

## C - HANDLING OF PIPES AND SPECIALS

### 1.0 GENERAL

The Contractor shall supply all the pipes and specials required unless otherwise specified and construct and complete the pipeline and all associated works as shown on the Drawings and included herein under the Contract.

### 2.0 ORDER FOR PIPES AND SPECIALS

The quantities of the items in the Bill of Quantities are only approximate and shall be ascertained by the Contractor after the pipeline profiles are determined by joint survey.

Where a pipe special is to be used for connection to existing works, the Contractor shall manufacture the special after he has ascertained the existing pipe diameter, flange and other details at the exact location where it is to be laid.

Excess order of pipes and fittings shall be the responsibility of the Contractor and shall be at his own cost.

### 3.0 HAULING AND HANDLING

Great care shall be exercised to ensure that the pipes and specials are not subject to any kind of shock or sudden load during hauling and handling.

Attention is drawn to the Contractor that thin wall pipes, defined as pipes with a diameter/plate thickness ratio greater than 125, shall be so handled, stored and transported as to prevent distortion or damage to the pipes and shall not be moved in any manner involving rotation of the pipe about the longitudinal pipe axis. Thin wall pipes during delivery and when in transit around the Site shall be supported on three rubber covered saddles shaped to give at least 90° circumferential support and shall be firmly held in position at each saddles by straps tightened by turnbuckles in such a manner that the external coating is not damaged. One saddle shall be at the centre of the pipe length and the other two shall each be positioned at a distance one-fifth of the pipe length from each end of the pipe.

Thin wall pipes in temporary storage or strung out along the pipeline reservoir routes shall be supported on hessian bags filled with fine sawdust straw or similar and shaped

so as to give continuous support under at least 40°-50° of the circumference. The positions of supports shall be the same as that for pipes during transit. The underside of the pipes shall be kept clear of the ground by at least 100mm.

The Contractor shall be unloaded the pipe using hydraulic crane and to ensure cover are not dislodged during handling.

All pipes and pipe specials shall be lifted by means of reinforced canvas slings. The pipes shall be lifted by two reinforced canvas slings at least 300mm wide suspended from a lifting beam so that the slings are positioned approximately one-fifth of the pipe length from each end of the pipe. On no account shall the pipes and specials be

dropped or let fall onto the ground and under no circumstances shall the pipes or pipe specials be lifted by means of hooks to the ends of pipes and pipe specials.

All the open-ends of pipes and specials shall be kept closed by means of end-caps or polyethylene sheets approved by the S.O. before delivery to site from the factory.

After delivery to site, these end-caps or polyethylene sheets shall not be removed until the pipes or specials are ready to be laid in place. All open ends of pipes and specials in the trenches shall remain covered to prevent the entry of any dirt, mud, stone and contaminant. The cover shall also be water tight to prevent the entry of dirty water.

The Contractor shall be deemed to have allowed the cost of providing the above necessary measures in the Contract Rates for supply and laying.

Any damage to or loss of materials shall be made good, or the damaged or lost materials replaced, by the Contractor at his own expense and if approved by the S.O. damaged materials shall be returned to the manufacturer for repair as directed by the S.O.

## 4.0 RECORDS

The Contractor shall keep full and detailed records including item numbers, size of each, and location of all pipes and specials which are :

- delivered to Site
- declared to be defective
- used in the Works
- cut, broken or removed from Site

The Contractor shall keep such records continuously up to date, and shall have them available for inspection by the S.O. at any reasonable time.

## 5.0 LAYING OF PIPES AND SPECIALS

### 5.1 *Prospecting*

The Contractor shall prospect for the position of buried or otherwise hidden obstructions such as existing services, drains, pipes, cables, culverts, etc. Trial holes and pilot trenches to ascertain the exact positions of these shall be sunk, well ahead of pipe-laying and excavation, in places where they are known or thought to be and elsewhere and these shall be backfilled with approved materials immediately and in any case not exceeding 24 hours and subsequently reinstated. Approved marker posts shall be erected to mark the position of all located services, drains, etc, and these shall not be removed until reinstatements have been completed. The S.O. shall instruct further prospecting if he is not satisfied with the sufficiency of the Contractor's prospecting.

Where necessary the Contractor shall make arrangements prior to trench excavation proper for the temporary or permanent support or diversion of services, drains, etc, to the approval of the S.O. and the authority concerned. The full cost of prospecting shall be deemed to be included in the Contract Rates for excavation unless separate items are provided in the Bill of Quantities.

Attention is drawn to Clauses concerning the responsibility of the Contractor for the security of existing services. The Contractor shall be deemed to have allowed for the unavoidable delay of the Works due to any obstruction he may encounter with the existing services and no claim for any extra costs on account of this will be allowed.

## **6.0 PIPE ALIGNMENT AND COVER**

The routes of the pipelines shall be as shown on the Drawings or as directed by the S.O.

Pipes shall be laid to a minimum gradient of 1 on 500 unless otherwise ordered by the S.O. Where the gradient of a pipeline is 1 on 20 or steeper, pipes shall be laid on an ascending gradient starting from washout (low point) and finishing at the air valve (high point).

Pipes shall be laid in straight lines on plan but curves of long radius shall be obtained by deflecting up to a maximum of 5 for spherical type and 2 for hemi-spherical type at welded slip joints and using short pipe lengths if necessary.

The minimum cover to the top of pipes shall be 1000mm unless otherwise specified.

Before commencing excavation the route of the pipeline shall be pegged accurately. Strong sight rails shall be fixed and maintained at each change of direction and gradient, and at as many intermediate points not more than 35 metre apart as may be necessary. On these rails shall be marked the centre line and the level to which the pipe is to be laid.

## **7.0 PIPE-LAYING IN GROUNDS WITH HIGH WATER TABLE**

The Contractor shall note that some parts of the pipelines will be laid in grounds with high water table, especially in areas adjacent to streams, river crossings and ponds.

The Contractor shall allow for all costs for thickening of bitumen thickness to 10mm, for dewatering, keeping all the excavations and trenches dry for the whole pipe-laying work and in a safe manner during construction and the Contractor shall price these works accordingly.

## **8.0 DANGERS OF FLOTATION**

Although flotation of pipes in completely refilled trenches or of the completed works will not occur, the Contractor's attention is particularly drawn to the danger of flotation of pipes laid in trenches left unrefilled and allowed to be flooded with water in the partially completed works.

The Contractor shall, immediately after pipes have been laid, jointed and approved by the S.O., refill and compact excavated materials to at least two thirds of the length of the pipe trench leaving only sufficient space un-refilled to allow for the completion of the external joint. Notwithstanding this, the Contractor shall make all necessary provision to avoid the flotation of any pipe during the construction stage.

Any damage caused by flotation of pipes, specials or fittings in un-refilled trenches shall be made good to the satisfaction of the S.O. at no extra cost.

## 9.0 TEMPORARY CESSATION OF TRENCH EXCAVATION

If in the opinion of the S.O. there is undue delay in:

- refilling pipe trenches,
- testing the pipelines,
- removing surplus material
- general tidying up of areas where pipes have been laid and
- partial restoration or maintenance of surface

The S.O. may order that no further trench excavation shall be opened until the outstanding work has been carried out to his satisfaction and the Contractor shall have no ground for a claim on this account.

## 10.0 EXAMINATION OF PIPES AND FITTINGS

All pipes and specials shall be thoroughly brushed through, cleaned and carefully examined for cracks and flaws both internally and externally immediately prior to laying. Materials damaged in any way shall be shown to the S.O. who will give instructions regarding remedial work or otherwise.

Where ends to be jointed by welding are coated with ensis oil at the place of manufacture the ends shall be thoroughly cleaned with the ensis oil removed.

The ends of pipes and specials shall be wire brushed if necessary and thoroughly cleaned to remove all traces of rust and dirt.

Should any pipe or specials be found to be damaged, it shall be excluded out to the satisfaction of the S.O. In general no pipe shall be laid if an end has suffered distortion from the circular and a mechanical coupling or socket cannot be fitted or, if damage to the internal and/or external protection has not been satisfactorily repaired.

## 11.0 REPAIR OF LINING AND SHEATHING

Only specially competent and skilled workers shall be employed to carry out repair work to damaged linings and sheathing.

Small cracks and flaws in the internal mortar lining of steel pipes and specials may, with the prior approval of the S.O. and if they are accessible, be repaired on Site. Such cracks may be repaired by cutting out a 9mm x 9mm dovetailed key and making good with a semi-dry mortar (proportion 1 part cement to 2 parts coarse sand) well tamped into the groove, and cured by keeping it damp for 7 days. Alternatively, small cracks may be caulked with any epoxy resin filler.

The external sheathing of steel pipes and specials shall be made good wherever the steel has been exposed or the thickness of the coating does not adhere tightly to the steel. Where the steel has been exposed all rust and dirt shall be removed carefully by wire brushing or otherwise, and when perfectly clean and dry, a coat of approved special

quick drying primer applied before re-fettling. Small stones which may have become embedded in the sheathing shall be picked out and the coating refettled by heating

locally with a blow lamp and smoothing over with a fettling knife. Additional external jointing material shall be added wherever necessary.

All defects to linings and sheathings shall be made good to the entire satisfaction of the S.O. Where in his opinion the damage is such that satisfactory repairs on Site will not be practicable, e.g. when damage or cracking is extensive and/or inaccessible, the pipes or specials in question shall be either returned to the factory for proper repair or replaced completely. The Contractor shall be responsible in either case for all costs involved in this respect and for any delays to construction work thereby caused. The compound used for repairing sheathings shall be compatible with the sheathing material and shall be approved by the S.O.

## **12.0 LAYING PIPES AND FITTINGS**

All pipes and fittings shall be laid to the lines and levels shown on the Drawings or as otherwise directed by the S.O. No pipe shall be laid until the pipe trench has been inspected and approved by the S.O. The trench shall be kept sufficiently dry for making joints.

No pipe shall be rolled into place for lowering into the trench. If a crane is used for handling the pipes into the trench, the pipes shall be slung with slings passed around the outside. A recess shall be formed in the trench foundation beneath to permit each sling to be withdrawn without damage to the coating or sheathing. All struts at the ends of the pipes and pipe specials shall not be removed until they are ready for engagement.

Before any pipe or special is lowered into the trench, it shall be cleaned by using water jet where necessary and re-examined for cracks and flaws whilst hanging in the sling. All excavated areas in the trench must be dry and clean. If undamaged it shall be placed in position ready for jointing. Except for pipework to be embedded in concrete, all pipes and specials shall be placed on a solid and even foundation for their full length. Pipe and specials shall be placed in position singly and the order of laying pipes shall be subject to the approval of the S.O. Working space of 450mm gap beneath the pipe joint area is required for proper jointing and cleaning. If any sewer pipe is damaged during trench excavation and causes flooding in trench, 65% concentration calcium hypochlorite shall be used to disinfect the pipeline and the excavated trench.

Joint holes shall be formed in the excavation as necessary for the convenient and proper making of the joints, and each pipe or special shall be individually set for line and level using boning rods.

Pipes and specials to be embedded in concrete shall be held firmly in position and protected from damage while the concrete is being placed. Should any pipe become either partially or wholly clogged before final acceptance of the work, it shall be cleaned out or replaced by the Contractor at no extra cost.

After laying, the interior of pipes or specials shall be carefully cleaned again to remove any debris, dirt, stones or other matter that may have entered during laying. Except when work is actually proceeding, all open ends of pipes and specials in the trench shall be kept closed by means of a fine wire gauge wooden stoppers or other approved means, to prevent the entry of dirt, stones and the like, but such stopper shall allow the entry of water.

## **13.0 SPECIALS**

The approximate positions of all specials are shown on the Drawings. The exact positions shall be determined on Site by the Contractor to the approval of the S.O.

## **14.0 PIPE CUTTING**

Where it is necessary to cut pipes to provide closing lengths or for laying pipe specials or in the repair of damaged or chipped pipes, the cutting shall be neatly and accurately performed so as to leave the end of the pipe truly normal to the axis of the pipe.

## **15.0 WELDING OF JOINTS**

### **15.1 *Welding Procedure***

All electric arc welding equipment shall be to the approval of the S.O. The Contractor shall submit details of the welding procedure, which he proposes to adopt for the S.O.'s approval. Details shall include:

- Make, type and gauge of electrodes
- Size, shape and number of runs in welded joint
- Direction of welding
- Current strength

The Contractor shall make test specimens on pipes of the same size and thickness on the pipelines to be welded. These pipes shall be supplied by the Contractor. The joints shall be tested in the presence of the S.O. for each procedure proposed in accordance with the requirements of Clause 7 of BS 4515.

Only procedures approved in writing by the S.O. shall be adopted in the welding of the pipelines, and change from one procedure to another will not be permitted without submitting the new procedure for re-testing.

## **16.0 WELDING PERSONNEL**

Only the most highly skilled welders shall be employed on the Works, and every welder before commencing any joint welding shall prepare specimens for testing in accordance with Clause 7 of BS 4515 for each welding procedure proposed by the Contractor. Every welder shall be tested in accordance to Clause 8 of BS 4515. The Contractor shall be responsible for the preparation, setting up, provision of specimen, all necessary equipment and materials for the testing of welding personnel.

The S.O. will advise the Contractor in writing which welders pass the performance qualification test. Only these welders will be allowed to weld the pipe joints and the S.O. shall be at liberty to withdraw his approval to any welder responsible for making joints, which fail to meet the required standard.

## **17.0 MAKING WELDED JOINTS**

Where the steel pipes are to be jointed by welding it shall be by means of an internal and an external circumferential electric arc weld at each joint.

Before placing the pipes together the portion of the sockets and spigots to be welded shall be cleaned to a bright metallic finish, the spigot end shall then be placed in the socket and forced inside so that the spherical surfaces are in contact and that the gap between the pipes at the end of the spigot is nowhere greater than 1.5mm. For longitudinally welded pipes, the longitudinal welds on adjacent pipes shall be at least 15 out of line. Details of the socket and spigot welded joint are shown on the Drawings

Where pipes are to be jointed by a steel split collar, the pipe ends and the collar shall be cleaned to a bright metallic finish. The collar shall then be placed on the ends of the pipes so that the space between the pipe ends shall be about 25mm from the centre line of the collar. The collar shall be clamped tightly onto the pipes using the lugs and welded longitudinally. After completion of the internal and external circumferential welds, the lugs shall be removed and the longitudinal weld completed.

The weld shall be of the convex full fillet type for lap welded joints made manually by the metal arc process using approved types of electrodes. Each time the arc is started it shall be manipulated to obtain complete fusion of the weld metal with the pipe and any previously deposited weld metal. Before welding over any previously deposited weld metal all slag shall be completely removed and the weld metal and the adjacent pipe metal shall be cleaned by wire brushing.

All welds shall be subjected to inspection by the S.O. and shall comply with the requirements of Clauses 9 and 11 of BS 5135 for freedom from undercutting, fusion penetration and soundness.

## **18.0 AIR TESTING OF WELDED JOINTS**

After each joint has been welded it shall be air tested in the presence of the S.O.

The annular space between the two welds shall be air tested to a pressure of 1.7MPa. While this pressure is maintained for a minimum period of ten minutes, the welds shall be examined carefully for leakage. Any defective welding shall be treated as directed by the S.O. The tap holes shall be then sealed off with welding after each joint has been satisfactorily tested. The Contractor shall provide all necessary gauges, pumps, etc, for the air testing.

## **19.0 COMPLETION OF SHEATHING AT WELDED JOINTS**

After the S.O. has advised the Contractor in writing that a welded joint has passed the air test the external sheathing shall be completed to ensure continuity of protection along the pipeline.

Bare metal shall be thoroughly cleaned to a bright metallic finish and it shall be immediately coated with a primer solution. The primer shall be applied cold by brush.

As soon as the primer has set the sheathing shall be completed by running hot bitumen into a metal mould placed over the joint and overlapping the sheathing by 75mm on either side of the joint. The bitumen shall be Type 2 of BS 4147.

Priming and sheathing material for the purpose shall be provided by the Contractor including the supply of all the necessary mould boxes and funnels required to form the

protective mould and whitening for use in lining the mould boxes prior to each pour. The Contractor shall also supply all necessary boilers to heat the bitumen to the application temperature recommended by the manufacturer.

## **20.0 COMPLETION OF INTERNAL LINING AT WELDED JOINTS**

On completion of the external sheathing the steel exposed by the gap in the internal lining, together with the adjacent lining shall be thoroughly cleaned and wire brushed. The adjacent lining shall be wetted with thick cement slurry but no accumulations of water in the gap shall be allowed. The internal lining shall then be made from one volume of cement to two volumes of fine aggregate to ensure a smooth continuous lining throughout the pipeline. Where necessary wire mesh may be introduced for ease of completing thick concrete lining particularly those of spherical type joints.

## **21.0 PAYMENT FOR MAKING INTERNALLY AND EXTERNALLY WELDED SLIP AND COLLAR JOINTS**

The Contract Rates for making internally and externally welded slip and collar joints shall cover the cost of providing, operating and maintaining all services, plants, equipments, fuels, materials of all kinds, apparatus space of all types and everything necessary for air testing, making good and/or completion of internal lining and external coating, protecting pipe ends and completing external protection of the welded joints all as specified.

## **22.0 MECHANICAL COUPLING AND FLANGED JOINTS**

### **22.1 *Making Joints with Mechanical Couplings and Flange Adapters***

Mechanical couplings and flange adapters joints shall be installed in strict accordance with the instruction given by the manufacturer and to the S.O.'s approval.

Before jointing, the ends of each pipe shall be wire brushed to remove any protective material adhering to the coating, together with any protuberances which may have been caused by rubbing of the packing material and also be removed all rust at exposed places due to stripping of the bitumastic coating. The ends shall than be recoated with quick drying solution so as to produce a smooth coat of uniform thickness.

On completion of the joint the surfaces of the coupling and adapter shall be painted with a quick drying primer and an external sheathing mould formed to enclose the coupling and ends of the adjoining pipes. This work shall be carried out by specially competent and skilled men in strict accordance with the instructions given by the manufacturer.

The primer and sheathing material compatible to the sheathing material on the pipes and the mould boxes and funnels required to form the protective mould and whitening used for

lining the mould boxes prior to each pour shall be supplied by the Contractor, who shall also supply the necessary boilers to heat the sheathing material to the application

temperature. The Contract Rates for making coupling and adapter joints shall cover all costs in complying fully with the requirements of this Clause.

Mechanical couplings and flange adapters located in chambers shall be painted with two coats of bituminous paint.

**23.0 MAKING FLANGED JOINTS**

When making flanged joints care shall be taken to see that the rings remain in position undistorted while the bolts are tightened and the ring may be fastened to the bolts with cotton thread, or stuck to the flange with rubber solution. The use of jointing paste will not be permitted. The bolts shall be tightened in regular sequence starting from opposite sides of the bolt circle and then going round in this way until every bolt is tight. Excessive tightening of flanged joints shall be avoided. For precise tightening, preset torque wrench shall be used.

Flanged joints located in chambers shall be painted with two coats of bituminous paint but flanges which will be subsequently buried in trench and not encased in concrete shall be carefully wrapped with 'Denso' tape as manufactured by Winn and Coales Ltd., or similar approved material.

**24.0 PIPELINE INSPECTION/CLEANING**

On completion of the pipeline, the Contractor and S.O shall inspect and cleaning the pipeline according as follows:

- i. > 1100mm = Physical Cleaning / Inspection Internally
- ii. 600mm 1100mm = Air scouring or swabbing or pigging and full bore scouring also be allowed / CCTV
- iii. > 600mm = Air scouring or swabbing or pigging and full bore scouring also be allowed / CCTV

All report shall be provided to confirm the pipe is clean, to be signed by the consultant/contractor and witnessed by SYABAS.

**25.0 TESTING OF PIPELINES.**

**25.1 Testing Pipelines**

After a length of the pipeline has been completed it shall be tested as a whole against stop ends. The stop ends shall be supplied to the S.O.'s approval and fixed by the Contractor and shall be properly strutted to ensure that no movement can take place and they shall be of sufficient strength to withstand the full test pressure which is to be applied.

Testing shall be carried out over completed pipeline by each gang as follows:

No	Description of Pipeline	Max length
1.	Trunk main	3km
2.	Reticulation Pipe	2km

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Testing shall be carried out where possible between air valves but not against adjacent valves. Testing shall not be carried out until the backfilling of the pipe trenches except at the joints, have been completed. Backfilling at flexible joints shall be left uncompleted to facilitate inspection joints during testing.

Temporary marker posts shall be installed immediately after testing at all junctions between tested lengths.

Before any length of pipeline is subjected to test pressure, care shall be taken to ensure that all weight thrust and anchor blocks intended to prevent vertical and lateral displacement of pipes or specials have been properly completed. All valves shall be checked before the test to ensure that they are in working order.

Prior to filling the line with clean water for water testing, the line shall be thoroughly inspected jointly with the S.O. to ensure that the line is cleaned from stones, dirt, debris, plastic paper or any other matter that may have entered after laying of pipework.

The water for filling and testing the pipeline shall be obtained from an approved source. . It shall be free from silt, contamination and pollution. All water sources used for testing must be clean and free bacteria and preferably source from SYABAS pipeline. SYABAS must approve first for water source other than from SYABAS pipeline. SYABAS shall ascertain and verify the water quality of other water source on water quality tests carried out by developer. The Contractor shall make all arrangements necessary for conveying the water to the point of filling. The test ends shall be tapped for suitable size test connection. The Contractor shall supply all necessary apparatus including pipework, pumps, pressure gauges and automatic pressure recorder and carry out all work necessary to test the pipeline. Pressure gauges are to have a dial at least 200mm in diameter, and are to be checked against a guaranteed standard unit before use and at other times as the S.O. may direct. The pressure recorder or single channel logger shall have a 24 hour chart to record the pressure drop continuously. The test pressures to be applied shall be to SYABAS' requirements.

The field pressure shall be carried out first. Each section of the ABS., HDPE and Steel pipeline shall be tested to the respective pressures as shown in Table 1. Ductile iron pipes shall be tested to the pressures given in Table 2 respectively. When more than one material of pipe is used on the same pipeline or pipe network, the lowest of the field pressure test values stipulated shall be used.

After the section of the main has been filled with water for a period of not less than 7 days for lined pipes and 1 day for another unlined pipes, more water shall be pumped into the section to raise the pressure slowly increments of 1 bar with a pause of one minute between each increment. Should any appreciable drop in pressure be noted during any of these pauses the test shall be stopped until the cause of the pressure drop has been investigated and rectified. An engine driven pump may used until 90% of the test pressure has been attained, and thereafter only a hand operated pump shall be used.

The pressure test shall be considered to have been passed when the pressure gauge shows no reduction in pressure during the specified one minute pause and also during the period of 10 minutes after full test pressure has been attained. If these conditions are not satisfied a thorough inspection of the section of the main shall be made. All defects shall be repaired and the test shall be repeated.

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The leakage test shall then follow. The pressure shall be reduced to the relevant leakage test pressure as shown in Table 1 and 2. The pressure shall be maintained as constant as possible for a period of 24 hours. Make-up water shall be pumped into the section of the main from time to time to maintain this pressure. The leakage calculated as 0.34 litre per cm of pipe diameter per km of pipe per 24 hours per 1.0 bar of water pressure. If this specified rate of leakage is exceeded a thorough inspection of the section of the main shall be made. All leaks discovered shall be repaired and the section shall be tested again.

Every section of all pipelines shall be tested as described above in the presence of the S.O. Testing may be carried out between sluice valves but not against the gates of valves.

**Table 1: Test Pressures for Field Pressure and Leakage Test of ABS, HDPE and Steel Pipe**

TYPE OF PIPE	CLASS / SERIES OF PIPE	MAXIMUM PERMISSIBLE WORKING PRESSURE (BAR)	PRESSURE FOR PRESSURE TEST (BAR)	PRESSURE FOR LEAKAGE TEST (BAR)	PRESSURE FOR LEAKAGE TEST FOR PIPELINE WITH FERRULE CONNECTION (BAR)
ABS	PN 12	12	15	12	6
	PN15	15	15 X 1.5	12	6
HDPE	PN 12.5*	12.5	15	12	6
	PN15**	15	15 X 1.5	12	6
** *STEEL		15	15 X 1.5	12	6
		10****	15	10	6

\* Electrofusion Saddle Tapping.

\*\* 2 Half Saddle Tapping c/w Gasket.

\*\*\* Steel pipes are capable of withstanding a working pressure of more than 15 bars. If these pipes are used to their maximum working pressure i.e. half the factory hydrostatic test pressure, all valves used shall then be of the appropriate rating

\*\*\*\* If field working pressure > 10 Bar, test pressure to 15 bar.

**Table 2: Test Pressure for Field Pressure and Leakage Test of Ductile Iron**

Nominal diameter (mm)	Maximum Permissible Working Pressure (bar)			Pressure for Pressure Test (bar)			Pressure for Leakage Test (bar)					
	Pipes	Pipes with Welded on flanged		Cast-On	Pipes	Pipes with Welded on flanged		Cast-On	Pipes	Pipes with Welded on flanged		Cast-On
		PN 16	PN 25 Flanges			PN 16	PN 25 Flanges			PN 16	PN 25 Flanges	
*80 – 300	16.0	12.5	16.0	12.5	21.0	17.5	21.0	18.5	16.0	12.5	16.0	12.5
*350 - 600	16.0	12.5	16.0	8.0	21.0	17.5	21.0	13.0	16.0	12.5	16.0	8.0
	16.0	12.5	16.0	5.0	21.0	17.5	21.0	10.0	16.0	12.5	16.0	5.0
	16.0	12.5	12.5	5.0	21.0	17.5	17.5	10.0	16.0	12.5	12.5	5.0
	12.5	12.5	12.5	5.0	15.5	17.5	17.5	10.0	12.5	12.5	12.5	5.0
	12.5	1.2.5	-	-	-	-	-	-	12.5	-	-	-

Pipes of these diameters are capable of withstanding working pressure higher than 16 bar. If these pipes are used to their Maximum Working Pressure, i.e. half the Factory Hydrostatic Test Pressure given by supplier, all valves used shall then be appropriate rating. The pressure used during the pressure test shall then be 5 bars higher than the selected working pressure. Pressure for the leakage test shall be the same as the selected working pressure.

## **25.2 Testing of MS/DI Pipelines**

All pressure and leakage test shall be recorded by a continuous chart recorder or electronic pressure logger according to SYABAS requirements. All charts to be properly endorsed by S.O or his representatives.

## **25.3 Testing of HDPE Pipelines (Whole system inclusive of fittings, tapping tees and com pipes).**

### Testing Procedure

During first stage, a test procedure of 1.2 times the maximum working pressure (For PN 12.5 – Working Pressure = 10 bar) shall be applied to the section test. The test section should then be allowed to stand without make-up pressure with the allowable drop a maximum 10% of the test pressure. If there is no leak of the test water after at least 1 hour under pressure, then proceed to second stage test.

The pressure is then reduced by rapidly bleeding water form the system to a nominal pressure (8 bar). The control valve is then closed and the pressure readings are recorded at intervals of 5 minutes for 2 hours by an automatic pressure recorder/ chart recorder. A sound pipeline without leaks should exhibit a stable constant pressure over the time of measurement after the initial rise in pressure (visco-elastic response of PE pipe), but the final pressure must not be less than 8 bar.

All recording should use electronic lodger/chart recorder and not manual recording. Graph shall be plotted and certified by all parties immediately during test or after plotting from computer. A standard leakage test from certified by all parties during test shall be submitted.

The section is considered to have passed the leakage if the procedure and results from the graph plotted complied to requirement.

### References:

The following reference publications provide pressure testing information:

- ASME B31.1. Power Piping, Section 137, Pressure Tests (Ref 6)
- PPI TR-31 Underground Installation of Polyolefin Piping, Section 7 System Testing (Ref 1)
- PPI Inspection, Test and Safety Consideration
- JKR Tender Specification for Polyethylene (PE) Pipe Systems for Water Supply
- MWA Guideline
- SAJ PE Pipe Testing Procedure

**26.0 PAYMENT FOR PRESSURE TESTING PIPELINES**

The rate for testing pipelines shall include for the supply of clean water and all necessary testing apparatus, pumps, gauges and pipe-works, the cost of supervision and labour in testing and retesting, if necessary and all other work, materials and equipment in complying with the requirements of testing of pipelines.

**27.0 COMMISSIONING OF PIPELINE**

Pipe shall be commission over completed pipeline by each gang as follows:

No	Description of Pipeline	Max length
1.	Trunk main	5km
2.	Reticulation Pipe	3km or Not Exceeding 1500 Properties

**28.0 MISCELLANEOUS**

**28.1 *Measurement of Steel Pipes and Fittings***

Spigot and socket ended straight pipes shall be measured in linear metre, their lengths being defined as their effective lengths as laid measured along the centre line of the pipe. The effective length shall mean the net length of the pipe as laid, after deduction of the length of overlap at any spigot and socket joint to be made with the pipe. Plain ended pipe shall be measured and paid by effective length as laid. Pipe specials shall be measured by numbers unless otherwise specified.

The Contract Rates for supplying and laying steel pipes and specials shall include for the full cost of manufacturing, testing, transporting, storage at Site, hauling and handling, repairing, lining and sheathing where necessary and laying in position in the Works ready for jointing and/or building in together with other costs incurred in complying with the requirements of the Specifications for which no separate items are included in the Bill of Quantities.

**28.2 *Concrete Protection to Pipes***

Pipes shall be bedded and haunched or fully surrounded in concrete where shown on the Drawings or as directed by the S.O. Where concreting is required a sufficient amount is to be placed and left to set in position before the joints are made to prevent any subsequent movement of the pipes when further concrete is placed.

In order to allow relative movement between pipes, flexible joints shall not in general be partially or completely cased with concrete. Concrete bedding and haunching or surround shall be omitted for a distance of 150mm from the face of flexible joints except as may be otherwise directed by the S.O.

In general pipes shall be bedded on or protected by concrete in the following circumstances:-

- A 150mm bed and partial haunch where the pipe is in rock
- A 150mm surround where the pipeline is under stream and ditches.

**28.3 Thrust and Anchor Blocks**

Bends, tapers, tees and other points where horizontal thrust will occur shall be supported with concrete blocks. The cover between the side of the pipe and the excavated face of the ground which will subsequently take the thrust shall in no circumstances be less than 150mm.

Where pipes are laid at gradient steeper than 1 in 12 anchor blocks in concrete shall be provided at the middle of pipes as follows:

Gradient exceeding	Anchor blocks
1 in 12	Every third pipe
1 in 8	Every second pipe
1 in 3	Every pipe

Details of thrust and anchor blocks are given on the Drawings. The dimensions shown may, however, be amended by the S.O. after examination of the ground prior to concreting, having regard to the likely thrust developed under test pressure and the actual nature of the ground. Additional anchor blocks may also be needed.

For horizontal bends in cross-fall ground, care shall be taken to ensure that additional cover over the pipes is allowed in order that the same passive resistance may be developed as would be the case in level ground.

For thrust and anchor blocks to fulfill their purpose they must abut against undisturbed ground. Where timbering has been used in the excavation it shall be withdrawn as the concrete is being placed.

**28.4 Valve Chambers**

The operation of all valves including scour and air valves shall be checked by the Contractor and any necessary adjustments made to ensure correct operation. Valve chambers shall be constructed in accordance with the details shown on the Drawings or as directed by the S.O. The same care shall be taken as for thrust blocks to ensure that concrete transmitting thrust abuts against undisturbed ground.

The Contractor shall first obtain from the manufacturers the minimum required size of the chambers. The S.O.'s approval shall be sought should there be any variation. The Contractor shall pay all subsequent costs due to any such variations.

Drainage from valve chambers to suitable outfalls shall be provided as directed by the S.O.

**28.5 Crossing Over Streams, Culvert and Rivers**

Details of pipe-work and support arrangements of over-crossings at streams and rivers are shown on the Drawings. The Drawings also list pipe specials which are required for

each crossing. The lines, and levels of the pipe-work shall be as shown on the Drawings or as directed by the S.O.

## **28.6 Swabbing of Pipelines**

When the final connections have been made and the pipelines have been tested to the satisfaction of the S.O. the pipelines shall be cleaned by using hard grade polyurethane foam swabs.

The recommended density of the swabs to be used is 30 to 40 kg/m<sup>3</sup>. The recommended speed of the swabs is about 0.6m/s.

The swabs shall be at least 50 mm bigger in diameter than the internal diameter of the pipe for small size pipe (i.e. 100mm, 150mm, and 210mm). For large diameter pipes of 300mm and above, it is advisable to use a size at least 100mm bigger than pipe internal diameter. The length of the swab shall be 2 times the pipe's diameter.

The cylindrical shaped cleaner was propelled by differential hydraulic pressure using a pumper truck to provide water pressure (generally 15 to 26 bars for 30 to 40 seconds). A temporary launch point (possibly a wye or tee) shall be used to enter the foam plug into the flow of water or it may be inserted into the first joint of pipe laid and remain until the cleaning process is begun.

As the plug moved through the pipelines, it pushed the debris downstream. A small flow or bypass around the plug assisted in suspending and carrying the debris to the discharge end of the pipelines.

After the cleaner has been received at the end of the system (usually fitted with temporary piping to direct flow to ground level), the pipelines were tied into the desired final connector.

## **28.7 Sterilization of Pipelines**

The section of the main to be sterilized shall be filled with water mixed with a solution of chloride of lime containing about 40 milligrams per litre of chlorine. The Contractor shall have to adopt a dosing system to sterilize the line effectively. The system shall be provided with a set up of temporary equipment, chemical mixing tank mixer, dosing pump and other necessary accessories for the solution to be injected into the lines when potable water will be introduced gradually. After the main has been filled with chlorinated water, it shall be closed and left for at least 24 hours. The main shall be deemed to have been sterilized if the samples of water taken from various tappings on the main show a chlorine residual of 0.2 ppm.

After the main has been sterilized to the satisfaction of the S.O. it shall be flushed with clean water.

Pipeline shall be filled with solution of Calcium hypochlorite 65% to 40 ppm level and left for 24hours.

The main shall be deemed to have been sterilized if water samples taken from various locations of the pipeline show a total chlorine level of more than 10ppm after 24hours.

**28.8 Flushing of Pipelines**

Flushing shall be carried out after disinfection has been achieved. Water sources that being used for flushing must be clean and meet treated water quality. Flushing shall proceed systematically from water supply source to end of pipe system. Procedure to be used in flushing shall be discussed and agreed to by SYABAS and the Contractor/ Consultant prior to beginning of flushing works. Flushing of pipeline is deemed to be complete only when the turbidity level of the water is less than 2 NTU and pH level less than 9.0, residual chlorine is more than 0.2 ppm, E.coli and total coliform are absent. Report on flushing shall be completed and signed by Contractor / Consultant and witnessed by SYABAS personnel.

**28.9 Payment for Sterilizing Pipelines**

The rate for sterilizing and flushing the pipeline shall include the supply of clean water, the full cost of supplying, transporting to and storing on the Site, hauling, handling and mixing chemical, the cost of all apparatus for dosing and measuring the chemicals, the cost of supervision and labour in testing and all other work, materials and equipment in complying with the requirements of Clause 26.7.

**28.10 Clearing Up**

During the progress of pipe-laying work the Contractor shall clear up the Site and remove from the surface of the ground all temporary buildings, plants, materials, litter, rubbish and surplus spoil which may have been left on the ground or in and about the Works or lands temporarily occupied by the Contractor and he shall leave in a clean and sightly condition all and any lands occupied by him. Clearing up of the Site as herein specified shall follow closely on the refilling of the trench.

**28.11 ABS Maker Post.**

The Contractor shall provide and fix ABS maker post as shown in Drawing No. SYABAS/MARKER POST/2006/01. The indicator post is made up of a 750mm x 50mm dia. Class 9 ABS (Acrylonitrile Butadiene Styrene) straight pipe, with a 50mm diameter end-cap solvent cement welded at one end and a 50mm full-face flange at the other end.

The Indicator post shall be set with 50mm thick lean concrete which shall be laid under the Indicator post before pouring 200mm x 200mm mass concrete (1:3:6) . Refer to Drawing No. SYABAS/MARKERPOST/06/01. The top 50mm shall be covered with top soil and the indicator post shall be installed as indicated in the drawing or as directed by the S.O.

Indicator post shall be measured by number. The rate for the supplying and fixing indicator posts shall include for all necessary concrete, excavation and backfilling.

**28.12 Painting Pipe-work and Valves in Chambers**

After installation the exposed surfaces of all pipe-work, valves and fittings in chambers shall be properly cleaned, primed and painted thoroughly with two (2) coats of approved polyurethane paintwork to 100 micron (min. dry finished thickness)

The paint required for these purposes shall be supplied by the Contractor and approved by the S.O. and SYABAS. The cost of supplying primer and paint and painting pipe-work and valves shall be included in the rates for laying pipes and the installation of valves.

## **28.13 *Painting Pipe Work Above Ground***

Steel pipe-work for installation above ground including stream and river over crossings shall be painted with two (2) coats of high solid epoxy to 150 micron (min. dry finished thickness). After installation this pipe work shall be painted with two coats of approved polyurethane paintwork to 100 micron (min. dry finished thickness).

## **28.14 *Payment of Fees to Authorities***

The Contractor shall pay to all authorities or developers all deposits, fees and charges required in relation to the execution of the Works or to any Temporary Works.

If after due notice to the Contractor calling his attention to the necessity for the payment of fees and/or charges to the Authorities the Contractor has failed to make payment, the Employer/S.O. shall be entitled to pay such fees and/or charges direct to the Authorities concerned out of any moneys at any time due to the Contractor under the Contract and such payment shall be deemed to be payment made to the Contractor under and by virtue of the Contract.

The cost of all fees and charges payable by the Contractor shall be deemed to be included in the Contract Rates unless otherwise expressly provided for in the Bill of Quantities.

## **29.0 PIPE JACKING**

### **29.1 *General***

Pipe jacking shall be the process of installing pipes below a surface obstruction by driving them successively through the in-situ soil from one pit (the jacking pit) to another (the receiving pit) such that the finished pipe forms a watertight continuous conduit between the pits on the desired alignment.

Plans and details of the equipment, materials and the method of construction to perform and complete the work shall be submitted by the Contractor and must be approved by the S.O. before commencing these operations. Approval by the S.O. shall not relieve the Contractor of his sole responsibility for the efficiency, reliability and soundness of the method employed in completing the work in a satisfactory manner.

The Contractor shall satisfy himself as to the soil conditions along the pipe jacking route and if he judges it to be necessary, he shall carry out further soil investigations at his own cost.

It shall be the responsibility of the Contractor to maintain stable soil conditions at the jacking face to prevent loss of ground above the jacking operation and movement of the surrounding earth. The methods of maintaining face stability and preventing ground movement and subsidence shall be by means of compressed air or other plenum methods where fluid slurry or earth pressure is applied to the tunnel face. Alternatively,

unstable ground ahead of the jacking face may be stabilized by the injection of suitable chemicals. Methods which require dewatering of the ground will not be accepted, nor will methods which may lead to significant ground loss. The Contractor's proposal must be submitted to the S.O. for his approval.

Movement or settlement of structures, utilities and pavement shall be monitored by the Contractor during the jacking operation and reported to the S.O.. If movement or settlement occurs which in the opinion of the S.O. may cause damage, the contractor shall take immediate action to prevent further movement, settlement or damage. He shall repair at his own cost any damage and restore structures or pavements to the satisfaction of the S.O..

The Contractor shall be responsible for inspecting the location and familiarizing himself with the conditions under which the work will be performed and with all necessary details as to the orderly execution of the work. The omission of any details shall not relieve the Contractor of full responsibility for the satisfactory installation of the work in its entirety. No monetary or other claims made by the Contractor on the grounds of want of knowledge will be entertained.

The Contractor shall survey the location of pipe-jacking prior to any commencement of work to identify the exact location of an existing box culvert. The exact location of the pipe jacking shall be confirmed by the S.O.

## **29.2**     ***Performance Requirements***

The centre-line of the fully jacked pipeline shall at all points along its length be within 75mm of the required alignment in the horizontal plane and 25mm in the vertical plane.

No movement, upheaval or settlement of soil, which in the opinion of the S.O. may cause damage to structures, utilities or pavements shall be permitted.

The fully jacked pipeline shall pass the water-tightness test specified for the pipelines in trench.

## **29.3**     ***Approval of Owner***

Before commencing preparations for pipe jacking the Contractor shall obtain the written consent to his proposed procedures to the Owner or Owners of the land, services and structures below which (or close to which) the jacked pipeline will pass.

## **29.4**     ***Jacking Operation***

The Contractor shall be fully responsible for the materials, equipment and facilities required in conjunction with jacking the pipes.

Before starting work, the Contractor shall submit to the S.O. for approval, a detailed schedule of the entire jacking operation. Approval of such schedule shall not relieve the Contractor of his responsibility to provide a fully satisfactory installation. The Contractor shall include with his submission evidence that he has successfully completed a jacking installation using procedures similar to those proposed.

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Where chemical stabilization of soil is used, a chemical grout shall be pressure injected into the soil over and ahead of the pipe jacking to stabilize the soil. The chemical grout used shall have a demonstrated history of success for stabilizing soils similar to that through which the pipe is to be jacked.

Where a mechanical shield is used, the Contractor must provide proof that the particular model of shield has been used successfully in soils similar to that on the site. The crew for the operation of the shield must be specialist, with experience in the use of that particular type of machine.

After the jacking operation has begun, the Contractor shall work continuously and expeditiously in accordance to programme until the complete length of jacked pipes is installed. This continuous work where required shall not be constructed as overtime work.

During jacking and excavation, the Contractor shall constantly ensure that the internal lining of the jacking pipes is not damaged, and he shall remove the excavated spoil to the jacking pit by conveyor to minimize traffic on the invert.

The pipes shall be jacked into place true to line and level. The maximum tolerance allowable in the displacement of the center-line of the jacked pipe from the design center-line is 75mm in the horizontal plane and 25mm in the vertical plane but there shall be no back-fall at any point.

The pipes for the jacking operation shall not exceed 3m long. The pipe ends shall be jointed by thrust sleeves before the pipeline is jacked. Details of how the pipes are to be lowered into the pit and welded shall be submitted to the S.O. for approval.

The Contractor shall be required to furnish and install and remove to the extent required, thrust blocks or whatever provisions may be required for backing up the jack employed in jacking the pipe forward. The jacking pit shall also be equipped with steel rails or beams embedded in concrete for placement and alignment of each pipe during the jacking operation.

The Contractor shall be fully responsible for the design and construction of the jacking and receiving pits, thrusting wall, installation of jacking equipment, sheeting, bracing, etc., and for the efficient execution of the jacking operation. Full details of the proposals,

including plants, shield machines, equipment, operating procedures, jacking pits and intermediate jacking stations etc., shall be submitted to the S.O. and shall be fully satisfactory to him before construction. However, review of the plans shall not relieve the Contractor from his responsibility to provide a safe and satisfactory jacking pit. On successful completion of the jacking operation, jointing of the length of jacked pipes, hydraulic pressure testing of the pipelines and after the connections at the extreme ends of the jacked pipeline have been made, the Contractor shall remove completely the jacking pits and receiving pits together with all the temporary works.

The Contractor shall be required to monitor closely the progress of the jacking operation. Daily site records of thrusting pressures, rates of thrusting, the line and level measurements of the jacking pipes and any movement or settlement of existing structures shall be properly maintained and shall be submitted to the S.O.

For the sections of the pipeline crossing under roads, railway or structures along the pipeline route, the Contractor shall be required to incorporate in his tunneling method measures to arrest settlement or upheaval of the soil so as to safeguard the integrity of the structures and other properties. The Contractor shall ensure that the traffic flows along railway lines and roads are not affected in any way of his work.

## **29.5 Safety**

The minimum of plants shall be used in the pits, and any which produces noxious gases or is operated by electricity at a greater voltage than 240V shall be permanently outside the pit at ground level.

A ladder shall be fixed permanently in the receiving pit. Two ladders shall be permanently fixed on opposite sides of the driving pit, one on each side of the pipe jacking line. These ladders shall be kept clear of obstructions to allow rapid exit in an emergency. Excavated materials and plant other than small tools shall not be passed via the ladder but shall be handled by crane.

Pits shall be securely fenced to prevent unauthorized persons from entering in.

All persons entering the pits shall wear safety helmets constantly, and shall leave the pits for meal breaks, rests and the like.

At the beginning of each shift and after any break for refreshment or other reason, the Contractor shall provide and use an approved instrument to check for noxious gases before anyone re-enters either pit.

All costs associated with the provision of safety equipment and measures shall be deemed included in the Contract Rates.

## **29.6 Design of the Jacking Pipes**

The Contractor shall design the pipes to be jacked and the pipe joints in accordance with the jacking procedure and operation prepared by the Contractor. Four (4) copies of a detailed specification giving full particulars of the jacking pipe, pipe joint and construction method proposed shall be submitted. The design shall be submitted with full detailed calculations and drawings (4 sets each) to the S.O. for approval before construction commence. The detailed design shall be prepared, checked and approved by any experienced & qualified Professional Engineer registered with the Board of Engineers Malaysia. The design shall take into account the following requirements:-

- Diameter of the pipes for the jacking shall be as specified and shall not be less than 10mm thick. The pipes as specified shall be lined internally with 25mm thick concrete and externally clad with reinforced concrete. The outer diameter of the steel pipe shall not be less than 970mm.
- The length of each pipe shall not exceed 4m and the pipe ends shall be suitable for jointing with internal split collar by fillet welding in the field.
- Each length of pipe shall be provided with steel thrust flanges at the pipe ends designed to take the jacking load applied and transfer the load to the next pipe.

- The transfer of the jacking load shall be through the external reinforced concrete cladding by means of a steel thrust collar between the thrust flanges of the pipes.
- The thrust collar shall be fitted onto the pipes with flexible rubber rings to prevent ingress of water into the pipe from outside.

## **29.7 Welding of Pipe in the Field**

After jacking of the whole pipeline is completed, the pipes shall be jointed by internal steel split collars. The pipe ends and the collars shall be cleaned to a bright metallic finish. The collar shall then be placed inside the ends of the pipes so that the air release hole will be at the crown of the pipe ends with the air release pipe extending vertically

up into the space between the pipe ends. The collar shall be clamped tightly against the pipe such that the gap between the outside surface of the collar and the inside surface of the pipe at the fillet weld locations do not exceed 1.6mm anywhere. After completion of the internal collar, the longitudinal butt weld at the split ends of the collar shall be carried out.

Weld shall be of the convex full fillet type for lap welded joints made by manual or semi-automatic metal arc process using approved types of electrode. Each time the arc is started it shall be manipulated to contain complete fusion of the weld metal with the pipe metal and any previously deposited weld metal. Before welding over any previously deposited weld metal all slag shall be completely removed and the weld metal and the adjacent pipe metal shall be cleaned by wire brushing.

All welded joint shall be inspected visually and tested by ultrasonic examination in accordance with BS 3923 in the presence of the S.O. before any grouting or concrete lining at the joints can be carried out.

All welds shall comply with the requirements of BS 5135 for freedom from undercutting, fusion penetration and soundness. Any welds showing cracks or other cavities, slag, inclusions, porosity, or in which the weld metal tends to overlap onto the parent metal without proper fusion, in excess of the amount permitted in Part II of API Standard 1104 shall be cut out and re-welded to the satisfaction of the S.O..

All welds performed in the field shall be subjected to a 100% ultrasonic examination. Clearance and acceptance of the ultrasonic examination shall be in accordance with BS 3923. The S.O.'s instructions given as a result of the examination of ultrasonic results shall be final.

The Contractor shall submit his proposals to the S.O. for site ultrasonic examination. The size, number and make of ultrasonic equipment proposed shall be stated. The Contractor shall provide adequate equipment and qualified and experienced personnel to deal with the ultrasonic examination.

The S.O. reserves the right to carry out any independent ultrasonic examination of the welded joints as he may deem fit. Such independent ultrasonic examination shall be carried out by an Inspector appointed by the S.O.

The Contractor shall provide such assistance, labour, materials, electricity supply, ultrasonic examination equipment and other apparatus as may be necessary to allow a thorough and extensive independent examination to be carried out.

## **29.8 Grouting at Welded Joints**

After the S.O. has advised the Contractor in writing that a welded joint has cleared the ultrasonic examination; the void at the joint between the thrust collar and the welded collar shall be completed by pressure grouting. The Contractor shall provide all plants and equipment for mixing and injecting grout. The composition of the grout shall consist of 1 part of cement to 2 part of sand slurry, the crushing strength of which when set shall be equaled to that of the internal lining of the pipe.

Grout shall be injected at a pressure which will enable the whole void between the thrust collar and the internal collar to be filled up completely. Grout pipes shall be secured to the grout holes in such manner that no leakage shall occur during grouting. Grouting shall start from the bottom hole upwards with all other holes left open and shall continue until grout escapes from the two holes on the horizontal diameter of the collar joint. The bottom hole shall then be plugged and sealed off by welding. Grout shall be

injected through both the horizontal holes. When grout escapes through the vertical hole at the crown of the collar, the two horizontal holes shall be plugged by welding. Grouting shall continue through the top most hole until all air is expelled by the grout escaping through the air release pipe. The grout hole and the air release hole at the crown of the collar shall finally be plugged. All grout holes and the air release pipe shall be plugged by depositing weld to the full depth of the thickness of the internal collar.

The Contractor shall ensure that fouling of the equipment and lines is prevented by constant circulation of grout and by periodic flushing out of the system with water. Flushing shall be undertaken with grout intake valve closed, the water supply valve open, and the pump running at full speed.

## **29.9 Internal Lining at Welded Joints**

After completion of pressure grouting of the void at the joint between the thrust collar and the welded collar and plugging of the grout holes and air release pipe, the internal lining shall be completed to ensure continuity of protection along the pipeline. The bare metal and the adjacent lining shall be thoroughly cleaned and wire brushed. The adjacent lining shall be wetted with thick cement slurry but no accumulation of water in the gap shall be allowed. The gap between the concrete lining shall then be filled with

1:2 by volume cement-sand mortar to ensure a smooth continuous lining throughout the pipeline.

## **29.10 Connections at Ends of Jacked Pipeline**

The connections at the extreme ends of the jacked pipeline shall be made only upon successful completion of the hydraulic pressure test of the jacked pipeline.

The connections at the two ends of the jacked pipeline will be made at the jacking or receiving pits. The Contractor shall maintain and keep these pits intact and in a safe condition to facilitate the connections. The Contractor shall remove all other temporary works and any concrete blocks including cutting and removing part of the walls of the pits that are in the way of the pipe-work connections.

When the Contractor has completed the connections of the pipelines and has completed the protection of these connections with sand or concrete surround, he shall then backfill the pits with well compacted sand. The removal of the temporary bracings and struttings shall be carried out systematically together with the backfilling of the pits to prevent collapse of the pit walls. The walls of the pits shall only be removed when the backfill of the pits are completed.

## **30.0 HORIZONTAL DIRECTIONAL DRILLING METHOD PIPE INSTALLATION**

The Contractor shall design the Horizontal Directional Drilling (HDD) method in accordance with the pipes provided by the Contractor. The design shall be submitted with full detail calculations to the S.O for approval before construction commences.

The drilled pipes shall be designed to withstand in conjunction with the jacking load applied, the external loads derived from the overburden load from the site.

Excavation material shall be removed from the conduit as the work process progresses. And no accumulation of excavated material within the conduit will be permitted. Should appreciable loss of ground occurs, the voids shall be backpacked to the extent practicable with neat cement grout. After the completion of the drilling operation, the contractor shall fill up the voids, if there is any, at the interface between the external surface of the pipe and the surrounding earth. This shall be carried out by pressure grouting with neat cement grout through the grout holes provided around the pipe.

### **(a) Submittals**

- i. Contractor shall submit the following shop drawings, product data as well as design calculations prepared, checked and approved by a Professional Engineer registered with the Board of Engineering Malaysia :-
- ii. Horizontal directional drilling experience meeting the requirements of works.
- iii. Detailed construction scheduling plan complying with overall work progress prior to the pre-construction meeting.
- iv. Prior to construction, submit the type and capacity of the drilling rig to be used on the project, include manufacturer, pullback and push torque. Contractor to verify that allowable pipe stresses of the pipe will not be exceeded by the drilling rig. Submit information on the type of locating and tracking system. In addition, submit type and capacity of mud mixing system. Include proposed composition of drilling fluid, viscosity, and density.
- v. Prior to construction, submit a drawing showing proposed crossing configuration, including entry and exit angles, radius of curvature, and entry and exit points. Drawings to include location and dimensions of the starting area at both entrance and exit pits. Also include information on the diameter of the pilot hole and size and number of pre-reamers used for development of the borehole.

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- vi. Prior to construction, submit information on the method to address and mitigate obstruction problems during drilling, reaming, and potential problems of product pipe becoming stuck during pipe pull back, emergency procedures when drilling through existing underground utilities, or other events that lead to work stoppage. Procedures must comply with all regulations.
- vii. Prior to construction, submit information on the method of slurry containment, method of recycling drilling fluids and spoils (if applicable), or method of containing drilling fluids or spoils and transporting drilling fluids and spoils off-site (including anticipated volume), and identify method and disposal site for drilling fluids and spoils. All material must be disposed in accordance with local, state, and federal regulations.
- viii. Prior to construction, submit plan for cleanup and disposal of spills and fracouts (drilling fluids, hydraulic fluids) including measures to contain and clean the affected area. Include details for cleanup of surface seepage of drilling fluids and spoils. All material must be disposed in accordance with local, state, and federal regulations.
- ix. Prior to construction, submit information on the method to address and mitigate collapse or subsidence of surface roadways, adjacent utilities during drilling, reaming and installation of the pipe.

The Contractor shall maintain a logbook that includes driller notes and records for bores using steering and tracking system. Data will include pipe number, depth, pitch, steering commands, and notes. Log must also include rig performance parameters (thrust, pullback, torque, drilling fluid circulation, drilling fluid composition), ground conditions, obstructions encountered, time shift started and ended, footage during the shift). Logbook will include information on drilling fluid (composition, viscosity, density). This logbook must be available for review throughout the project and must be submitted to the Engineer and Owner at completion of project.

At the completion of the horizontal directional drilling, the pipe log indicating the horizontal and vertical position at 5 or 10 meter intervals along the pipe to confirm conformance with the depth and line shown on the Drawings. This submittal shall include the type and manufacturer of tracking equipment used, date of most recent shop calibration record, and the method to ensure the data was captured. No payment for any footage of pipe will be made until its corresponding log is submitted to the S.O and SYABAS.

## (b) Quality Assurance

The horizontal directional drilling shall be performed by the drilling company who is experienced in the installation of sewer pipelines utilizing the horizontal directional drilling method.

The Contractor shall submit data on the horizontal directional drilling company's experience. The drilling company shall have at least three previous successful projects

of 15-inch diameter or larger of High Density Polyethylene (HDPE) pipe utilizing the horizontal directional drilling method and at least one previous successful on-grade installation of 18-inch diameter or larger. The drilling company shall provide an installation list including the following information: City or District, project name and location, contact person and phone number, contract amount, project environment (river crossing, urban area), date of installation, pipe diameter, pipe material, maximum length of each bore, and total length of directional drilling.

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(c) Pipe

All pipe installed by the horizontal directional boring method shall be PN10 High Density Polyethylene (HDPE) pipe.

The butt-fusion method for pipe joining shall be carried out in the field by qualified fusion technicians following the pipe and fitting manufacturer's specifications. The joints shall be smooth, uniform, and de-beaded while supplying the proper melt, pressure, and alignment. It shall be the sole responsibility of the contractor to provide an acceptable butt-fusion joint.

All joints shall be made available for inspection by the S.O. before insertion.

(d) Directional Boring System

Contractor to provide a pneumatically or hydraulically operated, fluid assisted remote guided boring system capable of installing the pipe by trenchless methods per the Drawings without damage. The equipment shall be designed to provide accurate control of both the line and the grade of the boring head.

Contractor to provide pumps, compressors, tools and all equipment certified as suitable by the system manufacturer to install the new pipe without stressing or damaging the pipe.

Contractor shall provide a circulatory and recovery system that will recover the bentonite or other drilling fluids. Contractor shall supply water for mixing drilling fluid.

(e) Protection

The Contractor shall field verify the location and depth of all existing utilities, including service connections, to be paralleled or crossed prior to the start of directional drilling operations. The Contractor shall modify alignment, depth or grade as necessary to avoid utilities and minimize the number of peaks and valleys along the alignment.

The Contractor shall expose all utilities that they will be crossing with horizontal directional drilling. All major utilities (high pressure gas, fiber optic, high voltage electric, major pipe lines, water and sewer lines, etc.) should be exposed every 30 meter at minimum, if parallel within 1.5 meter of excavation area to verify depth and location of the utility. If the location is not accurate, the utility owner should be contacted immediately.

(f) General Pipe Installation

Install pipe by the directional drilling methods unless conditions require open trench installation. Obtain Owner approval prior to open trench construction.

Install pipe by continuously pulling the pipe into place from insertion point to exit point without causing damage to the pipe being inserted. Provide lubricants as required by the pipe manufacturer to avoid stressing the pipe past its elastic limit. Contractor shall provide rollers or alternative apparatus to prevent damage to the pipe.

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Provide installation and receiving pits as necessary for complete installation of the pipe. The excavation of the installation and receiving pits shall be incidental to the work.

The Contractor shall not start the pullback unless it can be completed without interruptions. Contractor shall coordinate scheduling with the S.O.

The Contractor shall provide sediment and erosion control measures to prevent drilling fluid or borehole cuttings from entering the adjacent parcels to the construction limits.

The pilot hole shall establish the horizontal plane of the pipeline. A plot of length versus elevation versus left/right variance will dictate the actual as-built plan and profile of the pipeline. Data feedback and electronic guidance systems shall be used to provide confirmation of position.

Reaming shall consist of using an appropriate tool to open the pilot hole to a slightly larger diameter than the carrier pipeline. The percentage oversize shall depend on soil types, soil stability, depth, drilling fluid hydrostatic pressures, etc. Normal oversizing shall be from 120 to 150 percent of the product pipe diameter. Drilling fluid shall be forced down the hole to stabilize the hole and to remove soil cuttings. The Contractor shall carefully monitor the reaming operations to prevent damage to adjacent utilities.

The Contractor shall maintain accurate alignment and grade control and shall determine the pipe elevation (above mean sea level) at intervals not exceeding 100 meter.

The pipe shall be installed by continuously pulling and/or pushing the pipe into place through the drilling fluid along the reamed hole pathway from insertion point to exit point without causing damage to the pipe and pipe joints being inserted. The pullback speed shall be within the pipe manufacturer's recommendations. Drilling fluid/lubricants shall be provided as required by the pipe manufacturer's recommendations and specifications to avoid stressing the pipe and joints past the materials elastic limits. Proper pipe handling, cradling, bending minimization, and consistent insertion velocity shall be recorded.

Any bits, drills, reamers, or other tools lost or stuck in the hole shall be removed at the Contractor's expense. If tools cannot readily be removed, Contractor may at Contractor's option abandon the hole. The Contractor will seal the borehole and re-drill the crossing. No payment shall be made for any lost equipment, material, or work on abandoned holes.

Drilling fluid to be used to facilitate the installation of the pipe shall be adjusted within acceptable limits such that ground heaving and subsurface cavity formation through erosion are prevented.

A variation greater than  $\pm 18$  inches from the horizontal and  $\pm 0.5$  percentage points from the designated grade may be sufficient reason for the rejection of the pipe, and the pipe shall be re-bored to proper grade if so directed by the S.O. at no cost to the Owner.

The alignment shown on the Drawings shall be adhered to unless existing physical obstructions prevent otherwise. The number of setups and the length of pipe installation per set up as shown on the Drawings is merely a suggested layout to achieve the alignment shown on the Drawings. The Contractor shall be ultimately

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responsible for determining the number of set ups required to install the pipe to the alignment shown on the Drawings. The number of setups shall be incidental to the work.

The Contractor shall supply portable mud tanks or construct temporary mud pits to contain excess drill fluids during construction. Spent drilling fluids and cuttings shall be confined to the entrance and exit pits. The Contractor shall take all necessary precautions to minimize the damage to the adjacent properties. Any drilling fluid that

enters the pipe shall be removed by flushing or other suitable methods. Upon completion of the bore, contractor will dispose of any drill cuttings and excess drill fluids in a manner consistent with the local and state regulations. If working in an area of contaminated soil, the slurry shall be tested for contamination and disposed in accordance with local and state regulations. The disposal of the drilling fluids and any necessary flushing of the pipe shall be incidental to the work.

The Contractor shall be responsible for cleanup and restoration, due to hydro-fractures from excessive pressure in the drilling fluid. Contractor shall prevent drilling fluids from entering streams or other water bodies and municipal storm or sanitary sewer lines (unless prior approval is obtained from the S.O). No additional payment shall be made for cleanup costs required by S.O., or regulatory agencies due to loss of drilling fluid.

Pits excavated to permit connection of bored pipe shall be backfilled, and disturbed areas shall be restored to their original state or better. Sections of sidewalks, curbs, and gutters or other permanent improvements damaged during horizontal directional drilling operations shall be repaired or replaces at the Contractor's expense. The backfilling of the boring and receiving pits shall be incidental to the work.