Diameter (mm)	Minimum Pressure Rating (bars)	Minimum Cover (m)	Pipe Bedding
≤ 125	10	0.9	S1, (or S2 if approved by the Engineer)
150 – 275	12.5	0.9	
≥ 300	To suit specific design calculations, agreed design criteria, using SSRN 267 design code of practice, and with the approval of the Engineer		
Transmission Mains and off- takes			
All pumping mains	Not Permitted		

The following subsections are related to manufacturing, handling, transportation and storage of PVCu pipes and fittings and shall be in conformance to SSRN 300, SSRN 301 and SSRN 305.

a. Manufacture of PVCu Pipes and Fittings

All the fittings to be used with PVCu pipes shall generally be of ferrous material as specified for steel and ductile iron fittings. Injection moulded PVCu bends and tees shall be allowed with prior approval of the Engineer. Steel fittings shall meet the requirements of SSRN 213 (a), (b) and (c) and SSRN 228 (a)

b. Suitability of Production Process to meet Long Term Minimum Required Stress

The Contractor shall ensure that his pipe manufacturer is capable of meeting the minimum required stress (MRS) in Long Term Hydrostatic Tests and shall have carried out such a test in the past 36 months in accordance with appropriate standards. Such tests shall also have been carried out by the manufacturer at 20 deg. C over at least 10,000 hours with 18 data points, and the minimum required stress for 50 years at 20 deg C by extrapolation shall be 25 MPa.

c. Quality Control Records

The Contractor shall ensure that the manufacturer keeps accurate records of all types of component raw materials such as polymer powder, additives, stabilizers, lubricants, etc. used in the manufacture of PVCu pipes, together with detailed manufacturer's test reports carried out on the raw materials, date produced and date received, and batch or lot numbers.

During production, records shall be kept for mixing ratios of all the components used in the PVCu blend and these mixing ratios shall not be changed without the prior approval of the Engineer.

PVC material silos shall be equipped with appropriate sized sieves.

Pipes shall each be identified individually by a unique number. Such numbers shall be recorded along with the Blend and Lot number they were manufactured from.

The pipe lot shall be the pipes manufactured during a single work shift. The Contractor shall state in its bid the length of shift the manufacturer intends to use. The number of pipes in a lot shall be the number of pipes manufactured during the specified shift period.

d. Polymer Certification

The manufacturer shall state for each batch and lot of pipes and fittings manufactured the K value of the polymer which shall have certifications from the polymer supplier. If required by the Engineer, tests will be carried out to determine that the K value is in accordance with the relevant standards.

e. Inspection and Testing during Production

The manufacturer shall carry out the necessary inspections and tests during production in accordance with the relevant standards and such tests shall include all tests relevant for PVCu pipes and fittings as required by SSRN 313 (b).

The number of pipes to be tested and the frequency of testing shall be in accordance with SSRN 319.

f. Inspection of pipes and pipe fittings

The inspection will consist of visual examining the external surfaces of the pipe that must be smooth and free of the following defects:

- grooving
- blistering
- scoring (scratches)
- cavities
- impurities
- other surface defects which will be deleterious defects

In addition the pipes will be inspected for correct chamfering at 15 degrees to half the wall thickness on the spigot end and squareness of both ends to the pipe longitudinal axis.

The numbers of samples that do not comply with the above requirements during inspection shall not exceed the quantities given in the relevant standards.

g. Testing of Pipes and Fittings

For each Lot, the pipes and fittings shall be tested at the factory before shipment in accordance with the relevant standards such as SSRN 310, SSRN 311, SSRN 313, SSRN 315 (a) and 316 (c) among others for softening temperature, resistance to creep, pipe dimensions, ovality, thermal reversion, resistance to dichloromethane, freedom from toxicity, hydrostatic pressures, vacuum, fracture toughness and resistance to impact etc. The whole Lot will be rejected if the quantity of non-compliant pipes exceeds the acceptable level.

h. Marking of Pipes and Fittings

Each Pipe or Fitting shall be marked clearly with indelible ink with the following data:

- the manufacturers trade name or trade mark
- the designation PVC-U
- the pressure class and/or SDR ratio of the pipe
- the nominal diameter of the pipe
- the individual pipe number or fitting number
- the week number of manufacture
- the Lot Number the pipe belongs to
- the Blend Number the pipe belongs to

i. Release from manufacturers works

No PVCu pipes and fittings shall be released from the manufacturer's works until all tests results on the particular Blend and Lot it belongs are in conformance with requirements. In addition no pipe shall be delivered from the manufacturers premises before a full lapse of 6 weeks from its production to allow for positive results of accelerated resistance hydrostatic test pressure testing.

j. Determination of pipe and socket wall thickness

All pipes shall be manufactured in accordance to SSRN 300 and SSRN 301 and the design pressure rating stated or based on specific design using the internationally acceptable design code of practice for PVCu pipes.

The Contractor shall demonstrate and obtain approval from the Engineer that the pipe thicknesses proposed achieve the necessary operating and test pressures, and can withstand the external pressures and that they are in conformance with the acceptable international standards for the purpose of its use in this project

k. Pipe Lengths

Pipes shall be in effective lengths (i.e. overall length minus the depth of engagement in the socket) not exceeding 6.0 m length.

l. Pressure Classification

All PVCu Pipes supplied shall be classified by their PN operating pressure rating and their SDR ratio as required under this contract.

m. Protection of Fittings used with PVCu Pipes

All types of fittings shall be protected in conformance with their respective required standards.

- (i) Protection of extruded PVCu fittings - Protection shall be in conformance with SSRN 301 and their other respective standards.
- (ii) Protection of Steel Fittings: - Steel fittings shall be coated and lined with fusion bonded epoxy to SSRN 241(a) with a thickness of between 305 to 406 microns. In addition, for transport, fittings shall be shrink

wrapped in 0.2 mm polythene packing to reduce the risk of transport damage.

- (iii) Protection of DI fittings: - DI fittings shall be coated and lined with fusion bonded epoxy to a thickness as for the steel fittings above and shall similarly be shrink wrapped in 0.2 mm polythene packing for transport.

n. Packing for Shipment – PVCu Pipes

Pipes up to 300 mm diameter may be bundled; with larger sizes packed loose. Containerised packing and transportation is also acceptable and if proposed shall be so indicated by the Tenderer. Notwithstanding any intention to utilise containers, all nuts, bolts, rubber gaskets etc. shall be packed in wooden boxes and protected against the elements. Nesting of pipes is not permitted. Fittings up to and including DN 200 mm and flanged pipe pieces up to DN 200 mm and length not exceeding 1 metre shall also be packed and supplied in wooden boxes. All other fittings, protected for shipment as described above may be packed loose. All flanges shall be protected with discs of wood, wool, fibre or timber. Flexible couplings shall be bundled if not containerised. Pipe sockets, spigots, and plain ends shall be protected by suitable wrapping prior to transportation.

The Contractor shall further have described in his Tender in full detail the method(s) of offloading for imported items or on-loading for locally manufactured ex-works items, the methods of road/rail transportation and of site off-loading including the lifting methods intended.

He shall further have described in his Tender in full detail the method(s) of stacking and storage. His Tender rates shall also be deemed to have included for the transportation as described and for the provision of all the necessary facilities for off- loading at the storage sites, and for proper stacking and storage.

At the time of tendering the Contractor shall also have stated the approximate areas of land required for the off- loading, and stacking of the pipes and for the storage of the fittings and of any special protection/storage facilities needed for any particular item(s) of his goods

o. In-country Storage, Handling and Transportation of PVCu Pipes

(i) Storage Areas

The Contractor shall provide storage for PVCu pipes in a manner and in facilities approved by the Engineer's Representative. For pipes of local manufacture, this may include a temporary fenced-off area at the manufacturers premises, provided a Contractor in his Tender has so indicated his intention to do this and the area to be fenced off is shown to be sufficient for the purpose.

(ii) Pipe Stacking and Storage

Upon arrival at the pipe storage area, all pipes delivered in containers shall be immediately removed therefrom and stacked in properly protected pipe storage sheds.

Pipes shall be stacked at the pipe storage areas using one or all of the following methods.

- square stacking for small diameter pipes
- parallel stacking using wooden roller boards
- pyramidal stacking

All pipes shall be stacked on raised wooden battens at least 100 mm thick and 225 mm wide. The PVCu pipes should be uniformly supported throughout their length or at not more than 1 m centres. Pipe stacks shall be suitably wedged and the Contractor shall be deemed to have included for an adequate number of timber, wedges, etc., in his Tender.

Where socket and spigot pipes are stacked, the sockets should be placed at alternate ends of the stack with the sockets protruding.

The Contractor shall further have described in his Tender in full detail the method(s) of offloading for imported items or on- loading for locally manufactured ex-works items, the methods of road/rail transportation and of site off-loading including the lifting methods intended. He shall further have described in his Tender in full detail the method(s) of stacking and storage. His Tender shall also be deemed to have included for the transportation as described and for the provision of all the necessary facilities for off- loading at the storage sites, and for proper stacking and storage.

At the time of tendering the Contractor shall also have stated the approximate areas of land required for the off-loading, and stacking of the pipes and for the storage of the fittings and of any special protection/storage facilities needed for any particular item(s) of his goods

The following table indicates the maximum stacking heights allowable:

Pipe Outside Diameter (OD) in mm	Maximum number of layers in stack, PVCu pipes
Up to 100	7
150	7
200	5
250	5
300	4

In addition PVCu pipes shall not be stored out in the sun unless they are fully protected by a free-venting, opaque cover (tarpaulin or black polyethylene). Except immediately prior to transfer to trench side, PVCu pipes shall not be stored at temperatures exceeding 25 deg. C at any time, whilst the requirements of SSRN 302 shall be met with regards to storage, handling and transport.

- (iii) Vehicle used to transport PVCu pipes shall have flat beds free from projections. Pipes shall be uniformly supported along their entire length and shall not overhang the end of the vehicle. Upright side supports on vehicles shall be flat, at 2m spacing and free of sharp edges. Socket and spigot pipes shall be stacked on vehicles in alternate layers so that the

socket carries no load. Thicker wall pipes shall always be loaded before thin wall pipes.

- (iv) Where PVCu pipes are delivered from abroad in containers, such containers shall not be exposed to sunlight on their upper surface during either dockside storage or shipment and all pipes shall be immediately removed and stored as indicated in e(ii) above upon arrival on site. Site storage in the supply containers is not permitted, unless all pipes are first removed and then stored in accordance with e(ii) above.
- (v) Care shall be exercised in the transporting, handling, off-loading and loading of the pipes. For PVCu pipes, a minimum of two persons per pipe shall assist in the loading and offloading and pipes shall be neither thrown down nor dropped or rolled.

p. Distribution of PVCu Pipes from Storage

All PVCu pipes shall be distributed to the trench side and laid without being out in the sun for more than the day of installation unless they are to be protected from the sun's rays in which case this period may be extended at the discretion of the Engineer's Representative up to an absolute maximum of 5 days.

They shall then be supported at not less than three approximately equally spaced intervals so as to be fully clear of the ground.

When pipes are being loaded into vehicles, care shall be taken to avoid their coming into contact with any sharp corners such as cope irons, loose nail heads, etc. Whilst in transit, pipes shall be well secured over their entire length and not allowed to project unsecured over the tailboard of the lorry.

Pipes may not be offloaded from lorries by rolling them, nor shall pipes be rolled or dragged along the ground. Visual inspection shall be done along the whole length at trench side before laying.

2 MATERIALS & STANDARDS, HIGH DENSITY POLYETHYLENE PIPES AND FITTINGS

HDPE (PE100 and PE100 layer) pipes and fittings shall meet the requirements of SSRN 307 and SSRN 317. All manufacturing materials used shall be in conformance with SSRN 320.

HDPE pipes shall be transported, laid, jointed and backfilled in accordance with the manufacturers written instructions except where this specification is more rigorous in which case this shall be followed.

At all time, latest and updated confirmed standards and procedures for design and installation shall be used and adopted. This will help ensure that the Employer benefits from superior materials with enhanced useful life. In the same context the Contractor may provide with the approval of the Engineer superior materials using other standards not listed here provided they can demonstrate so through tests and guarantee certifications.

The polyethylene used shall be of a high molecular type with average to high density. For the manufacture of the pipes, not less than Third Generation polyethylene, known as PE 100 shall be used. Second Generation polyethylene (PE 80) shall not be offered. The polyethylene shall be stabilised against the effects of ultraviolet radiation by the addition of carbon black.

The Contractor shall provide pipeline materials to the pressure classes and SDR ratios referred to on the Drawings and in the Bills of Quantities. Unless otherwise indicated on Tender Drawings or in the Bills of Quantities, the pressure ratings shall not be lower than PN 10.

In all cases minimum cover shall be 900 mm and the bedding shall be restricted to S1 or S2 if specified by the Engineer. Where S2 material is permitted, it may comprise or include screened 'as-dug' materials that meet this requirement.

Where specific design is carried out, the pressure rating shall be calculated taking into consideration: the operating and test pressures, surges if applicable, external pressures, HDPE pipe strength characteristics, temperature, soil condition, trench width and depth, appropriate traffic loads and impact fatigue.

Maximum Allowable Deflection of HDPE (PE100) Thermoplastic Pipes

PE pipes with electrofusion joints	5%
PE pipes with mechanical joints	2%

Minimum pressure ratings and cover for HDPE pipes shall be as follows:

Nom. Diameter (mm)	Pipe thickness and SDR to suit following minimum Pressure Rating (bars)	Minimum Cover (m)	Pipe Bedding
0 – 125	10	0.9	S1, S2 if approved by the Engineer
150 – 275	12.5	0.9	
≥ 300	To suit specific design calculations, agreed design criteria, using SSRN 267 design code of practice, and with the approval of the Engineer		
Transmission Mains And off-takes			
All pumping mains			

For diameters up to and including 110 mm, PE pipes can be supplied in coils of up to 100 m long. For coils of diameters greater than 63 mm each layer shall be bound separately to facilitate safe unwinding. For diameters from 125 mm upwards they shall be supplied in lengths not exceeding 12 m. Installation – including fusion jointing work on HDPE pipelines – must be directed and supervised by suitably qualified and experienced persons and the Contractor shall have demonstrated his ability to provide this in his Tender, if necessary from his intended manufacturer.

a) Inspection and Testing during Production

The manufacturer shall be carrying out the necessary inspections and tests during production in accordance to the relevant standards and such tests shall include all tests relevant for HDPE pipes and fittings as required by SSRN 306(f). Steel fittings shall meet the requirements of SSRN 213, SSRN 228 and SSRN 229.

The number of pipes to be tested and the testing frequency shall be in accordance with SSRN 319.

b) Electro-fusion Fittings

All HDPE fittings shall be injection moulded from recognised top quality PE 100 resin and will conform to SSRN 307. Where jointing or connection is not done by electro-fusion, joints shall be of the compression type, or alternatively ferrous fittings connected by flange assemblies shall be used. Jointing with adhesives, cement glue or threaded joints is not acceptable.

Fittings shall be suitable to be used in conjunction with pressure pipes from polyethylene manufactured to the appropriate international standards, and all fittings must be packed in such a way as to allow their use on site without additional cleaning.

The heating coils contained in each individual fitting and saddle should be so designed that only one complete process cycle is necessary to fully electro-fuse the fitting to the adjoining pipe or pipeline component as applicable. No heating element may be exposed and all coils are to be fully imbedded into the body of the fitting for protection purposes.

The pipe fixation device shall be an integral part of the body for all fittings in the sizes up to and including nominal diameter 63 mm and on saddles up to 250mm.

An individual data carrier card in compliance with SSRN 321 and SSRN 322 containing a magnetic strip and an appropriate barcode or codes as well as manual setting information for data transfer purposes must be supplied with each fitting.

All fittings must have moulded-in identification and appropriate product information. Fittings without such identification will be rejected.

Process voltage of all fittings must not exceed a maximum of 39.5 volts.

Insulated contact heads for the terminal pins are to be provided, and terminal pin size shall be 4 mm in diameter.

A limited path style fusion indicator acting for each fusion zone as visual recognition of completed fusion cycle should be incorporated into the body of the fitting or saddle near or adjacent to the terminal.

The design of the fusion indicators must prevent the escape of fusion melt.

All couplers in the sizes up to and including nominal diameter 160 mm must have an easily removable centre stop not requiring tools for removal.

All internal or externally threaded transition adaptors in the nominal sizes up to and including 63 mm diameter must be designed with an integrated polyethylene collar from PE 100 for jointing purposes not relying on rubber or synthetic seals for leak prevention.

Threaded adapter bodies may be from brass or stainless steel and should be of the modular principle, not being supplied moulded into an electrofusion fitting socket.

c) Product training and Technical Information

The manufacturer or the material supplier shall provide a specialised theoretical and active practical product training given by qualified instructors to enable installers of the above mentioned products to be able to understand and use the products correctly and efficiently under site conditions. The courses are to be held on the purchaser's own premises upon demand.

The manufacturer is to provide accurate and easy-to-understand assembly instructions in English which can be used at any subsequent time for reference purposes.

d) Manufacturing, Testing, Handling, Transport and Storage

The quality control procedure in manufacturing, transporting, handling and storage of HDPE pipes and fittings shall be in accordance Clause 529 (a) to (o) where appropriate and in conformance to their respective standards if not covered in this section.

e) In-country Storage, Handling and Transportation of HDPE Pipes

- (i) Before transporting HDPE pressure pipes, the loading surface of the vehicle must be cleaned and free from projecting nails, screws or other sharp objects. The bottom layer of all pipes must as far as possible be in contact with the loading surface throughout their entire length and not

project beyond it. The pipes must be secured from slipping and shall not be pulled over sharp edges when loading and offloading. Pipes shall not be dragged along the ground.

- (ii) Pipes, fittings and coils of HDPE pipes shall be stored in such a way that they are completely protected from direct sunlight. When covered they must be well ventilated to avoid accumulation of heat and resultant deformation. Transparent coverings shall not be used. The storage location shall be flat and shall, for pipes, support the pipes throughout their length. Stones and sharp objects shall not be present. Pipes shall not be stacked to a height exceeding 1 m. The pipes must be secured at the sides to prevent them from rolling. Contact with harmful materials shall be avoided. As far as possible, coils shall be stored in a horizontal position. The area shall be free of stones and sharp objects. If stored upright they must be secured to avoid tilting.
- (iii) HDPE Pipes supplied in coils of up to 63 mm diameter may be unrolled with the coil in the vertical position. For larger diameters an unwinding device shall be used. A turnstile can be used with the coil laid in a horizontal position on it or with the coil mounted vertically on a slow moving lorry. The pipe shall never be removed from a coil in a spiral manner as this may cause kinking. Should kinking nevertheless occur the Contractor shall cut the pipe on either side of the kink, prepare the ends, and then use an approved joint after laying. All costs of dealing with kinking shall be to the Contractors expense. A minimum bending radii of 35 x the diameter shall be observed.

f) **Distribution of Materials from Storage**

The Contractor shall make his own arrangement for storage including for temporary occupation of the necessary land, provision of suitable fencing, preparation of site and security, and the selected storage areas shall be suitably close to the final pipeline alignment to allow for speedy transfer to the installation location.

HDPE pipes shall be distributed to the trench side and laid without being out in the sun for more than the day of installation unless they are to be protected from the suns rays in which case this period may be extended at the discretion of the Engineer's Representative up to an absolute maximum of 5 days. Pipes not in coils shall then be supported at not less than three approximately equally spaced intervals so as to be fully clear of the ground.

When pipes are being loaded into vehicles care shall be taken to avoid their coming into contact with any sharp corners such as cope irons, loose nail heads, etc. Whilst in transit, pipes shall be well secured over their entire length and not allowed to project unsecured over the tailboard of the lorry.

Pipes may not be offloaded from lorries by rolling them. Pipes shall not be rolled or dragged along the ground.

3 Materials & standards, Glass Reinforced Polyester (GRP) PIPE

Scope

This specification applies to the furnishing of all labour, materials and services in connection with the manufacture, testing, delivery and installation of large diameter underground glass reinforced plastic piping, joints, fittings and specials as specified in the engineering documents and drawings.

Codes and Standards

All pipes, joints and fittings supplied under this specification shall, as a minimum, meet the requirements of the AWWA C950, AWWA Standard for Fibreglass Pressure Pipe, and ASTM D3517, Standard Specification for "Fibreglass" (Glass-Fibre Reinforced Thermosetting-Resin) Pressure Pipe, for pressure pipes and ASTM D3262 Standard Specification for "Fibreglass" (Glass Fibre-Reinforced Thermosetting Resin) Sewer Pipe, in the case of gravity sewer pipes and ASTM D3754 Standard Specification for "Fibreglass" (Glass Fibre-Reinforced Thermosetting Resin) Sewer and Industrial Pressure Pipe for pressurised sewer and industrial waste pipes.

Test Methods

- ASTM D638 Standard Test Method for Tensile Properties of Plastics.
- ASTM D1586 Standard Method for Penetration Test and Split-Barrel Sampling of Soils.
- ASTM D2290 Standard Test Method for Apparent Tensile Strength of Ring or Tubular Plastics and Reinforced Plastics by Split Disk Method.
- ASTM D2412 Standard Test Method for External Loading Properties of Plastic Pipe by Parallel- Plate Loading.
- ASTM D2487 Standard Test Method for Classification of Soils for Engineering Purposes.
- ASTM D2583 Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
- ASTM D2992 Standard Method for Obtaining Hydrostatic Design Basis for "Fibreglass" (Glass- Fibre Reinforced Thermosetting Resin) Pipe and Fittings.
- ASTM D3567 Standard Method Determining Dimensions of "Fibreglass" (Glass-Fibre Reinforced Thermosetting Resin) Pipe and Fittings.
- ASTM D3681 Standard Test Method for Chemical Resistance of "Fibreglass" (Glass-Fibre Reinforced Thermosetting Resin) Pipe in a Deflected Condition.
- ASTM D3754 Standard Specification for "Fibreglass" (Glass Fibre-Reinforced Thermosetting Resin) Sewer and Industrial Pressure Pipe
- ASTM D5365 Long- Term Ring Bending Strain of Fibre Glass (Glass-Fibre Reinforced Thermosetting Resin) Pipe.

Product Standards

- ASTM D3754 Standard Specification for "Fibreglass" (Glass Fibre-Reinforced Thermosetting Resin) Sewer and Industrial Pressure Pipe
- ASTM D4161 Standard Specification for "Fibreglass" (Glass-Fibre Reinforced Thermosetting Resin) Pipe Joints Using Flexible Elastomeric Seals.

Product Description

Materials:

- Only approved polyester resin systems for which documented performance is available shall be used in this particular application. The data shall have been acquired from a composite material of similar construction and composition as the product proposed for this project.

- The reinforcing glass fibres to be used to manufacture the components shall be of highest quality commercial grade of glass filaments suitably treated with binder and sizing compatible with impregnating resins.
- Silica sand or other suitable materials may be used as fortifiers in the laminates.
- Resin additives, such as pigments, dyes and other colouring agents, if used, shall in no way be detrimental to the performance of the product nor shall they impair visual inspection of the finished product.
- Elastomeric sealing rings must be supplied by recognised, acceptable, quality manufacturers. The elastomeric compound used must be approved for use in potable water systems.

Manufacture and Construction

- The pipes shall be supplied in accordance with the diameters and tolerances specified in "Dimensions". They shall be manufactured by a controlled, reproduction process using the materials described in the PGRP 3.1 to result in corrosion resistant, composite structure to meet the operating conditions for the pipe classes as specified on the drawings. Stiffening ribs may be used to increase the overall pipe stiffness.
- Plain-ended pipes shall be field connected with glass reinforced plastic sleeve couplings that utilise elastomeric sealing rings as the sole means to maintain joint water- tightness. Spigot and socket pipes shall be field connected using the bell and spigot joint with double O-ring and pressurisation socket. The joints must meet the performance requirements of ASTM 3754 and ASTM D4161.
- Flanges, bends, reducers, tees of various descriptions, wyes and other fittings shall be Grade B mild steel. Couplings shall be GRP collars or VI couplings or a combination of the two with the ends fabricated to suit the contractor's requirements.

Dimensions

- Pipes will be supplied in accordance with the nominal diameters as shown on the longitudinal section drawings or in the Schedule of Quantities.
- Pipes shall be supplied in accordance with an OD series.
- Pipes shall be supplied in 12 metre lengths, + 25 mm.
- Other section lengths may be supplied for special orders, subject to the Engineer's approval. A maximum of 10% of the pipe sections may be supplied in random lengths, again subject to the approval of the Engineer.
- The minimum average wall thickness shall be the thickness as stated. The minimum single point thickness shall not be less than 87.5% of the stated thickness.
- All pipe ends shall be square to the pipe axis + 6 mm or 0.5% of the nominal diameter, whichever is the greater.
- The tolerance of the angle of a bend and the angle between the main and a leg of a wye or tee shall be 2 degrees. The tolerance on the laying length of a fitting shall be 50 mm.

Product

Pipes shall be supplied to the minimum initial specific stiffness of SN 5000. Pressure class shall be PN 25.

Qualification Testing

The physical properties and characteristics of the pipes shall be determined by prototype testing of the manufactured product. These tests need not be conducted specifically for this project if prior tests on similar products have been previously completed. Testing may be conducted on one diameter and extrapolated to other diameters if the pipes are of similar composition and material arrangement and are manufactured from the same materials specification using a similar process.

All prototype tests results must be retained by the manufacturer and be available for inspection by the purchaser or his representative upon request.

The Hydrostatic Design Basis (HDB) will be obtained in accordance with procedure B of ASTM D2992, being established at an extrapolated 50-year value.

The long-term ring bending strength (S_b) will be determined in accordance to ASTM D5365 for water projects. The ambient test temperature for maximum operating temperatures not to exceed 50 degrees C. Minimum values for S_b , expressed as relative pipe deflection, are 12% for SN 5000

Coupling joints shall be qualified per the tests of Section 7 of ASTM D4161.

Product Use

The maximum allowable operating temperature of the pipes shall be 50 degrees C.

The minimum allowable operating temperature of the pipes shall be -40 degrees C. The actual operating temperature shall range between 0 and 20 degrees C.

Standard Installations

Glass Fibre Reinforced Pipes shall be installed in accordance with the Manufacturer's Installation Instructions. The minimum standard installation for each station and corresponding stiffness class based on this specification is SN 5000, 90SPD sand, full burial.

Unless otherwise noted, trenches shall be constructed in accordance with the dimensions given in the Standard Specification or as shown on the drawings.

Quality Control Testing

Quality control testing on pipes shall be conducted in strict accordance with this specification. These tests will, as a minimum, cover:

- Raw materials
- Pipe stiffness
- Hydrostatic testing (as agreed with the Engineer)
- Load capacity
- Barcol hardness
- Critical dimensions
- Visual appearance

Adequate records must be kept by the manufacturer; such reports must be readily available for inspection by the Contractor, the Engineer or the Engineer's Representative. Quality control tests may be witnessed by the Contractor, the Engineer or the Engineer's Representative.

Raw materials for use in pipes covered in this specification shall be sampled and tested by the manufacturer prior to their use to ensure that they comply with the specifications in effect at the time of purchase. Any materials failing to meet the requisite standards shall immediately be rejected.

All materials shall be delivered with appropriate vendor certificates to demonstrate their compliance with the Manufacturer's specification.

Samples of pipe shall be tested for compliance with the pipe stiffness. The frequency of pipe ring samples shall be once per shift/machine or one per 100 pipes, whichever is the most frequent. If the one sample fails it should be retested. If it still fails, cut two (2) additional samples from the lot (from the preceding and following pipes). If they both pass, then the entire batch except the failed pipe is considered acceptable. If not as above, the pipes must be proven individually acceptable. Testing will be carried out in accordance with ASTM D2412, with the stiffness value rated at 5% deflection.

Hydrostatic Leak Testing Pipes shall be hydrostatically tested in accordance with section 3.1.1 of AWWA A C950. The pressure class of pipes will be that specified. Any pipes failing to pass this test will be rejected. Rejected pipes may be repaired and retested; if they pass, they will be accepted

Tests shall be performed in accordance with the requirements of AWWA C950 and ASTM D3517 to check load capacity (or strength) in both the hoop and axial directions. One of each test shall be made per 100 pipes. Should samples fail to meet or exceed the stated values for each test, two additional samples shall be cut from the preceding and following pipes. If they both pass and the average of all three sets also passes, then the entire lot is considered acceptable.

Barcol hardness tests will be conducted in accordance with ASTM D2583. Pipes failing to reach the required level of cure will be rejected. Rejected pipes may be retested in accordance with this specification. If their cure at this time has reached the required standard, they will be acceptable.

Pipes will be measured for compliance with critical dimensions as specified in PGRP 3.3 including diameter, thickness, end squareness and length. Measurements will be made in accordance with ASTM D3567.

Checks on diameter will be made at each change of diameter manufactured. Tolerances will be such that joints meet the performance requirements of ASTM D3754 and ASTM D4161.

All pipes will be checked for compliance with thickness stated. The minimum average thickness must be greater than or equal to stated thickness. The minimum single point thickness must be greater than or equal to 87.5% of stated thickness.

Any pipes with stepped ends shall be checked to ensure compliance with tolerances.

All pipes will be measured to ensure compliance with the requirements.

The pipes shall be free from all defects, including delaminations, bubbles, pinholes, cracks, pits, blisters, foreign inclusions, and resin-starved areas that, due to their nature, degree or extent, detrimentally affect the strength and serviceability of the pipe.

The pipe shall be as uniform as commercially practicable in colour, opacity, density and other physical properties.

Submittals to be Given Before or at the Time of Tendering

At tender stage and in a covering letter, the Manufacturer, through the Contractor, shall, in addition to the items specified, provide sufficient data for the broad evaluation of his proposed pipe. This data shall include, a minimum, the following specific information:

- Details of the proposed pipe wall thickness and properties including Pressure Class and Stiffness Class.
- Details of joints.
- Hydrostatic testing plan.
- Exceptions
- Details for nesting and packaging of pipe together with methods for de-nesting and unpacking of pipes
- Instruction for the storage and handling of pipes and couplings
- Installation Instructions including inter-alia bedding requirements, backfilling procedures and proposals for measuring initial diametrical deflections.

4 TRENCH EXCAVATION AND EARTHWORKS FOR THERMOPLASTIC PIPES

This clause for excavation shall apply except for thrust boring as specified in Clause 549 below.

- (i) All trench excavation will as a minimum precaution be taped off to alert members of the public to its existence.
- (ii) The excavation shall be made in open cutting unless tunnelling or heading is specified by the Engineer's Representative or it is specified in the Bills of Quantities.
- (iii) Trenches for pipes shall be excavated to the lines and depths shown on the Drawings, or as directed by the Engineer's Representative, and shall be of sufficient width to give an equal clearance on both sides of the barrel of the pipe or pipes such that in general the total trench width is $3/2 'D'$ where 'D' is the outside diameter of the pipe or the average outside diameter of the group of pipes or will be equal to the outside diameter or the pipe plus 300 mm whichever is greater. For pipes bedded in concrete sections, the breadth of concrete bedding for the pipes will be equal to the width of the trench. Excavation for fire hydrants, valve chambers or any other water works structures shall be carried out to the levels and outlines of such structures, and the rates shall include for any additional excavation or other temporary Works required.
- (iv) If in the opinion of the Engineer's Representative due to delays in laying which are the fault of the Contractor the ground becomes weathered prior to the laying of the pipes, the Contractor shall remove the weathered soil and replace it with suitable compacted material to the original formation level at his own expense.
- (v) Where pipes are not laid on concrete, the bottoms of the trenches as excavated shall be smooth and shall be free from stones or other projections. Holes cut out for joints in the lower bedding shall be of as small a size as possible throughout their entire length. The trench shall be dug to within 150 mm of its formation and proper grade pegs shall then be set in the bottom of the trench by the Contractor for the accurate taking out of the rest

of the excavation. Grooves about 50 mm deep shall be cut across the trench in the lower bedding at the required positions to enable the easy removal of pipe slings.

- (vi) The materials excavated from trenches shall be laid completely and neatly on the sides of the trench except where in the opinion of the Engineer's Representative's Representative this would so obstruct a road or footpath as to prevent the passage of traffic or pedestrians. In such cases the Contractor must dig out the pipe trench in such lengths as directed and keep his excavated material at such a distance as may seem advisable, and the rates shall be deemed to cover for this.
- (vii) During excavation, the Contractor shall ensure that all material suitable for re-use and which he intends for re-use are kept separate and set aside and protected as necessary to prevent loss or deterioration. Materials forming the surface and foundations of roads shall when excavated and if required for further use, be carefully separated. Paving slabs, bricks and similar surfaces shall be carefully removed and stacked for re-use, or as otherwise instructed by the Engineer's Representative.
- (viii) No pipes shall be laid nor lower bedding introduced and no excavation filled in or covered with concrete until the formation has been inspected and written permission to proceed with the Work obtained. The Contractor shall provide to the Engineer, a weekly schedule in advance indicating the dates and approximate times he expects to request such inspections.
- (ix) Where pipes are to be laid under a road formation or in open country, or in cutting, trenches shall generally be excavated after the earthwork is completed. The Engineer's Representative may permit these pipe trenches to be excavated before the earthwork is complete, but payment for the excavation of the trench will only be made upon the volume excavated below the road formation.
- (x) The unit of measurement for the excavation of trenches shall be per linear metre or per cubic metre of void calculated from the deemed width of the trench, and the average depth of excavation as mentioned in the Bills of Quantities. Unless otherwise indicated, for valve chambers and other water works structures, the unit of excavation will be per number or per cubic metre of excavated material calculated to the exact outer dimensions and depths of the Permanent Works. In neither case will allowance will be made for bulking.
- (xi) The rates for excavation of trenches in "normal" material shall include removal of all material except "rock", selecting and segregating material to be backfilled in special layers, supporting or sheeting, shoring and strutting, any additional working space or room for timbering or sheeting required, dealing with water, maintenance of the trench, and all labour, tools, materials, plants, supervision, overheads and profit.
- (xii) The provisions of the above Clause shall also apply to the rates of excavation in "rock" and in addition the Contractor shall allow in his rates for back-filling the invert with Class 15 concrete or other materials as directed by the Engineer's Representative and removing to a spoil dump all "rock" excavated.

- (xiii) Where rock is encountered and should the Contractor wish to excavate the rock in advance and temporarily to refill the excavated trench with the excavated material until he is ready to proceed with the laying of the pipe, he shall be permitted to do so, which permission must be given in writing by the Engineer. Such work shall normally be included in the Contractors rates unless he can show that the amount of rock is in excess of the amount billed to an extent that his work programme will be unduly delayed if he does not do so in which case he may seek to be paid both the E.O. item rate for the rock and twice the rate quoted for excavation in class III material.

5 PIPE LAYING FOR THERMOPLASTIC PIPES

Individual Pipes not supplied in Coils

- (a) Pipes shall only be laid in the presence of the Engineer's Representative unless written authority from the Engineer has been granted.
- (b) Pipes generally shall be laid and jointed in accordance with the manufacturer's or his licensor's instructions. Extra excavation must not be carried out so as to avoid backfill, excessive deviation in joints and other irregularities. Otherwise, the pipe grade will follow the Drawings, with a continuous (but not necessarily uniform) fall towards washout-valves and rise towards air-valves.
- (c) Every pipe shall be laid separately and shall bear evenly upon the lower bedding or concrete for its full length, holes to receive sockets, couplings or flanges being cut in the bottom of the trench of such size and depth as to allow the joints to be properly made. The pipes shall be laid to true inverts, straight lines and falls, each pipe being separately boned between sight rails. The pipes shall be thoroughly brushed inside insofar as is practicable and outside prior to laying, and no foreign matter shall be allowed to enter the pipe during or after laying. At the end of each working day the exposed pipe end shall be stoppered up with a stopper plug of appropriate diameter and not merely covered in polythene sheet tied around the end.
- (d) Trenches shall be bottomed up only immediately in advance of pipe laying, although at least 15 metres shall be prepared in advance of any given pipe. Trenches and joint holes shall be kept free from water, until the pipes are laid and the joints completed and no ground water shall be allowed to enter the new pipes.
- (e) Prior to laying in trench the lower bedding in the trench must provide support throughout the entire length of the pipe. The pipe shall never be laid directly on cohesive, rocky or stony material. Where the natural trench bottom meets the bedding class required, this shall initially be loosened to a depth of 100 mm and then re-compacted to at least 90% MPD and then the surface loosened on the day of and prior to laying
- (f) In rock excavation, the pipes shall be bedded on concrete or selected granular fill, e.g. gravel, to a minimum thickness of 150 mm and the exclusion of rocks and other hard material to at least 300 mm around the pipe, leaving proper joint holes and subsequently making good with selected materials to the Engineer's Representative's approval.
- (g) All flanged joints shall be made with jointing rings, which shall be carefully inserted concentric to the bore of the pipe, so that undue stresses shall not be caused in any of the bolts or on the flanges when bolting up. The joint ring

shall be compressed gradually and evenly by taking a few turns on each diagonal bolt in succession. Manufacturers' recommendations on the maximum tightening torque shall be followed, and over-tightening shall be avoided. Where one or both of the flanges is itself of plastic, torque-wrenches shall always be used, and the bolts shall first be hand tightened and then diagonally tightened progressively to achieve 5%, 20%, 50%, 75% and finally 100% torque. For metal to metal flanges and if the Engineer is dissatisfied with the degree of care being taken, the Contractor shall provide and use torque-wrenches for this purpose at no extra cost.

- (h) Mechanical joints shall be made in accordance with the manufacturer's instructions. After successful testing of pipelines, the joints will receive external protection as specified or to the Engineer's Representative's approval.
- (i) The threads of any screw connections shall be coated with red lead before the joint is made.
- (j) Concrete anchor blocks shall be provided at bends, tees, stopped ends, etc as shown on the drawings or as directed by the Engineer's Representative.
- (k) Where a pipeline crosses under roads or railway lines, the pipe shall be sleeved or surrounded with concrete or protected by reinforced concrete slabs as instructed by the Engineer's Representative, and Tenderers shall have been deemed to have made allowance in their rates for compliance with the requirements of the relevant authority. Where roadside verges are liable to receive traffic, this protection shall be extended under the areas concerned and Tenderers shall have been deemed to have made allowance in their rates for compliance with this requirement.
- (l) For the insertion of valves and other fittings into existing pipelines, pipes may need to be cut. Approved tools and machines specially made for the purpose, shall be provided and used by the Contractor.
- (m) The Contractor shall provide and fix wooden drumheads to the open ends of the mains, and similar drumheads shall be used to close the ends of any pipes to exclude dirt and stones, etc. when the pipe laying is not actually in progress. Wooden markers properly inscribed, shall be left projecting out of the ground to indicate the ends of all pipes, where these are buried in the ground in open country. In public highways, a danger sign or other suitable means as approved by the Engineer's Representative shall be adopted.
- (n) At every point of loading or unloading, pipes must be handled by approved lifting tackle. (Unloading by rolling them down planks of any form or including ramp will not be allowed except with the special consent of the Engineer's Representative).
- (o) The stacking of pipes shall be used such as to prevent damage during storage. Timber runners shall be laid to keep the upper row separated from the lower and the bottom row shall be staked to prevent any rolling. The whole arrangement shall be subject to the approval of the Engineer's Representative.
- (p) Care should be taken to minimise the risk of bush fires damaging any pipes laid out along the line of the mains.
- (q) Refilling of pipe trenches shall conform to the specifications provided in Clause 530.

- (r) The requirements for making good subsidence after refilling are provided for in Clause 531.
- (s) Reinstatement of surfaces shall conform to the specifications provided for in Clause 532.
- (t) For Thermoplastic Pipes Laid in Trenches:
 - (i) The soil cover shall be a minimum of 900 mm. and the embedment material shall be S1 or S2 (single size or graded gravel). For details of the trench specifications, and backfill material sizes and grading refer to Clause 530 Tenderers shall allow for the price of such trenching and importation of necessary backfill material and compaction as part of the pipe installation price.
 - (ii) For all bedding classes, compaction shall be 90% MPD minimum.
 - (iii) Marker tapes made of a pigmented low density polyethylene and aluminium foil in a bright colour or other approved material not less than 100 mm wide and 0.15 mm thick shall be placed in the ground above the PVCu and HDPE pipelines laid underground as a measure to detect the pipe and at the same time to reduce the risk of accidental damage which may be caused by future excavations. The tape shall be laid about 300 mm above the crown of the pipe. The tape shall be continuously labelled with black printing "DANGER-PLASTIC PIPE. The price tape shall be deemed included in the price for the supply and installation of the pipe.

Pipes supplied in Coils

- a. All sub-clauses of Clause 525 that are appropriate to pipe coils shall also apply and in case of any dispute, the Engineers ruling shall be final.
- b. Pipe coils generally shall be laid and jointed in accordance with the manufacturer's written instructions. A re-rounding and straightening tool shall be used prior to making each joint. Extra excavation must not be carried out so as to avoid backfill, excessive deviation in joints and other irregularities. Otherwise, the pipe grade will follow the Drawings, with a continuous (but not necessarily uniform) fall towards washout-valves and rise towards air-valves. Horizontal alignment shall be as straight and central to the trench as is practicable, and if necessary, wooden pegs shall be used initially to ensure this until the upper bedding has been compacted at which juncture they shall be carefully withdrawn.
- c. Electrofusion Control Units for HDPE Pipes
The Contractor shall provide electrofusion control units as recommended by the HDPE pipe manufacturer and confirming to EN 60335, EN 5008, EN 55014 and EN 61000. The workmanship shall be in accordance to the manufacturer's recommended procedure and quality.

6 BACKFILLING OF PIPE TRENCHES FOR THERMOPLASTIC PIPES

All excavation of pipe trenches shall be of such form and to dimension as shown on the drawings or as the Engineer's Representative may direct, and in all respects provide with embedment configurations and minimum covers as detailed here below. As a general rule trench width shall be not less than 1½ times the OD of the pipe but subject to the following figure and tables.

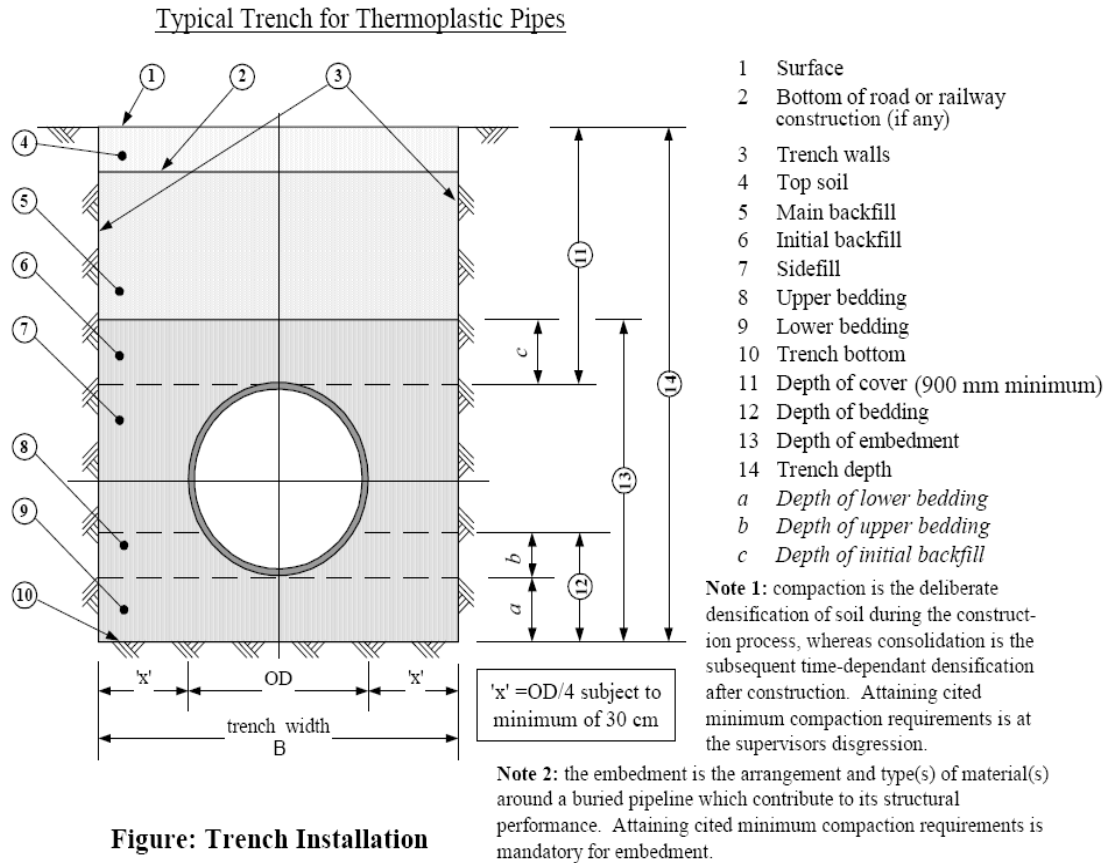


Figure: Trench Installation

Lesser trench widths may only be authorised if the Contractor can prove to the satisfaction of the Engineer that he can consistently achieve the required compaction for a lesser width in which case an absolute minimum of OD + 450 mm may be permitted.

Minimum Trench Width

Pipe Size	Trench Width
General	OD + minimum 600 mm
≤ 125 mm	OD + 450
150 – 300	OD + 600
> 300	To suit site condition and to the approval of the Engineer

If called for in the Bills of Quantities or if in the Engineer opinion, the risk of vandalism in a particular area is higher than anticipated at the time of design, cover shall be increased to a minimum of 1.2 m and the Contractor shall be paid for the removal and replacement of the additional materials at the same rates as quoted in the Bills of Quantities for the depth range indicated.

Embedment for PVCu and HDPE (PE100) Thermoplastic Pipes

Embedment Class	Bedding, Sidefill & Initial Backfill Material Allowed	Notes
S1 and S2	Class S1: Gravel – single size Class S2: Gravel – graded	processed granular materials required for all plastic pipes

S1 and S2 Embedment Material for Thermoplastic Pipes

Nominal Pipe Diameter (mm)	Grading [to ASTM Sieve Sizes]	
	S1 Embedment	S2 Embedment
80	10 single-size gravel	10 single-size gravel
100	10 single-size gravel	10 single-size gravel
150	10 or 14 single-size gravel	14 to 5 graded
200 to 500	10, 14 or 20 single-size gravel	14 to 5 graded or 20 to 5 graded
> 500	10, 14, 20 single-size crushed rock, or gravel	14 to 5 graded or 20 to 5 graded

- (i) The placing and compaction of pipe embedment shall only be undertaken in the presence of the Engineer's representative unless written authority from the Engineer has been granted.
- (ii) No pipes shall be laid nor lower bedding introduced and no excavation filled in or covered with concrete until the formation has been inspected and the permission to proceed with the Work obtained.
- (iii) In every instance, embedment material (consisting of bedding, side fill and initial backfill) filled around the pipe and for 300 mm over the top of the pipes shall be totally free from stones, rock fragments, tree roots or similar objects which through impact or by concentrating imposed loads might damage the pipes and shall not include black cotton type soil. The filling shall be carried out with utmost care, special attention being paid to tamping of material around the pipes and to joint holes so as to obtain the greatest possible compactness and solidity. The material shall if necessary, be screened to exclude material which would damage the pipes. The embedment material shall be in accordance with the relevant pipe embedment drawing but shall be no less stringent than a class S2 material for thermoplastic pipes and the source and any material brought to the site from elsewhere shall be approved in writing by the Engineer's Representative before excavation commences. Any delays as a result of not seeking this approval in good time shall be entirely to the Contractor's account.
- (iv) Where the 'as-dug' trench material contains material which meets the bedding class requirements as specified and providing that this is carefully screened to the sizes indicated above, and segregated from material that does not, the Contractor may, at his discretion, use it as such or incorporate such material into the imported embedment material being used.
- (v) The lower bedding for the pipes shall have a minimum thickness of 100 mm in normal trenches, and 150 mm where rock/stones are present and at designated road crossings. In trenches where there is a continuous accumulation of groundwater, the trench shall after obtaining the approval of the Engineer's Representative, be over-excavated by 150 mm and shall be backfilled using compacted granular material. Bedding material shall be compacted in layers not exceeding 50 mm thickness. Compaction of fill around the pipe shall be in layer thickness not exceeding half the pipe diameter or 75 mm whichever is the lesser. Layer thickness is however subject to consistently achieving 90% MPD (Modified Proctor Density) or better, failing which layers shall be reduced in depth as necessary to achieve the % compaction.

- (vi) The upper bedding shall be introduced as carefully and thoroughly as practicable to the underside or haunch of the pipe such that no large spaces remain before it is compacted.
- (vii) The sidefill and backfill material within the embedment shall be placed in layers of not more than 150 mm thickness when compacted and where hand ramming is employed the number of men filling shall not be more than half the number of men ramming. Sidefill shall be placed simultaneously on both sides of the pipe. Where mechanical-ramming of the remaining backfill is employed, the machines shall be to the approval of the Engineer's Representative and soil shall be replaced and well rammed down by hand for a depth of not less than 600 mm to give sufficient cover to the pipes and obviate risk of damage to them before the mechanical rammer is brought into operation. The rammer shall not cease to be used on any length of trench until thorough compaction has been obtained. All backfill soil shall be free from clay lumps, boulders stones and rock fragments greater than 20 mm and 90% MPD shall be attained in all instances. All backfill soil above the embedment shall be free from clay lumps, boulders and rock fragments greater than 50 mm and as far as practicable 90% MPD shall be attained, but this may be relaxed (e.g. in fields and open areas) by the Engineer's Representative.
- (viii) The Contractor in excavating the trench from which he wishes to use 'as-dug' material for bedding shall ensure that materials from strata containing no stones or rock-fragments and suitable for filling around the pipes as described above, shall be kept separately and used for this purpose. The Contractor shall not be entitled to claim for any extra costs (as provided for below) for screening if this requirement is not complied with. If no such strata occur in the excavation, the excavated material shall either be screened or suitable material transported to the Site from other excavations as the Engineer's Representative shall direct. The cost of such work shall be paid for according to the rates in the Bills of Quantities.
- (ix) Before commencing the placing of embedment in the trenches, the Contractor shall obtain approval from the Engineer's Representative as to the methods he proposes to use and he shall demonstrate by means of tests that the specified compaction can be achieved (according to SSRN 601 using the "sand replacement" method). The method of compaction and the testing thereof shall be at all times to the approval of the Engineer's Representative and in general at a frequency of once every 30 metres unless this is specifically relaxed based on continuously good in-situ test results.
- (x) The pipe trench shall be backfilled entirely without leaving out areas around and at pipe joints uncovered, for subsequent filling. To facilitate the subsequent location of any suspected leaking joints during pipe testing, should this become necessary, the Contractor shall provide marker pegs at regular intervals and/or use a handheld GPS to be able to relocate joint positions.
- (xi) Where for pipes other than those used for service connections a minimum cover of 900 mm cannot be maintained, including highways and trafficked areas then the pipe must either be laid in a protective ferrous sleeve or be protected by a 150 mm thick reinforced concrete slab above the pipe. A minimum of a 150 mm layer of appropriate grade granular bedding material

must first be placed and lightly compacted as a cushion above the crown of the pipe before the slab is laid, and the slab must extend at least 150 mm out beyond either side of the trench.

7 MAKING GOOD SUBSIDENCE AFTER REFILLING

Should any but very localised subsidence occur of the pipe trench after refilling and before the expiry of the maintenance period, the Contractor shall first demonstrate that such subsidence is only to the backfilling above the pipe and not to the pipe, embedment, bedding or sub-soil itself.

Should this not be so demonstrated then the Contractor at his own expense shall, excavate and remove the pipe or pipes affected and return the bottom of the trench to grade through a process of over-excavation, re-compaction or use of a lean concrete mix as determined by the Engineer's Representative, who shall also determine whether or not the affected pipes may be re-used or replaced.

The affected section or sections will in any event be liable for a further twelve months maintenance period.

All subsequent refilling shall be thoroughly compacted by ramming as with a newly completed trench. Any subsidence due to consolidation shall be made up by the Contractor at his own expense with extra compacted material. Should subsidence occur after any topsoil has been replaced, the topsoil shall first be removed before any hollows in the backfilling are made up before being replaced.

8 REINSTATEMENT OF SURFACES

- (i) All surfaces of roads, fields, paths, gardens, verges, etc. whether public or private which are affected by the operations of the Contractor shall be temporarily restored by him in the first instance and permanently reinstated in the second instance when the ground has consolidated fully. Separate payment for reinstatement shall be made only for surfaced roads (e.g. tarmac, concrete, paving bricks or similar material), and for officially designated dirt roads of at least 6m width, grassland, cultivated lands and sports fields. All other reinstatements both temporary and permanent are deemed to be covered by the pipe installation rates.
- (ii) The Contractor shall be responsible for the temporary reinstatement and permanent reinstatement of all surfaces whether or not the area requiring restoration is within the limits of his excavations if the necessity for the restoration arises from causes due to the operations of the Contractor. The Contractor's prices shall include for restoring all surfaces so damaged to their original condition, as no extra payment will be made for any such work. The Contractor shall take all necessary measures to ensure that no toxic materials that may cause damage to vegetation or livestock or pollute streams or water-courses are used in any temporary restoration or permanent reinstatement and shall indemnify the Employer against any claims arising out of the use of such materials.
- (iii) Temporary restoration shall be carried out immediately after the excavations have been refilled by returning the excavated material to the position from which it was removed and adding such suitable materials as may be required and consolidating the various materials as the Work proceeds in order to provide a surface that is adequate for the purpose that the original surface fulfilled. Temporary surfaces shall be maintained in a condition satisfactory to the Engineer's Representative and/or responsible Authority until the

permanent reinstatement is made. In the case of roads and streets the surface shall be necessary to consolidate the filling and keep the surface fit for traffic, suitable material being added to all placed which have sunk or become rough.

- (iv) Permanent reinstatement shall not be made until the ground has consolidated permanently and until sanction to do so is received from the Engineer's Representative. It shall be carried out with materials similar to those that were used in the original Work to the entire satisfaction of the Engineer's Representative and/or responsible Authority.
- (v) In all verges and other, grassed surfaces, the topsoil shall be removed, stored and replaced after consolidation of the filling and planted or seeded with approved grass. Should subsidence occur, it shall be made good with additional topsoil and be replanted with grass or re-seeded. New grass shall be planted if for any reason the grass fails to grow or is destroyed.
- (vi) The trenches, channels, gutters and kerbs shall be reinstated to the condition in which they were before excavation was commenced. The final surface of the trench shall be flush with the surrounding ground.
- (vii) If the work of restoration or reinstatement as carried out by the Contractor is not to the satisfaction of the Engineer's Representative and/or the responsible Authority and should the Contractor not remedy the defect forthwith, any remedial work considered necessary may be undertaken by the Engineer's Representative and/or the responsible Authority and the cost thereof shall be borne by the Contractor.
- (viii) If at any time any trench becomes dangerous, the Engineer's Representative shall be at liberty to call upon the Contractor to restore it to a proper condition at three hours' notice and should the Contractor fail to carry out the work, have it done at the Contractor's expense.

10 PART IV - ALL PIPELINES DURING DELIVERY, INSTALLATION, TESTING AND COMMISSIONING

9 ON-SITE INSPECTION

All pipes, valves and fittings shall be inspected upon arrival at the pipe storage areas for damage to:

- the pipe or fitting itself
- external coatings (if any)
- internal linings (if any)
- jointing surfaces (incl. sockets if any)

The Contractor shall be responsible for and shall undertake any work required by the Third Party Inspector or by the Engineer's or his Representative as appropriate or where deemed necessary, replace defective pipes and fittings. All expenses in connection with such remedial works or replacements shall be deemed covered by the Tender.

10 HANDLING FROM STORAGE TO TRENCH

All pipes shall be handled from storage to trench in accordance with the manufacturer's recommendations.

The Contractor shall obtain and keep on Site copies of all the manufacturer's literature relating to the proper handling, storage, laying, installation and testing of their products and shall make them or copies thereof available to the Engineer's Representative on Site.

11 MEASUREMENT FOR PIPE LAYING

Pipe laying and jointing where in trench is included in the Bill of Quantities with excavation, backfilling, and temporary reinstatement, all as described in the Bills of Quantities. Measurement of the work done will be along the centre-line of junctions in the pipe network, and branches, unless otherwise indicated in the Bills of Quantities

12 WORKING WIDTH

Where pipelines are within 20 metres of a motorable track, or through light bush or thicket a wayleave clearance of 2 metres plus nominal bore of pipe will be allowed. Where pipelines are through dense bush, thicket or forest a wayleave clearance of five metres plus nominal bore of pipe will be allowed. Payment for Site Clearance will be based upon this width except that the Engineer reserves the right to restrict this width due to the presence of obstructions, roads, houses and the like. Payments will then be according to the actual area cleared. No claims for additional space nor for inconvenience and the like caused by obstructions, will be allowed.

13 LOCATION OF UNDERGROUND SERVICES ETC.

It shall be the Contractors obligation when trenching, to locate and avoid the damaging of any existing services, be they water, drainage, sewage, electricity or telecom. Notwithstanding this obligation and should damage occur, it will be the Contractor's further obligation at his own cost to urgently liaise with the utility organisation concerned and to bear the cost of the repair or replacement of the damaged article to the entire satisfaction of the utility concerned.

14 CONCRETE PROTECTION

Unless otherwise provided in the Special Specification or Bills of Quantities or directed by the Engineer, a concrete surround of not less than 0.15 m shall be provided to water mains in the following circumstances:-

- (a) Water mains with less than 0.6 m or more than 6.0 m of soil cover over the pipes.
- (b) Water mains under carriageways if depth of soil cover is less than 1.30 m
- (c) In the places where shown on the Drawings or directed by the Engineer.

All concrete for beds and surrounds shall be class 15 concrete.

Alternatively under carriageways and where indicated on the drawings, the pipeline shall be laid in a stepped trench with the immediate surround backfilled with approved granular material and then across the step shall be laid precast reinforced concrete slabs of class 25 concrete.

The unit of measurement shall be cubic metre or linear metre as indicated in the Bills of Quantities.

The rate shall include for the provision, transporting and placing of concrete, all strutting and formwork, protection and curing and all labour, tools, plant, supervision overheads and profit.

15 ANCHOR BLOCKS

Pipelines with mechanical (or flexible) joints shall be adequately anchored at bends, tees, sluice or butterfly valves, tapers, blank ends, etc. Anchor blocks shall be constructed from Class 20 concrete to the dimensions indicated on Drawings unless otherwise directed by the Engineer. Support blocks shall be constructed from Class 15 concrete and allowed to cure for 7 days. Soil around anchor blocks shall then be compacted thoroughly before the hydraulic testing of the pipeline. Payment for anchor blocks will be per unit volume of concrete in the blocks and shall include for all the earthwork, formwork and other operations required for their construction. No separable payment shall be made for any temporary or permanent anchor blocks constructed by the Contractor specifically for the testing of the pipeline.

Anchor and Thrust blocks at proposed tie-in points between old and new pipework will be cast at least 7 days prior to the proposed tie-in works and post tie-in pipeline testing for the affected section. Where this is impracticable then a thrust wall shall be constructed similarly in advance first instead and the final connecting fitting propped initially from this thrust wall by means of a horizontal steel joist with the contact face with the fitting curved to the outside diameter of the fitting and fitted with a protective rubber insert. Immediately after re-commissioning, the space between the thrust wall and the propped fitting shall be filled with class 20 concrete, thereby permanently encapsulating the steel joist. The proposed tie-in works described in Clause 550 will therefore be preceded by the required anchor/thrust block casting.

16 INDICATOR PLATES AND MARKER POSTS

Precast concrete indicator plates to the dimensions indicated on the Drawing shall be installed at all sluice valves, single-air valves, double air valves, fire hydrants and washouts, with letters SV, AV, FH, WO, respectively, indented in them. The plates shall be painted with at least two coats of all-weather plastic emulsion paint of approved colour.

Marker posts to the dimensions indicated on Drawings shall be installed at 100 m spacing along the pipelines installed in open country or as directed by the Engineer. Marker posts shall be painted with at least two coats of all weather plastic emulsion paint of approved colour.

17 Additional PROTECTION TO FLEXIBLE COUPLINGS AND FLANGE ADAPTORS IN CHAMBERS AND/OR ABOVE GROUND

Such mechanical joints e.g. flexible couplings, flange adaptors, etc. in chambers and/or above ground shall have been factory epoxy coated and where indicated on drawings or in the Bill of Quantities shall after installation be cleansed by brushing away soil and then shall have an approved mastic blanket moulded around them so as to provide a contour suitable for wrapping the component with an approved petrolatum anti-corrosion tape suitable for tropical climates which shall then be done so as to achieve a clean and neat good tape finish..

18 PROTECTION TO FLEXIBLE COUPLINGS AND FLANGED ADAPTORS FITTED TO EPOXY COATED PIPE SPIGOTS.

Where factory coated flexible couplings have been used on pipes whose exposed surfaces beyond other protection materials have been factory protected using epoxy, then such joints shall be site protected by a polythene outer wrap sheathing of minimum thickness 200 microns that shall extend beyond the pipe

epoxy coating by at least 500 mm. This outer wrap shall be double strapped using a non-metallic strap to each pipe end beyond and not to the epoxy coating.

19 BURSTING DISCS AND BURSTING DISCS DEVICES

Bursting discs and bursting disc devices shall be in general accordance with SSRN 233. A minimum pack of 5 such bursting discs shall be provided with each bursting disc device.

20 IN-SITU WELDING OF STEEL FITTINGS AND FLANGES

Wherever it is necessary to undertake in-situ welding of steel fittings and flanges the work shall be undertaken under cover, temporary or otherwise. Outside of buildings, the cost of providing such cover shall be deemed included in the Contractors rates. Only suitably qualified welders shall be employed.

Welding procedures used shall comply with SSRN 670.

Prior to deployment of any welder he shall within the preceding 3 months have satisfactorily undergone an 'approved testing' in accordance with SSRN 671 and certification thereof shall be provided to the satisfaction of the Engineer. Each welder deployed shall at intervals of not more than 6 months undergo similar approved retesting and only those who pass such retesting will be allowed to continue to undertake the in-situ welding works.

All testing and retesting will be deemed to be covered in the Contractors rates.

21 PIPE SUPPORTS

Pipe supports shall meet the requirements of SSRN 406.

22 SERVICE PIPE CONNECTIONS

All tapping shall be carried out using tapping saddle clamps (sleeves or collars type – surrounding the pipe). Self tapping directly on pipes shall not be permitted. Ferrules alone shall not be permitted

The form of the customer connection tapping clamp shall be two equal halves held together by threaded ends, washers and bolts. The tapping clamp for flexible pipes shall be double band with a minimum thickness of 1.5 mm if made from stainless steel. The body part of the tapping clamp shall be of robust ductile iron or stainless steel with a fusion bonded epoxy coating of not less than 300 microns dry film thickness. The seal shall be of elastomer or nitrile rubber material and shall surround the pipe circumference completely and shall be suitable for use with potable water. The tapping clamp shall be supplied complete with removable and lockable ferrule (if indicated on drawing). They shall be of approved manufacture which shall not be unreasonably withheld.

The customer connection tapping clamp shall have following features:

- They shall be impressed with the logo of the Employer.
- All stainless steel parts shall conform to high corrosion protection grade (AISI 316 L).
- The rubber lining shall eliminate metal to metal contact or metal to plastic contact and insulate against galvanic corrosion between two different types of metals.
- They should be able to fit range of pipe diameters and also be able to adapt to pipe irregularities and ovality

- Double band or wide bodies to allow large surface area contact with the pipe body for supporting the pipe.

Any Tenderer who in his Tender offers service pipe connections that are not fully in compliance with these requirements will be required to confirm in writing that he will meet the requirements of this clause in full without any price adjustment to his offer if his Tender is to be considered for possible award.

23 HYDROSTATIC TESTING OF PIPELINES

After laying, new pipelines shall be tested under pressure and where in trench, such tests shall be made before it is completely back-filled. During the test, all joints shall be clear of earth, timber, etc. to allow visual inspection. Testing shall commence when not more than 20% of all pipework has been laid and at no time may there be more than that remaining untested.

Where old pipelines that are yet to be taken into service are involved they shall be similarly tested, except that the Engineer may specify at what stage testing is required.

The pipeline shall be tested in lengths between valve locations or in such shorter lengths as the Engineer may approve on the understanding that no extra cost will be incurred to the Employer but the maximum length of main to be tested, shall not normally exceed 1 km.

The Contractor shall supply all necessary materials to carry out the test in accordance with the requirements including force pumps, water pressure gauges, including tools for the use of the Engineer, interconnecting pipework, feeding tank, blank flanges, temporary stop-ends, struts and water for the test. The test section shall be capped or flanged off at each end and all branches. Testing shall not take place against closed valves.

For a pipeline incorporating flexible joints, testing shall not commence until after all the permanent anchor blocks along the pipeline have been constructed and soil around them backfilled and compacted. Capped or flanged ends along the pipeline shall also be anchored adequately to withstand the force due to test pressure. The Contractor shall submit his proposals for temporary anchoring to the Engineer for approval.

After the main has been clear of debris, and all necessary stop-ends and gauges fitted to the Engineer's approval, the Contractor shall fill up the pipe with water free from silt, and sand and grit and bring up the pressure steadily to the nominal pressure of the pipe or incorporated fittings, whichever is the lesser, (except for old pipelines where a lower value may be specified by the Engineer), and maintain it with a force pump for 24 hours.

The pressure shall then be increased steadily in increments of 1.0 kg/cm² with a pause of one minute between each increment to the specified test pressure for the section. Unless otherwise specifically mentioned, the applied test pressure shall be measured at the lowest point along the section being tested.

Where test pressure has not been specified, it shall be assumed to be 1.5 times the rated nominal pressure (PN or NP) of the pipe.

After a period of half an hour, the fall in test pressure shall be recorded and sufficient water again pumped into the line under test to bring the pressure back to the test pressure. The procedure shall be repeated every half-an-hour for a total

period of 3 hours, or longer, if the Engineer so directs, and the amount of water pumped in recorded.

The rate of leakage shall be calculated from the amount of water pumped in during testing and if it is less than 1 litre of water per 10 mm diameter of pipe per km of length of pipeline, for each 24 hours and for every 30 m head, the pipeline will be considered to have passed the test.

Leaks exceeding permissible amounts shall be made good. And faulty pipes, fittings, and specials, shall be replaced by the Contractor at his own expense and the section tested again before approval is given for backfilling. Payment for the section will not be certified, until the test has been passed and backfilling completed.

24 FLUSHING AND STERILISATION

This shall be done in accordance with the recommendations set out in SSRN 651.

All tested pipework shall be flushed and cleaned and all treated water pipework shall additionally be sterilised. The rates inserted are to be for the flushing and sterilising, and where appropriate for cleaning shall be inclusive for, sampling, testing and inclusive of the reports on the bacteriological quality of water.

25 Horizontal Directional Drilling (HDD) for Road and Rail Crossings

The Contractor shall install pipes using horizontal directional drillings at the locations specified in the drawings and the bills of quantities. The locations are normally across heavily trafficked roads and railway crossings where bypass or diversions cannot be readily made. The Contractor shall be responsible for all the design, permit acquisition from the relevant authority responsible for roads or rail and for implementation and restoration. The following procedure shall be applicable for HDD:

A. Design Guidelines

Prior to submitting an application for a Right-of-Way Permit to the relevant authority responsible for roads or rail that will involve horizontal directional drilling (HDD), the Contractor shall ensure that the following decision process and tasks are completed and approved by the Engineer:

- (i) Prepare or obtain scaled mapping for the planned installation
 - including all exiting surface facilities and improvements.
 - and including any indication of underground facilities or improvements.
- (ii) Collect existing underground utility information
 - including the horizontal location of all known substructures (expected).
 - and including the depth of all known substructures (whenever possible).
- (iii) Obtain Right-of-Way information from the relevant authority responsible for roads or rail.
- (iv) Obtain general and/or specific geotechnical information as required or deemed necessary
 - including soil data for the project area.

- and possibly including site-specific geotechnical sampling and analysis to confirm the soil data.

(v) Prepare Design Drawings using the information noted above

- including the location of all planned improvements,
- including existing underground utility information, and
- including right-of-way limits and property ownership information (as required).

In addition to the design requirements listed above, the Contractor shall take into consideration the following:

(vi) the minimum horizontal and vertical clearance requirements when determining the HDD alignment

- including road setbacks and existing surface features,
- and including exiting underground utilities and other underground facilities;

(vii) pipe sizes to be installed and their corresponding reamer diameter requirements;

Pipe Diameter	Reamer Diameter
< 200 mm	Diameter + 100 mm
200 – 600 mm	Diameter + 150 mm
> 600 mm	Diameter + 300 mm

(viii) the bore geometry for the given ground profile

- including bore length(s) and depth requirements, and
- including bending radii for the final product pipe (Typically 13 m radius per 10 mm pipe diameter, with 200 m to 330 m radius minimums depending on subsurface materials and equipment requirements);

(ix) drilling equipment requirements for the given geotechnical conditions, geometry and final product diameter

- including thrust and pullback ratings
- including mud motors vs jetting heads and
- including wire line vs walkover tracking systems;

(x) equipment and material handling requirements

- including drilling fluid and drilling fluid containment
- and including drill operation and final product staging.

(xi) material strengths, capacities, and coupling methods.

B. Right-of-Way Permit Application Requirements

The Contractor shall submit the following information with the application:

(i) Provide proposed HDD Location Information

- Pipe diameters, type, pressures etc.,
- Locations, length and depths, covers, clearances.

(ii) Provide Design Drawings on scalable mapping and shall include:

- the proposed alignment (dimensioned),
 - existing utility information (within 10m of the proposed crossing), and
 - the road right-of-way information
- (iii) Provide specific installation requirements or typical installation parameters indicating the design bending radii and diameter(s).
 - (iv) Provide assumed subsurface geotechnical conditions based on local knowledge or based on specific site soil tests.
 - (v) Provide a Traffic Control Plan
 - (vi) Provide a Storm Water Pollution Prevention Plan
 - (vii) Provide a Construction Schedule indicating the proposed start date(s), completion date(s), and restoration schedule.

C. Construction Safety Guidelines

Prior to performing work involving HDD under a Right-of-Way Permit, the Contractor shall consider the following safety guidelines and shall obtain approval of the Engineer:

- a) Perform all operations in compliance with safety guidelines and ensure that all personnel are properly trained and equipped to work in the public right-of-way;
- b) Ensure that the approved traffic control plan (required with the permit application) is implemented and followed at all times;
- c) Ensure that all storm water pollution prevention measures (required with the permit application) are implemented and followed at all times;
- d) Ensure all setbacks, offsets, and clearances are maintained;
- e) Ensure that **the relevant authority responsible for roads or rail** or other utility coordination requirements have been met;
- f) Positively identify from records or by potholing all crossed utilities that are expected to be
 - above and within 2 m of the proposed vertical alignment,
 - below and within 1 m of the proposed vertical alignment,
 - and additionally as requested by the relevant responsible authorities;
- g) Positively identify from record or by potholing all parallel utilities at the beginning and ending of all bores and
 - every 70 m if it is within 2 m of the proposed alignment,
 - every 15 m if it is within 1 m of the proposed alignment,
 - and additionally as requested by the Engineer.
- h) The HDD Contractor shall have a planned response in the event of a utility strike including utility owner notification and
 - avoiding electrocution in the event of an electric strike,
 - avoiding combustion in the event of a gas line strike,
 - avoiding contamination in the case of a sewer strike.

D. Drilling Fluid Containment and Disposal Requirements

The HDD Contractor shall contain, handle, and dispose of drilling fluids in accordance with the following requirements:

- a) The use and composition of all drilling fluid and fluid additives shall be disclosed to the Engineer in advance.
- b) Excess drilling fluid shall be confined in a containment pit at the entry and exit locations until recycled or removed from the site.
- c) Precautions shall be taken to ensure that drilling fluid does not enter roadways, streams, municipal storm or sanitary sewer lines, and/or any other drainage system or body of water.
- d) Unintended surfacing of drilling fluid shall be contained at the point of discharge and recycled or removed from the site.
- e) Drilling fluids that are not recycled and reused shall be removed from the site and disposed at an approved disposal site.
- f) Drilling fluids shall be completely removed from the construction site prior to back filling or restoring the site.
- g) Collection, transportation, and disposal of drilling fluids shall be environmentally safe and comply with local ordinances and government regulations.

E. Construction Requirements

All construction work shall be performed in accordance to the following unless stated otherwise by **the relevant authority responsible for roads or rail**, and as outlined below. For all work involving horizontal directional drilling under a Right-of-Way Permit, the Contractor shall perform the following:

Prior to Construction:

- a) The HDD Contractor shall familiarize itself with the work area and the technical requirements of the plans;
- b) The Contractor shall establish construction marking/staking, prior to construction, to indicate
 - HDD entry and exit locations, and
 - proposed HDD alignment at 10m (max) intervals;
- c) Provide the Engineer with a contact list of all crew foremen.

During Construction:

- a) The HDD Contractor shall calibrate its tracking and locating equipment at the beginning of each work day;
- b) The HDD Contractor shall monitor and record the alignment and depth readings provided by the tracking system
 - every 10 m for normal conditions,
 - every 2 m where precise alignment control is necessary;
- c) The HDD Contractor shall complete the HDD installation as designed and permitted both horizontally and vertically unless otherwise authorized by the Engineer;

- d) The HDD Contractor shall attempt to maintain drilling fluid circulation throughout the HDD process;
 - during the initial pilot hole installation, and
 - during the reaming and back pull process(es)
- e) The HDD Contractor shall not expand the bore hole by more than 150mm using only compaction reamer(s);
- f) The HDD Contractor shall plan its reaming and back pulling operations carefully to insure that, once started, all reaming and back pulling operations can be completed without stopping and within the permitted work hours;
- g) The HDD Contractor shall at all times and for the entire length of the HDD alignment be able to demonstrate
 - the horizontal and vertical position of the alignment,
 - the fluid volume used, return rates, and pressures;
- h) The HDD Contractor shall inspect the work and surrounding area to insure that no construction-related damage has occurred
 - including heaving or humping of paved surfaces, and
 - including drilling fluid fractures or releases.
- i) At all times the Contractor shall provide access to the Engineer's representative for inspection of the HDD operations;

Following Construction:

- a) The Contractor shall notify the Engineer as appropriate upon completion of the authorized work;
- b) Prior to the start of backfilling excavations under paved surfaces, the Contractor shall notify the Engineer to schedule an inspection. Upon completion of all right-of-way restoration activities, the Contractor will schedule a closeout inspection;
- c) The Contractor shall insure that all cleanup and restoration is in compliance with the requirements for restoration, reinstatement and cleaning up;
- d) The Contractor's 1 year maintenance period will not begin until any corrective actions required have been completed and inspected to the Engineer's satisfaction.

F. Storm Water Pollution Prevention

All construction activities shall be performed in accordance with the acceptable international standards and Best Management Practice, to ensure that storm water runoff is not contaminated by sediment caused by land disturbances associated with construction activities. The following seven main objectives shall be applied for all Storm Water Pollution Prevention planning:

- a) ensure that sediment controls are in place prior to disturbance.
- b) Maintain sediment controls throughout the construction and restoration processes.

- c) Minimize the overall disturbance whenever possible.
- d) Protect disturbed areas throughout the construction process.
- e) Prevent storm water runoff from entering disturbed areas.
- f) Never intentionally discharge construction contaminants directly into creeks, rivers, ditches, or storm systems.
- g) Complete permanent restoration as soon as possible.

In addition to those overall goals stated previously, the contractor shall, at a minimum, implement the following specific Best Management Practices:

- h) Provide temporary erosion protection whenever possible:
 - Mulch, seed, or gravel may be applied even if a disturbed area may and/or will be disturbed again or other permanent measures of stabilization are to follow;
 - Cover spoil piles with a tarp or contain with a sediment barrier.
- i) Contain disturbed sediment on site:
 - Use sediment barriers such as silt fence, sand bags, straw bails, rock checks and/or sediment traps to contain sediment on the construction site;
 - Existing vegetation may be used as a sediment filter where minimal grades and sheet flow runoff will occur;
 - Ensure that all sediment barriers are installed and functioning properly.
- j) Avoid causing flooding in roadways and adjacent right-of-way:
 - Do not block existing culverts and storm inlets except as a last resort;
 - Ensure that sediment is removed from sediment traps and filters after storm events.

G. Construction Records and As Built Plan Requirements

The HDD Contractor shall keep detailed and accurate records of all activities associated with the HDD process. Upon completion of HDD installations, the Contractor shall provide the Engineer with As Built plans and any supporting documents within 60 days of project completion. As Built plans are preferred in AutoCAD format but may be submitted in paper form. HDD construction records and As Built plans shall include the following:

- a) HDD tracking data and operator logs shall be maintained daily and shall be made available upon request from the **relevant authority responsible for roads or rail**. These field records and operator notes shall specify:
 - the type of tracking equipment used,
 - the length and depth of the HDD installation,
 - additional information that may include steering adjustments and other equipment performance parameters;

- b) As Built plans shall be derived from the tracking data and operator logs. At a minimum, the drawings shall indicate:
 - horizontal and vertical HDD alignment,
 - existing utility horizontal locations and depths at all exposed locations,
 - existing utility horizontal locations where indicated with field locates.

26 Tie-in Works Between Existing and New Pipelines

a) General

This specification clause shall apply to any tie in works between existing operational and new pipelines which involve closing down of any main which is in service supplying water, either Raw or Treated, within the existing supply system. It shall further apply to any new fitting that has to be inserted into an existing operational pipeline.

The Contractor shall be responsible for the execution of the works except under circumstances where the execution of the tie in operation is assumed by Engineer as mentioned under (f) below, from the date of the Engineer's instruction to perform described under (g) below. The Engineer's instruction to perform the tie in will be given at least 14 days before the date on which the tie in is to be executed.

b) Fittings

The Contractor shall take delivery of any fittings required at the Works not less than 96 hours before the commencement of the tie in operations. He shall provide all the necessary guarding to ensure that such fittings do not get misplaced or stolen. The Contractor shall, check the suitability of such fittings including checking of all dimensions, particularly the external diameter of the pipe into which the connection is being made and the internal diameter(s) of couplings which are to be used for such connection. This shall be done by measuring diameter at 4 positions to a tolerance of 0.25 mm. The Contractor shall certify the suitability of such materials to Engineer not less than 48 hours before the commencement of tie-in operations.

The Contractor shall prepare a schedule of fittings including those on existing pipes that are to be used for such tie-in or redeployed elsewhere as instructed on the drawings and shall obtain approval of the Engineer not less than 48 hours before the commencement of tie in operations of such schedule.

The Contractor shall ensure that all materials are at the site of the works not less than 24 hours before the commencement of the tie-in operation and shall inform the Engineer who shall check the materials against the schedule as approved where he deems this necessary

Any non-standard fittings which are required for the execution of the tie-in works shall be fabricated under the Engineer's supervision and shall be hydro statically tested to at least one and a half times the maximum working pressure.

c) Personnel

The Contractor shall ensure that at least one senior member of his field supervisory staff who has proven experience of such operations and fluent in English and the language of his labourers is on site throughout the whole duration of the tie in operation.

The Contractor shall also ensure that all necessary skilled artisans for the operation of all his plant are on site for the whole duration of the tie-in operation.

The Contractor shall furnish the Engineer's Representative a list of the key personnel to be involved in the tie in exercise at least 48 hours before the commencement of the exercise and shall get the Engineer's approval at least 24 hours before the commencement in respect of such personnel. To gain this approval the Engineer may require that operative is tested in the performance of his duties in the operation of the plant for which he is in attendance. In particular this requirement shall apply to all welders, pipe cutters using either mechanical or flame cutting equipment and lifting plant operators.

The Contractor shall ensure that an adequate number of labourers are in attendance upon the site during the period of the tie in operation.

d) Pre Tie-in Works

The Contractor shall execute all works possible before the commencement of the operations which shall include:-

- Excavation and supports to the excavation.
- Blinding with concrete the bottom of the excavation and (where instructed by the Engineer) immediate working areas.
- Provision of any required drains a sump of adequate size from which any accumulating water is to be pumped out.
- Casting of the floor of any chamber which is to be constructed around such tie-in works.
- Casting of any thrust blocks or thrust walls or any other works necessary for effective execution of the tie-in works as may be required by the Engineer.

The Contractor shall complete these works at least 96 hours before the commencement of the tie-in operation or within a period that may be otherwise set by the Engineer upon issue of the Engineer's instruction to perform the tie-in works, and obtain the Engineer's approval not less than 24 hours before commencement of the tie-in operations.

e) Plant

The Contractor shall prepare a schedule of the plant which he proposes to have on site either to use, or on standby, or for emergency use and shall obtain the approval of the Engineer not less than 48 hours before the commencement of the tie-in operations.

Such Plant shall include:

- Excavation plant
- Cutting equipment

- Lifting equipment
- Pumping equipment (unless a drain is provided)
- Concrete Mixer
- All tools necessary for the erection and assembly of the plant.

The Contractor shall also ensure that all plant is on site not less than 24 hours before the commencement of the tie-in operation and shall inform the Engineer who shall check the plant against the schedule as approved where he deems this necessary.

f) Actual Tie-in Works

The Contractor shall prepare a programme giving details of the proposed scheduling and sequencing of tie-in works necessary for minimising the interruption to the existing water supply. Approval of such programme by the Engineer shall be obtained not less than 72 hours before commencement of the tie-in operation.

The Contractor, unless relieved of the responsibility by the Client or the Engineer, shall first empty the section of the main on which the tie-in is to be made and shall ensure that the nearest air valves and washouts immediately upstream and downstream are all open and the washout dry.

Where the Contractor is relieved of this operation, which shall be notified to him by the Engineer not less than 96 hours before the tie-in operation is due to commence, he shall check that air-valves and washouts mentioned above are in the state described.

When the Engineer is also satisfied that the main is empty of water he shall verbally give the order to commence the works from which time the Contractor shall be solely responsible for the execution and completion of the tie-in works unless relieved of such responsibility by the Engineer.

In event that the Engineer directs that the required tie-in works be carried out during the night for purposes of minimising the effect of such tie-in on the respective consumers/authority, the Contractor shall make all required preparation for provision of lighting (including standby and emergency) and any other measures as the Engineer may direct.

The Contractor shall provide all the insurance normally required by the Engineer and the operating FIDIC Condition of Contract and shall obtain an endorsement if necessary to ensure that the insurances remain valid in the event that the Engineer takes over the direction of the works.

When the Engineer is satisfied that the tie-in works are completed he shall give notice for the main to be re-commissioned, when this has been satisfactorily accomplished the Contractor shall re-deploy his staff on the Engineer's verbal instructions of completion of the tie-in.

g) Post tie-in Works

Within 48 hours of the completion of the tie-in works the Contractor shall have completed all permanent works required to support the plant installed during the tie in operation, and shall remove all temporary supports within a further 48 hours after the permanent support works have been approved by the Engineer. The temporary supports shall not be removed before such approval has been given.

Within 14 days from the date of the completion of the tie-in the Contractor shall have completed all the other permanent works required to allow operation of the plant installed during the tie-in operation, or other plant for which the tie- in executed, and shall obtain the approval of the Engineer on the completion of such works.

The Engineer shall issue the Contractor with a notice stating the operations for which the plant installed during the tie-in operation may be used, which shall remain in force for a period extending for 28 days from the date of approval of the completion of the Post tie-in works as described above.

Before the expiry of the 28 day period described above the Contractor shall obtain the approval of the Engineer for the completed works when the Engineer shall issue a notice allowing full operation of the plant on the expiry of the above mentioned period upon which the Contractors responsibility for the works, unless requested otherwise shall cease.

h) Form to be Used

A copy of the Form to be used for each tie-in work is given below.

SCHEDULE OF INSTRUCTION, SUBMISSIONS AND APPROVALS FOR THE TIE-IN WORKS				
1)	Engineers Instructions to Perform Tie-in		.....
	14 Days			
2)	Materials: Acceptance by Contractor		.....	96
	hours			
	Certificate of Suitability by Contractor		.....	48
	hours			
	Schedule of those needed	submission	.....
	approval		.....	48
hours				
	Arrival on Site		.....	24
	hours			
	Checked on Site by the Engineer		.....
3)	Works Programme of Execution	submission	.....
		approval	.....	72
hours				
	Schedule of plant	submission	.....
		approval	.....	48
hours				
	Plant	arrival on site	.....	24
	hours			
		checked on site by engineer	.....
	Artisans	approved by engineer	.....
	24 hours			
		testing of by engineer	.....
4)	Notice of Responsibility for Drawing Mains		.....	96
	hours			
5)	Pre-tie in Works	completion of	.....	96

hours	inspection by engineer	.....	24
hours			
6)	Engineer's Verbal Instruction to Commence when Main is Dry		
7)	Engineer's Verbal Instruction to Re-commission Main	.....
8)	Engineer's Verbal Approval of the Tie-in Completion	.....
9)	Engineer's Notice of Plant Operations Allowed	.....
10)	Support Works: completion	.....	48
hours			
	approval by engineer	.....
	removal of temporary	.....
11)	Post tie-in Works completion	.....
14 days			
	approval by the engineer	.....
12)	Final Approval by the Engineer of Whole Works	.....
42 days			
NOTE: A) Times given are the latest			
B) Where items are not given the Contractor shall ensure execution of that item so as not to cause any other item to be delayed.			

11 PART V – VALVES, METERS, FITTINGS AND OTHER RELATED ITEMS

27 VALVES - GENERAL

Isolating Valves up to and including DN 300 shall be gate valves, and valves larger than DN 300 shall be butterfly valves, except where otherwise specified on drawings or in Bills of Quantities.

All valves shall bear an identification mark on the upper body that shall include:

- the name of the manufacturer and/or his trade mark
- the nominal diameter (DN)
- the nominal pressure (PN)

The manufacturer's full technical leaflets shall be supplied to the Engineer in triplicate by the Contractor for approval prior to confirmation of any order for valves.

The valve body shall be cleaned and shot blasted to SSRN 937 before being internally and externally protected.

All isolating valves shall be protected by fusion bonded powder epoxy or equivalent, internally suitable for potable water and to a minimum thickness of 150 microns, or in aggressive soils of 300 microns thickness indicated as such on drawings and in the Bills of Quantities.

All valves shall be designed for a maximum permissible pressure of 16 bar except where otherwise specified on drawings or in bills of quantities. All valves shall close when the stem rotation is in a clockwise direction unless otherwise specified.

28 Gate Valves

Unless otherwise specified gate valves of nominal diameters up to and including DN 300 shall be made of epoxy coated cast ductile iron in accordance with SSRN 501. The epoxy coating shall be not less than 150 microns thickness. The gate shall be completely rubber encapsulated, the gate valve being of pocketless type with a straight through port. Gate valves shall be capable of sustaining a maximum permissible working pressure of 16 bar except where otherwise indicated on drawings or in bills of quantities. Gate valves shall be provided with integral flanged ends unless otherwise indicated on drawings or in bills of quantities.

Unless otherwise specified the face to face dimensions of gate valves with integral flanged ends shall be in accordance with SSRN 518 basic series 14 (short) or basic series 15 (long) as indicated on the drawings or in the bills of quantities.

Where specified, valves for replacement washouts shall have valve bodies of epoxy coated ductile iron and the flanges shall be undrilled. Face to face dimensions for these valves shall be to EN 558 and EN 12627 basic series 14 (short).

Gate valves shall be of the non-rising stem type except where specifically indicated otherwise. The stem seal shall be of toroidal sealing rings (O-rings) with at least two such seals. Seals shall be capable of being replaced with the valve under pressure and in the fully open position.

The gate shall be of ductile iron fully rubber encapsulated, the gate sealing in the body being ensured by compressing of the rubber. Wedge/gate guides of wear resistant plastic with high gliding features shall be provided in the body, optimally placed to guarantee low wear and tear of the gate and low closing torques.

The bonnet gasket shall be of elastomer (suitable for potable water). The bonnet studs or allen screws shall be corrosion-protected. In addition the studs/allen screws shall be placed in countersunk holes in the bonnet and completely sealed with wax or a suitable material, which can be removed by low-temperature melting in case they have to be disassembled.

The gate valves bodies shall be works cleaned and shot-blasted in accordance with SSRN 937 before being coated internally and externally. The body, the bonnet and the gate of the valve shall be made of ductile iron to SSRN 240, the gate being encapsulated with elastomer EPDM, nitrile or equivalent.

The operating stem shall be made of stainless steel at least equivalent to SSRN 936/A, except in areas of aggressive soils where this shall be to SSRN 936/B, indicated as such on drawings and in bills of quantities.

The stem nut shall normally be made of high tensile brass to SSRN 941, except in areas of aggressive soils where this shall be aluminium bronze to SSRN 942, indicated as such on drawings and in bills of quantities.

Furthermore and in aggressive soils indicated are such on drawings and in bills of quantities, outside bolts and nuts shall be made of stainless steel to SSRN 936/C or as detailed on drawings.

29 Butterfly Valves

Butterfly valves for manual operation shall comply with SSRN 506 and shall be double flanged, resilient and metal seated tight shut-off design and of the eccentric disc type supported from two shafts placed in self lubricating bearing bushes.

Butterfly valves shall be capable of sustaining a maximum permissible differential working pressure of 16 bar except where otherwise indicated on drawings or in bills of quantities.

They shall operate with a clockwise closing direction. The valve disk shall rotate through an angle between 0 degrees and 90 degrees inclusive. The sealing ring shall be made of EPDM rubber and shall be attached at the disk edge circumference by a retaining ring without adjustment to form a resilient and durable seal.

The valve disc seal shall be replaceable without dismantling the operating mechanism, disk or shafts, and without removing the valve from the pipeline.

The Butterfly valve shall be equipped with an inversible and proportional worm gear operator. This shall be either with or without an additional primary reduction gear placed within a waterproof housing dependant upon nominal valve diameter and maximum working conditions as stated in the bills of quantities.

The operating mechanism shall be permanently lubricated, not in contact with the water and tilted with an OPENED/CLOSED proportional position indicator in order to indicate the disk angular position. The mechanism shall be sized in order to minimise torque for ease of manual operation under maximum differential pressure and shall be with high-class enclosure IP67 to SSRN 038. Valve body, disk and disk retaining ring shall be in ductile "SG" iron casting to SSRN 240. Disk shafts shall be in stainless steel to SSRN 936/A.

The valve body shall be cleaned and shot blasted to SSRN 937 and internally and externally protected with paint suitable for potable water.

Each butterfly valve shall be works pressure tested in accordance with SSRN 517

- body test at a minimum pressure of 1.5 times the maximum permissible pressure
- seal test at a minimum pressure of 1.1. times the maximum permissible pressure.

30 Handwheels and Valve Caps and Valves

Handwheels are to be provided for all valves in chambers. They shall have cast into them the words 'open' or 'closed', together with an arrow indicating the direction for such opening or closing.

Valves for tee-key operation shall be provided with valve caps conforming to the appropriate tender/contract drawing.

31 VALVE KEYS

These shall be of mild steel with ends to suit either valves to SSRN 501, valves to SSRN 506 or valves to SSRN 511 fitted with valve caps, dimensioned to the appropriate Tender Drawing.

32 NON-RETURN VALVES

These shall have bodies made from bronze for DN not greater than 40 mm and they shall be of the swing pattern and shall be rated for at least PN 10 or greater

as specified. The ends shall be either screwed to SSRN 223 or flanged to SSRN 207, PN 10 or as the installation demands.

For DN greater than 40 mm they shall be of a profiled poppet type with non-slam characteristics (surge suppressing type) and be of approved manufacture. The proposed valve shall be of low pressure loss and maintenance free with PN 16 rating (unless otherwise specified) and shall achieve a movement from fully open to fully closed on pump stoppage in 0.1 to 0.3 seconds. The valve housing shall be of epoxy-coated cast iron and flanged with the closing system of stainless steel.

With his tender, a Tenderer shall have supplied full technical details of the valves he proposes to supply and install. If the Engineer deems the valve proposed to be appropriate he will accept the offer. If however the Engineer considers the offer to be inappropriate he will reject the offer from the Tenderer and instruct him instead as to the

acceptable manufacturer(s) of these items. Should a financial offer from a Tenderer in this regard be obviously under-priced then the cost of supplying an appropriate valve shall be fully to the account of the Contractor.

33 Air Release and Vacuum Break Valves

Automatic air relief and vacuum break valves (air valves) shall be of the anti-shock anti-surge type (Ventomat RBX or approved equivalent) design.

Bids which apparently contain non-compliant offers will be required to confirm that they will meet these specifications in their totality at the rates quoted in their offer.

Such valves shall meet the following requirements:

The required valves shall provide all of the functions described below.

i. Pipeline filling

Uninterrupted high volume air discharge through the large orifice.

ii. Pipeline draining or Column Separation

Uninterrupted high volume air intake through the large orifice.

iii. Pipeline full and operating

Discharge of disentrained pressurised air through the small orifice.

iv. Rapid Filling / Column Separation

The valve must incorporate an integral surge alleviation mechanism that will automatically dampen surge pressures due to rapid air discharge or the subsequent rejoining of separated water columns.

The air release and vacuum break valve shall be of a compact single chamber design with solid cylindrical High Density Polyethylene control floats. These shall be housed in a tubular stainless steel or corrosion protected body with epoxy powder coated cast iron, or s/steel ends secured by means of stainless steel tie rods.

The valve shall have an integral surge alleviation mechanism which shall operate automatically to limit transient pressure rise or shock induced by closure due to high velocity air discharge or the subsequent rejoining of separated water columns. The limitation of pressure rise must be achieved by deceleration of approaching water prior to valve closure. Relief mechanisms that act subsequent

to valve closure cannot react in the low millisecond time span required and are therefore unacceptable.

Large orifice sealing shall be effect by the flat face of the control float seating against a nitrile rubber 'Ó' Ring housed in a dovetail groove circumferentially surrounding the large orifice. Discharge of pressurised air shall be controlled by the seating and unseating of a small orifice on a natural rubber seal affixed to the control float.

The intake/discharge area shall be equal to the nominal size of the valve i.e. a 150 mm valve shall have a 150 mm intake/discharge orifice.

The valve construction shall be proportioned with regard to material strength characteristics, so that deformation, leaking or damage of any kind does not occur by submission to twice the designed working pressure.

The valve design shall incorporate an over pressure safety feature that will fail without an explosive effect, such as is normally the case when highly compressed air is released suddenly. This feature shall consist of easily replaceable components such as gaskets, seals or the like.

The air valve shall be provided with a separate isolating gate valve or if so specified with a separate isolating butterfly valve.

Unless otherwise specified all air valves shall be provided with an integral flanged inlet with studs appropriate to SSRN 207 NP 10 or as the installation demands and complying with the appropriate nominal pressure.

All air valves at new installations shall be fitted to an air accumulator tee with the branch of a diameter not less then 0,6 times the diameter of the main. Where necessary, a concentric taper either integral with or as a separate fitting shall be inserted between the branch and the isolating valve immediately beneath the air valve and an abrupt diameter change between branch and isolating valve shall be avoided.

34 Surface Boxes

These shall be of cast iron, (hinged and locked) and from an approved manufacturer to SSRN 513. They shall be sized to suit the purpose required and as otherwise shown on the relevant drawings.

The number of keys required (if any) is indicated in the Bills of Quantities.

35 Valve Chambers

New chambers shall be constructed in accordance with the drawings, and where indicated shall incorporate thrust walls.

Rehabilitated chambers shall be constructed or rebuilt or repaired in accordance with the original drawings or as directed by the Engineer's Representative using materials approved by the Engineer's Representative.

Notwithstanding the size and shape of the valve to be supplied the Contractor shall ensure that the minimum clearance as indicated on the drawings are provided within the chamber and that where chambers have pre-cast roofs, the manhole cover provided shall be of a size sufficient to allow for the removal and replacement of the valve without disassembly.

36 Valves Chamber Covers

Unless otherwise indicated in the Bills of Quantities, valve chamber covers shall be reinforced concrete with a weight of minimum 50 kg per piece and provided with embedded steel device for lifting at each end. They shall be supplied complete with lifting keys. Except where a chamber is provided with pre-cast roof slabs to facilitate placing and removal of the valve or valves within the chamber, the clear opening in the chamber cover shall in all cases allow for this. It will be the Contractor's responsibility to ensure that the covers he provides are of an appropriate clear opening size.

37 Reservoir Inlet Valves

All reservoir inlet float operated valves shall be of one of the following types as specified:

- (a) Of the streamline type wherein operation is effected automatically by change of displacement of the float, the alternate actuating forces provided by weight and buoyancy being transmitted by lever mechanism to the valve element.

The float action shall operate the pilot valve housed within the plunger thereby ensuring sensitive response to the small mechanical forces applied. Closure shall be drop tight and the valves shall discharge vertically downwards. The valve shall act from fully open to fully closed with a change in reservoir water level of the order of magnitude indicated below.

Inlet Diameter (Nominal) (mm)	Reservoir Level Change (valve open to close) Approx. (mm)
80	130
150	230
200	260
250	320
300	380
400	850

Where controlled closing and opening of the float valve is required the valve will be provided with a stilling basin to ensure gentle transition on valve closure so as to avoid sudden pressure rise in the incoming main as a result of closure.

- (b) Of a type that has been specifically designed to overcome problems of influence in operation by water surface turbulence and of the risk of causing surge pressures in the upstream pipeline as a result of the closing mechanism deployed. They should further be simple to service without the need for special tools or lifting equipment.

In either case, the valves shall be of approved manufacture.

38 TWO-POINT TIME-MODULATED PRESSURE REDUCING VALVES

To facilitate pressure management, the tender may call for shall supply and installation of two-point time-modulated pressure reducing valves as indicated on the drawings and in the Bill of Quantities.

The time modulated Pressure Reducing Valves shall comprise a main valve and a pilot control system. The valve gate shall comprise a horizontally mounted

resilient disc moving upward to open the valve and downward onto a seat so as to close the valve. It shall be held in place by a diaphragm assembly and spring, accessible from above via a removable cover. Opening, closing and throttling shall be achieved through the connection of upstream, cover chamber and downstream compartments of the valve through appropriate restrictions and throttling controls.

The throttling control shall be capable of being adjusted automatically from outside of the valve at a minimum of two outlet pressures through a time based modulator such that both the pre-set time of adjustment of outlet pressures and the outlet pressures themselves can be changed if circumstances require it. The time modulating device shall be an encapsulated, self contained, watertight device inclusive of a power pack. The power pack shall have a minimum guaranteed usable life of two years. Means of replacing battery pack, and adjusting time and pressures shall be straightforward.

If included, a Tenderer shall be specifically required with his tender to have supplied full technical details of the valves and PRV controllers he proposes to supply and install. If the Engineer deems the valves and controllers proposed to be appropriate he will accept the offer. If however the Engineer considers the offer to be inappropriate he will reject the offer from the Tenderer and instruct him instead as to the acceptable manufacturer(s) of these items. Should a financial offer from a Tenderer in this regard be obviously under-priced then the cost of supplying an appropriate valve and controller shall be fully to the account of the Contractor.