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GENERAL SPECIFICATION FOR WATER MAIN CONSTRUCTION

October 2011

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SECTION 1 - GENERAL

1.1 Scope of works

- 1.1.1 Unless otherwise specified in the Special Specification, the Contractor shall supply at his own risk and cost, all labour, plant, materials, including all pipes, joints, valves, fittings and specials, tools, transport, temporary works and everything else needed for the proper execution and completion of the works described in the Special Specification, all in accordance with other Contract Documents.
- 1.1.2 Where the Government or Water Authority is to supply completely or partially, free of charge, pipes, joints, valves and specials, these materials shall be specifically listed in the Special Specification.
- 1.1.3 Any pipes, specials, etc. supplied by the Government or Water Authority and not used in the Works, shall be delivered back to the J.K.R. Store/Pipe Dump by the Contractor, who shall obtain a receipt for the articles so returned.

1.2 Contractor to visit site

- 1.2.1 The Contractor shall be considered to have visited the site of the Works before tendering and to have taken into account all site conditions there, such as means of access, facilities for transport, storage and movement of plant and materials, and any other contingencies liable to affect his Tendered Price, as no claim for extra payment in this connection will be entertained.

1.3 Setting out

- 1.3.1 The Contractor shall be responsible for the true and proper setting out of the Works and for the correctness of the position, levels, dimensions and alignment of all parts of the Works as stipulated in the Form of Contract. He shall also provide the Superintending Officer with any assistance including chainmen and instruments; the latter may be required in checking whether the Works are correctly set out.
- 1.3.2 Pipes shall be laid to the alignment and gradient shown on the Drawings. The Superintending Officer reserves the right to alter line or level as he finds expedient as a variation from the Contract. No claim by the Contractor on the grounds that the line or level of the main has been altered shall be considered, except in as far as quantities are altered.
- 1.3.3 Before commencing the Works, the Contractor shall ascertain the locations and values of the permanent bench marks to be used and to which all temporary bench marks shall refer. The Contractor shall establish sufficient temporary bench marks on the site as the Superintending Officer directs and confirm the levels thereof with the Superintending Officer. He shall carefully protect and preserve all temporary bench marks, sight rails, pegs and other items used in setting out the Works from being disturbed or damaged.

1.4 Supply of Materials by Government or Water Authority

- 1.4.1 Where the Government or Water Authority is to supply completely or partially, free of charge, pipes, joints, valves and specials, these materials shall be specifically listed in the Special Specification.
- 1.4.2 Where the Contractor is required to supply the materials but fails for any reason to supply, or if he fails to supply any materials in sufficient time to enable the Works to be completed by the agreed date for completion, then in either event, the Government or Water Authority may supply any portion, or all, of such materials. If Government or Water Authority supplies such materials, the cost in respect thereof to be borne by the Contractor shall be either the current market rates or the actual cost to Government or Water Authority at the date of supply including overheads and any other charges, whichever is the greater.

1.4.3 The cost to be borne by the Contractor as detailed in 1.4.2 above, shall be deducted from money due or to become due to the Contractor under this Contract and the Contract Sum shall be adjusted accordingly. Provided that any variation order issued by virtue of this clause shall not be taken into account when computing the final amount of this contract and no claim for loss of profit under the Conditions of Contract shall be deemed to arise. No action by the Superintending Officer under this Clause shall be deemed in any way to affect or modify the right of the Government or Water Authority to a claim for damages in the event of the Contractor's failure to complete the Works by the agreed date for completion.

1.5 Requirements of other Contractors

1.5.1 The Contractor shall afford every facility to other Contractors where appointed by the Superintending Officer as per the Conditions of Contract on the site and allow them to carry out their work unhindered. The Contractor shall maintain constant and careful liaison with them to ensure the correlation of the respective programme of the work and the accurate laying and building in of pipes, formation of ducts, and the like as the Works proceed. The Superintending Officer will do everything possible to assist in the maintenance of this liaison and co-operation and the Contractor shall be prepared to assist in the progress of the works by other Contractors generally by carrying out construction and laying operations in the order required.

1.6 Public and Private Roads

1.6.1 The Contractor shall ensure that no unnecessary inconvenience is caused to the public or to the users of any roads that may be affected by the Works or used by him during the progress of the Works.

1.6.2 No private road shall be blocked or obstructed by the Contractor without notice to the owner and the prior approval of the Superintending Officer.

1.6.3 No public road shall be blocked or obstructed by the Contractor without the approval of the Superintending Officer.

1.6.4 The Contractor shall at his own expense provide, operate and maintain to the satisfaction of the Superintending Officer and the relevant Authorities, all temporary bridges, barriers, traffic signals, lights, reflective warning signs and watchmen, as may be required to ensure the safety and convenience of users of public and private roads affected by the Works or disturbed by him during the progress of the Works.

1.6.5 Where a pipe trench is being excavated in a public road necessitating single lane traffic being brought into operation with the permission of the relevant Authorities, adequate warning notices, flagmen etc. shall be provided by the Contractor for the efficient regulation of the traffic at all times. Loose stones and material from the excavation, must be swept clear of the space left for traffic at all times. The Contractor shall indemnify the Employer against all claims arising under this clause.

1.6.6 The Contractor shall comply with all relevant Authorities requirements regarding obstructions and shall be deemed to have included for this in his price and he shall not be entitled to any extra payment on this account.

1.6.7 Where the lineal pipe trench has to be excavated in a public road or verge thereof, not more than 500 metres of continuous trench shall be opened at any one time and there shall be a minimum of 250 metres clear between consecutive road openings.

1.6.8 The Contractor shall give 7 days notice in writing of his intention to excavate in any public road, footpath or verge and serve the necessary notices on the Road Authority and other

relevant Authorities and any special requirements regarding such work must be strictly complied with by the Contractor, without extra payment.

- 1.6.9 The Contractor shall take care to avoid damage to all boundary fences, hedges and walls during the execution of the Work, and shall indemnify the Employer against any claims arising from such damage caused as a result of his operations.

1.7 Other Services

- 1.7.1 The Contractor's attention is specially drawn to his responsibilities under the Form of Contract. In this connection, he shall take special precautions to safeguard other services such as electricity supply lines, water pipes, telephone cables, sewers, gas lines and surface drains which pass under, over or near the site of the Works. Every care shall be taken to locate and excavate without damage around such services.
- 1.7.2 If during excavations, the Contractor's workmen uncover any services laid underground, the matter shall be reported to the Superintending Officer and all excavations near the services in question shall be stopped until instructions are issued by the Superintending Officer giving directions as to the manner in which work shall be continued.
- 1.7.3 The cost of deviating or re-aligning any of those services shall not be borne by the Contractor, but he shall provide and maintain at his own cost, any temporary works necessary to support or protect the services affected by his excavations, to the satisfaction of the Authorities concerned.
- 1.7.4 The Contractor will be responsible for any damage to services caused by his excavation methods and shall pay the costs of repair.
- 1.7.5 The Contractor shall attend upon the Authorities concerned and afford them all facilities necessary to enable them to undertake any work required to deviate those services, or to prevent interruption of such services, during the progress of the Contract.

1.8 Temporary works including temporary buildings

- 1.8.1 The contractor shall at his own expense provide and maintain all necessary temporary works including temporary buildings, site offices, storage sheds, work sheds, access roads, etc. as may be required to complete the Works.
- 1.8.2 The Contractor shall maintain at all times during the construction and maintenance of the Works, an adequate and efficient labour force of the requisite standard on the site for the satisfactory execution of the Works.
- 1.8.3 Notwithstanding the aforesaid, all temporary works and buildings shall not be erected without the prior approval of the Superintending Officer and where such approval is given, shall be set out, built and maintained to the satisfaction of the Superintending Officer and to the requirements of the relevant Authorities concerned.
- 1.8.4 Where such temporary works and buildings are to be erected on private property, the Contractor shall at his own expense make his own arrangements with the owner concerned and pay necessary fees or charges in connection therewith.

1.9 Site Office for use by the Superintending Officer

- 1.9.1 If required, the Contractor shall at his own expenses provide and maintain, in a perfectly usable and weatherproof condition and in such a position on or near the Works as the Superintending Officer may approve, a site office furnished, equipped and serviced for the use of the Superintending Officer and/or his representative as specified in the Special Specification. A firm path shall be maintained in all weather conditions between the nearest access road and the

office. The Contractor shall clean daily and when necessary, light the office throughout the progress of the Works.

1.10 Assistance to the Superintending Officer

1.10.1 The Contractor shall render all necessary assistance to the Superintending Officer or his representative and shall provide and maintain a sufficient supply of pegs, poles, sight rails, paint, lines, spirit levels, stores, and tools required for checking the setting out of the Works.

1.10.2 The cost of the labour, plant and materials required by the Superintending Officer or his representative for checking the setting out of the Works, inspection and supervision of the Works and for the sampling and testing of materials shall be deemed to be included in the Contract Sum.

1.11 Sanitary Measures

1.11.1 The Contractor shall undertake at his own cost, such anti-malarial precautions and other health measures as may be necessary to meet the requirements of the relevant Authorities concerned. He shall provide washing and toilet facilities suitable for his workmen employed on the site. He shall keep the site clean and free from rubbish at all times.

1.12 Safety and Security Measures

1.12.1 The Contractor shall conduct his operations in a manner so as to ensure the safety of his employees and all persons on site.

1.12.2 The Contractor shall at his own expense provide and maintain to the satisfaction of the Superintending Officer all notices, fencing, watching and lighting necessary to ensure the security of the Works and the safe-keeping of materials and tools stores on site.

1.13 Explosives

1.13.1 The Contractor shall not use any explosive without the permission of the Superintending Officer in writing, who may subsequently withdraw such permission and no claim for extras will be allowed to the Contractor on account of such withdrawal.

1.13.2 The location of each explosives magazine and store for any other dangerous substance on the site, shall be approved in writing by the Superintending Officer.

1.13.3 The Contractor is responsible for obtaining the permission of any other relevant Authority.

1.14 Damage to existing works

1.14.1 The Contractor shall be responsible for any damages to roads, verges, drains, ditches, tufted and landscaped areas, service water mains, gas lines and telephone and electricity cables, etc., which may result from his work or the passing of his vehicles, plant or equipment of whatever kind to or from the site of the Works and shall immediately make good such damage at his own expense and to the satisfaction of the Superintending Officer or relevant authorities.

1.15 Protection of Works

1.15.1 The Contractor shall at his own expense, case up and protect all work liable to injury, either by the weather or by the method adopted for the execution of the Works.

1.16 Drainage of Site

1.16.1 The Contractor shall make proper provision for the drainage of surface water from the site of the Works, including rainfall run-off from surrounding areas which drain onto the site.

1.16.2 The Contractor shall at his own cost provide, form, fix, maintain and work as and where directed by the Superintending Officer such pumps, chutes, walls, drains, bunds, silt traps, and other temporary works necessary for the proper drainage of the site so that no flooding or other damage or disturbance is caused in the areas surrounding the Works or to the Works for the duration of the Contract.

1.17 First Aid outfit

1.17.1 The Contractor shall be required to provide at his own cost a complete First Aid Outfit and shall keep it in a suitable container in his site office. The outfit shall be in the charge of either the Contractor's site representative or some other responsible person who will be on the site during all working hours to ensure that the First Aid Outfit is available without delay at all times when work is in progress. One senior member of the Contractor's staff shall be trained in simple first aid duties.

1.18 Contractor's plant

1.18.1 All Mechanical plants used by the Contractor in the execution of the Works shall be of such type, size and method of working as the Superintending Officer shall approve.

1.18.2 The Superintending Officer's approval to use mechanical plant will not be unreasonably withheld, but if in the Superintending Officer's opinion circumstances arise which make it desirable that the use of plant should be suspended either temporarily or permanently, the Contractor shall change the method of performing the work affected at his own cost and he shall have no cause for claim against the Government or Water Authority on account of having to carry on the work by another method nor shall he have cause for claim if any order issued by the Superintending Officer, results in the mechanical plant having to stand idle for a period of any duration whatsoever or having to be removed from the site.

1.19 Clearing up and reinstatement on completion

1.19.1 On completion of the Works, the contractor shall dismantle and remove from the site all his plant, equipment, temporary buildings and unused materials. He shall fill in and make good all holes and temporary excavations, dig up and remove all temporary roads if directed, clean out all gutters, clear away all rubbish, and leave the whole site of the works in a clean and tidy condition acceptable to the Superintending Officer.

1.19.2 The Contractor shall clean and wash all windows, paint work, walls and floors and shall leave all permanent buildings, tanks and other structures in a clean and perfect condition ready for use.

1.20 Storage of plant, materials, etc

1.20.1 The contractor shall ensure that all his plant, materials, temporary workshops, stores, offices, etc. are kept within the area allotted to him by the Superintending Officer. If it should be necessary to utilise land outside this area, he shall obtain the prior approval of the Superintending Officer in writing before occupying it.

1.21 Restriction of workmen

1.21.1 The Contractor shall be responsible for restricting his workmen only to the site of the Works and shall take all necessary precautions to prevent and shall indemnify Government or Water Authority against any damages arising from nuisance of any kind.

1.22 Regulations and approved standards

1.22.1 The Works shall comply with all statutory instruments and regulations current at the date of tender and in particular with the following:

- (a) Malaysian Standard (MS), BS EN or equivalent;
- (b) The Water Ordinance 1994 and the Water Supply Regulations 1995 together with all subsequent amendments;
- (c) Any relevant Regulations and Circulars issued by the Water Supply Authority, Electricity Authority, Road Authority and Local Authority.

1.22.2 The Approved Standards are those listed in Schedule A and any amendments or replacements thereof.

1.22.3 The Contractor shall list in his tender, any alternative Standard proposed in place of the Approved Standard Specification and Codes of Practice, together with full details, for comparison. If accepted by the Superintending Officer, the contractor shall supply two (2) copies of each such alternative Standard accepted at the commencement of the Contract.

SECTION 2 - EXCAVATION AND BACKFILLING

2.1 Site clearing

2.1.1 The Contractor shall fell and dispose off trees and bushes within the site of the Works, as and whenever directed by the Superintending Officer.

2.1.2 In any case, all trees and bushes within 3 metres on both sides of all pipelines to be laid under the Contract shall be felled and disposed off.

2.1.3 All stumps and roots of trees, bushes and shrubs which are felled as specified above, shall unless otherwise directed by the Superintending Officer, be grubbed up and removed to a place of deposit to be provided by the Contractor, or as directed by the Superintending Officer. Brushwood, roots and refuse shall be disposed off or removed from the site.

2.2 Excavation generally

2.2.1 Excavation shall be classified as:

- (a) Excavation in material other than rock;
- (b) Excavation in rock

2.2.2 The Contractor shall carry out all excavation in whatever material that may be found and shall deposit all excavated material as directed by the Superintending Officer.

2.2.3 Where so directed by the Superintending Officer, the turf and top-soil shall be excavated separately from the sub-soil and shall be reserved and stacked separately until required for re-use in reinstatement.

2.2.4 All excavations shall be carried out to the required lengths, widths, depths, inclinations and curvatures as may be necessary for the proper construction of the Works, or as shown on the Drawings. All excavations shall be sufficient to provide for the necessary working space, shuttering and any other temporary structures required during construction.

2.2.5 Unless otherwise stated, the excavations, whether in open cut or in trench, shall be proceeded with in such portions at a time as the Superintending Officer may direct and shall not in the first instance be carried down to a depth nearer than 150 mm above formation level; the last 150mm of depth to formation level shall be carried out by manual labour immediately in advance of placing concrete screed, concrete or pipe-laying. The bottoms of all excavations shall be carefully trimmed and leveled, well rammed and consolidated to prevent damage to the formation due to exposure to the weather.

2.2.6 Until the Superintending Officer has inspected and approved the excavation, no concrete shall

be placed and no pipes shall be laid upon the surfaces prepared by excavation. Any works built upon foundations which have not been approved by the Superintending Officer, shall on the order of the Superintending Officer be uncovered or removed by the Contractor and the foundations reinstated all at the Contractor's expense.

- 2.2.7 All excavations shall be measured nett and no payment shall be made for the extra lengths, widths and depths to provide for working space, timbering, etc. or for any additional excavation which the Contractor may be permitted to carry out for his own convenience; and no over-excavation will be paid for. The Contractor shall be deemed to have allowed for such contingencies in his tendered sum and rates for excavation.
- 2.2.8 The Contractor shall include in his tendered sum and rates for excavation, the re-handling of all excavated material as often as may be necessary, whether it be used for re-filling excavations, for the construction of embankments, slopes, verges, tips, etc. or for covering trenches.
- 2.2.9 The rates for excavation shall include all temporary timbering, shoring, trimming and grading bottoms of trenches, maintaining the surfaces of the excavations and keeping the excavation clear of water by pumping or other recognised methods of dewatering.
- 2.2.10 The rates shall also include dealing with excavated material during pipe laying operations, for ramming and backfilling as hereinafter specified for removal and disposal of surplus excavated material and for restoration of surfaces.

2.3 Excavation for pipe trenches

- 2.3.1 Before commencing the excavation of pipe trenches, the routes of the pipelines shall be pegged out accurately. Strong sight rails shall be fixed and maintained at each change of gradient, and at intermediate points not exceeding 60 m apart. On these rails shall be marked the centre line and the invert level of the pipes and such rails shall be maintained in positions and at the correct levels from the time excavation commences until back-filling is completed.
- 2.3.2 The trench shall be excavated to such width as will ensure that a minimum working space of 150 mm will be available on either side of the outside of every pipe when properly aligned. Where pipes are to be laid on a concrete bed, the width of the excavation at the bottom of the trench shall be the width of the underside of the concrete bed. At all joints, the trench shall be excavated to give a working space of not less than 300 mm all round the joint. Where bends are made by deflecting pipes at joints, the trench shall be widened to permit this operation. The sides of the trench shall be cut vertically and where necessary, shall be protected against caving in by timbering to the satisfaction of the Superintending Officer.
- 2.3.3 The trench shall have a maximum width of 300 mm either side of the pipe. If the trench is excavated beyond this width, the Superintending Officer may order concrete bedding or other measure which shall be at the Contractor's expense.
- 2.3.4 When excavating pipe trenches in carriageways or other paved surfaces, the Contractor shall first remove all metal, slabs, or bricks forming the existing paving to the width of the trenches and deposit these materials clear of the trenches for re-use in reinstatement.
- 2.3.5 The trench shall be excavated to depths intended or shown in the Drawings and shall be finished and trimmed accurately to level and grade. Where no invert levels are shown or indicated, the bottom of the trench shall be graded so that the pipe invert slopes evenly between the adjacent invert levels.
- 2.3.6 Unless otherwise shown on the Drawings or as directed by the Superintending Officer, the trench shall be deep enough to provide 1000mm cover to the top of the pipe.

2.4 Excavation in soft ground

- 2.4.1 Should the ground be so wet or soft that, in the opinion of the Superintending Officer, it does

not form a firm base for the pipe, the Contractor shall be instructed to proceed as follows:-

(a) Excavation for Pipes with Flanged Joints

- (i) The Contractor shall excavate an additional 150 mm in depth of trench. A foundation 100 mm thick of grade 15 concrete as specified, shall then be put down over the full width of the trench and of such length that only the joint holes between adjacent beds at the intended positions of joints shall not be concreted. Such joint holes shall extend 300 mm on each side of the flanged joint. When the concrete foundation has set and has been approved by the Superintending Officer or his representative and immediately before laying the pipe or special, an additional layer of Grade 15 concrete, as specified, shall be placed on the concrete foundation already cast. This additional layer of Grade 15 concrete shall comply with the relevant thickness specified below to ensure even bearing for the pipes or specials.

<u>Pipe Diameter(mm)</u>	<u>Thickness of Additional Concrete (mm)</u>
100	25
150	40
200	50
300	75
450	100

- (ii) Joint holes shall be completely filled with approved backfill material up to the centre line of the main. The approved backfill material shall be carefully placed and worked into position.
- (iii) If, in the opinion of the Superintending Officer, piling is necessary, the number, length, size and type of piles shall be decided by the Superintending Officer who will issue the necessary written instructions to the Contractor.

(b) Excavation for Pipes with Flexible Joints

- (i) The Contractor shall excavate an additional 200 mm to 300 mm or to such depth as the Superintending Officer may direct in writing. A foundation, equal in thickness to this extra depth, of best selected soil, shall then be put down over the full width of the trench and of such length that only the joint holes between adjacent beds at the intended position of joints shall not be filled.
- (ii) The selected soil shall be free from stones and shall be approved by the Superintending Officer. The Contractor shall bring suitable material from other parts of the works or from such other sources as may be approved by the Superintending Officer.
- (iii) After the first 100 mm layer of selected material has been placed in position and rammed to thorough consolidation, the remainder of the filling material shall be placed in layers not exceeding 100 mm in depth, each layer being rammed to thorough consolidation before the next layer is placed.
- (iv) Joint holes shall extend for 300 mm on either side of the joint.
- (v) Joint holes shall be filled as specified for joint holes for flanged joints.

2.5 Excavation in rock

- 2.5.1 For the purpose of this Contract, rock is defined as any hard materials which can only be removed by blasting or by pneumatic tools and cannot be removed by the teeth of a mechanical excavator, or cannot be broken with a pickaxe. The mechanical excavator shall be of minimum weight of 20 tonnes and nett horse power rating of 200 brake horse power or more, in good condition and operated by experienced personnel skilled in the use of ripping equipment.
- 2.5.2 The decision as to whether or not the material of the excavation is classified as rock shall rest with the Superintending Officer.
- 2.5.3 Where rock is encountered in the excavation, it shall be removed to a depth of 100 mm below the designed trench bed level of the pipe at the direction of the Superintending Officer. Voids formed by the removal of rock at the base of excavations shall be refilled with granular bedding such as sand or quarry dust approved by the Superintending Officer, well rammed and consolidated to the required levels. The requirements stated in clause 2.19.2 shall be followed.
- 2.5.4 The volume of rock excavated shall be taken as its volume in-situ before it is broken up. The volume of rock on which extra is payable, shall be measured and agreed upon weekly between the Contractor and the Superintending Officer. Measurement shall be based upon the minimum width of trench specified as in clause 2.3.2.

2.6 Blasting

- 2.6.1 The Contractor shall use explosives only with the written consent of the Superintending Officer. He shall comply with all instructions issued by the Superintending Officer in connection with usage and storage. The Contractor must also comply with all existing Regulations covering blasting and the storage of explosives. Blasting shall be carried out only by licenced rock blasters under the supervision of the Superintending Officer or his representative.
- 2.6.2 Prior to the starting of blasting operations, the contractor shall notify nearby householders and shall place flag men at a reasonable distance on either side of the site, to direct or temporarily prevent traffic from entering the danger zone.
- 2.6.3 Trenches shall be covered with mats, planking or other suitable protective material to break showers of rock and stone and to prevent damage to adjacent buildings. Should the operation be conducted in a manner which the Superintending Officer considers dangerous, he may order modifications in the number, size and depth of holes, or the weight and nature of the explosive used, or he may order the work to be carried out by hand or mechanical means.
- 2.6.4 In each and every circumstance, the Contractor shall be entirely responsible for all damages and accidents arising out of or in relation to blasting operation and shall hold the Employer indemnified against any claims for injury or damage arising therefrom.

2.7 Unauthorised excessive excavation

In the event of any excavation, including rock excavation, being carried out beyond the limits of, or against which permanent work is to be supported in accordance with the Drawings, unless otherwise directed or authorised by the Superintending Officer, the Contractor shall at his own expense, be required to fill the excess excavation with Grade 15 concrete or other suitable materials as directed by and to the satisfaction of the Superintending Officer.

2.8 Additional excavation ordered by Superintending Officer

- 2.8.1 When the Contractor is ordered by the Superintending Officer to lay pipes and specials at a greater depth or width than is specified, he shall be paid for the extra excavation so ordered, according to the rates entered in the Schedule of Rates. Such rates shall include for all extra timbering, pumping, refilling and disposal of surplus excavated materials and for all operations, obligations and contingencies, included in the excavation prices for ordinary depth and width of

trench and all clauses of the Specification which apply to such excavation, shall apply to excavation in extra depth and extra width of trench.

2.8.2 Excavation in extra depth and extra width shall only be paid for when carried out on the written instruction of the Superintending Officer.

2.8.3 Payment shall be made for additional width of excavation only over the maximum specified trench width.

2.9 Stability of excavation

2.9.1 The Contractor shall be responsible for the stability of excavations at all times. He shall without extra cost to the Government or Water Authority, slope the sides of the excavations and/or provide and place all shoring works necessary for supporting the sides of trenches and other excavations and shall be responsible for their safety. The sides of the trenches shall be properly and securely shored to the extent necessary to prevent falling in of the sides and to support adequately and securely the adjacent carriageway, footpath, verge, or private land and all adjacent property.

2.9.2 In soft or sliding soils, or in such other locations as appear to warrant it, the Superintending Officer may order the sides of the trenches to be shored in a continuous partition. The Contractor shall provide and place such shoring works without extra cost and shall maintain it in position to the satisfaction of the Superintending Officer.

2.9.3 The clear width inside the shoring works shall be at least 75 mm in excess of the external diameter of the pipe barrel, in order to allow it to be freely lowered into position in the trench, without damage to the external protection. Additional excavation in width of trench to accommodate shoring works, shall not be measured for payment, but shall be allowed for by the Contractor and included in his prices for excavation in pipe trenches.

2.9.4 Shoring works must be carried out to the entire satisfaction of the Superintending Officer. Notwithstanding the Superintending Officer's inspection and approval, the contractor shall be held responsible for all claims, demands, proceedings, damages, costs, charges and expenses arising out of or in relation to the failure or inadequacy of the shoring works.

2.9.5 The Contractor shall maintain the shoring works until, in the opinion of Superintending Officer, the construction work is sufficiently advanced to permit the shoring works to be withdrawn. Shoring works shall be removed only under the personal supervision of a competent foreman.

2.9.6 The Contractor shall be responsible for any injury to the work or consequential damage caused by, or arising out of the removal of shoring works and any advice, permission or approval given by the Superintending Officer relating to the removal of shoring works, shall not relieve the Contractor from his responsibility under the Contract.

2.10 Timbering left in excavation

2.10.1 It is intended that shoring works shall be removed as the work proceeds, but the Superintending Officer may require any portion of it to be left in the excavation for safety. Such shoring as are left in the trenches on the written instructions of the Superintending Officer, will be paid for according to the rates entered therefor in the Schedule of Rates, but the Contractor must bear at his own expense any shoring or supports left in the trenches without the express instructions of the Superintending Officer or which are required as a consequence of carelessness or neglect on the part of the Contractor.

2.10.2 Only the actual quantity of shoring left in will be paid for and the Contractor's rate shall include for labour in cutting off, at any level as directed by the Superintending Officer and for the disposal of additional surplus excavated materials due to leaving in of the shoring works.

2.11 Excavations to be kept dry

2.11.1 The Contractor shall be responsible for keeping dry all excavations, whether in open cut or in trench, so as not to interfere with the work in progress. He shall without extra cost to Government or Water Authority provide, form, fix, maintain and work as and where directed by the Superintending Officer, such pumps, wells, drains, dams, and other things necessary to effectively deal with all water which may collect or find its way into the excavation from any cause whatsoever. Nevertheless all methods employed for dealing with water shall be to the approval of the Superintending Officer. Such approval shall not relieve the Contractor from his liability for any damage to the Works or adjoining land and property or watercourse due to his operations.

2.11.2 The Contractor shall carry out any diversion and subsequent restoration of such existing rivers, watercourses, land springs, ditches, etc. wherever encountered during the execution of the Works, whether shown on the Drawings or not.

2.12 Underpinning/shoring of building

2.12.1 The Contractor shall shore up any building, the stability of which may possibly be endangered by excavation works. The Contractor's price for excavation shall be deemed to cover any claims, demands, proceedings, damages, costs, charges and expenses arising out of or in relation to such matters.

1.12.2 In excavating near the foundations of existing structures, the Contractor may be required to underpin and ensure the stability of those foundations. In such circumstances, the excavation shall be carried out in short lengths and the underpinning shall be constructed in alternate sections.

2.12.3 In excavating each length, the foundations of the existing structure and all sides of the trench or heading, shall be adequately shored all round and properly strutted. The Contractor's rate for excavation shall include for all operations herein specified and he shall be entirely responsible for the safety of such structures and should any subsidence or any damage occur due to the insufficiency of the underpinning or other supports provided, the damage shall be made good by the Contractor at his own expense.

2.13 Backfilling of excavations other than pipe trenches

2.13.1 Backfilling of all excavations shall not be carried out until the works therein have been approved by the Superintending Officer.

2.13.2 In backfilling excavations other than pipe trench excavations, the best and most suitable portions of the excavated material shall be employed. The material shall be deposited and spread in layers of not more than 300 mm deep; each layer shall be thoroughly rammed and watered if required.

2.13.3 If so directed by the Superintending Officer, the backfilling shall be finished off slightly proud of the surrounding ground to allow for settlement, but the Contractor shall make good any settlement, which may occur during the construction of the Works and during the Defects Liability Period of the Contract at his own expense.

2.14 Bedding

2.14.1 Trenches shall be excavated as described in clause 2.3 and accurately trimmed so that pipes are supported uniformly along their length. The Contractor shall remove all sharp projections, stones etc. and prepare the trench floor by hand. Where the nature of the ground is unsuitable, the Superintending Officer shall instruct the Contractor in writing to bring suitable materials

such as compacted sand or approved granular material from other parts of the works, or from other sources to provide a suitable bedding layer for the pipes. Unsuitable ground shall be defined as soft ground which can result in settlement of pipe.

2.14.2 Unsuitable materials shall include:

- (a) running silt, peat, logs, stumps, perishable or toxic material, slurry or mud or;
- (b) any material consisting of highly organic clay and silt; which is clay having a liquid limit exceeding 80% and/or a plasticity index exceeding 55%; which is susceptible to spontaneous combustion; which has a loss of weight greater than 2.5% on ignition; containing large amounts of roots, grass and other vegetable matter;
- (c) Materials that are soft or unstable merely because they are too wet or too dry for effective compaction are not to be classified as unsuitable, unless otherwise classified by the Superintending Officer.

2.15 Backfilling of pipe trenches

2.15.1 After the pipe laying has been approved by the Superintending Officer and before the pipelines have been satisfactorily tested, only sufficient backfilling of the trench to prevent snaking and to maintain the pipes in position will be permitted, but all joints shall be left exposed. In low lying ground or any locality where the trench may be filled with water and cause flotation of pipes, or elsewhere as may be decided by the Superintending Officer, the backfilling shall follow the pipe laying as closely as possible.

2.15.2 For road crossing or under road pavement, compacted layers of the same material shall extend all the way up to the road surface. The requirements stated in clause 2.19.2 shall be followed.

2.15.3 For road crossing or under road pavement, the remainder of the backfilling may consist of coarse material including broken rock free from boulders and large earth clods. It shall be placed to finish off slightly proud of the surrounding ground. The Contractor shall make good any settlement during the Defects Liability Period of the Contract.

2.15.4 Where the pipe trench is located in a road formation, or elsewhere as shown on the Drawings, the backfilling and tamping shall be carried out with extra care to the top of the trench. The requirements stated in clause 2.19.2 shall be followed. The Contractor shall replace any stones or metalling which were removed while excavating the trench, with material equal in strength, thickness and construction to the original formation and shall leave the backfilling level with the adjoining road surface, and maintain it level during the Defects Liability Period.

2.15.5 Mechanical means may be employed for compaction of backfill only after hand consolidation of backfill to 300 mm over the pipe. Only mechanical equipment of the type and weight approved by the Superintending Officer and suitable for the work involved, shall be used. Water may be used to assist consolidation when approved by the Superintending Officer.

2.15.6 If the quantity of selected fill is not available from the excavated material, the Contractor shall at his own expense, obtain the balance by excavation in areas approved by the Superintending Officer.

2.16 Removal of surplus spoil

2.16.1 The Contractor shall allow in his tendered sum and in his rates for excavation, for the removal and disposal of all surplus excavated material, earth, rubbish, and waste materials to an approved dump to be provided by him unless otherwise directed by the Superintending Officer.

2.16.2 The Contractor shall allow for spreading spoil at the disposal site and leaving the area in a tidy

and free draining condition.

2.16.3 When removing surplus spoil, the Contractor shall remove all spoils, clear up all carriageways, footways and verges affected by his work and leave the site of the Works clean and tidy. If surplus spoil is tipped into or removed from private property, the operations shall be executed in accordance with the requirements of the relevant authorities with the approval of the owner and with the least possible amount of inconvenience to the owner and occupier of the same.

2.16.4 The Contractor shall have no right of ownership to the surplus materials excavated.

2.16.5 The Contractor will not be permitted to use sand, gravel, clay, or other materials arising out of the excavations for incorporation in the permanent Works, except with the permission in writing of the Superintending Officer.

2.17 Soiling and turfing

2.17.1 The exposed surfaces of embankments and cuttings shall be properly graded and covered with good top soil at least 75 mm in depth before turfing. Turf shall be freshly cut approved runner grass. For spot turfing, the slabs of grass shall not be smaller than 150 mm square and shall be set at 450 mm spacing to ensure satisfactory rooting.

2.17.2 The Contractor shall water, cut and maintain the turf in good condition until it has well established itself.

2.18 Hardcore

2.18.1 Hardcore shall be composed of approved broken stone, brick, concrete or other similar approved material free from, foreign matter and other impurities. It shall be of approved quality and size. Samples of hardcore material shall be submitted for approval before use.

2.18.2 The approved hardcore material shall be uniformly placed in position in layers to make up to the required level. The interstices in each layer shall be filled and blinded with sand and well watered and rammed. Each layer shall not exceed 200 mm thickness.

2.19 Embankment and compaction

2.19.1 Embankments and filled areas shall be made by depositing approved soil in regular layers not more than 300 mm in loose thickness. Each layer shall be well compacted with approved mechanical rammers or rollers before the next layer is placed. Compaction shall continue until the soil is at a density not less than that of any adjacent cuttings in the insitu state. All practical steps shall be taken to avoid the inclusion of excess water in the fill and the finished surface of each layer shall be sufficiently even to prevent the ponding of rain water in ruts and hollows. The Superintending Officer may direct the filling to stop in inclement weather. In dry weather, effective consolidation shall be assisted by watering. If the soil for the fill or the previous layer of compacted soil is too moist for further effective compaction, compaction shall be deferred until, in the opinion of the Superintending Officer, it has dried sufficiently. The Contractor shall harrow the soil to aid the drying if so directed by the Superintending Officer. The fill material shall be obtained from the surplus excavated material at the side of the Works, or from approved borrow pits.

2.19.2

- (a) All materials used for embankments and backfill shall be compacted as soon as practicable after being placed and spread. All compaction requirements shall be controlled by means of field density measurement. Field density tests on each layer of compacted earthfill shall be carried out using the sand replacement method in accordance with BS 1377 or by using other means of testing of comparable accuracy approved by the Superintending Officer.

- (b) The whole of the embankment below the top 300mm of the subgrade shall be compacted to not less than 90% (for cohesive materials) or 95% (for cohesionless material) of the maximum dry density determined in the BS 1377 Compaction Test (4.5 kg rammer method).
- (c) Throughout the top 300mm of subgrade, the material shall be compacted to not less than 95% (for cohesive materials) or 100% (for cohesionless material) of the maximum dry density determined in the BS 1377 Compaction Test (4.5 kg rammer method).
- (d) If the Superintending Officer is fully satisfied that the subgrade in its natural state possesses a density exceeding the requirements, then the surface of the subgrade shall be trimmed and rolled to obtain a smooth finish.

2.20 Serviceable materials

2.20.1 Dry sand or ballast found in the excavation is to be considered as being the property of the Employer and if suitable for use in the Works, is not to be removed from the site except with the Superintending Officer's written permission.

2.20.2 Dry sand or gravel if approved by the Superintending Officer, may after being washed and sieved, be used in the composition of the concrete. No digging beyond the limits of the excavation will be allowed.

2.21 Disposal of offensive matter

2.21.1 All filth, garbage and other offensive matter encountered during the progress of the works, shall not be deposited on the surface of any street or placed near dwelling houses, where it is likely to cause a nuisance, but shall forthwith be removed to a suitable place of disposal by the Contractor, at his own costs.

2.22 Restoration of surface

2.22.1 The Contractors shall be held entirely responsible for restoration of all surfaces. Trenches shall generally be refilled and mounded to allow for subsequent settlement and maintained during the Period of Maintenance.

2.22.2 Foundations for roads shall be replaced with materials equal in thickness, strength and construction to the original foundation and surfaced with sand or gravel. The Contractor shall maintain the trench surface whenever settlement occurs. If the trench crosses a road or footpath, the Contractor shall liaise with the relevant Authority for the reinstatement of the excavated trench and pay all costs incurred in the reinstatement work.

2.22.3 Trenches crossing grassed areas shall be restored by replacing turf and top soil excavated or by spot-turfing, so that the final restored surface shall be equal in appearance, profile and texture with the surface before it was disturbed.

2.22.4 Paths, tracks and drives shall be restored to their original condition and allowance made for settlement of backfill before final restoration.

SECTION 3 - CONCRETE AND CONCRETING

3.1 Reference to Approved Standards

3.1.1 The whole of the concrete work shall be based upon the Approved Standards.

3.2 Cement

- 3.2.1 The cement used in the work shall be ordinary Portland Cement of approved manufacture and complying with the requirements of the Approved Standard. The manufacturer's certificates of test will be accepted as proof of the quality of the cement, but the Superintending Officer may at his discretion, cause additional tests to be made on samples of cement stored at the site.
- 3.2.2 In the event of any sample being found to be not in accordance with the Approved Standard, the whole consignment from which the samples are taken shall be rejected and removed from the site immediately, notwithstanding any previous acceptance based on the manufacturer's certificate.
- 3.2.3 The Contractor shall ensure that the cement is protected from moisture and damage in transit and stored on the site in a weatherproof cement store provided with a wooden floor raised not less than 300 mm above the ground.
- 3.2.4 Notwithstanding any previous acceptance, any bag of cement containing material which has hardened or otherwise deteriorated, shall be rejected and removed from the site immediately.

3.3 Fine aggregate

- 3.3.1 Fine aggregate for concrete work shall be hard, clean, well-graded natural sand, free from adherent coating or organic impurities and shall contain no harmful material in sufficient quantities as to affect adversely the strength of the concrete, or to attack the reinforcement. The fine aggregate shall be washed and/or screened, should the Superintending Officer so direct. The grading of the fine aggregate shall comply with BS882.
- 3.3.2 Mining and beach sand shall not be used for concrete work. Fine aggregate shall be stored at the site in such a manner that it is not contaminated by coarse aggregate, earth, or other foreign matter.

3.4 Coarse Aggregate

- 3.4.1 Coarse aggregate shall be sound, hard, durable, dense crushed stone, gravel or other material approved by the Superintending Officer. It shall consist of clean, well-shaped cubical particles and shall be free from splintered or flaky particles, crusher dust, soil, organic matter, or other harmful materials. It shall be graded within the limits laid down in the Approved Standard for coarse aggregates, with a maximum size of 20 mm.
- 3.4.2 Coarse aggregate for Grade 35 concrete shall be crushed granite or other material approved by Superintending Officer.
- 3.4.3 Coarse aggregate shall be stored at the site in such a manner that it is not contaminated by fine aggregate, earth or other foreign matter. Adequate precautions shall be taken to prevent segregation of the coarse aggregate while it is transported and stored.

3.5 Combined Aggregate

- 3.5.1 The grading of the fine and coarse aggregates shall be such that when they are mixed in the proportions decided for each grade of concrete, the grading of the combined aggregate shall be suitable for making a dense concrete of appropriate workability with the proportions of cement and water with which the aggregate is to be used. The actual proportions of fine aggregate to coarse aggregate to be used in each grade of concrete shall be approved by the Superintending Officer.

3.6 Water

- 3.6.1 The contractor shall make his own arrangements to deliver at his own cost, sufficient water to the site for use in mixing and curing the concrete. Provision shall be made to store sufficient water for one day requirement at the site.
- 3.6.2 The water shall comply with the requirements of BS 3148.

3.7 Reinforcement

- 3.7.1 The reinforcement shall be rolled mild steel bars complying with the requirements of the Approved Standard. The manufacturer's certificates of test will be accepted as proof of the quality of the steel reinforcement, but the Superintending Officer may at his discretion, require additional tests to be made on samples of steel reinforcement stored at the site.
- 3.7.2 In the event of any reinforcement being found to be not in accordance with the Approved Standard under the additional tests or in the course of being worked, the whole batch of mild steel bars from which the faulty reinforcement comes, may be rejected by the Superintending Officer notwithstanding any previous acceptance on the basis of the manufacturer's certificate. Any reinforcement rejected by the Superintending Officer shall be removed from the site forthwith.
- 3.7.3 The reinforcement shall be cleaned free from loose mill scale, loose rust, oil, grease, earth and other harmful matter, before being placed on the forms and shall be free from these at the time the concrete is placed.
- 3.7.4 All reinforcement shall be bent cold, using a bar bending machine and appliances approved by the Superintending Officer. Unless otherwise specified in the Drawings, the bending dimensions and tolerances and the dimensions of end anchorage, hooks, binders, stirrups and the like, shall be in accordance with the Approved Standard.
- 3.7.5 The reinforcement shall be accurately assembled and firmly secured by wire ties made from 1.6 mm diameter soft annealed wire, so that the whole assembly is rigid and will not be displaced while concrete is being compacted around it. The ends of the wire ties shall be turned inward away from the face of the forms and shall not be left projecting beyond the reinforcing mild steel bars.
- 3.7.6 Temporary bracing shall be provided to prevent movement of all steel projecting from the concrete during the course of construction.
- 3.7.7 The concrete cover over the mild steel bars as shown on the Drawings, shall be maintained by precast spacing blocks securely wired to the bars, or by other means approved by the Superintending Officer. Spacing blocks for the various cover dimensions, shall be cast from cement mortar made from one part of cement and two parts of sand. The blocks shall be well compacted and shall receive full curing treatment before being used.

3.8 Welding of reinforcement

- 3.8.1 Welding of reinforcement will be permitted only where shown on the Drawings. The welding shall be by electric arc and shall be performed by a licenced welder approved by the Superintending Officer. No welding shall be performed except under the supervision of the Superintending Officer's representative. The surface of the bars must be thoroughly cleaned and scrubbed with a wire brush immediately before welding and the weld must be deposited evenly and all slag shall be removed. The finish surface of the weld shall be of even contour without cavities and undercutting.

3.9 Formwork

- 3.9.1 Formwork are to be of timber, plywood, steel or other suitable and approved material which is to be adequately strong, impervious and resistant to the action of cement.
- 3.9.2 If so required, the contractor is to submit for approval, details of the proposed formwork.
- 3.9.3 Formwork is to be true to the required shape and dimensions, line and level and is to be adequately supported by struts and shores in such a manner that there is no undue deflection

under the loads incidental to the placing and maturing of the concrete and so that no load shall be transmitted to concrete work not completely set, or sufficiently strong to support it. The faces of the formwork are to be constructed so as to avoid leakage of mortar from the concrete and all joints are to be flushed, so as to avoid any marking appearing on the finished work, unless clearly specified in a particular manner to the contrary. Where bolts or rods for the formwork pass through the concrete, they are to be provided with metal sleeves of internal diameter slightly larger than the bolts or rods; wire ties are not to be used without the written approval of the Superintending Officer

3.9.4 Formwork is to be so constructed that it can be removed without jarring the concrete or subjecting the same to sudden shock.

3.9.5 Before any concrete is placed, all rubbish shall be removed from the interior of the forms. The forms and all concrete joint surfaces within the forms shall be thoroughly flushed with water. The forms may, with the approval of the Superintending Officer, be treated with an approved composition which shall be kept out of contact with the reinforcement and concrete joint surfaces.

3.9.6 The time for the removal of formwork is to be subjected to the Superintending Officers' approval.

3.10 Concrete mix proportions

3.10.1 Concrete for the Works shall be proportioned as indicated in Table 'A'. Cement fine aggregate and coarse aggregate shall be measured either by volume in gauge boxes or by weight using weigh-batching machines. Water shall be measured by volume, using accurate gauging equipment and allowance shall be made for the water contained in the aggregates when calculating the water to be added to the mix.

3.10.2 The mix proportions specified in Table 'A' shall generally be adhered to, but may be adjusted by the Superintending Officer should it be considered necessary.

3.11 Admixtures

3.11.1 A plasticising agent or other admixture may only be used with the Superintending Officer's written approval.

3.12 Concrete test cubes

3.12.1 For each grade of concrete, test cubes shall be made whenever the Superintending Officer may require. After casting of the concrete, a set of six (6) 150 mm concrete test cubes, three (3) for carrying out '7 days cube test' and three (3) for carrying out '28 days cube test', shall be made on each day on which concrete is placed.

3.12.2 If any of the test cubes tested at 7 days show a compressive strength less than that specified, the Superintending Officer shall, at his discretion, order all concreting work to stop until adequate measures have been taken to produce concrete complying with this Specification.

3.12.3 If the test cube strength at 28 days are less than that specified, the work from which the concrete or the test cubes was taken, may be rejected by the Superintending Officer and if rejected, will be broken up and rebuilt or otherwise made good as directed by the Superintending Officer at the contractor's own expense.

3.13 Mixing concrete

3.13.1 All concrete shall be mixed in an approved mechanical mixer, until there is a uniform distribution of the materials and the mass must be uniform in colour and consistency. In no case shall the time of mixing be less than two minutes or more than five minutes after the

water has been added to the batch.

3.13.2 Hand-mixing will only be allowed for small quantities of concrete and in this case, 10% extra cement shall be added to the proportion specified in Table 'A'.

3.13.3 Concrete mix exceeding the maximum slump specified shall be rejected.

3.14 Placing and compacting concrete generally

3.14.1 No concrete shall be placed until the formwork and reinforcement have been approved by the Superintending Officer. The concrete shall be transported from the mixer and placed in position without delay, segregation of the mix, or loss of grout. Any concrete which has attained its initial set before being placed shall be discarded. Placing of concrete shall be suspended during rain.

3.14.2 The concrete after placing, shall be thoroughly compacted by both hand tamping and mechanical vibration. Concrete shall be compacted before initial set is attained and the surface shall be worked to a dense true finish with a wooden float. The set concrete shall not be disturbed and shall be allowed to attain its final set.

3.15 Curing

3.15.1 When the freshly placed concrete has hardened sufficiently to withstand such treatment without damage, the exposed surfaces shall be completely covered with wet gunny bags which shall be kept wet continuously with water for a period of 8 days.

3.16 Concrete finishing

3.16.1 Where concrete is to show an exposed face on completion, the Contractor shall immediately upon removal of the shuttering, rub off any projecting imperfections, and a one to one (1:1) Portland Cement and approved sand mixture moistened with water, shall be worked upon and into the pores and imperfections of the surface with a wooden float, in such a manner that only the amount of material necessary to fill the surface pores is left on the face of the concrete. The exposed face shall in this manner, be left with a smooth and uniform surface.

3.17 Precast concrete

3.17.1 Unless otherwise specified or shown on the Drawings, all precast concrete units shall be manufactured in accordance with the relevant British Standards.

3.17.2 If any of the precast concrete units is manufactured away from the site of the work, the contractor shall satisfy the Superintending Officer that the concrete proportions, reinforcement, etc. are in accordance with the Drawings and this Specification. If required, he shall produce samples for testing.

3.17.3 All precast units shall be handled and stacked so as to avoid damage and to ensure that no stress is imposed on them. The Contractor shall remove from the site and replace at his own cost, any precast unit which is rejected by the Superintending Officer.

3.18 Traffic over concrete

3.18.1 No traffic whatsoever shall be allowed over any part of the finished concrete until it has set and been properly protected to the satisfaction of the Superintending Officer.

SECTION 4 – BRICKLAYING

4.1 Generally

4.1.1 Brickwork may be used for piers, supports, walls, manholes and chambers as shown on the Drawings or described in the Special Specification. All materials used for brickwork and cement, sand or lime shall comply with the Approved Standards.

4.2 Brick

4.2.1 All bricks used in the Works, unless otherwise shown in the Drawings, shall be hard, well burnt, machine made wire cut clay bricks of standard size and from approved sources and conforming to the Approved Standard. They shall be regular in size and shape, with good-faces, undamaged and free from all defects. Before any bricks are ordered, samples shall be submitted to the Superintending Officer for approval and all deliveries of bricks shall be up to the standard of the samples approved and kept on the site. All rejected bricks shall be removed from the site forthwith at the Contractor's own expense.

4.3 Cement

4.3.1 Cement shall be as previously specified under Section 3 - "Concrete and Concreting."

4.4 Lime

4.4.1 Lime shall be of approved well burnt quality, free from lumps or unburnt stone. Quick lime is to be properly slaked and run to putty and matured for at least two weeks before use in the case of non-hydrated and semi-hydrated lime and for at least 36 hours in the case of hydrated lime.

4.4.2 Hydrated lime is to be run to putty, or mixed with sand and water and allowed to stand for at least 16 hours before use, or where of an approved type free from unslaked particles, may be used dry.

4.5 Sand for mortar

4.5.1 Sand for mortar shall be natural sand obtained from rivers or approved pits and shall be hard, durable, clean and free of adherent coats such as clay and from clay pellets and shall comply with the requirements of the Approved Specifications. It shall not contain harmful organic impurities or harmful materials such as iron pyrites, salt, coal, mica, shale laminated or flaky or elongated particles in such a form or in sufficient quantities to affect adversely the hardening strength or durability of the mortar, or as might attack the reinforcement in reinforced brickwork. The Superintending Officer's decision as to the suitability of any sand shall be final.

4.5.2 The grading of fine aggregate shall be analysed as described in M.S. 30 and shall be within the limits of one of the grading zones given in Table 4.5.2.

Table 4.5.2 : Fine aggregate

B.S 410 Test Sieve	% Passing by weight			
	Grading			
	Zone 1	Zone 2	Zone 3	Zone 4
10 mm	100	100	100	100
5mm	90-100	90-100	90-100	95-100
2.36mm	60-95	75-100	85-100	95-100
1.18mm	30-70	55-90	75-100	90-100
600mm	15-34	35-59	60-70	80-100
300mm	5-20	8-30	12-40	15-50
150mm	0-10	0-10	0-10	0-15

4.6 Mortar

4.6.1 Mortar for brickwork below damp proof course level, piers and bearing walls shall consist of one

part of cement to three parts of sand by volume and shall be made in as small quantities as is required and shall be used within half an hour of mixing.

4.6.2 Mortar for brickwork above damp proof course level shall be composed of one part cement, one part lime and six parts of sand with the addition of an approved mortar plasticiser, used strictly in accordance with the manufacturer's instructions.

4.7 Mixing mortar

4.7.1 The ingredients for the mortars shall be measured in proper gauging boxes and a boarded platform shall be used for mixing. The mixture shall be thoroughly mixed dry after which only sufficient water shall be added and the mass thoroughly mixed again to produce a uniform material of good consistency. No making up of partially set mortar shall be permitted.

4.8 Brick laying

4.8.1 Bricks shall be carefully handled from carts or lorries and stacked and all broken bricks shall be removed from the site without delay.

4.8.2 All bricks shall be soaked in water for at least half an hour immediately before being laid and shall then be kept wet until they are set in the structure.

4.8.3 New brickwork shall be protected from the sun and kept moist for at least one day after it has been built.

4.8.4 The tops of all walls where work has stop, shall be made thoroughly wet immediately before further work is commenced.

4.8.5 All brickwork shall be constructed in English bond unless otherwise specified and shall be carried up perfectly true and plumb through successive courses so that no part of the work is more than 1 metre above any adjacent brickwork. No overhand work will be permitted and scaffolding shall be carried up as the work proceeds.

4.8.6 Bed and vertical joints of brickwork shall be filled solid with mortar and no vertical joint shall be allowed to be flushed up from the top; each joint must be filled up as the bricks are laid. All work found not complying strictly with this requirement shall be taken down and rebuilt at the Contractor's expense.

4.8.7 Joints shall not be more than 12 mm in thickness and all joints shall be raked out to a depth of 12 mm to form a key for plastering as the work proceeds.

4.8.9 All wall angles, piers, plaster and other brickwork shall be properly bonded together in the best approved manner. No broken bricks shall be used except when bats cut to the correct size and shape are used to form the bond.

4.8.10 All brickwork adjacent to reinforced concrete shall be bonded to the concrete structure with metal ties of approved pattern set at 1 metre centres. Metal ties or cramps shall be 150 mm in length, zinc coated mild steel wire of the butterfly type, complying with the Approved Standard.

4.9 Rendering

4.9.1 Unless otherwise specified, the exposed surfaces of brickwork including piers, supports and the internal faces of manholes and chambers, are to be rendered in cement and sand (1 part cement to 3 parts sand) 12 mm thick and troweled smooth.

SECTION 5 – HANDLING AND STORAGE OF PIPE MATERIALS, LAYING, JOINTING, TESTING, DISINFECTION AND FLUSHING

5.1 Pipes and materials supplied by government

- 5.1.1 Where the Government or Water Authority is to supply completely or partially as mentioned in clause 1.1.2, the Contractor shall, in his tendered sum and rates, allow for collecting from the designated Store and transporting to the site, all the pipes, specials, etc., supplied by the Government or Water Authority as specified above, unloading the pipes, specials etc., at the site and storing them in a safe place until they are required for fixing or laying in position.
- 5.1.2 Before accepting any materials supplied by the Government or Water Authority the Contractor shall satisfy himself that such materials are sound, free from defects and in good order and he shall issue a receipt for the articles and materials accepted by him.
- 5.1.3 The Contractor shall be fully responsible for the proper handling, proper storage, safe keeping, use and maintenance of materials accepted by him for use in the Contract and he shall make good at his own cost and to the satisfaction of the Superintending Officer, any damage, defects or shortage arising from his negligence in this respect.
- 5.1.4 Pipes, fittings, specials, joints, valves, etc. shall be kept under control while being loaded or unloaded by the proper use of ropes and skids. They shall be carefully secured against movement while being transported on lorries. On no account shall they be dropped from any height or subjected to shock. When pipes are stacked, the bottom layer of pipes shall be supported clear off the ground.

5.2 Damage to pipes and fittings

- 5.2.1 All pipes, specials, etc. shall be carefully examined for damage prior to fixing or laying and prior to concreting or backfilling.
- 5.2.2 If any pipe, fitting and special, etc. is found to be damaged in any way, the Contractor shall notify the Superintending Officer. The damaged item shall be clearly marked and set aside for repair, cutting to a shorter length or removal from site as the Superintending Officer may direct; and should such damage in the opinion of the Superintending Officer be caused through negligence on the part of the Contractor, the expense of repairing, cutting and or replacement shall be borne by the Contractor. The Contractor shall be responsible for any delays caused thereby. Only pipes, etc. which on inspection are found to be sound in every respect, shall be fixed or laid.

5.3 Pipe laying

- 5.3.1 No pipe shall be laid until the trench has been inspected and approved by the Superintending Officer or his representative on the site. The trench shall be kept sufficiently dry for making joints.
- 5.3.2 The pipes shall be gently lowered into the trench manually or by means of a crane, or suitable shear legs and chain blocks, with rope slings. No pipe shall be rolled and dropped into the trench.
- 5.3.3 Before any pipe, special and valve is laid in position ready for jointing, its internal surfaces shall be thoroughly wiped clean and free of all dirt, stones, etc. to ensure that no debris, sticks, stones, rags or other foreign matter is left in the pipeline. The pipes shall be laid true to alignment and gradient as shown in the drawings, or as indicated by the Superintending Officer; each pipe being bonded between sight rails. In no case shall the pipelines be laid to a gradient flatter than 1 in 500. Care shall be exercised to ensure that the barrel of every pipe is evenly bedded throughout the whole length. The interior and exterior of each pipe at the joint shall be thoroughly cleaned before the joint is made.
- 5.3.4 To prevent the entry of foul water, earth and other foreign matter into the pipelines, the

Contractor shall provide and fix suitable stops to close off all open ends of the pipelines in the trench at all times when work is not actually being carried out at such open ends.

5.3.5 Air valve tees and washout tees may be installed at the pipe joints nearest to the specified positions, provided that the approach gradients are amended to ensure that the air valve tees and washout tees are installed at the highest and lowest points respectively of the sections of the pipelines concerned.

5.4 Progress of pipelaying

5.4.1 All necessary pipes, bends, collars, tees, valves, etc. shall be brought on to the ground and deposited along the site at the Contractor's risk and with the minimum inconvenience to the public. Pipes shall be laid with the least possible delay and the trenches shall be refilled at the earliest time following the Superintending Officer's inspection and approval of the workmanship and suitability of the pipe lines.

5.4.2 In the case of gateways and crossing, the Contractor shall not open the trenches until he is ready to undertake the pipe laying and shall refill the trenches immediately after the pipes are laid.

5.5 Depth of cover and protection of pipes

5.5.1 Except where otherwise shown on the Drawings or as directed by the Superintending Officer, the depth of cover to the pipes shall be as specified in 2.3.6.

5.6 Closure units

5.6.1 The use of closure units shall be avoided as far as possible by laying each pipeline in a continuous length. However, where this proves impossible at any point, the Contractor shall form the closure units by cutting pipes to the exact lengths required. No pipe shall be cut for any closure without the prior consent of the Superintending Officer. Cutting shall be done with appropriate cutting equipment and machines of an approved type.

5.6.2 All pipes shall be cut off clean and square with the axis.

5.6.3 The cost of pipe cutting, which shall be necessary for correctly locating tees, etc. shall be included in the items for laying and jointing.

5.7 Pipe jointing

5.7.1 Notwithstanding the above requirements for pipe laying, the Contractor shall pay due regard to the manufacturer's recommendations and not perform any work contrary to those recommendations unless with the specific approval of the Superintending Officer.

5.8 Torque wrenches

5.8.1 For tightening of all bolts in joints, the Contractor shall provide and use appropriate torque wrenches, set to give a torque determined by the Superintending Officer or recommended by the manufacturer.

5.9 Concrete surround, haunching and bedding

5.9.1 Where it is specified or shown in the Drawings that concrete shall be placed around or under a pipe, the pipe when laid, shall first be supported on not less than two concrete supporting blocks and the remaining concrete shall first be placed on one side of the pipe only and carefully punned or vibrated until it has spread under the pipe to the opposite side of the pipe to the full length of the surround, haunching or bedding. Concrete may then be added on both sides of the pipe until the top of the surrounding haunching or bedding has reached the level specified. Such concrete surround or bedding shall not be placed until the joints at both ends of the pipe have been made.

Except where otherwise specified, concrete shall be omitted on either side of a Gibault Joint, Viking Johnson Coupling or other flexible joint for a distance of 300 mm from the centre of the joint.

5.10 Thrust blocks and anchor blocks

5.10.1 The Contractor shall build thrust and anchor blocks to the details shown in the Drawings specified in the Special Specification or details to be issued by the Superintending Officer. Plain Concrete shall be in Grade 15 concrete while reinforced concrete shall be in Grade 20 concrete specified in Table 'A' under Concrete and Concreting.

5.10.2 Unless otherwise specified, anchor blocks on slopes shall be provided every 20 metres intervals if the slope exceeds 1 in 15, on every second pipe if the slope exceeds 1 in 8 and on every pipe for slopes steeper than 1 in 5.

5.10.3 The bearing faces of all thrust and anchor blocks shall be cast against the bearing sides of the excavation defined in the Drawings or by the Superintending Officer. Where timbering has to be used in the bearing side of the excavation, such timber shall be withdrawn as the concrete is placed, so that the concrete will be in direct contact with the undisturbed bearing side. If through negligence the Contractor has excavated beyond the bearing sides, the voids so formed shall be filled in with Grade 15 concrete at his own expense.

5.10.4 The tops of concrete blocks shall in general be 200 mm below ground level.

5.11 Fixing pipe through masonry and brickwork

5.11.1 Where it is necessary for any pipe to pass through masonry or brickwork, the masonry or brickwork shall be arched over the pipe. The diameter of the hole thus formed shall be 25 mm larger than the external diameter of the pipe; and the space between the masonry or brickwork and the pipe at the hole, shall then be filled with bituminous felt to provide a cushion to the perimeter of the pipe.

5.12 Joint inspection and records of pipes and fittings to be buried

5.12.1 Before any excavation is backfilled, the Contractor or his representative and the Superintending Officer or his representative, shall make a joint inspection and compile a record of the number of pipes, specials, fittings, valves, joints, etc. which will be buried under the backfill. All such records shall be signed by both parties and shall be binding.

5.12.2 The Contractor's attention is drawn to his responsibility under this Contract in respect of storage, safe-keeping, use, damage, defects and shortages of articles accepted by him for use in the Contract. The cost of replacing any articles or materials unaccounted for shall be deducted from money due or to become due to him under the Contract.

5.13 As built drawings

5.13.1 The Contractor shall prepare drawings to record all as-built construction details of the Works and the drawings shall be certified by the Superintending Officer. The originals which shall be in good quality transparencies and two printed copies of all as-built drawings, shall be supplied to the Superintending Officer progressively as sections of the Works become complete. All drawings shall be completed within one month after the completion of the respective section.

5.13.2 As-built drawings shall be A3 size (297mm x 420 mm) unless otherwise approved by the Superintending Officer. One set of good quality transparencies and two (2) sets of printed copies in A1 size and one (1) set in A3 size, together with a CD containing AutoCad copies of the as-built drawings are to be submitted.

5.14 Valve and hydrant chambers

- 5.14.1 Valve chambers to be provided under the Contract shall be constructed in accordance with the details shown in the drawings. During the progress of the works the Superintending Officer may issue further drawings and instructions to the Contractor to suit actual site conditions encountered. Any increase or decrease in the work involved as a result of such further instructions shall be treated as a variance under the terms of the Contract.
- 5.14.2 The pipes, specials and valves in the chamber shall be set in Grade 15 concrete block to exact line and level prior to the construction of the chamber walls and all parts of the pipes and specials which are to be encased in concrete shall be brushed clean.
- 5.14.3 Unless otherwise specified or shown in the Drawings, the chamber walls shall be formed of precast concrete block and shall bear on a precast concrete slab laid on thoroughly consolidated soil. All precast concrete shall be Grade 20 concrete as specified in Section 3.
- 5.14.4 For precast concrete chambers, surface boxes shall be accurately set to conform to the surface of the adjoining ground. Hydrant and air valve surface boxes shall rest on the top layer of precast blocks in which a special groove shall be cast to receive the boxes. Sluice valve surface boxes shall rest on precast concrete slab or a cast in-situ slab having an opening of the same size as the inside of the base of the surface box. All precast work shall be laid dry. For reinforced concrete and brick chambers, the surface boxes shall be installed according to the Contract Drawings.
- 5.14.5 Reinforced concrete and brick chambers shall be drained by a 100 mm diameter hole and soak away so that the valve is never submerged.

5.15 Washouts

- 5.15.1 (a) Washouts shall be constructed at the locations shown on the Drawings or as directed by the Superintending Officer. The washout branches shall be connected to the pipeline by level invert tees and sluice valves. For pipe sizes up to 300mm diameter, a 80mm or 100mm diameter washout complete with sluice valve and HDPE pipe laid on a falling grade to the nearest drain or stream shall be constructed. For pipe sizes more than 300mm diameter, the sluice valve and washout pipe should be of appropriate size as shown on the drawing. The discharge end of the washout pipe shall face downstream.
- (b) Where the invert level of the washout tee is below the drain or stream level, a pump out type washout shall be constructed as detailed on the drawings. The pump out chamber shall be provided with an outlet pipe located at a level at the chamber such that the pipe can be laid at a falling grade to discharge by gravity flow to the drain or stream.

5.16 Air valves

- 5.16.1 Air valves shall be located as shown on the Drawings or as directed by the Superintending Officer.

5.17 Bridge, culvert and water course crossings

- 5.17.1 Work required at bridge, culvert and water course crossings shall be carried out as described in the Special Specification or as shown on the Drawings. The Contractor's rates for these items shall be deemed to include for all contingencies and he shall have no claim other than the inclusive figures entered by him in the tender.

5.18 Testing of Pipelines

The following testing procedure shall apply to all types of pipes where the testing medium is water. For HDPE and steel pipes, the testing procedures under clauses 6.1.8 and 6.3.33 are relevant.

- 5.18.1 The Contractor shall provide all water required for filling, testing and retesting the mains (pipelines) and any testing equipment including pumps, pipework fittings and pressure gauges required for the purpose. The Contractor shall give notice to the Superintending Officer in writing, not less than 48 hours prior to the test.
- 5.18.2 Whenever a section (which shall not exceed 1000 m long) of any main has been laid, joined and part back-filled as specified, it shall be prepared for testing by sealing the open ends temporarily with stop ends. The stop ends shall be of ductile iron or steel. The stop end at the lower end of the section of the main, shall be fitted with a valved inlet pipe for use to fill the section of the main with water and the stop end at the higher end of the section of the main, shall be fitted with a valved air release vent pipe.
- 5.18.3 A pressure gauge shall be connected to the valved inlet pipe. The pressure gauge shall have a dial of not less than 150 mm diameter and graduated to read up to 150 m head of water with 1 m graduations or as otherwise specified in the special specifications. All pressure gauges shall be tested by the Superintending Officer by a qualified calibration company before use and provision shall be made for connecting the Superintending Officer's pressure gauge, if he so elects, to the valved inlet pipe. All pressure gauges calibrated by a qualified calibration company shall be accompanied with the relevant test certificate. All pressure readings shall be recorded on pressure chart recorders which have been calibrated.
- 5.18.4 The stop ends shall be braced to the satisfaction of the Superintending Officer in order to withstand the end thrust forces as a result of water pressure. All weight, thrust and anchor blocks intended to prevent the vertical and lateral displacement of the pipes and specials shall have been properly completed and have attained an adequate strength before the tests are carried out. When gentle curves are affected by deflection at pipe joints, these pipes shall be securely packed with backfill to prevent movement. Ensure that all permanent valves in a test section remain in the open position. Flexible joints shall not be backfilled so as to facilitate inspection of these joints during testing.
- 5.18.5 The section of the main to be tested shall be filled with water of acceptable quality free from stones, dirt, debris, plastic objects and other matter that may have entered the pipeline during the laying of the pipeline and from a source approved by the Superintending Officer. The water shall be introduced into the section of the main through the valved inlet at the stop end at the lower end of the section. During filling, provision shall be made for the air to escape from all high-spots in the section by properly installing all air valves and from the air release vent pipes in the stop end at the higher end of the section. Where positive displacement pumps are used for filling or testing, they shall be provided with suitable pressure relief valves.
- 5.18.6 Whenever possible, the fill and test position should be located at the lowest point of the pipeline profile to encourage the expulsion of air as the pipeline is being filled. Adequate air vents should be sited at all high points. The pipeline should then be filled with water and ensure that all air is removed. It is then left to stabilize at its temperature until the next day.
- 5.18.7 Temporary marker posts shall be installed immediately after testing at all junctions between tested lengths.

5.18.8 Pressure and leakage test

- (a) Pressure and leakage test shall be carried out for sections of the pipeline. All the test sections must be certified to have passed the pressure and leakage test before the system test can be carried out.
- (b) Each section of the main shall be tested to the rated working pressure of the pipe or to a pressure of 1.5 times of the maximum system design working pressure, whichever is higher.
- (c) After the section of the main has been filled with water for a period of not less than 48 hours, more water shall be pumped into the section to raise the pressure to the specified test pressure. This is to be done slowly in increments of 10 m head of water, with a one minute pause

between each increment of pressure. Should any appreciable drop in pressure be noted during one of these intervals, the test shall be stopped until the cause of the pressure drop has been investigated and rectified. An engine driven pump may be used until 50 m head pressure is attained and thereafter, only a hand operated pump shall be used.

- (d) The length of mains under the test shall be deemed to have passed the leakage test if the make-up water pumped into the section of the main does not exceed the allowable leakage recommended by the manufacturer of the pipe. If the specified rate of leakage is exceeded, a thorough inspection of the section of the main shall be made. All leaks detected shall be repaired and the section shall be tested again.

5.18.9 System Test

- (a) System test shall be carried out for the whole system after all the section tests have been certified to have passed the pressure and leakage test.
- (b) The complete system shall be tested under a sustained pressure head equal to the rated working pressure of the pipe or not less than 1.5 times of the maximum system design working pressure, whichever is higher, for a period of not less than 20 minutes and shall satisfactorily bear the test pressure.
- (c) The satisfactory completion of the system test shall be the ultimate criteria for acceptance of the completed pipe system by the Superintending Officer. Nothing shall relieve the Contractor of his responsibility in this regard, and practical completion shall not be deemed achieved until the Superintending Officer is entirely satisfied as to the water tightness of the completed system.

5.18.10 Disinfecting, Flushing and commissioning pipelines

- (a) When the final connections have been made and upon satisfactory completion of the pressure and leakage tests, the mains must be disinfected before commissioning. The main is to be thoroughly flushed to remove any debris trapped during the pipe laying, until the water runs clear. The Contractor shall thoroughly flush and disinfect in sections, the pipeline as directed by the Superintending Officer.
- (b) A minimum flushing velocity of 1 m/sec. is required. If the minimum velocity cannot be achieved or if the pipeline cannot be satisfactorily cleaned to the satisfaction of the Superintending Officer, a form swab shall be passed through the main for final cleaning. The process shall be repeated until the wash water runs clear. The Contractor shall provide swabs, temporary pipework and water required for proper cleaning.
- (c) The section of the main to be disinfected shall be filled with water and a solution of Calcium Hypochlorite shall be added at such concentration such that a concentration of at least 20 milligrams per litre is maintained throughout the section to be disinfected and let stand for 24 hours. The contractor shall provide a dosing system to disinfect the line thoroughly. The main shall be considered to have been disinfected and safe for putting into service if the samples of water taken from various points on the main passed the bacteriological tests and the residual

chlorine show a positive value of at least 0.2mg/l.

5.18.11 Pressure Test Certificate

All pressure tests upon satisfactory completion should be fully documented using the attached report "WATERMAIN PRESSURE TEST REPORT" which should be duly signed by all the required parties, and a copy returned to the relevant JKR Divisional Office for record purpose.

5.18.12 Payment for disinfecting the pipeline

- (a) The rate for disinfecting and flushing the pipeline shall include all costs involved in supplying water and chemicals and temporary connections where necessary.
- (b) The pipe volume for flushing of new pipelines shall be fifteen times the pipe volume for the section to be flushed and the water used to be charged at commercial rate based on the current water tariff.
- (c) Where the residual chlorine exceeds 1.0 mg/litre, it shall be neutralized with sodium thiosulphate to achieve a residual of less than 1.0 mg/litre, before the chlorinated water is discharged to waste.

5.19 Installation of submarine mains

- 5.19.1 HDPE submarine mains can be connected by butt fusion using fully automatic butt fusion machine and electrofusion couplings using electrofusion machine conforming to the requirements of the standard.
- 5.19.2 The HDPE pipes shall be welded on the shore or river bank before launching across the river/stream and suitable ballast shall be provided to keep the pipes submerged. The ballast must be of the type approved by the Superintending Officer. The bolts and nuts holding the ballast together must be of double-lock nut and of stainless steel of grade 316.
- 5.19.3 The welded pipes fabricated on one bank of the river shall be towed by barge or boat all the way across to the other bank and then sunk by filling the pipeline with water and putting on the ballast. During the towing operation, it may be necessary to add floats to the pipeline; in this case, sinking is achieved by controlled release of the floats. If the depth is greater than 10 metres, it is necessary to control the sinking so as not to exceed the maximum allowable angular deflection at the joints.
- 5.19.4 The launching and sinking operation should be carried out only in calm weather conditions and preferably in between the rising and ebbing of the tides.
- 5.19.5 After the successful launching of the submarine main, one end of the main should be connected and the other end left free for a period of two weeks unless otherwise directed by the Superintending Officer, to allow settlement of the mains.
- 5.19.6 A reference peg should be driven into the ground at the free end of the mains to gauge pipe movement and settlement and daily readings taken of the distance between this peg and the stub end of the slip-on flange of the sluice valve on the HDPE pipe. When the readings show no increase, the open end of the HDPE pipe may be connected.
- 5.19.7 A sluice valve should be installed on the HDPE mains on each side of the river crossing at a distance of at least 30 metres from the river banks.
- 5.19.8 A pressure gauge shall be installed permanently on the downstream end of the submarine main.

SECTION 6: PIPES AND FITTINGS FOR CONVEYANCE OF WATER

6.0 General

(a) Subject to the specific requirements of this Specification, the pipes, fittings and specials supplied under this Contract shall be of approved manufacture and shall comply with the requirements of the current editions of the Approved Standards, including all amendments. Pipes, fittings and Specials meeting any other internationally accepted Standards ensuring a quality equal to or higher than the Approved Standard will also be accepted.

(b) All pipes, fittings and specials supplied, shall bear the following markings on the outside:-

- (i) Manufacturer's logo or name,
- (ii) Nominal diameter in 'mm',
- (iii) The letters 'J.K.R. Sarawak' unless otherwise specified,
- (iv) Length of the pipe in 'm',
- (v) Approximate weight of the pipe or special in 'kg'(for mild steel pipes only),
- (vi) Serial/batch number/year,
- (vii) Manufacturing Standard,
- (viii) SIRIM certification mark and number,
- (ix) Pressure Rating.

(c) Where required by the Superintending Officer, the contractor shall produce factory test certificates for each batch of pipes and fittings that are delivered.

6.1 HDPE Pipes

6.1.1 All HDPE pipes and fittings shall be manufactured to the requirements of the current editions of MS 1058 and include blue stripes; and have been approved by SIRIM, IKRAM Bhd.

6.1.2

(a) The raw materials from which the pipes are made shall be of PE 80, PE 100 or other approved grades and consist substantially of high density polyethylene (HDPE) to which may be added those additives that are needed for the manufacture for the pipes. The raw materials shall contain carbon black of not less than 2% by weight. Any stabilisers and additives involved must comply with the requirements of DIN 19533.

(b) HDPE pipes shall comply with the requirements in the latest edition of MS 1058 and shall have blue stripes manufactured in accordance to the relevant clauses of the aforementioned Malaysian Standard.

6.1.3 HDPE fittings such as tees, bends, reducers, stub ends must be of moulded type. Fabricated segmented fittings will not be accepted. Ductile Iron fittings can also be used. Flanges supplied shall be of ductile iron material to BSEN 545 and the dimensions of the bolt holes to BS EN 1092 PN 16 dimensions. The bolts and nuts to be of hot dipped galvanized steel or grade 304 stainless steel or grade 316 stainless steel c/w washers, unless otherwise specified.

6.1.4 The HDPE pipes may be of PN8, PN10 or PN12.5 according to the specifications. Unless otherwise specified, the length of the HDPE pipes shall be 6.1 metres. However, in special circumstances, HDPE pipes of longer lengths are also allowed if specified.

6.1.5 Unless otherwise specified, all HDPE pipes to be joined using a fully automatic butt fusion machine complying with the requirements of the current editions of JKR Standard Specification. However, electrofusion jointing is also acceptable and if this is to be used, then the requirements of the current editions of JKR Standard Specification for electrofusion machines shall be complied with.

6.1.6 The butt fusion or electrofusion of the HDPE pipes must be carried out by certified personnel in possession of a certificate on his competency to perform the trade; the certificate needs to be subjected to recognition by the water supply authority.

6.1.7 When making connections of HDPE pipes to valves, hydrants and pipes of other materials, mechanical flanged joints, flanged adaptors or flanged stepped couplings shall be used. HDPE pipes connected to plain ended pipes of other materials shall be by means of appropriate flange adaptors and properly anchored.

6.1.8 Testing of HDPE pipelines

6.1.8.1 Preparation For Testing

- (i) PE pipelines should be hydraulically tested in reasonably lengths appropriate to the diameter and site condition. Pipelines longer than 1000 meters may require testing in sections. Testing of a pipe system shall include not only the pipeline but also joints and fittings including as far as possible all tappings and connections that form part of the whole system.
- (ii) HDPE pipeline may be tested before the pipeline is placed inside the trench. The section to be tested shall have both ends blanked off with flanged connections, using stub ends and backing rings. The test ends should be designed to enable the measured filling and subsequently emptying of the pipeline. The end cap should have the relevant tappings to accommodate the necessary pressure gauges.
- (iii) Before testing, the pipeline shall be placed on the surface such that no high points exist between the flanged ends. If the section included air valves, these shall be left fully opened for the duration of the test. When the section included bends, tees or valves, these shall be secured against movement by means of temporary battens or partial burial of the pipe in the immediate vicinity. All valves and mechanical joints shall be left exposed throughout the test period. A pressure gauge shall be installed at the lower end of the section of pipeline to be tested.
- (iv) When the pipeline has been laid, it is important to provide sufficient compacted surround and backfill, at least over the barrel of the pipe, to provide lateral restraints and to maintain ambient temperatures as far as possible. Any exposed pipe should be temporarily sheltered while testing.
- (v) Whenever possible, the fill and test position should be located at the lowest point of the pipeline profile to encourage the expulsion of air as the pipeline is being filled. Adequate air vents should be sited at all high points. The pipeline should then be filled with water and ensure that all air is removed. It is then left to stabilize at its temperature until the next day.
- (vi) The testing should be carried out before 10 am in the morning or after 5 pm in the evening. The PE pipe temperature should be maintained at ambient temperature at approximately 30°C as this is critical during the pressure testing. At temperature above this, reduced test pressure is required in accordance with the HDPE pipe manufacturer's recommendations.

Note: Where positive displacement pumps are used for the tests they must have suitable pressure-relief provisions.

- (vii) The pressure in a test section should be read from a gauge placed as close as practicable to the lowest point of that section. The gauge should allow accurate reading of pressure changes of 2 percent of the test pressure. A marked loss of test pressure, together with visual inspection of the test section for leaks, is used as evidence of failure of the test section.
- (viii) Account should be taken of the pressure loss due to pressure expansion of the pipe. An increase in pipe temperature will also result in a pressure drop. To ensure that all permanent valves in a test section are tested, these should remain in the open position, and the pressure is held in the section by filling temporary valves or blanking ends where necessary.

6.1.8.2 Testing Procedures

(a) Pressure and leakage test

- (i) The test procedures consist of two steps: the initial expansion and the test phase. For the initial expansion phase, the test section is pressurized to the test pressure which is 1.5 times the maximum system design working pressure. Make-up water is added as required at hourly intervals to maintain the test pressure for four (4) hours. All components, such as fittings and valves in the test section must have pressure ratings equal to or more than the maximum system design working pressure.
- (ii) After the initial expansion phase of 4 hours, the test pressure is reduced by 0.7bar. This reduced test pressure is referred to as the target test pressure. If the pressure remains within 5% of the target test pressure for an hour, this indicates that there is no leakage in the system and the test section of the pipeline shall be deemed to have passed the pressure test. Otherwise, a physical inspection of the test section shall be carried out to detect the leakages.
- (iii) If leaks are discovered, depressurize the test section before repairing the leaks. Allow the test section to remain depressurized for at least eight (8) hours before retesting.
- (iv) The recommended maximum section of pipeline to be tested should not exceed 1,000 metres.
- (v) If the HDPE pipeline is tested before the pipeline is placed inside the trench, the HDPE pipeline shall after passing the test, be placed inside the trench beginning at one end and gradually feeding in the rest of the pipeline. The trench and overlay shall be of suitable sand, free from rocks and other sharp objects larger than 12mm and well-graded crushed rock or gravel with a maximum size of 12mm.

(b) System Test

- (i) System test shall be carried out for the whole system after all the section tests have been certified to have passed the pressure and leakage test.
- (ii) The complete system shall be tested at the rated working pressure of the pipe or under a sustained pressure head of not less than 1.5 times of the maximum system design working pressure, whichever is higher, for a period of not less than 20 minutes and shall satisfactorily bear the test pressure.
- (iii) The satisfactory completion of the system test shall be the ultimate criteria for acceptance of the completed pipe system by the Superintending Officer. Nothing shall relieve the Contractor of his responsibility in this regard, and practical completion shall not be deemed achieved until the Superintending Officer is entirely satisfied as to the water tightness of the completed system.

6.1.9 Handling of HDPE pipes

- (a) HDPE pipes should be handled following recommended procedures. Avoid dragging over rough surfaces or sharp objects. When HDPE pipes are delivered to site in loose form, either loose straight lengths or coils, unloading can be done manually using timber skids and ropes or leather sling. Bundles of HDPE pipes should be moved by forklift. HDPE pipes loose lengths are to be stacked in pyramidal manner and the stack should not exceed a height of one(1) metre. The bottom layer of pipes should be restrained against lateral movement.
- (b) All HDPE fittings should be stored under cover in the manufacturer's protective wrappings or cartons until it is required for use.
- (c) HDPE pipes bundles should always be stored on site on sufficiently flat ground. The bundles

may be stacked to a maximum height of three (3) metres.

- (d) HDPE pipe coils should be stored flat and the number of coils per stack is limited to the following quantity:

Nominal Diameter (mm)	Nos. of coils
20	7
25	6
32	5
50	4
63	3
90	2
110	1
125	1

6.2 Ductile Iron Pipes

6.2.1 Ductile iron pipes shall conform to BS EN 545. The pipes shall be manufactured with push-on joints of class K9 or class 40 unless otherwise specified. The length of each pipe shall be 6m unless otherwise specified and shall be supplied complete with gaskets of neoprene rubber or equivalent. The supply of all ductile iron pipes, fittings and their accessories (except valves) shall be from the same manufacturer.

6.2.2 All ductile iron fittings shall conform to BS EN 545. Fittings without branches shall be Class K12 and fittings with branches shall be Class K14. Unless otherwise specified, all fittings are to be push-on joints complete with gaskets of neoprene rubber or equivalent.

6.2.3 All flanged pipes shall be Class K12 PN 16 and conform to BS EN 545. The dimensions of the bolt holes shall conform to BS EN 1092 PN 16 Dimensions. The bolts and nuts to be of hot dipped galvanized steel or grade 304 stainless steel or grade 316 stainless steel c/w washers, unless otherwise specified. All flanges shall be cast integral or weld-on flanges. Screw-on flanges are not acceptable.

6.2.4 In the event of pipes being laid in exceptionally aggressive soils, some further form of protection may be required and will be detailed in the Special Specification. Polyethylene sleeves complying with BS 6076 for buried ductile iron pipes shall be provided by the contractor. The sleeve material shall be of good tearing resistance and of minimum thickness of 0.2mm.

6.2.5 Assembly of ductile iron pipes and fittings

(a) Ductile Iron push-on joints may be assembled using either one of the following methods:

(i) Crowbar Method

Complete entry of the spigot into the socket may be obtained by pushing firmly with a crowbar against the face of the socket of the entering pipe.

(ii) Trifor or Come-Along Method/rake and lever

For joints above 150mm a wire rope or chain puller can be used.

(iii) Trench Excavator Method

Where the trench is being prepared using a backhoe or excavator, either machine may be used to push the spigot home. This system is mainly used on large diameter pipe and timber header should be placed between the pipe and the bucket of the excavator to avoid damage to the pipe.

(b) Small diameter socket fittings may be pushed onto the pipe using a crowbar. Larger diameter fittings are generally provided with a jointing lug suitably located in order that a wire rope or

chain puller can be used to pull the fitting onto the spigot of the pipe.

6.2.6 Installation with deflection

- (a) In such cases, make the trench wider, assemble the joint first in a straight line and then deflect the joint to the required angle, provided that this deflection angle is within the allowable limits specified in the standards. After the installation with deflection, the white line which is nearer to the spigot end should not be visible all round the circumference.

6.2.7 Connection with other types of pipes

- (a) When ductile iron pipes are connected to other kinds of pipes, change collars, change spigots or stepped couplings are used to accommodate the difference in outer diameter of the different kinds of pipes. For jointing to steel pipes, a steel plate can be welded on to the spigot to make its outside diameter the same as that of the ductile iron pipe.

6.2.8 Inspection of pipes and fittings for damages

- (a) The pipes, fittings, specials etc shall be inspected for damages using the following methods or other methods approved by the Superintending Officer, where applicable. One or other of the following methods of inspecting pipes and specials shall be employed in the search for damaged pipes and specials.
 - (i) The outer surface of the pipes, fittings and specials shall be examined for evidence of bruising, particularly at the spigot end. Damaged pipes shall be put on one side for more detailed inspection.
 - (ii) The sounding test shall be applied to each pipe before it is finally laid. This is done by slinging the pipe at its point of balance and rapping it with a light hammer. A crack is indicated by a dull sound as distinct from the clear vibratory note given by a good pipe. All loose protecting material including spigot hoops, glands etc. shall be removed before making the test.
 - (iii) Suspected cracks shall be verified by a simple test. The inside of the pipe, in the region where the crack is suspected, shall be dusted with dry cement or chalk. The corresponding outside portion of the pipe shall then be swabbed with a cloth soaked in paraffin. (Paraffin, having a low surface tension, quickly seeps through a fine crack and this seepage is readily detected by discolouration of the cement or chalk. Petrol or kerosene, with appropriate precautions, can also be used).
 - (iv) The surface in the suspected area of crack shall be chalked and the pipe rapped with a light hammer. A crack will be revealed by the appearance of a black line along the chalked area.
- (b) All pipes, fittings, valves and specials shall be examined for signs of rust and loss of paint prior to installing in position. The exposed surfaces if affected by rust, shall be wire-brushed and painted with two coats of approved bituminous paint. The ends of pipes and specials shall be wire brushed if necessary and cleaned, primed and painted with two coats of solution, compatible with the factory applied coating material.

6.2.9 Testing of Ductile Iron Pipelines

- (a) In instances where the installed ductile iron pipelines are of relatively short distance and of isolated lengths as compared to the main pipeline material installed for the project such as mild steel or HDPE, they may be tested together with the relevant sections of the main pipeline. Where ductile iron pipelines are required to be tested separately, the test procedure under 5.18 shall be followed.

6.3 STEEL PIPES, FITTINGS AND SPECIALS

6.3.1 Definitions and symbols

(a) Definitions

For the purposes of this Technical Specification, the following definitions apply:

- (i) **welded tube** : Flat product formed into a circular shape and spiral welded.
- (ii) **pipe:** : A straight conduit for fluid, or circular cross section, with plain or prepared ends.
- (iii) **specials:** : A fitting made from manipulated or fabricated pipe, i.e bend, gusseted bend, tee, collar.
- (iv) **lining:** : Durable materials applied to the internal surface of steel pipes and fittings to protect the metal from corrosion, erosion or chemical attack.
- (v) **coating:** : Durable materials applied to the external surface of steel pipes and fittings to protect the metal surface

(b) Symbols

For the purposes of this Technical Specification, the following symbols apply.

- DN : nominal diameter.
- OD : outside diameter of the tube, in millimeters.
- T : thickness of the tube, in millimeters.
- ReH : minimum yield strength, in Newton per square millimeter.
- Rm : tensile strength, in Newton per square millimeters.

6.3.2 Compliance with Standard

- (a) Subject to the specified requirements of this specification, all steel pipes and joints shall be from approved manufacturer and shall comply with the requirements of the current edition of BS 534 - *Steel pipes, joints and specials for water and sewage*.
- (b) All lining and/or coatings shall comply with relevant International Standards or in accordance with this technical specification.

6.3.3 Marking of Pipes and mechanical couplings

- (a) All steel pipes and mechanical couplings shall bear the following marks on the outside external surface:-
 - (i) the letters “JKR SARAWAK” or “KWB” or “SWB” or “LAKU” (at least 75 mm high),
 - (ii) the manufacturer’s name or identification,
 - (iii) the nominal diameter, length, serial number,
 - (iv) the approximate weight of the pipe or mechanical coupling in kg,
 - (v) the Standard the pipe and mechanical coupling is manufactured to e.g. BS 534,
 - (vi) the product certification certificate no. e.g. SIRIM,
 - (vii) the OD of pipe and,
 - (viii) the date of manufacture (mm/yy).

- (b) The marking specified hereinbefore shall be painted on only after the pipes and mechanical coupling have been found to have satisfied all tests and other requirements of this Specification.

6.3.4 Process of Manufacture

- (a) The pipes shall be made by spiral welding process i.e. by rolling a strip, sheet or plate so that a helical seam is formed around the circumference of the pipe. The helical seam shall be butt welded internally and externally by an automatic submerged arc welding process.

6.3.5 Grade of Steel

- (a) All pipes shall be made from carbon steel to Grade S275 having a minimum yield strength, R_{eH} of 275 N/mm² and tensile strength, R_m of 410 - 560 N/mm². See Table 1 of BS EN 10025 Part 2.
- (b) It is mandatory for the manufacturer to provide the mill certificate of the grade of steel used in the manufacture of each batch of pipe.

6.3.6 Thickness and Diameter

- (a) Pipes shall be designated by their nominal diameters. Unless otherwise specified, thickness of the steel pipe shells and finished internal diameters of the pipes shall be as shown in the Table 1 below:

Table 6.3.6 - Dimensions and Test Pressure

Nominal Diameter	Outside Diameter	Minimum steel shell thickness	Factory Hydrostatic Test Pressure
<i>mm</i>	mm	mm	bar
150	168.3	3.6	70
200	219.1	4.0	70
250	273	4.0	64
300	323.9	4.0	54
350	355.6	4.5	56
400	406.4	4.5	49
450	457	5.0	48
500	508	5.0	43
550	559	6.3	50
600	610	6.3	45
650	660	6.3	42
700	711	6.3	39
750	762	6.3	36
800	813	7.1	38
850	864	7.1	36
900	914	7.1	34
1000	1016	7.1	31
1200	1219	8.0	29

Table 6.3.6 - Dimensions and Test Pressure (con't)

Nominal Diameter	Outside Diameter	Minimum steel shell thickness	Factory Hydrostatic Test Pressure
1400	1422	8.8	27
1600	1626	10.0	27
1800	1829	11.0	26
2000	2032	12.5	27
2200	2235	14.2	28

- (b) The weld metal of pipes shall have a smooth finish and shall not stand more than 2.5 mm proud of the pipe shell internally and externally.
- (c) The weld metal on the external surface on the ends of all plain ended pipes shall be machined flush with the external surfaces of the pipe shell for a sufficient distance to facilitate joining with slip-on mechanical joints. At the ends of all spigot and socket pipes the weld metal shall be similarly machined externally on the spigots and internally on the sockets of the pipes.
- (d) For pipes of diameters equal or smaller than 600mm ND, the pipes shall be jointed using slip-on mechanical couplings. For pipes of diameters greater than 600mm ND, the pipe ends shall be of spigot and socket joint.

6.3.7 Lengths

- (a) Standard length of straight pipes shall be 10 m.

6.3.8 Tolerances on Dimensions

- (a) Where cut length is specified, the maximum variation in length shall be +6, -0 mm for lengths up to and including 6m. For every 3m increase in length above 6m, the plus tolerance shall increase by 1.5mm to a maximum of 12.5mm, in accordance to the current edition of BS 534 clause 10.
- (b) The outside diameter shall be measured by taping the circumference and shall not deviate from the specified diameter. See Table 6.3.8.

Table 6.3.8 - Tolerance on outside diameter for welded tubes

Outside diameter OD mm	Tolerance
139.7 to 323.9	± 1.6, -0.8 for 100
355.6 to 1219	± 1.6 for 150
1422	± 1.6, -3 for 150
1626 to 1829	± 3 for 150
2031 to 2235	± 3 for 200

6.3.9 External Coating

- (a) After the hydrostatic testing of each item has been completed satisfactorily but before the external coating and internal lining is applied, pipes and specials shall be thoroughly descaled by acid pickling or grit blasting to ensure effective adhesion of the external coating and internal lining.
- (b) Blast-cleaning shall be carried out to achieve a quality of surface preparation of at least Sa2, as in ISO 8501/1. Immediately before the application of the coating, the surface shall be free from all trace of abrasive and dust.

- (c) External coating system shall also comprise a layer of metallic zinc. This layer shall be works-applied by spraying with suitable spray-guns.
- (d) The metallic zinc coating shall cover the external surface of the pipe and provide a dense, continuous, uniform layer. It shall be free from such defects as bare patches or lack of adhesion. The uniformity of the coating shall be checked by visual inspection. The mean mass of zinc per unit area shall be not less than 130 g/m², with a local minimum of 110g/m².
- (e) Immediately after the application of the metallic zinc coating, a uniform thin coat of primer compatible with the coating material to be used shall be cold applied by flood coating, spraying or brushing. The primer shall be allowed to dry properly before the coating material is applied but if more than 96 hours elapse before coating or if the primer become dead, powdery or crumbly it shall be cleaned off and the pipe or specials shall be re-primed.
- (f) The pipes and specials shall be coated with a layer of bitumen containing a mineral filler complying with Type 2 Grade B of the current edition of BS4147. The coating shall be applied hot and shall have a minimum thickness of 3 mm complying with the current edition of BS 534 clause 26.4. The coating shall be reinforced with an inner and an outer wrapping.
- (g) The wrapping materials shall be spirally wound onto the pipes and specials simultaneously with the coating material. Each wrap shall be from 150mm to 225mm wide and the edges shall overlap by 12.5mm to 25mm. Care shall be taken to ensure that the inner wrap does not come in contact with the pipe metal or with the outer wrap.
- (h) The inner wrap shall be a glass fiber resin bonded tissue reinforced in the longitudinal direction with parallel glass threads spaced 10mm apart. The nominal thickness shall be 0.5mm and the minimum weight shall be 4.64kg per 100 square metre.
- (i) The outer wrap shall be of composite glass fibre fabric reinforced in the longitudinal direction with parallel glass threads spaced 10 mm to 25mm apart. It shall be impregnated with a material fully compatible with the coating material to give a finish thickness of 0.8 mm.
- (j) Reinforced wrappings shall be bitumen enamel wrapping complying with clause 26.4 of the current edition of BS 534 except that the outer wrapping shall be of composite glass fibre fabric.

6.3.10 Cathodic Protection

Where specified, cathodic protection shall be provided for buried steel mains.

6.3.11 Internal Lining

- (a) Unless otherwise specified, all steel pipes shall be lined internally to the thickness specified in Table 6.3.11 of this specification with concrete made from ordinary Portland cement and fine aggregate.
- (b) The materials used for the lining, the method of lining and the curing of finished lining shall comply with the current edition of BS 534. Two test cubes shall be made daily whenever concrete lining of pipes is in progress. The manufacture and testing of such test cubes shall comply with the current edition of BS 534.
- (c) After being lined, the pipes shall be stored undisturbed for 7 days for pipes above ND700mm for maturing. The curing period for pipes below ND700 mm may be reduced provided the crushing strength of the concrete has attained its minimum allowable value. The cube strength of test cube shall be not less than 31 N/mm² after 28 days of curing or 17 N/mm² after 7 days of curing. The density of test cube shall be not less than 2300 kg/m³ in the case of concrete and 2100 kg/m³ in the case of cement mortar. Means shall be employed to prevent the lining from drying to rapidly, particularly during 48 hours after the lining operation. The lining shall be

kept damp by spraying with water or by other means.

- (d) Fine crazing, hair cracks, or cracks up to 0.25mm in width in saturated lining and not over 300mm in length shall not be a cause for rejection. Cracks over 0.25mm in width in saturated linings and not over 300mm in length or other defective linings shall be made good using compatible materials.

Table 6.3.11 - Thickness of concrete lining

Outside diameter of pipe mm	Minimum thickness of concrete mm	Tolerance mm
Up to and including 168.3	6	+3, - 0
193.7 to 323.9	10	+3, - 0
355.6 to 610	13	+3, - 0
660 to 1219	19	+6, - 0
1422 to 2235	35	+6, - 0

Note 1

For both external and internal protective coatings, the surface to be coated shall, at time of application of the coating, be dry and free from all contaminants (such as previous coatings, paint, loose dirt, grease, oil, salt etc), which could be harmful to the surface preparation or to the adhesion of the coating to the steel.

6.3.12 Spigot & Socket Joints

- (a) For pipes of diameter greater than 600 mm ND, the pipe ends shall be of spigot & socket joint.
- (b) Spigot & socket joints shall be suitable for forming welded joints in the field by means of the metal -arc process and shall permit a deflection of at least 2° to be obtained at the joint. The minimum lap shall be four times the wall thickness of the pipe shell. The ends of all spigot and socket pipes and specials shall be machined so that fillet welds can be used for jointing. The spigot shall fit accurately into the socket so that the amount of metal required to form the weld is reduced to a minimum.
- (c) The socket ends of pipes of diameters equal or greater than 700mm ND shall have a 9.5mm diameter tapped hole provided with a matching plug to permit air pressure tests of the joint to be carried out on completion of welding.

6.3.13 Slip-on type mechanical couplings

- (a) For pipes of diameter 600 mm ND and smaller, the pipe ends shall be plain-ended and jointed using slip-on type mechanical couplings complying with the requirements of clause 14 under Section 3 of BS 534:1990.

6.3.14 Factory Hydrostatic Test

- (a) The manufacturer shall carry out the Factory Hydrostatic Test on all pipes before they are lined or coated. The hydrostatic test pressure shall comply with the requirements of Table 1 Section 2 of the current edition of BS 534.

6.3.15 Workmanship and Welding Standards

- (a) Welding shall comply with the requirements of the latest version of the current edition of BS 4515 along with BS 3601. As a control on weld quality, the manufacturer will be required to take and submit radiographs of all welds on straight pipes whenever required by the Government.

- (b) All defects detected in the weld shall be repaired and re-test. Lengths of pipes containing defects in welds after repairs will be liable to be rejected.
- (c) Slag inclusions and gas pockets or voids considered to be minor imperfections may be accepted if the maximum size and distributions do not exceed the limits shown in Table 8 and 9 and figure 7 and 8 of International Standard ISO 2604 Part VI.
- (d) If defects in weld are found in a length of pipes or specials, the welds of pipes immediately before and after the defective pipe or specials in the production line shall be tested until all the welds found satisfactory. Such test shall not be considered to form part of the requirement specified in sub-clause 6.3.14(a) of this specification.
- (e) All welds shall be subject to inspection by the Superintending Officer and shall comply with the requirements of the Approved Standard. The contractor shall be required to take and submit radiographs for 3% of all welds for the approval of the Superintending Officer, who will decide on where the radiographs are to be taken. Radiographs are to be taken every day whenever welding of steel pipes and specials are being carried out.
- (f) Weld defects and other minor imperfections associated with welding shall be within the limits of the approved standards. Where radiographic examination reveals defects in the welds, the Superintending Officer may reject the length of steel pipe wherein the defect occurs or may allow the contractor to carry out repairs and to submit radiographs of such repairs for his clearance. Lengths of steel pipes containing defects after repair will be liable to be rejected.
- (g) All electric arc welding equipment shall be subjected to the approval of the Superintending Officer and shall comply with the approved standard.
- (h) The Contractor shall adopt the welding procedure approved by the Superintending Officer in writing.
- (i) The Contractor shall make test specimens of the same size and thickness as the shell of the pipelines to be welded. The specimens shall be tested in the presence of the Superintending Officer and/or his Representative for each procedure in accordance with the requirements of the Approved Standard.
- (j) Any change from one procedure to another will not normally be permitted without submitting the new procedure for testing and approval by the Superintending Officer.
- (k) Only licenced welders shall be employed on the Works, and every welder before commencing any joint welding, shall prepare specimens for testing in accordance with the Approved Standard for each welding procedure approved by the Superintending Officer.
- (l) The Superintending Officer will advise the Contractor in writing which welders pass the performance qualification test. Only these welders will be allowed to join pipes in position and the Superintending Officer will be at liberty to withdraw his approval to any welder responsible for making joints which fail to meet the required standard.

Note 2

As an alternative for nondestructive inspection, and by agreement between the purchaser and the manufacturer, the weld of the pipes and specials can be tested for defects of predominantly longitudinal character using an ultrasonic technique. The ultrasonic test will be carried out on the full length or selected part of the weld area. The technique and method shall be in accordance with ISO 2604 Part VI.

6.3.16 Coating Tests, Inspection and Repairs

- (a) All metallic zinc coated pipes shall be tested for zinc coating mass in accordance to the

requirement of clause 6.6 and 6.7 of the current edition of BS EN 545.

- (b) All coated pipes shall be rigidly inspected for defects. Thickness shall be determined by pit gauge; continuity with a holiday detector and coating quality (adhesion test) by cutting out 75mm square samples at the rate of one sample per 10 lengths of pipe manufactured.
- (c) The whole coated surface area of all pipes and specials shall be tested for pin holes or other invisible defects in the coating using an approved holiday detector at a potential of 14000 volts.
- (d) Any length on which the coating is poorly applied shall be cleaned to bare metal and recoated. Minor defects may be touch-up. All repairs shall be checked for thickness and continuity.
- (e) Coated pipes shall be given two coats of approved vinyl acetate paint to reduce the risk of the coating becoming tacky.

Note 3

External coatings usually also have solar protection, commonly lime, to prevent excessive heating of the coating by solar radiation.

6.3.17 Externally painted pipes

- (a) Uncoated steel pipes and fittings required for installation above ground shall be concrete lined internally and protected externally with a layer of metallic zinc in accordance with clause 6.3.16 and two coats of approved zinc chromate immediately after the application of the metallic zinc coating. These pipes shall be designated as “painted” pipes.

6.3.18 End Protection

- (a) The internal concrete linings and external coatings of pipes to be joined by welding shall be omitted for sufficient distance from the ends to prevent damage during site welding. Unlined surfaces shall be suitably protected with an approved rust inhibitor during manufacture so that extensive cleaning of the surfaces is not required before and after joining on site.

6.3.19 Inspection

- (a) All pipes and mechanical couplings to be supplied shall be inspected by the Government or its representative at the place of manufacture. Thus the manufacturer is required to inform the Government at least 7 days before commencement of the work.
- (b) The manufacture shall provide such office facilities, assistance, labour, store, apparatus and instruments including ultrasonic equipment or other non-destructive testing equipment and high voltage holiday detectors as may be necessary to allow a thorough and extensive inspection to be carried out.

6.3.20 Transportation, handling and storage

- (a) Pipes and mechanical couplings shall be kept under control while being loaded or unloaded. On no account shall they be dropped from any height or subjected to shock.
- (b) The pipes and mechanical couplings shall be so handled, stored and transported as to prevent undue distortion and the pipes shall be carefully secured against movements while on lorries which shall not be moved in any manner involving rolling of pipes about the longitudinal axis. All pipes shall be provided with sufficient struts to fit the pipe circumference to prevent distortion during handling and delivery. Such struts shall be left in position when thin wall pipes are delivered to the pipe dumps or strung along the pipeline route.

- (c) Coated pipes shall be lifted and moved only by wide non-abrasive slings or other suitable materials. Large diameter pipes especially 1400 mm and above shall be lifted by means of two reinforced canvas slings positioned at a distance of one fifth of the pipe length from each end of the pipes. Wire ropes, chains and hooks shall not be permitted to come in contact with any external coating.
- (d) Pipes delivered to the pipe dumps or strung along the pipeline route shall be supported on timber with special wedges, padded with hessian or straw and shaped so as to give continuous support under at least 60° of the circumference, the supports being positioned as for slings.
- (e) When pipes are stacked, the bottom layer of pipes shall be supported clear of the ground. Coated pipes shall be staked in one layer only and in such a manner that any external coating is not damaged.

6.3.21 Independent Tests

- (a) The Government reserves the right to carry out any independent tests he may deem fit on the completed pipes to be used in the Contract, at any stage of manufacture or delivery.
- (b) Any samples of pipes which may be required for such tests shall be provided by the supplier at no extra cost to the Government.
- (c) The cost of making such independent tests shall be borne by the Government.
- (d) Unless it can be shown that the workmanship or materials under test are not in accordance with the Specification, in which case the cost of the tests shall be borne by the supplier.
- (e) Any materials, workmanship or completed pipes which are shown by such independent tests to be not in accordance with the Specification shall be rejected notwithstanding any previous acceptance which may have been considered in accordance with Clause 6.3.22 of this specification.

6.3.22 Supplier's Test Certificate

- (a) The supplier shall submit to the Government, one copy of the results of all tests which have been performed on pipes to be supplied under this Contract.

6.3.23 Rectification of damaged covering, lining etc

- (a) Before steel pipes and specials are laid, all damaged covering and lining shall be cut out and replaced with new materials compatible with the coating or lining material as directed by the Superintending Officer. Cracks in the internal mortar lining of steel pipes and specials may be caulked with an epoxy resin filler, with the exception of hairline cracks.

6.3.24 Protection against damage during transportation

- (a) The ends of all pipes and specials shall be suitably covered and protected against damage during transit, with straw contained in hessian secured to the pipe ends or other means acceptable to the Superintending Officer. All flanges shall have substantial wooden discs temporarily bolted on. Pipes and specials shall be wrapped or cushioned so that no load is taken directly on the external surface.

6.3.25 Spigot and socket joints

- (a) Spigot and socket joints shall be of the hemispherical sleeve type with a minimum penetration of the formed ends and allow for angular deflections. Before placing the pipes together, the portion of the sockets and spigots to be welded shall be cleaned of all rust, mill scale or other matter deleterious to the welding process. The spigot end shall then be placed in the socket and forced home so that the spherical surfaces are in contact and that the average gap between the

pipes at the end of the spigot is nowhere greater than 1.5 mm. For longitudinally welded pipes, the ends of the pipe shall be orientated such that the longitudinal welds on adjacent pipes shall be at least 15° out of line.

6.3.26 Plain ends for use with mechanical joints or flange adaptor joints

- (a) Plain ends for use with mechanical joints or flange adaptor joints shall be truly circular with a diameter tolerance of ±1mm over a distance of 225 mm from the pipe ends.

6.3.27 Requirements of flanged joints and joint gaskets, bolts and nuts

- (a) All flanged joints shall conform to the requirements of BS 4504 unless otherwise specified and be of steel and welded to the pipe by the electric arc process or other approved method. All flanges shall be rated 16 or 25 bars and adequate to withstand test pressures for the fittings to which they are attached. Joint gaskets shall be contained within the bolt pitch circle and shall be made from 4.5mm thick rubber to the current edition of BS 1154 Class Y3 reinforced with two layers of fabric in accordance with the current edition of BS 5292. Each bolt shall be supplied and installed with a nut and two washers and each bolt shall be of sufficient length to show two threads past the nut when so installed.

6.3.28 Collars

- (a) Collars shall be provided for jointing cut pieces or closure pieces by means of internal and external fillet welding. Minimum lengths of collars shall be 150mm. Collars may be provided as single split collars with temporary bolts and lugs. Collars shall have two tapped and plugged holes of not less than 6mm diameter to permit air pressure testing of the joints after field welding, one on each side of the collar clear of the welding runs and approximately 25mm from the edge of the collar. The collar shall be 1.5mm thicker than the equivalent standard straight pipe thickness.

6.3.29 Jointing of pipes using a steel split collar

- (a) Where pipes are to be joined by a steel split collar, the pipe ends shall be cleaned to a bright metal finish. The collar shall then be placed centrally on the ends of the pipes so that the space between the pipe ends shall be about 25 mm from the centre line of the collar. The collar shall be clamped tightly onto the pipes, using the lugs provided. Collars shall make close contact around the circumference of both pipes connected and the gap between the ends of a split collar after tightening shall not exceed 3mm. After completion of the circumferential welds, the lugs shall be removed and the longitudinal weld completed. The tolerances of the collar shall be such that nowhere shall the gap between the inside surface of the collar and outside surface of the pipe at fillet weld locations exceed the tolerances permitted for spigot and socket joints.

6.3.30 Weld type and welding

- (a) 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 complying with the requirements of the Approved Specification. Each time the arc is started, it shall be manipulated to obtain 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.

6.3.31 Deflection of collar joints

- (a) Collar joints shall not be required to take any deflection.

6.3.32 Requirement of flanged pipe ends, flanged branches and plain ends for use with

mechanical couplings or flanged adaptors

- (a) All flanged pipe ends, flanged branches and plain ends for use with mechanical couplings or flanged adaptors shall have a 6mm steel retaining ring welded into the bore of the pipe flush with the end of the pipe. The radial width of the ring shall be the same as the thickness of the concrete lining and shall not be less than 6mm. The ring shall be protected with two coats of approved two-pack epoxy based enamel if it is too thick to be effectively covered by the concrete lining.

6.3.33 Air testing of mild steel pipeline

- (a) After each joint has been welded it shall be air tested in the presence of the Superintending Officer. The annular space between the two welds shall be air tested to a pressure of 1.7Mpa. The welds shall be inspected for leakages while maintaining this pressure for a period of 10 minutes. Any defective welding shall be treated as directed by the Superintending Officer. The tap holes shall then be then sealed off with welding after each joint has been satisfactorily tested. The contractor shall provide all necessary equipment for the testing. The Superintending Officer shall inform the contractor in writing that a welded joint has passed the air test.
- (b) The pipeline shall be tested in lengths between section valves. Testing of shorter sections using temporary closures may be carried out with the written approval of the Superintending Officer.
- (c) The whole section of pipeline should be properly supported at the ends at all bends along the pipeline. A pressure gauge should be placed at the lower end of the pipeline. A stopcock should be placed at the higher end of the pipeline to release trapped air.
- (d) The pipeline shall be pressurized gradually until the required test pressure is achieved and the pressure shall be held for 60 minutes during which time the pressure drop shall not exceed 2metres. If the pressure drop exceeds 2metres, water shall be pumped into the pipeline to bring the pressure back to the test pressure. The total volume of make-up water added over the test period shall be measured and recorded.
- (e) The following formula may be used for estimating the maximum allowable leakage:

$$\text{Allowable leakage (litre)} = 0.1 * D_{in} * L * t/24 * H/30$$

Where :

D_{in} = internal diameter (mm)

L = length of pipeline (km)

T = duration (hour)

H = head (m)

The volume of make up water to be added, shall not exceeded the calculated allowable leakage.

6.3.34 External protection of welded joint

- (a) After the Superintending Officer has advised the Contractor in writing that a welded joint has been tested and complied with the requirements of the Approved Standard, the external coating shall be completed to ensure continuity of protection along the pipelines.
- (b) The bare metal shall be thoroughly cleaned to a bright finish to the satisfaction of the Superintending Officer and it shall be immediately coated with a primer solution. The primer shall be applied cold by brush.
- (c) As soon as the primer has set, the coating shall be completed by running hot bitumen into an aluminium mould placed over the joint and overlapping the coating by 75 mm on either side

of the joint. The thickness of the coating completed by the Contractor shall not be less than 10 mm. The Contractor shall test the coating at each joint for defects by using a Holiday detector.

- (d) Before running the mould, it shall be prepared by coating it internally, preferably while hot, with a wash of whiting or similar material. This wash should be mixed to a creamy consistency to leave a thick coating and the inside of the mould shall be thoroughly dry before use. This operation is essential to prevent sticking of the moulds.
- (e) Priming and coating material for the purpose shall be provided by the Contractor including all the necessary mould boxes and funnels required to form the protective mould and whiting for use in lining the mould boxes prior to each pour. The Contractor shall also supply all necessary boilers complete with thermometers to heat the compound to the temperature recommended by the manufacturer.
- (f) The Contractor may propose for the Superintending Officers' approval, an alternative system for external protection of the joints based on petroleum mastic and tape as described in Clause 5.9.1 and applied strictly in accordance with the recommendations of the manufacturer.

6.3.35 Internal lining at welded joint

- (a) On completing of the external coating, 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 completed by filling the gap with cement mortar made from one volume of cement to two volumes of fine aggregate to ensure a smooth continuous lining throughout the pipeline.

6.3.36 Protection of buried flexible mechanical joints

- (a) Mild steel joints such as flexible mechanical joints which are buried, shall be cleaned and all loose rust removed and one of the following protective systems provided:-
 - (i) Protection shall comprise of a bituminous compound poured into a suitable mould in accordance with the pipe manufacturer's recommendations, unless otherwise specified in the Contract;
 - (ii) Protection shall comprise the application of approved petroleum mastic paste in sufficient quantity to cover all protruding edges, bolt heads and sharp edges of flanges, so as to give a smooth external profile, followed by wrapping with approved protective tape, wound spirally with half width overlap. The tapping shall extend along 150 mm of the pipe barrel or to provide an overlap of 75 mm with the pipe coating on each side of the joint.

6.3.37 Protection of exposed mild steel joints

- (a) Exposed mild steel joints shall be protected by painting the external surfaces with suitable bituminous paint, or other paint system specified in accordance with the manufacturer's instructions.

SECTION 7 - VALVES, HYDRANTS AND SPECIALS

7.1 Supply of Materials

- (a) The following clauses give information regarding materials which will normally be supplied by the Government or Water Authority in accordance with Clause 5.1.1. Any material to be supplied by the Contractor shall comply with the following clauses unless otherwise specified.

7.2 Pipes and Fittings

7.2.1 HDPE Pipes and Fittings

- (a) All HDPE pipes and fittings shall comply with the requirements of Section 6.1 of this specification.

7.2.2 Ductile Iron Pipes and Fittings

- (a) All Ductile Iron pipes and fittings shall conform to the requirements in Section 6.2 of this specification.

7.2.3 Steel Pipes and Fittings

- (a) Mild steel pipes and fittings shall comply with the requirements of Section 6.3 of this specification.

7.3 Valves

7.3.1 General

- (a) All valves shall be designed to seal the water passage completely when shut and to have minimum head loss when fully opened. Unless otherwise specified, valves shall be clockwise closing.
- (b) Unless otherwise specified, all valves shall be of ductile iron to the approved standard.
- (c) All protective coatings shall be non-toxic and shall not be subjected to microbiological growth or give rise to odour, taste or discolouration of the water.
- (d) Unless otherwise specified, all valves shall be flanged. The flanges of valves shall be machined and drilled in accordance with Clause 7.6 of this specification.
- (e) Unless otherwise specified, all valves shall be suitable for operating at a maximum designed working pressure of 10 bar and their bodies and covers when assembled, shall be capable of withstanding a hydrostatic test pressure of 16 bar without any sign of leakage.

7.3.2 Sluice valves

- (a) Sluice valves shall conform generally to the requirements in the latest edition of JKR Standard Specification JKR 20200-0083-00.
- (b) Unless otherwise specified, sluice valves shall have a nominal pressure rating of 10 bars.
- (c) Tenderers who propose to supply sluice valves not entirely in accordance with the Approved Standard must state in their tender the distinctions between the sluice valves they offer and those which comply with the Approved Standard.
- (d) The sluice valves shall have non-rising spindles.
- (e) All valves shall be suitable for operation by a maximum torque of 40 Nm under the maximum designed working pressure. Valves of diameter 400 mm and above shall be operated by spur gearing or valve actuators.
- (f) Sluice valves shall have high tensile forged bronze or stainless steel spindles, gunmetal nuts, wedge gates with gunmetal faces and seats; or resilient gates.
- (g) All spindle contacting surfaces in the gland and neck of the stuffing box shall be bushed with

gunmetal. Packed gland shall be arranged so that the packing in the stuffing box may be easily replaced with the valve in the fully open position and under pressure.

- (h) Each sluice valve shall be provided with a ductile iron valve spindle cap unless otherwise specified.
- (i) All sluice valves up to and including 200 mm diameter shall be 'open end' tested as described in the Approved Standard and shall show no signs of leakage under these tests.
- (j) All sluice valves over 200 mm diameter shall be 'close end' tested as described in the Approved Standard and shall show no signs of leakage under these tests.

7.3.3 Air Valves

- (a) Air valves shall conform generally to the requirements in the latest edition of JKR Standard Specification.

7.3.3.1 Single Orifice Air Valves

- (a) Single orifice air valves shall be suitable for automatic releasing of air that may accumulate in pipelines under pressure and shall be capable of opening and discharging free air when the pressure in the pipeline is at the maximum designed working pressure of 10 bars. The valve shall not be subjected to premature closing when air is discharged at high velocity, even at the critical velocity of 300 metre/second.
- (b) The ball or float shall be of ABS plastic float counterweighed such that the seam/joint of the ABS ball will always remain horizontal and will seal against the seat of the air valve in one position only. Vulcanised rubbers or natural rubbers are not allowed.
- (c) Each air valve shall be fitted with a full bore gate valve of approved type at the inlet.

7.3.3.2 Double Orifice Air Valves

- (a) Double orifice air valves shall be of the combined small and large orifice valve pattern. Each valve shall be fitted with a screwdown isolating valve with clockwise rotation of the spindle for closing. It shall be provided with a 12 mm drain outlet which shall be closed with a brass screw plug. The inlet end shall be flanged and the flange shall be machined and drilled to the Approved Standard corresponding to the nominal diameter of the inlet bore.
- (b) The design of the valve shall be such that the air-flow actively holds the valve open during the discharge of air at all flows. The ball for the small orifice shall be similar to that for the single air valve. The diameters of the balls in each unit of the air valve shall be suitable for operating under a maximum designed working pressure of 10 bars unless otherwise specified.

7.3.4 Butterfly valves

- (a) Butterfly valves shall conform generally to the requirements in the latest edition of JKR Malaysia Standard Specification.
- (b) The valve shall provide a positive shut off at the fully closed position. A mechanical position indicator shall be provided.
- (c) All valves shall be provided with gearing, headstocks and extension spindles for electric actuator.
- (d) No pins or bolts shall be used for connecting the shaft to the disc. A splined or keyed shaft/disc connection internal to the disc shall be used. The disc shall have a smooth profile for easy flow

and reduced turbulence to minimize pressure drop across the valve and to ensure stable hydraulic flow characteristics.

7.3.5 Fire Hydrants

- (a) All fire hydrants shall comply with the Approved Standard and may be of the pillar hydrant type or sluice valve hydrant type, unless otherwise specified. The pillar hydrant type shall conform generally to the requirements in the latest edition of JKR Malaysia Standard Specification.

7.3.6 Coating of Pipes, Valves and hydrants

- (a) Unless otherwise specified, all ductile iron and steel pipes and fittings shall be externally coated with fusion bonded epoxy or nylon coating complying with the relevant requirements of the Approved Standard, or an equivalent system approved by the Superintending Officer. The coatings shall not impart taste, smell or odour to water and shall be smooth and tenacious and non-toxic.
- (b) All machined surfaces shall be thoroughly cleaned and before they become affected by rust, shall be treated with an approved protection composition.

7.3.7 Transport and packing

- (a) All valves and hydrants shall be protected from damage during transit.
- (b) All valves up to and including 100 mm diameter shall be packed in strong cases battened and bound with steel strip or equivalent, of 25 mm wide. The flanges of valves above 100 mm in diameter shall be protected by substantial wooden discs secured in position by black service bolts or by approved steel strapping. Spindle caps of sluice valves shall be removed and where the size of the valve permits, they shall be secured to the inner side of one of the wooden discs by means of a steel strip. Otherwise they shall be packed in a case. The projecting end of the spindle shall be well wrapped with straw rope covered by hessian cloth and secured in place by binding wire which shall be carried under the flange of the gland.
- (c) All plain ends shall be adequately protected by straw rope secured in place by binding wire or strap.

7.4 Surface Boxes

7.4.1 Surface Boxes shall be of ductile iron and shall comply in respect of materials and workmanship with the Approved Standard for Surface Boxes.

7.5 Joint Rings and Lubricants

7.5.1 Unless otherwise specified, joint rings shall comply with the relevant requirements of the Approved Standard and shall be obtained from the same pipe manufacturer. Joint rings shall be compatible for use with the water to be conveyed and shall provide a positive seal under applied pressures or joint deflections.

7.5.2 Joint lubricants for sliding joints shall have no deleterious effects on either the joint rings or pipes and be unaffected by the liquid to be conveyed. Lubricants to be used for jointing watermains shall not impart to the water, taste, colour, or any deleterious effects to health, and shall be resistant to bacterial growth.

7.6 Flanges

7.6.1 Flanges are to be of ductile iron, full-faced and drilled in accordance with the Approved

Specification and shall be in accordance to the current edition of BS EN 1092 PN 16 dimensions unless otherwise specified.

7.6.2 Back faces of flanges shall be fully machined or spot faced for nuts and washers.

7.6.3 Flange faces shall be machined medium finish all over.

7.6.4 Washers shall be provided where necessary and be such that no bending stress is caused in the bolt.

7.6.5 Nuts and bolts shall be of stainless steel 304, unless otherwise specified.

7.7 Gaskets

7.7.1 Flange gaskets shall comply with the requirements and dimensions of the Approved Standard and shall be suitable for their application and to flanges specified in Clause 7.6.

7.7.2 Compressed asbestos fibre gaskets shall be grade A and 1.6 mm thick for pipe 250 mm diameter and below and 3.2 mm thickness for larger pipe sizes.

7.7.3 Rubber gaskets shall be 5 mm thick medium rubber reinforced with two-ply flex fabric.

7.7.4 Gaskets shall be full faced if compressed asbestos fibre or shall extend to the inner edge of the bolt holes, if of rubber composition.

7.8 Flexible couplings and Flange Adaptors

7.8.1

- (a) They shall be of ductile iron and conform generally to the requirements in the latest edition of JKR Standard Specification without center register, unless otherwise specified.
- (b) Flexible couplings and flange adaptors shall be coated with fusion bonded epoxy or nylon on all surfaces. The flexible couplings for mild steel cement lined and ductile iron cement lined pipes shall be capable of an angular deflection equal to that of the spigot and socket joint for the same pipe diameter and pipe material.

SECTION 8 - MISCELLANEOUS

8.1 Mild Steel

8.1.1 All mild steel shall be of approved manufacture and comply with the Approved Standard and shall be free from grease, rust and scale.

8.2 Step Irons

8.2.1 All step irons shall be heavily galvanised malleable iron castings complying with the Approved Standard. Unless otherwise shown in the Drawings, general purpose pattern step irons with 120 mm tails shall be used in walls 225 mm or more in thickness, and rounded bar pattern step irons shall be used in 100 mm walls.

8.3 Mild Steel Ladders

8.3.1 Mild steel ladders for vertical fixing shall comply with the relevant requirements of the Approved Standard. After fabrication, mild steel ladders shall be hot dipped galvanised in accordance with the Approved Standard.

8.4 Marker Posts

8.4.1 The Contractor shall provide and fix marker posts, details of which are shown in Figure 9.11, close to the centre line of the pipes at all locations of valves, washouts, changes of direction, every 50 m on horizontal curves, each side of road crossings and other points as directed by the Superintending Officer. The marker posts shall be firmly set into the ground to the depths shown on the Drawings and the backfilling well rammed.

8.5 Painting of Pipeworks And Valves

8.5.1 After installation, the exposed surface of all pipeworks, valves and fittings shall be properly cleaned and painted with two coats of approved paint as specified in the Special Specifications.

8.5.2 The cost of painting all exposed pipeworks, valves and fittings including those in the chambers and the supply of paint, shall be included in the laying cost of the pipes and the installation of valves.

8.6 Maintenance

8.6.1 The Contractor shall maintain the whole of the works of the Contract during the Defects Liability Period.

8.6.2 The Contractor shall during the progress of the work and during the Defects Liability Period, repair all leaks and other defects and continuously make good to the satisfaction of the Superintending Officer.

8.7 House and Other Service Connections

8.7.1 At any time after the pipelines have been tested and the works taken over by the Employer, but before the expiry of the defects liability period, service connections may be made by others who are not employed by the contractor. The execution of the work shall not in any way relieve the Contractor of his liability under the Contract.

8.8 Connections to Existing Main

8.8.1 Provision for connection to existing mains shall be made. The contractor shall install branches from the new mains at the locations indicated on the drawings and shall make the interconnection with the existing mains at a time to be agreed between the contractor and the employer, unless stated otherwise in the Special Specification.

SECTION 9 –TYPICAL INSTALLATION LAYOUT

The following typical installations shall generally be followed unless otherwise specified:

- 9.1 Pillar Hydrant
- 9.2 Sluice valve hydrant
- 9.3 Sluice valve
- 9.4 Single air valve
- 9.5 Double air valve
- 9.6 Washout
- 9.7 Water course crossing
- 9.8 Desirable positions for air valve
- 9.9 Positioning of sluice valves at pipe junction
- 9.10 Positioning of fire hydrant and washout
- 9.11 Marker post

**PIHAK BERKUASA BEKALAN AIR JKR SARAWAK
WATER MAIN PRESSURE AND LEAKAGE TEST REPORT**

Scheme: _____

Contractor: _____

Contract no. _____

Mains profile Drawings No.: _____

Section of Main under test
(chainage) _____

Diameter of mains (mm): _____

Type of mains: _____

PRESSURE AND LEAKAGE TEST RESULT

Date	Time	Pressure (Bar)	Volume of Water Added (litres)	Testing Officer	Observations
Total Volume Of Water Added					
Certified By				Witness for JKR	
Signature: _____					
Name: _____					
Designation: _____					
Date: _____					

TABLE A

PROPORTIONS AND STRENGTH OF CONCRETE

Concrete Grade	Characteristic strength at 28 days (N/mm²)	Minimum Cement content (kg/m³)	Maximum Cement content (kg/m³)	Maximum free water /cement ratio	Typical use
45	45	400	400	0.45	Precast pile
35	35	325	400	0.55	Water retaining structures
30	30	325	400	0.55	Reinforced concrete structure for elevated water storage tanks
25	25	325	400	0.55	Building works, building slab and all reinforced concrete except the following
20	20	280		0.55	Drain, culvert and cross over and concrete pavement, un-reinforced concrete structures
15	15	200			Backfill to cover excavation where required or similar, blinding below slabs and foundations

Schedule A : List of approved standards

1.0 British Standards (BS/BS/EN)

Pipes and Fittings

BS 10:1962 Specification for flanges and bolting for pipes, valves, and fittings

BS 3063:1965 Specification for dimensions of gaskets for pipe flanges

BS EN 1515-1:2000 Flanges and their joints. Bolting. Selection of bolting

BS EN 1515-2:2001 Flanges and their joints. Bolting. Classification of bolt materials for steel flanges, PN designated

BS EN 1515-3:2005 Flanges and their joints. Bolting. Classification of bolt materials for steel flanges, class designated

BS 4882:1990 Specification for bolting for flanges and pressure containing purposes

BS 534:1990 Specification for steel pipes, joints and specials for water and sewage

BS 750:2006 Specification for underground fire hydrants and surface box frames and covers

BS 3063:1965 Specification for dimensions of gaskets for pipe flanges

BS 1560-3.2:1989 Circular flanges for pipes, valves and fittings (Class designated). Steel, cast iron and copper alloy flanges. Specification for cast iron flanges

BS 2035:1966 Specification for cast iron flanged pipes and flanged fittings

BS EN 1092-2:1997 Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Cast iron flanges

BS EN 1759-1:2004 Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, class-designated. Steel flanges, NPS 1/2 to 24

BS 4882:1990 Specification for bolting for flanges and pressure containing purposes

BS EN 12560-1:2001 Flanges and their joints. Gaskets for Class-designated flanges. Non-metallic flat gaskets with or without inserts

BS EN 12560-2:2001 Flanges and their joints. Gaskets for Class-designated flanges. Spiral wound gaskets for use with steel flanges

BS EN 12560-3:2001 Flanges and their joints. Gaskets for Class-designated flanges. Non-metallic PTFE envelope gaskets

Welding

BS 638-4:1996 Arc welding power sources, equipment and accessories. Specification for welding cables

BS 638-5:1988 Arc welding power sources, equipment and accessories. Specification for accessories

BS 4677:1984 Specification for arc welding of austenitic stainless steel pipework for carrying fluids

BS 4515-1:2004 Specification for welding of steel pipelines on land and offshore. Carbon and carbon manganese steel pipelines

BS EN 14525:2004 Ductile iron wide tolerance couplings and flange adaptors for use with pipes of different materials: ductile iron, grey iron, steel, PVC-U, PE, fibre-cement

BS EN 545:2006 Ductile iron pipes, fittings, accessories and their joints for water pipelines. Requirements and test methods

BS ISO 4179:2005 Ductile iron pipes and fittings for pressure and non-pressure pipelines. Cement mortar lining

BS EN 14628:2005 Ductile iron pipes, fittings and accessories. External polythene coating for pipes. Requirements and test methods

BS EN 15189:2006 Ductile iron pipes, fittings and accessories. External polyurethane coating for pipes. Requirements and test methods

BS 7123:1989 Specification for metal arc welding of steel for concrete reinforcement

Coatings and corrosion protection

BS EN ISO 1461:1999 Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods

BS 3416:1991 Specification for bitumen-based coatings for cold application, suitable for use in contact with potable water

BS EN ISO 1460:1995 Metallic coatings. Hot dip galvanized coatings on ferrous materials. Gravimetric determination of the mass per unit area

BS EN 10240:1998 Internal and/or external protective coatings for steel tubes. Specification for hot dip galvanized coatings applied in automatic plants

BS EN ISO 1461:1999 Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods

BS EN 10300:2005 Steel tubes and fittings for onshore and offshore pipelines. Bitumen hot applied materials for external coating

BS EN ISO 14713:1999 Protection against corrosion of iron and steel in structures. Zinc and aluminium coatings. Guidelines

Accessories

DD 140-2:1987 Wall ties. Recommendations for design of wall ties

BS EN 14396:2004 Fixed ladders for manholes

BS 5834-2:1983 Surface boxes, guards and underground chambers for gas and waterworks purposes. Specification for small surface boxes

BS 5834-3:1985 Surface boxes, guards and underground chambers for gas and waterworks purposes. Specification for large surface boxes

BS 4190:2001 ISO metric black hexagon bolts, screws and nuts. Specification

BS 4211:2005 Specification for permanently fixed ladders

BS 4320:1968 Specification for metal washers for general engineering purposes. Metric series

BS 5292:1980 Specification for jointing materials and compounds for installations using water, low-pressure steam or 1st, 2nd and 3rd family gases

Plastic pipes

BS 4346-3:1982 Joints and fittings for use with unplasticized PVC pressure pipes. Specification for solvent cement

BS EN 911:1996, BS 2782-11: Method 1123W:1996 Plastics piping systems. Elastomeric sealing ring type joints and mechanical joints for thermoplastics pressure piping. Test method for leak tightness under external hydrostatic pressure

BS EN 1277:2003 Plastics piping systems. Thermoplastics piping systems for buried non-pressure applications. Test methods for leaktightness of elastomeric sealing ring type joints
BS EN 681-4:2000 Elastomeric seals. Material requirements for pipe joint seals used in water and drainage applications. Cast polyurethane sealing elements

BS EN 681-2:2000 Elastomeric seals. Material requirements for pipe joint seals used in water and drainage applications. Thermoplastic elastomers

BS EN 681-3:2000 Elastomeric seals. Material requirements for pipe joint seals used in water and drainage applications water and drainage applications. Vulcanized rubber

BS EN ISO 15877-5:2003 Plastics piping systems for hot and cold water installations. Chlorinated poly(vinyl chloride) (PVC-C). Fitness for purpose of the system

BS EN ISO 15877-2:2003 Plastics piping systems for hot and cold water installations. Chlorinated poly(vinyl chloride) (PVC-C). Pipes

BS EN ISO 15874-3:2003 Plastics piping systems for hot and cold water installations. Polypropylene (PP). Fittings

BS EN ISO 15874-5:2003 Plastics piping systems for hot and cold water installations. Polypropylene (PP). Fitness for purpose of the system

BS EN ISO 15875-5:2003 Plastics piping systems for hot and cold water installations. Crosslinked polyethylene (PE-X). Fitness for purpose of the system

BS EN ISO 15876-3:2003 Plastics piping systems for hot and cold water installations. Polybutylene (PB). Fittings

BS EN ISO 15876-5:2003 Plastics piping systems for hot and cold water installations. Polybutylene (PB). Fitness for purpose of the system

Reinforcement

BS EN 10080:2005 Steel for the reinforcement of concrete. Weldable reinforcing steel. General

BS 4449:2005 Steel for the reinforcement of concrete. Weldable reinforcing steel. Bar, coil and decoiled product. Specification

BS 8666:2005 Scheduling, dimensioning, bending and cutting of steel reinforcement for concrete. Specification

BS 4482:2005 Steel wire for the reinforcement of concrete products. Specification

BS 4483:2005 Steel fabric for the reinforcement of concrete. Specification

Valves

BS 5154:1991 Specification for copper alloy globe, globe stop and check, check and gate valves

BS 5163-1:2004 Valves for waterworks purposes. Predominantly key-operated cast iron gate valves. Code of practice

BS 5163-2:2004 Valves for waterworks purposes. Stem caps for use on isolating valves and associated water control apparatus. Specification

BS 336:1989 Specification for fire hose couplings and ancillary equipment

BS EN 671-1:2001 Fixed fire fighting systems. Hose systems. Hose reels with semi-rigid hose

BS 3165:1986 Specification for rubber and plastics suction hoses and hose assemblies for fire-fighting purposes

Bricks

BS 3921:1985 Specification for clay bricks

BS 6649:1985 Specification for clay and calcium silicate modular bricks

Cement, concrete and aggregates

BS 1370:1979 Specification for low heat Portland cement

BS 4027:1996 Specification for sulfate-resisting Portland cement

BS 4248:2004 Supersulfated cement

BS EN 932-1:1997 Tests for general properties of aggregates. Methods for sampling

BS 1881-112:1983 Testing concrete. Methods of accelerated curing of test cubes

BS 1881-113:1983 Testing concrete. Method for making and curing no-fines test cubes

BS 1881-125:1986 Testing concrete. Methods for mixing and sampling fresh concrete in the laboratory

BS EN 12350-2:2000 Testing fresh concrete. Slump test

BS 8110-1:1997 Structural use of concrete. Code of practice for design and construction

BS 8110-2:1985 Structural use of concrete. Code of practice for special circumstances

BS 8110-3:1985 Structural use of concrete. Design charts for singly reinforced beams, doubly reinforced beams and rectangular columns

BS EN 196-2:2005 Methods of testing cement. Chemical analysis of cement

BS EN 933-7:1998 Tests for geometrical properties of aggregates. Determination of shell content. Percentage of shells in coarse aggregates

DD 249:1999 Testing aggregates. Method for the assessment of alkali-silica reactivity. Potential accelerated mortar-bar method

BS EN 1744-1:1998 Tests for chemical properties of aggregates. Chemical analysis

Sieves

BS 410-2:2000, ISO 3310-2:1999 Test sieves. Technical requirements and testing. Test sieves of perforated metal plate

BS 410-1:2000, ISO 3310-1:2000 Test sieves. Technical requirements and testing. Test sieves of metal wire cloth

Soils

BS 1377-1:1990 Methods of test for soils for civil engineering purposes. General requirements and sample preparation

BS 1377-7:1990 Methods of test for soils for civil engineering purposes. Shear strength tests (total stress)

BS 1377-8:1990 Methods of test for soils for civil engineering purposes. Shear strength tests (effective stress)

BS 1377-6:1990 Methods of test for soils for civil engineering purposes. Consolidation and permeability tests in hydraulic cells and with pore pressure measurement

BS 1377-3:1990 Methods of test for soils for civil engineering purposes. Chemical and electro-chemical tests

BS 1377-2:1990 Methods of test for soils for civil engineering purposes. Classification tests

2.0 Malaysian Standards (MS)

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