



**GARISSA WATER AND SEWERAGE COMPANY**

**TENDER DOCUMENTS - TECHNICAL SPECIFICATIONS**

**VOLUME IV  
OF  
Bidding Document for the  
Procurement of**

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**CONSTRUCTION OF OFFICE BLOCK IN GARISSA TOWN AND  
ADMINISTRATION BLOCK/LABORATORY IN DADAAB**

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**NCB No:** KE-GAWASCO-436012-CW-RFB

**Project:** WATER AND SANITATION DEVELOPMENT PROJECT  
(WSDP)

**Employer:** GARISSA WATER AND SEWERAGE COMPANY (GAWASCO)

**Country:** REPUBLIC OF KENYA

## **TECHNICAL SPECIFICATIONS**

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## **CHAPTER 1**

### **GENERAL**

## **CHAPTER 1 – GENERAL**

### **101. DRAWINGS**

The Drawings for this Contract are listed in Volume 1 of the Contract Document. The Book of Drawings form Volume 3 of the Contract Documents. Where the Contractor is required to furnish drawings, they shall be provided in accordance with the Conditions of Contract and Contract Data.

The Contractor shall be responsible to supply as built drawings of the constructed works. To this extent he will be required to provide the necessary survey and other data to mark- up the drawings and will provide one draughtsman (proficient in the use of AutoCAD) on a continuous basis throughout the contract period to update the electronic copy drawings, under the direction of the Engineer's Representative.

### **102. BENCH MARKS**

Benchmarks and points or origin for survey will on request be indicated to the Contractor on site by the Engineer's Representative. Where deemed appropriate or necessary the Engineer or Engineer's Representative may place Temporary Bench Marks (TBMs) to direct the Contractor in setting out the works. Upon the Contractor being shown the location on site of any TBM, the responsibility of protecting and preserving the same shall from that time onwards rest with the Contractor and the Contractor shall at his own expense re-locate and replace any such TBM which shall for any reason be displaced or removed from its original location.

### **103. LEVELS AND DIMENSIONS**

The levels of the ground and the levels and dimensions of the natural features are believed but are not guaranteed to be correct. Wherever dimensions or levels are marked on the Drawings, such dimensions or levels shall take precedence over dimensions scaled from Drawings and scaled dimensions shall be used only in the absence from the Drawings and/or elsewhere of other information and then only on the written instruction to do so from the Engineer or Engineer's Representative. Large scale Drawings shall be taken in preference to Drawings of a smaller scale.

### **104. PROGRAMME AND WORK SEQUENCE**

The Programme shall be drawn up in accordance with the Conditions of Contract using the Programme Evaluation and Review Technique (PERT) or the Critical Path Method (CPM). No other form of Programme shall be allowed or approved.

In addition, and as a compliment to the Programme the Contractor shall submit at the same time schedules of Contractor's Equipment and labour indicating the projected numbers and types of Contractor's Equipment and labour to be utilised on the Works to enable compliance with the Programme. The schedules shall be itemised under the same heads of items of work as are used in the Programme.

The Programme shall include as a minimum the following activities:

- Confirmation of Quantities and Placing of Orders
- Erection of materials storage facilities
- Local procurement of major materials
- Offshore procurement of major materials
  - (i) Manufacture/Preparation for shipping
  - (ii) Shipping
  - (iii) Clearing at Port, transport to site and offloading to appropriate storage facilities.
- Mobilisation to commence Works on Site
- Sequence of work
- Major elements of work on Site, insufficient itemisation to allow for continuous monitoring of progress of Works
- Tests on Completion

The Contractor shall construct the works as summarised in the Invitation to Tender and as detailed in the drawings, Bill of Quantities and Technical Specifications upon mobilisation on site.

Those works that do not interfere with the existing operations shall be executed with maximum expedition, to the satisfaction of the Engineer, utilising such levels of Contractor's Equipment and labour as shall be necessary for the most rapid completion. Those works that interfere with the existing operations or require temporary closure of the existing supply will only commence once the final extent is agreed between the Engineer and the Contractor and all necessary materials have been received on site. In this regard attention is drawn to Clause 552 of these Technical Specifications with regard to interconnections between existing and new pipework.

The Contractor shall be deemed to have allowed for the above in all aspects of the tender.

#### **105. PROVISION OF FACILITIES FOR ENGINEER'S INSPECTION**

The Contractor shall provide the necessary tackle, access and labour to enable the Engineer and/or the Engineer's Representative conveniently to carry out such inspections as they deem necessary at all times during the currency of the Contract.

**106. PROVISION OF LABOUR FOR ENGINEER'S REPRESENTATIVE**

The Contractor shall provide all such labour and assistance as required by the Engineer or the Engineer's Representative and his staff and payment of the same shall be made through the appropriate items in the Bills of Quantities.

**107. FACILITIES FOR THE ENGINEER'S REPRESENTATIVE TO TAKE SAMPLES**

The Contractor shall provide all facilities and equipment for the Engineer's Representative to take samples for testing of any of the materials. Such samples may be taken before incorporation into the works or at any time during Construction, at the discretion of the Engineer's Representative.

No claims for delays due to the taking of samples by the Engineer's Representative will be allowed.

The taking of any samples by the Engineer's Representative shall not relieve the Contractor of his responsibility that all materials and workmanship comply with the specification, nor shall it relieve the Contractor for any of his duties under the Contract.

**108. CONTRACTOR'S OFFICE**

The Contractor shall provide and maintain an office on or near the Works on Site approved by the Engineer for the use of his Agent, where written instructions may be delivered by the Engineer's Representative and in such cases, will be deemed to have been delivered to the Contractor. This office shall be open during the Contractors working hours and shall when open have at least one person present whom the Contractor has authorised to receive on his behalf correspondence or written messages.

**109. WORKING HOURS**

The Engineer's normal working hours shall be defined as 0700hrs to 1700hrs on weekdays and 0800hrs to 1200hrs on Saturdays. Sundays shall be set aside for rest. If the Contractor wishes to execute permanent works outside these hours, he shall obtain written permission from the Engineer at least one full working day in advance to enable the Engineer to make provision for supervision of such work. Payment for the overtime of the Engineer's staff shall then be reimbursed in full by the Contractor to the Engineer, including the approved percentage for administrative overheads.

If the Contractor wishes to execute works on a regular basis outside the Engineer's normal working hours over a prolonged period, the Engineer may, if he deems necessary, employ additional supervisory staff for which the required salaries including the approved percentage for administrative overheads shall be reimbursed in full by the Contractor to the Engineer and the Contractor shall provide the required adequate accommodation facilities for such staff at his own cost.

The Contractor shall not be reimbursed any of these costs.

#### **110. ACCOMMODATION FOR EMPLOYEES**

The Contractor shall provide and maintain sufficient suitable adequately ventilated and weather-proof shelter and mess rooms for his workmen, together with a sufficient number of proper latrines which shall be properly and regularly cleansed and kept in thorough sanitary conditions and adequately screened from public view.

Camps for workmen, if provided, shall comply with all relevant Government Regulations and shall be laid out in an approved and orderly manner.

Proper provision shall be made for the disposal of all waste and refuse, and there shall be an adequate supply of water for washing, cooking and drinking purposes. Quarters shall be properly ventilated and lighted, and the whole camp shall be maintained and cleansed at all times to the satisfaction of the Government Medical Officer of Health and the Employer.

#### **111. PRECAUTIONS AGAINST CONTAMINATION OF THE WORKS**

The Contractor shall at all times take every precaution against contamination of the Works. He shall give strict instructions to all persons employed by him to use the sanitary accommodation provided. The Conditions of Contract will be rigidly enforced in any case where these instructions are disobeyed.

#### **112. FIRST AID OUTFITS**

During the progress of the Works the Contractor shall at each place of work provide an adequate First Aid Outfit which shall be easily accessible at all times, and which shall include the following: -

- |                          |                     |
|--------------------------|---------------------|
| • Range of bandage sizes | • Plasters          |
| • Antiseptic Ointments   | • Thermometers      |
| • Scissors               | • Cotton Wool       |
| • Aspirins               | • Safety Pins       |
| • Anti-Malaria tablets   | • Sticking Plasters |

and shall replenish and maintain as use demands, at his own cost. The provision of these kits shall be considered part of the Contractor's obligations in setting up his camp. The first aid kits shall be available for use by the Engineer's staff as well as the Contractor's staff on site of the works, at camps and wherever the Contractor's staff may regularly live and work. The Contractor shall ensure that there are persons available to all such places with knowledge of simple first aid procedures.

#### **113. FLAGGING, LIGHTING AND WATCHING**

The Contractor shall be responsible for properly watching and lighting the Works even where they are on enclosed land and shall allow for the same within his rates.

In this matter and as to flagging and traffic control he shall comply with the requirements of the Employer, the Police and/or the competent Authority. Prior to the commencement of any works across or alongside public roads the Contractor shall obtain the approval of the Engineer's Representative of his plans for flagging and traffic control.

#### **114. TEMPORARY WORKS**

The Contractor shall provide, maintain and remove on completion of the Works all temporary Works including roadways, sleeper tracks and staging, etc. over roads, footpaths, streams or unstable ground and he shall make them safe and suitable in every respect to carry all Plant required for the Work or for providing access or for any other purpose.

Details of temporary Works shall be submitted in advance to the Engineer for his approval, which when approved, shall not relieve the Contractor of complete responsibility for their safety and satisfactory operation.

#### **115. SURVEY BEACONS**

During the progress of the Works, the Contractor shall not remove, damage, alter or destroy in any way whatsoever, any plot or survey beacons. He shall notify the Engineer of the need to interfere with any beacon. The Engineer shall be responsible for any removal and reinstatement that he considers necessary. Should any beacon be found to be above or below the level of the finished Work, the Contractor shall immediately report the same to the Engineer.

Should any beacon be damaged or destroyed by the Contractor he shall forthwith report the damage to the Engineer and the relevant authorities and shall be held liable for the cost of reinstatement thereof.

#### **116. DAMAGE TO LANDS**

Except where necessary for the proper execution of the Works, the Contractor shall not interfere with any fence, hedge, tree, land or crops within, upon or forming the boundary of the Site, or elsewhere. In the event the Contractor encounters conditions under which he considers such interference necessary, he shall forthwith notify the Engineer's Representative who shall direct the Contractor either on the manner of execution of the Works such as to avoid or render negligible such interference, or otherwise make the necessary arrangements with the owners of the property in question and thereafter give approval to the Contractor to proceed with the interference but to the minimum extent possible given the nature of the works and the usual or customary methods of executing such works.

Where damage or interference as above is occasioned to crops, trees, buildings or shelters, or other things and improvements to the land of economic value and not readily reinstated, the Engineer shall liaise with the relevant authorities for evaluation of the damage and thereafter, the owner shall be compensated by the Contractor, and the Contractor reimbursed under the relevant item in the Bills of Quantities. However, interference with fences, grass, unlined



channels etc. shall be made good with due dispatch and to the satisfaction of the owner and the Engineer and the Contractor shall allow for the same within his rates.

**117. REINSTATEMENT OF ROADS AND FOOTWAYS**

The opening up of public roads and reinstatement of the same shall in all respects be carried out to the requirements of the relevant authority. The Contractor shall be responsible for liaison, co-ordination and arrangements with the relevant authority in the obtaining of consents, payment of fees and all manner of things necessary to comply with the lawful orders of the relevant authorities and the Contractor shall allow for the same within his rates.

**118. PRIVATELY OWNED SERVICES**

If any privately-owned service, on, about or through the Site will be affected by the Works, the Contractor shall provide a satisfactory alternative service in full working order to the satisfaction of the owner of the service and the Engineer, before the cutting off of the existing services.

**119. ADDITIONAL LAND**

The Contractor shall select and arrange at his own expense for any temporary occupation of land outside the Site which he requires for the efficient execution of the Works. The Contractor must comply fully with all By-Laws and Regulations currently in force in the area.

**120. SUBMISSION OF SAMPLES**

Before the supply of any materials or articles which he intends to incorporate into the Permanent Works, the Contractor shall submit to the Engineers Representative for his approval a sample of each respective material or article, and such samples shall be delivered to and kept at his Office for reference. Should the samples be considered by the Engineer's Representative to be unsuitable for the purpose intended, or not to comply with the Specification or the nominated Standard Specification the Contractor shall submit samples of the materials or articles from a different source for approval. All the respective kinds of materials and articles used in and upon the Works, shall be at least equal in quality to the approved samples. Each and every sample shall be a fair average of the bulk material or of the article it represents. The Engineer's Representative may decide the method by which each sample to be taken from the bulk shall be obtained and the number of such samples. The Contractor shall allow for complying with the provisions of this Clause within his rates.

**121. PROCUREMENT OF MATERIALS AND MANUFACTURED ARTICLES**

The responsibility for so ordering and delivering materials and manufactured articles and samples so that they may be tested sufficiently far in advance of the Work so as not to delay it, shall rest upon the Contractor, and he shall not be entitled to any time credit for delay occasioned by his neglect to order sufficiently well in advance or to payment of any costs he may incur as the result thereof.

With regard to any item in the Bills of Quantities which is the subject of a Provisional Sum, the Engineer shall notify the Contractor of his requirements in ample time for the Contractor to make any necessary arrangements so that no delay occurs in the progress of the Works. The Contractor shall be deemed to have allowed for compliance with the provisions of this clause within his Tender.

**122. TESTING OF MATERIALS AND MANUFACTURED ARTICLES BEFORE USE**

Any or all of the materials and manufactured articles supplied by the Contractor for use on any of the Works shall be subject in advance to such tests as may be specified in the relevant Specification or as may from time to time be deemed necessary by the Engineer who may choose to witness the same. All costs (incl. business class flights for 3 persons, accommodation, transport, subsistence allowance) incurred during witness testing shall be borne by the Contractor and paid for under the relevant bill item.

Samples of materials and manufactured articles together with all the necessary labour, materials, equipment and apparatus for sampling and carrying out of tests on the Site shall be supplied by the Contractor at his own expense. The cost of special tests ordered by the Engineer to be carried out by an independent person at a place other than the Site or place of manufacture or fabrication shall be borne by the Employer, provided the tests show that the materials, articles or workmanship are in accordance with the Specification, otherwise the cost of such special tests shall be borne by the Contractor.

**123. REJECTED MATERIALS**

Should any materials or manufactured articles be brought on to the Site of the Works by the Contractor which are in the judgement of the Engineer unsound or of inferior quality including defects or damage sustained in transit or in any way unsuited for the Works in which it is proposed to employ them, such materials or manufactured articles shall not be used upon the Works but shall be branded if, in the opinion of the Engineer this is necessary, and shall forthwith be removed from the Site of the Works, all at the Contractor's expense and in each case as the Engineer shall direct.

**124. QUALITY OF MATERIALS AND WORKMANSHIP**

The materials and workmanship shall be of the best of their respective kinds and shall be to the approval of the Engineer. In the reading of this Specification the word "to the approval of the Engineer" shall be deemed to be included in the description of all materials incorporated in the Works, whether manufactured or natural and in the description of all operations for the due execution of the Works.

**125. STANDARDS**

The Contractor shall observe these Specifications and shall carry out all work in a skilled and workmanlike manner in keeping with the customs of the trade, and modern methods of

construction engineering. In addition, the Contractor shall conform to all conditions, regulations, laws and by-laws currently in force in the country with regard to the execution of construction work and shall follow all instructions issued by the competent Authorities and the Engineer.

The Tenderer shall at his discretion base his tender on Standard Specifications generally used or approved save that where a relevant Standard Specification issued by the local Bureau of Standard exists at the date of submission of tenders such a Standard should as a minimum be complied with. Where no local Standard Specification exists, then the relevant standard specification issued by the International Standard Organisation (ISO), if any, shall be the minimum to be complied with. Where a national standard other than a local Standard is referred to in addition to ISO this indicates that such national standard may expand or strengthen further the requirements of ISO. Where Standard Specifications are referred to in the Text of this Specification this is done by reference to a Standard Specification Reference Number (SSRN).

A table of comparison is provided in Chapter 10 of this Section where the SSRN is cross-referenced to ISO and to national standards that will be accepted in their English version by the Employer as providing for the quality of workmanship etc. required.

The Contractor shall have indicated in his tender the Standard Specification to which the particular item to be supplied complies, or where it meets the requirements of a national standard not so specified, this standard shall be indicated. In this event two copies in English of the alternative standard offered should have accompanied the tender and shall be subject to the approval of the Engineer.

In the event that at the time of tender the Contractor had neglected to nominate the Standard Specification to which any particular item to be supplied shall comply, and there is no relevant local standard or ISO standard for the item, then the Engineer may at his sole discretion and without extra cost to the Employer instruct the Contractor on the national standard to be adopted in the manufacture supply and erection etc. of the item and the works associated with the item.

#### **126. INSPECTION BY ENGINEER DURING DEFECTS NOTIFICATION PERIOD**

The Engineer will give the Contractor due notice of his intention to carry out any inspection during the Defects Notification Period and the Contractor shall upon receipt of such notice arrange for a responsible representative to be present at the times and dates named by the Engineer. This representative shall render all necessary assistance and take notice of all matters and things to which his attention is directed by the Engineer. Provided however that no notice shall be required in the event that at the time of the inspection there shall be any part of the Works that have yet to be Taken Over.

**127. OFFICE ACCOMMODATION FOR ENGINEER'S REPRESENTATIVE**

The Contractor shall, if so required, provide suitable office accommodation in an approved position on the Site, for the sole use of the Engineer's Representative and his Staff. The offices shall be established at the commencement of the Works and shall be occupied by the Engineer's Representative until one month after issue of the Taking-Over Certificate.

The office shall be constructed as per the drawing and/or bill item description, and shall be ready for occupation within 9 weeks of the order to commence issued by the Engineer.

The Contractor shall provide within the office in the appropriate rooms a water closet complete, wash hand basin, towel and toilet roll holder, kitchen sink and Formica topped working surface. The facilities shall be connected to a potable supply of piped water and suitable sewerage collection or disposal facility.

All doors shall be lockable and supplied with at least two keys. The external main door shall be fitted with a "Yale" type lock.

The whole of the accommodation shall be water tight and weather- proof and shall be adequately ventilated, insulated, lighted, painted, burglar-proof and fitted with an *Air Conditioner (AC)*, secure doors and window fastenings inclusive of a mesh to secure the place against insects. It shall be adequately wired for electric light and power. Suitable access for vehicles shall be provided, including a parking space with a light roof to hold not less than two cars.

All of the facilities provided as herein above described shall be paid for under the item in the Bills of Quantity for provision of office accommodation for the Engineer's staff.

The Contractor shall ensure the regular supply of water and electricity services to the office. The office, including lavatory, shall be cleaned daily and shall be provided and maintained for the duration of the Contract. A supply of lavatory paper, soap and towels is to be provided and maintained, clean towels to be supplied each day. Two portable fire extinguishers (5 litres) and two first aid kits shall be provided and maintained. Day and night security shall be provided for the office as well as a secretary who can speak and write English and use MS Office software. The Contractor will be paid for these services under the item for maintenance of offices in the Bills of Quantities.

The Contractor is also to provide the office furniture and equipment as directed by the Engineer's Representative. These items shall be reimbursed at cost together with the appropriate adjustment in the Bills of Quantities.

The Contractor shall also supply stationery as required by the Engineer's Representative, and be reimbursed the costs in this respect together with the appropriate adjustment in the Bills of Quantities.

The site office, furniture and equipment shall revert to the Employer one month after completion of the Works, unless stated otherwise in the relevant bill items.

**128. INSURANCE OF RESIDENT ENGINEER'S OFFICE, FURNITURE AND EQUIPMENT**

The buildings, furniture and equipment provided by the Contractor for the Resident Engineer's offices and accommodation shall be insured by the Contractor against loss or damage by accident, fire, and theft, for the duration of the Contract. Such insurance will be part of the "Insurance of the Works" provided for in the Conditions of Contract.

**129. TRANSPORTATION FOR THE RESIDENT ENGINEER AND HIS STAFF**

If so instructed, the Contractor shall procure vehicles for the use of the Resident Engineer and his staff. The Contractor shall pay all costs arising out of the running and maintenance of the vehicles until one month after completion of the Works, and as directed by the Engineer.

The costs of complying with this clause shall be reimbursed under the relevant Prime Cost Item.

If so instructed, the Contractor shall also provide qualified drivers exclusively for the Resident Engineer, and the rate for this service shall include for payment of all overtime, allowances, etc. to the drivers.

**130. SURVEY INSTRUMENTS AND EQUIPMENT**

If so instructed, the Contractor shall provide for the exclusive use of the Engineer and his staff the following equipment:

	<b>ITEM</b>	<b>NO.</b>
a)	Total Station c/w Tripod	2
b)	Automatic Level and Tripod	2
c)	Steel tapes, 100 m. long	2
d)	Steel tapes, 50 m. long	4
e)	Spirit Levels	4
f)	Plumb bobs	4
g)	Pocket tapes	4
h)	Survey staff and ranging rods	4
i)	Survey umbrellas	6

Other or additional equipment shall be provided by the Contractor if so requested for the occasional use of the Engineer without additional payment. In addition, experienced chainmen

and if necessary labour for clearance of survey lines shall be provided by the Contractor when requested by the Engineer, at no extra cost.

The equipment shall revert to the Employer on completion of the Works and shall be properly maintained and replaced as necessary, by the Contractor.

### **131. CLEANING UP OF SITE**

The Sites of all permanent and temporary works, including borrow areas and tips in connection with this Contract, are to be carefully cleaned up, and trimmed, and the Site is to be handed over to the Employer in a neat and clean condition to the satisfaction of the Engineer. Compliance with this Clause shall be a prerequisite condition for the issue of a Taking-Over Certificate.

### **132. SIGN BOARDS**

The Contractor shall provide, sign-write, erect and maintain until the expiry of the Defects Notification Period sign boards of sound steel construction and hollow section steel uprights to the dimensions, sign-written and painted in durable colours, as directed by the Engineer. Such signboards shall be removed upon expiry of the Defects Notification Period, such removal being a pre-requisite for release of final retention money.

The signboards shall be as per the relevant standard drawing. The steel uprights shall be imbedded in Class 20 concrete of sufficient volume to give the whole assembly adequate stability.

### **133. ALTERATION AND PRESERVATION OF SERVICES**

The Contractor shall acquaint himself with the position of all existing works, such as sewers, water drains, cables for electricity and telephone line, telephone and lighting poles, water mains, etc. before any excavation or other work likely to affect the existing services is commenced.

Where work is being carried in the vicinity of overhead power lines, the Contractor is responsible for ensuring that all persons working in such areas are aware of the relatively large distance that high voltage can "short" to earth when cranes or other large masses of steel are in the vicinity of the power line. The Contractor's attention is drawn to BS 61439 which gives safe clearance to the various voltages.

The Contractor shall be held responsible for injury to existing works or services, and shall indemnify the Employer against any claims in this respect (including consequential damages).

In all cases where such existing works are exposed, they shall be properly shored or hung up. Special care must be exercised in re-filling to consolidate the ground under any main cables, etc. exposed and not to cover up water meters and surface boxes, etc. Poles supporting cables, adjacent to the Works, shall be kept securely in place until the work is completed, and shall then be made as safe and as permanent as before.

Notwithstanding the foregoing requirements, and without lessening the Contractor's responsibility, the Contractor shall inform the Engineer immediately of any existing works that are exposed.

The Contractor shall be responsible for arranging for the moving of services, subject to the agreement of the Engineer, where necessitated by the Works, and shall pay for the moving of services or alteration to services such as power lines, telephone lines, water pipes, etc. A Provisional Sum for this work has been allowed for in the Bills of Quantities. The utilisation of that item shall be at the discretion of the Engineer who may direct that the work be done by others, or that the Contractor shall execute the work and be compensated on a day work basis. Where the Contractor encounters conditions where the alteration and preservation of existing services is necessary, he shall at once inform the Engineer's Representative who shall then direct the Contractor on the means and methods of so doing.

#### **134. CLOSURE OF ROADS**

Where a road used by the Contractor for delivery of any material to be used in the Works is closed by order of the Traffic Authorities, the Contractor shall obey such closure order and shall suspend operations or use an alternative route. The fact that the Contractor is performing work for the Government, will not give him any special privileges in this respect.

#### **135. LIAISON WITH GOVERNMENT AND POLICE OFFICIALS**

The Contractor shall keep in close contact with the Police and other Government officials of the area regarding their requirements in the control of traffic and other matters and shall provide all assistance or facilities which may be required by such officials in the execution of their duties and shall provide in the unit rates or elsewhere in the Bills of Quantities for any expenses arising out of compliance with this Clause.

#### **136. REGULATIONS OF LOCAL AUTHORITIES**

The Contractor shall at all times conform to the lawful provisions of any ordinance and of any order, proclamation, rule or notice made under any ordinance relating to the Works, employment of labour, etc., and to any regulation and/or by-law of any local authority and of the water or electricity undertaker within whose area and jurisdiction the Works are to be executed.

#### **137. BUILDING REGULATIONS**

All buildings erected by the Contractor upon the Site and campsite or sites, and the layout of the buildings and Sites shall comply with Laws of the country, and with all local by-laws in so far as they are applicable.

#### **138. PHOTOGRAPHS**

The Contractor shall, if required, provide a digital camera and portable data transfer devices (flash disks) to the Engineer, and shall further bear the cost of printing the photographs. The

costs to the Contractor of complying with this clause shall be paid through the relevant Bills of Quantity items.

**139. OPERATION AND MAINTENANCE MANUAL**

The Engineer will be compiling changes, alterations and additions to existing operation and maintenance manuals for use of the Employer's staff. To this end, the Contractor is required to provide in triplicate and in English details of all the different manufactured new Plant, materials and components incorporated in the Works including but not limited to all pertinent manufacturers' brochures. Reference is to be made to the relevant clauses in the Conditions of Contract and the E&M Specifications.

Taking-Over will not be considered until such detailed information as is required has been submitted to and accepted by the Engineer.

**140. TRAINING FOR THE EMPLOYER'S PERSONNEL**

The Contractor shall, if required, provide training to a number of the Employer's personnel, nominated by the Engineer during the construction of the Works. This shall include but not necessarily be limited to:- provision of a work gang or gangs with gangers or foreman to work alongside the Contractors staff in the fields of pipeline repair and the installation of valves, replacement consumer connections.

The Contractor shall also train the Employer's nominated personnel, as well as supervise the operation of the Works until the operators are fully conversant with the Plant. This training phase shall be conducted by a competent instructor(s) and shall include instructions in the operations and maintenance of the Works in accordance with a programme previously submitted to and approved by the Engineer. Refer also to the relevant E&M Specification.

**141. MISCELLANEOUS ACCOUNTS**

The Contractor may be instructed by the Engineer to purchase and supply to the Engineer or pay on his behalf for miscellaneous items including but not limited to stores, equipment, computer wares and training, hotel accommodation, services and the like. The Contractor shall submit, once a month, a miscellaneous account including receipts for all such items purchased or paid for, whose reimbursement is to be included in the Interim Certificate.

**142. ADVERTISEMENTS**

The Contractor shall not erect, cause to be erected or allow to be erected any plaque, sign, poster, banner or the like, intended to or having the effect of advertising the identity of the Contractor, his Subcontractors, or the manufacturers of Plant or materials for the Works on or about the site, without the authority of the Employer.

The provisions of this Clause shall not however apply to:

- a. Plaques affixed to Plant; or
- b. Inscriptions on Plant and materials



which are affixed and inscribed during manufacture in order to provide a means of identification of the brand and make of manufactured articles.

#### **143. ACCESS TO EXISTING FACILITIES**

Where necessary for the execution of the Works, the Contractor and his employees shall be granted access to enclosed and fenced off areas which belong to the Employer and are in use for the abstraction, treatment, storage and conveyance of water.

Such access shall be limited to the strict requirements for carrying out of the Works without delay but shall not constitute free and unhindered access to any and all parts of such premises, nor shall it constitute authority for access at any and all times.

Access to such premises shall be limited to: -

- (i) The Contractor's senior and responsible staff not normally engaged upon the Works on site but who are employed by the Contractor in a capacity related to the Works;
- (ii) A reasonable number of site supervisory staff who shall oversee erection and construction work;
- (iii) Organised gangs of technicians, artisans, workmen and labour, who shall enter the premises, work therein and leave as a group or groups, each group being under the supervision of a previously nominated person; and
- (iv) Crews operating Contractor's Equipment who shall remain with their piece of equipment whilst upon such premises.

Unless otherwise specified, any authorities provided for access to such premises shall be deemed to be restricted to the Contractor's normal working hours, with the addition of reasonable times for entering the premises to prepare to start work, leaving the premises on close of work for the day, and for work which may continue during normal meal or recess breaks. Access at other times shall not however be unreasonably denied.

The Contractor shall apply for access during normal working hours (and such extensions thereto as shall not require specific approval as specified above) at least seven days before work commences on such premises, and provide in his application: -

- (i) The estimated duration of the need for such access, in weeks;
- (ii) The normal working hours which shall be in effect;
- (iii) The names of the supervisory staff who shall be responsible for and who shall enter and leave with the working gangs;
- (iv) The areas in which work shall be carried out; and
- (v) The approximate numbers of workmen in such working gangs.

Applications for access outside the above times shall be by at least three days' notice, which notice shall be deemed to be approved if it is not rejected within two days of submission.

#### **144. REMOVAL OF GOODS FROM EMPLOYER'S PREMISES**

The Employer's staff at any of the Employer's premises shall be entitled to demand and to be provided with written descriptions of any goods removed from within the Employer's premises, whether the goods belong to the Employer or not.

The Employer's staff shall be permitted and assisted by the Contractor and his employees to determine that the description of such goods is true and accurate including the inspection of vehicles and the opening up of any containers, parcels or wrappings.

#### **145. INTERRUPTION OF WATER SUPPLY**

Where it is necessary for the supply of water by the Employer using existing facilities in and about the site to be reduced or interrupted in order for the Contractor to replace or repair existing facilities, or install new Plant or material, hereinafter called "Disruption", then the Contractor shall only be permitted to use methods of work, types and numbers of Equipment and levels of staff and labour which will result in minimum Disruption. The Contractor's proposals for the execution of such works shall be subject to the Engineer's approval, and the Engineer shall not be required to consider the costs to the Contractor, (including payments for overtime to the Contractor's personnel) or the convenience to the Contractor of particular sequencing of work, where such considerations conflict with the Employer's need to limit the extent of Disruption.

The Contractor shall indicate in the Programme submitted pursuant to Conditions of Contract Clause 27 the approximate dates and durations of Disruption, and shall, during the execution of the Works, notify the Engineer forthwith of any circumstances which arise which may affect the expected dates of such Disruptions.

At least 14 days before any Disruption proposed by the Contractor, the Contractor shall submit to the Engineer for his approval his plan for works associated with the Disruption and details of the dates and times intended for such Disruption. The Engineer shall within

7 days of such submissions:

- (i) Inform the Contractor of the dates and times when such Disruption will be permitted, which shall be not more than 3 days before or 7 days after the dates proposed by the Contractor;
- (ii) Instruct the Contractor on the methods of work and types and numbers of Equipment and labour to be employed on such works, or otherwise grant approval for the Contractor's plan; and
- (iii) Provide the Contractor with the text of a notice by the Employer to the public of the intended Disruption.

The Engineer may otherwise instruct the Contractor that the Disruption shall be on dates more than 7 days after the dates proposed by the Contractor in which case the period in excess of 7 days shall be deemed to be a Suspension.

Approval for Disruption may be withheld at the Contractors responsibility, if in the opinion of the Engineer the Contractor cannot execute the works associated with the Disruption in accordance with the Engineer's requirements. Notification of such withholding of approval such be accompanied with a description of the reasons therefore, and instructions on the action to be taken by the Contractor before approval is given.

The Contractor shall publish the Employer's notice to the public on the dates, one and two days before the commencement of the Disruption in three national newspapers at a minimum of quarter page size.

The costs and effects of compliance with this Clause (save for any Suspensions) shall be deemed to have been allowed for in the Contractor's rates and prices, and in the time for completion.

#### **146. COPIES OF STANDARDS**

Within 60 days of the acceptance of the Tender, the Contractor shall provide to the Engineer copies of all National and International Standards which are to apply to the Plant, materials and workmanship under the Contract, together with an Index cross- referencing these standards with the applicable aspects of the Works.

Three sets of such standards securely bound are to be provided.

#### **147. SITE HEALTH AND SAFETY**

The Contractor shall observe and cause his employees to observe health and safety standards commensurate with the nature of the Works and in accordance with the Occupational Health and Safety Act (OSHA) 2007 and its subsidiary legislation, and the Work Injury Benefits Act (WIBA) 2007. To this end the Contractor shall appoint as Safety Officer one of his senior staff who shall have specific knowledge of safety regulations and have had experience of safety precautions on similar works and who shall advise the Contractor on all aspects of safety and health on Site.

The Contractor shall provide his employees with:

- (i) overalls, boots or shoes with reinforced toe caps
- (ii) hard hats (helmets) suitable for a construction site
- (iii) other protective equipment such as gloves, earmuffs, goggles, etc. as are necessary for particular work
- (iv) adequate sanitary facilities and maintenance of these in a clean and hygienic state for use by all persons employed by the Employer, Engineer, Contractor or other contractors on the Site
- (v) reporting details of any accident to the Engineer as soon as possible after its occurrence
- (vi) Reasonable prevention of non-site personnel from entering the work areas.

The Contractor shall further provide hard hats for the Resident Engineer and his staff, and for the use of site visitors up to ten in number.

The Contractor is required to produce a Health and Safety Plan covering the hazards that may apply during the Contract, the rules and standards to be used in assessing risk and in undertaking work and the methods that he will employ to ensure compliance with his plan.

The Health and Safety Plan shall include details of the following:

- (i) Details of all potential risks and the proposals for dealing with such hazards
- (ii) Controls to regulate risks which occur during all construction, testing and commissioning activities
- (iii) Measures to avoid health risk in connection with the use, handling, storage and transportation of hazardous and harmful substances
- (iv) Safety equipment and training proposals in respect of equipment referred to above

No work shall be permitted to be executed unless the Engineer is satisfied that appropriate safety measures are in place and that the Contractor's employees are wearing suitable safety gear. The costs and effects of compliance with this Clause shall be deemed to have been allowed for in the Contractor's rates and prices.

#### **148. COUNTERPART CONTRIBUTIONS**

The Employer may provide certain counterpart contributions to the Works but shall where the contributions would affect the progress of the Works receive from the Contractor ample notice in this regard. Such counterpart contributions may include the obtaining of way leaves and rights of way, and purchases of land.

#### **149. LOCAL TECHNICAL AGENCY**

The Manufacturer of the Pumps and Motors and of the Electrical Switchgear supplied under this contract will be expected to have or shall prior to award undertake to appoint a local (based in the project country) representative with proven technical competence in the electro-mechanical field. The level of competence shall be such that if the Employer should decide to enter into a service or service/training contract for the maintenance of the equipment indicated here, then it would be practicable to do so. The Local Agents will be expected to have in their stores and workshop a sufficient quantity of the relevant spare parts, the necessary equipment and tools to service/ maintain the proposed Mechanical and Electrical Plant and suitably qualified and trained personnel to perform the required service/ maintenance works.

#### **150. ENVIRONMENTAL PROTECTION**

With reference to the Conditions of Contract and in order to mitigate the potentially adverse environmental impacts of the proposed rehabilitation works, the Contractor shall execute the Works in accordance with the Environmental Management and Coordination Act (EMCA) 1999 requirements, the Project's Environmental and Social Management Plan (ESMP), and the following technical and operational guidelines:

1. Waste Management, Health and Safety

- The relevant national and local authority's approved disposal methods for wastes shall be used.
- Waste dumping sites shall not be located in wildlife areas, wetlands, settled areas, cultural heritage and scenic sites
- Waste in abandoned mobile camps shall be buried or incinerated
- Training in the proper operation and maintenance of the extended and rehabilitated network facilities shall be an integral part of the programme

2. Water Resources Management

- The Contractor shall at all costs avoid conflict with water demands of local communities
- Abstraction of both surface and groundwater shall only be done in consultation with the local community and after obtaining a permit from the relevant water authority
- Abstraction of water from wetlands shall be avoided
- No construction water containing spills or site effluents especially cement and oil shall be allowed to flow into natural water draining courses
- Wash water from washing out equipment shall not be discharged into water-course or road drains
- Site spoils and temporary stockpiles shall be located away from drainage systems and surface runoff shall be directed away from stockpiles to prevent erosion

3. Site Installation

(a) Location

- Work camp sites shall be located no less than 2.5 km from any surface water sources
- The location of work camp sites within the boundaries of local authorities shall be done with permission from the authority and/or the local communities
- Work camp sites shall not be located in cultural heritage sites. A management plan for restoration when abandoning the site shall be outlined

(b) Drainage

- Work camp sites shall have perimeter drains. The perimeter drains shall be excavated outside the site fence
- All drainage channels inside the site shall discharge the effluent into oil interceptors
- All buildings shall be surrounded by spoon drains
- All sheds shall have spoon drains

(c) Buildings

- Buildings (which are to remain) shall be architected and constructed in a manner that will facilitate conversion to social service facilities such as schools, clinics, etc. at the end of the works.
- All Buildings in work and camp sites shall be approved by the Buildings Department
- All sheds shall have concrete floors

(d) Labour Camp Facilities

- Labour camps shall have approved rubbish bays
- Labour camps shall have toilet facilities approved by the Local Council Health Authorities
- Labour camps shall have one toilet for every 10-15 persons
- Pit Latrines shall be located no less than 250m in clay soils and 500m in loam soils and no less than 1000m in sandy soils from any wetland or water source.

(e) Community Education

- The Contractor shall provide awareness education on STDs and HIV/AIDS to local communities where significant social interaction between project workers and local communities is envisaged (see separate clause).
- The Contractor shall provide information about his activities to local communities

4. Petroleum Products Handling

(a) Transportation

- Fuels shall be delivered to the sites by certified petroleum tankers
- All petroleum tankers shall observe the regulations for transportation of petroleum products and the Traffic Act

(b) Storage

- Petrol shall only be stored in underground tanks
- Diesel may be stored in skid tanks positioned in a bund wall
- Underground tanks shall undergo regular pressure checks
- Oils shall be stored in oil sheds with concrete floors

(c) Dispensing and disposal

- Petroleum kerb sites shall be located on concrete platforms and surrounded by spoon drains
- Approved dispensing equipment shall be used for dispensing petroleum products

- Used oil shall be reused, recycled or incinerated
- Empty PVC containers of petroleum products shall be reused, recycled, or incinerated
- Sludge from petroleum storage tanks shall be incinerated

5. Material Mobilisation

(a) Haulage

- Haulage trucks carrying laterite or stone aggregate shall not exceed the speed limit of 60 km per hour on paved roads and 40 km per hour on gravel roads
- The height of the loaded laterite or stone aggregate shall not exceed haulage truck sides
- Haulage trucks carrying cement or lime shall be covered

(b) Storage

- Stockpiles of materials exceeding 10 tons and which are potentially polluting/ contaminating shall stand for no longer than 30 days
- The distance from the stock pile to the nearest community shall not be less than 2.5 km
- The stockpiles shall be located no less than 5 km from any surface water sources. The distance from the stockpile to the nearest wetland shall not be less than 5 km.
- Stockpiles shall not be located on cultural heritage sites. The distance from the stock pile to the nearest cultural heritage site shall not be less than 5 km
- Stock piles shall have perimeter drains and buffer vegetation
- Cement and lime shall be stored in enclosed sheds

(c) Material Handling

- Appropriate equipment shall be used in handling of materials
- The Contractor shall provide appropriate protective clothing to the workers handling hazardous and corrosive materials
- Safety techniques and accident emergency measures shall be outlined to all workers

6. Plant/Equipment Operations

(a) Noise Control

- Noise from plant and equipment operations shall be limited to no more than 90 db in human settlements
- Stationery Plant (generator) shall be noise masked
- No plant and equipment (with noise levels exceeding 45 db) shall be operated after 18:00 hrs near human settlements (i.e. within 1 km)

- No plant and equipment shall operate without exhaust silencers
- Plant and equipment speeds shall be limited to 60 km per hour

(b) Emission Control

- Plant and equipment exhaust pipes shall be fitted with catalytic converters
- Plant and equipment shall meet the national emission standards

(c) Safety Control

- Carrying of abnormal loads of plant and equipment shall be done when there is less traffic on the roads
- All abnormal load carrying regulations shall be observed (Road Traffic Regulations)

7. Drainage, Excavations and Construction

- All public water points shall be provided with appropriate drainage
- No major drainage excavations shall be done in the rainy season
- No excavations shall be done in gazetted cultural heritage sites

8. Borrow Pits (where applicable)

- Borrow pits shall not be located near wetlands. The distance from the borrow pit to the nearest wetland shall not be less than 5 km
- Contractors shall obtain licenses from the relevant authority to operate borrow pits
- The location of borrow pits shall be subject to approval by relevant government departments and local communities in the areas in which they are located
- Borrow pits shall preferably be located in less vegetated areas
- Borrow pits shall be surrounded by perimeter drains
- Borrow pit restoration plans shall be provided and approved by relevant government departments and local communities affected

9. Energy Acquisition

- Firewood will be collected from dead wood
- Permits for large quantities of firewood shall be obtained from the Forestry Department

10. Excess Materials

- Excess materials of laterite, stone aggregate, concrete blocks, etc. shall be removed from the work sites no longer than 2 weeks after completion of rehabilitation

11. Drainage Systems

- Drainage systems shall not discharge into settled and cultivated areas



- Drainage systems shall not discharge onto gazetted cultural heritage sites

12. De-vegetated Areas

- All de-vegetated areas shall be replanted by the Contractor at the end of the works
- There shall be no vegetation clearing near surface water sources, catchment areas, wildlife habitats, cultural heritage and scenic sites. All relevant legislation to this effect shall be observed

13. Post Excavation Works

- Borrow pits shall be restored at the end of rehabilitation and construction works
- Permanent borrow pits shall have embankments turfed
- Borrow pits in wildlife areas shall be restored at the end of the works unless required as water reservoirs for wildlife
- Restoration of borrow pits in settled areas shall be done only after consultations with local communities
- Borrow pits left as community water reservoirs shall be drainable
- Excavated and graded areas in cultural heritage and scenic sites shall be restored at the end of the works.

14. Abandoned Structures

- Permanent works buildings in settled areas shall be handed over to local communities for conversion into social service facilities such as schools, clinics, etc.
- The above notwithstanding, the Contractor shall comply with all requirements of the national environmental laws.

To adequately address the above requirements and those in Section 147, the Contractor shall prepare and implement a construction phase Environmental and Social Management Plan (C-ESMP) to be approved by the Engineer before implementation.

No separate measurement and payment shall be made for complying with the environmental protection clauses. The cost of all work required by these clauses shall be included in the Contractor's rates for other items of work under this Contract.

**151. HIV-AIDS PREVENTION**

With reference to the Conditions of Contract HIV-AIDS Prevention the Contractor shall conduct an HIV-AIDS awareness programme via an approved service provider and shall undertake such other measures to reduce the risk of the transfer of the HIV virus between and among the Contractor's Personnel and the local community, to promote early diagnosis and to assist affected individuals.

The Contractor shall throughout the contract (including the Defects Notification Period):

- Conduct Information, Education and Consultation Communication (IEC) campaigns, at least every other month, addressed to all the Site staff and labour (including all the Contractor's employees, all Sub-Contractors and Consultants' employees, and all truck drivers and crew making deliveries to Site for construction activities) and to the immediate local communities, concerning the risks, dangers and impact, and appropriate avoidance behaviour with respect to of Sexually Transmitted Diseases (STD)—or Sexually Transmitted Infections (STI) in general and HIV/AIDS in particular;
- Provide male or female condoms for all Site staff and labour as appropriate; and
- Provide for STI and HIV/AIDS screening, diagnosis, counselling and referral to a dedicated national STI and HIV/AIDS program, (unless otherwise agreed) of all Site staff and labour.

The Contractor shall include in the program to be submitted for the execution of the Works under Sub-Clause 8.3 of the Conditions of Contract an alleviation program for Site staff and labour and their families in respect of Sexually Transmitted Infections (STI) and Sexually Transmitted Diseases (STD) including HIV/AIDS. The STI, STD and HIV/AIDS alleviation program shall indicate when, how and at what cost the Contractor plans to satisfy the requirements of this Sub-Clause and the related specification. For each component, the program shall detail the resources to be provided or utilized and any related sub-contracting proposed. The program shall also include provision of a detailed cost estimate with supporting documentation. Payment to the Contractor for preparation and implementation this program shall not exceed the Provisional Sum dedicated for this purpose.

## **CHAPTER 2**

### **EARTHWORKS**

## **CHAPTER 2 – EARTHWORKS**

### **201. CLEARING OF THE SITE**

Trees, hedges and undergrowth shall be taken down and grubbed up, together with all other obstructions on the Sites of the landfill, roads, sewers, ponds, drains, water mains and structures and disposed of as directed.

The limits of clearing on this project shall extend a distance of three metres from the centre line of pipelines and for a distance of three metres in plan from any foundations. Roots are to be destroyed or removed within this width. All timber removed remains the property of the Employer and the Contractor shall dispose of timber in a manner as instructed by the Engineer.

Brushwood, roots and refuse and other combustible material cleared shall be disposed of by strictly controlled burning which shall be approved in each instance by the Engineer provided care is taken to prevent contamination of trench bottoms or backfill material with charcoal or other products of combustion. Alternatively, the waste matter could be removed from the site of the works to a tip to be provided by the Contractor.

Trees, bushes and hedges at the Site shall not be cut down, damaged or destroyed without approval of the Engineer. Trees shall be defined as having a girth exceeding 500 mm measured 600 mm above ground level except where a tree has buttresses when measurement shall be taken immediately above the buttresses.

The Contractor shall carefully strip top soil over the width of pipe trenches, set it aside for bringing back after backfilling of trenches and replacing over the top of trenches to restore the ground to its near as possible original condition.

If, owing to excessive cross-falls, the Contractor requires to carry out general levelling to facilitate use of Contractor's Equipment, such levelling may only be carried out after stripping and setting aside of top soil over the full width of the area to be levelled.

Where trees are felled, the roots shall be grubbed up and all removed from the Site by the Contractor. The holes shall be backfilled with approved materials and rammed in 30 cm layers.

### **202. SURFACE SOIL**

Unless otherwise directed by the Engineer all surface soil shall be removed from the area to be used for roads, structures, cuttings and embankments and stockpiled for re-use for any purposes such as the soiling of slopes of cuttings and embankments and the preparation of beds for the cultivation of trees and shrubs.

Surface soil shall be regarded as soil which on visual examination can be seen to have been broken down by natural processes, agricultural cultivation and/or is seen to be capable of supporting vegetation growth.

Surface soil shall be removed to an average depth as shown on the Drawings or as specified in the Bills of Quantities. The Contractor shall make his own arrangements for temporary storage sites for heaps of surface soil either inside or outside the site of the Works to suit his convenience. The cost of all operations needed in excavation, loading, carting, depositing and stacking together with arranging for the storage Sites, the hire or purchase of land therefore and all necessary access roads for this purpose is to be included in the item in the Bills of Quantities for stripping surface soil and is to be quoted whatever the nature of the underlying sub-soil.

All unsuitable soil comprising of underlying surface soil shall be excavated and run to spoil in accordance with the appropriate Clause.

### **203. CLASSIFICATION OF EXCAVATION**

Excavation shall be paid for separately for the following three Classes of material:

#### Class I:

"Rock" or "Hard Material" shall include all material which, in the opinion of the Engineer, requires blasting or the use of metal wedges and sledge hammers or the use of compressed air drilling for its removal or cannot be extracted by ripping with a tractor of at least 180 h.p. and rear-mounted heavy-duty ripper. Individual boulders greater than 0.2 m<sup>3</sup> in volume shall be included in this class when their nature and size are such that they cannot be removed without recourse to one of these methods.

Where a portion of excavation contains 50% or more by volume of boulders of this order, such portion shall be considered as Class 1 material throughout.

#### Class II:

"Compacted Gravel", "Slightly Decomposed" or "Altered Rock" shall include all material such as hard ferricrete and altered or stratified rock, stones, or boulders less than 0.2 m<sup>3</sup> in volume, which are harder than "normal" or "soft" material in that they may be extracted by ripping, as defined in Class 1, or in confined spaces, by hand excavation by using compressor tools, providing all reasonable steps to the satisfaction of the Engineer, have been taken to facilitate the removal of the material by other methods.

#### Class III:

"Normal" or "Soft Material" shall include weathered or decomposed rock (incl. murrum) and all material which, in the opinion of the Engineer, does not require blasting or metal wedges and sledge hammers or compressed air drilling, ripping or rooting.

A detailed summary to aid this classification is given in Table 2 - 1.

No additional allowances will be made for any material being wet or dry.

The Engineer or his representative and the Contractor or his representative shall be present during classification of material in question for excavation.

All necessary precautions shall be taken to preserve the excavation material below and beyond the lines of all excavation in the soundest possible condition.

All damages to the Works due to the Contractors operations shall be repaired by and at the expense of the Contractor except when over excavation is ordered in writing by the Engineer.

In excavation of Class 1 (hard) material isolated edges of undisturbed material may extend up to 15 cm within the prescribed lines.

Excavation of Class 1 - Material beyond the established lines shall be re-filled with concrete (Class 10) at the expense of the Contractor.

All excavation shall be classified either as unsuitable material or as suitable material. Unsuitable material shall comprise: -

- (i) Material from swamps or marshes, silt, perishable material, slurry or mud, or
- (ii) Any Material:
  - (a) which is a highly organic clay or silt,
  - (b) which is clay having a liquid limit exceeding 80 and or a plasticity index exceeding 55;
  - (c) which is outside the limits of moisture content specified in the earthworks series of Clauses either when excavated or thereafter;
  - (d) which is susceptible to spontaneous combustion;
  - (e) Consisting of such domestic refuse which by virtue of its physical or chemical composition or moisture content will not compact to form a stable fill.

Suitable material shall comprise all that are acceptable in accordance with the requirements of the Specification for use in the Works, whether obtained from within or without the Site. Any reference in this Specification to suitable material and unsuitable material shall have the meanings defined above.

For the purpose of selection for use in earthworks all common excavation shall be classified as either plastic or non-plastic. Non-plastic materials shall be those on which it is impossible to carry out a plasticity index test and shall include "coarse grained non-cohesive material" shown in Table 2 - 2, and in accordance with BS 5930: 1999 and such shales, silts and other materials which in the opinion of the Engineer are readily self- draining.

Plastic materials shall be all other materials included in the below-mentioned Table as "fine grained cohesive materials", as defined in BS 5930: 1999.

**TABLE 2 - 1: IDENTIFICATION OF SOIL TYPES**

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#### **204. EXCAVATION – GENERAL**

The excavation shall be taken out as nearly as possible to exact dimensions and shape so that the minimum of filling in will afterwards be necessary. The Contractor shall keep the sides of excavation true by struts, wallings, poling-boards, sheeting, bracing or otherwise and the supporting timbering shall be of sound construction and be sufficiently watertight to permit the excavation, concreting, etc. being carried out satisfactorily. Water shall be removed by pumping and all temporary expedients required for dealing with water shall be the Contractor's liability. The Contractor shall be responsible for the stability of all excavations and trenches.

Excavated material shall be deposited in spoil heaps confined to areas approved by the Engineer and shall be neatly finished off to the approval of the Engineer and other relevant authorities.

Top soil shall be stored separately from the main excavated material and on no account disposed of without the approval of the Engineer.

The Contractor shall at his own expense maintain the flow in all drains and water courses which may be encountered during the construction of works. Sewage shall not be allowed to flow onto open ground or into any watercourses, trench or sewers constructed under this contract except by permission of the Engineer's representative.

#### **205. MECHANICAL EXCAVATION**

- (i) A mechanical excavator shall be employed by the Contractor only if the sub-soil is suitable and will allow the timbering of the trenches or other excavations to be kept sufficiently closed up to ensure that no slips fall or disturbance of the ground takes place or there are no pipes, cables, mains or other services or property which may be disturbed or damaged by its use.
- (ii) When mechanical excavators are used, a sufficient depth of materials shall be left over the bottom of the excavations to ensure that the ground at finished excavation level is not damaged or disturbed in any way. The excavations shall then be completed by hand to the finished levels required.

#### **206. EXCAVATION FOR PIPE LAYING**

- (i) The excavation shall be made in open cutting unless tunnelling or heading is specified or approved by the Engineer.
- (ii) Trenches for pipes shall be excavated to the lines and depths shown on the Drawings, or as directed by the Engineer, and shall be of sufficient width to give an equal clearance on both sides of the barrel of the pipe or pipes such that the total trench width is  $\frac{3}{2}$  'D' where 'D' is the outside diameter of the pipe or the average outside diameter of the group of pipes or will be equal to the outside diameter of the pipe plus 30 cm on each side. For pipes bedded in concrete sections, the breadth of concrete bedding for the pipes will be equal to the width of the trench. Excavation for fire hydrants, valve chambers



or any other water works structure shall be carried out to the levels and outlines of such structures, and the rates shall include for any additional excavation or other temporary Works required.

- (iii) If in the opinion of the Engineer due to the fault of the Contractor the ground becomes weathered prior to the laying of the pipes, the Contractor shall remove the weathered soil and replace it with suitable compacted material to the original formation level at his own expense.
- (iv) Where pipes are not laid on concrete the bottoms of the trenches as excavated, shall be smooth and shall be free from stones or other projections. Holes cut out at the joints shall be of as small a size as possible throughout their entire length. The trench shall be dug to within 15 cm of its formation and proper grade pegs shall then be set in the bottom of the trench by the Contractor for the accurate taking out of the rest of the excavation. Grooves about two inches deep shall be cut across the trench at the required positions to enable the easy removal of pipe slings.
- (v) If instructed to do so by the Engineer, the pipe trench shall be excavated to a depth of 10 cm below the invert of the pipe and be refilled with suitable material free from stones and well rammed in order to provide a smooth bed for the pipes.
- (vi) The materials excavated from trenches shall be laid completely and neatly on the sides of the trench except where in the opinion of the Engineer this would so obstruct a road or footpath as to prevent the passage of traffic or pedestrians. In such cases the Contractor must dig out the pipe trench in such lengths as directed and keep his excavated material at such a distance as may seem advisable, and the rates shall be deemed to cover for this.
- (vii) During excavation, the Contractor shall ensure that all material suitable for re-use and which he intends for re-use are kept separate and set aside and protected as necessary to prevent loss or deterioration. Materials forming the surface and foundations of roads shall when excavated and if required for further use, be carefully separated. Paving slabs, bricks and similar surfaces shall be carefully removed and stacked for re-use, or as otherwise instructed by the Engineer.
- (viii) No pipes shall be laid and no excavation filled in or covered with concrete until the formation has been inspected and the permission to proceed with the Work obtained.
- (ix) Where pipes are to be laid under a road formation or in open country, or in cutting, trenches shall generally be excavated after the earthwork is completed. The Engineer may permit these pipe trenches to be excavated before the earthwork is complete, but payment for the excavation of the trench will only be made upon the volume excavated below the road formation.

- (x) The unit of measurement for the excavation of trenches shall be per linear metre or per m<sup>3</sup> of void calculated from the deemed width of the trench, and the average depth of excavation as mentioned in the Bills of Quantities. No allowance will be made for bulking. Unless otherwise indicated, for valve chambers and other water works structures, the unit of excavation will be per number or per m<sup>3</sup> of excavated material calculated to the exact outer dimensions and depths of the Permanent Works. No allowance will be made for bulking.
- (xi) The rates for excavation of trenches in "normal" material shall include removal of all material except "rock", selecting and segregating material to be backfilled in special layers, supporting or sheeting, shoring and strutting, any additional working space or room for timbering or sheeting required, dealing with water, maintenance of the trench, and all labour, tools, materials, plants, supervision, overheads and profit.
- (xii) The provisions of above Clause shall apply to the rates of excavation in "rock" and in addition the Contractor shall also allow in his rates for backfilling the invert with Class 15 concrete or other materials as directed by the Engineer and removing to a spoil dump all "rock" excavated.

## **207. EXCAVATION FOR FOUNDATIONS**

- (i) Foundations shall be excavated to such depths as the Engineer may direct and no concrete or other material shall be placed until the foundations have been examined and approved. Due notice shall be given to the Engineer to enable him to examine foundations well in advance.
- (ii) The Engineer may direct that a layer of excavation of not less than 75 mm thickness shall be left undisturbed and subsequently taken out by hand immediately before the concrete or other work is placed.
- (iii) If in the opinion of the Engineer due to the fault of the Contractor the ground becomes weathered prior to the placing of concrete or other material the Contractor shall remove the weathered soil and replace it with concrete (Class 15) to the original formation level at his own expense.
- (iv) The Contractor shall draw the attention of the Engineer to any patches of soft ground in the excavations and he shall excavate to such extra depth as the Engineer may direct and fill up with concrete Class 15. Payment for this Work will be made at the rates tendered.

## **208. EXCAVATION IN EXCESS**

If any part of a trench or foundation is by Contractor's error excavated deeper and/or wider than is required, the extra depth and/or width shall be made good at the Contractor's expense with Class 15 concrete or otherwise as the Engineer may require.

## **209. SITE CONCRETE**

Areas of excavation which are to receive a layer of Site concrete as a screeding under the structural concrete or which are to form foundations to thrust and anchor blocks shall be covered with the screeding immediately the excavation has been completed.

## **210. COMPACTION OF EARTHWORKS**

All filling material used in earthworks shall be compacted to specification by Plant approved by the Engineer for that purpose.

The Contractor shall submit to the Engineer for approval his proposals for the compaction of each main type of material to be used in the embankments, including those in relation to the types of Plant, the number of passes and the loose depth of layer. The Contractor shall carry out compaction trials, supplemented by any necessary laboratory investigations as required by the Engineer, using the procedure proposed by the Contractor for the earthworks, and shall satisfy the Engineer that all the specified requirements regarding compaction can be achieved. Compaction trial with the main types of material likely to be encountered shall be completed before the Works with the corresponding materials will be allowed to commence.

Work on the compaction of plastic materials in embankments shall proceed as soon as practicable after excavation and shall be carried out only when the moisture content is not greater than 2 per cent above the plastic limit for that material. Where the moisture content of plastic material as excavated is higher than this value the material shall, unless otherwise directed by the Engineer, be run to spoil. If the Contractor allows the moisture content of suitable plastic materials to increase to a value which is unacceptable for compaction he shall, unless he prefers at his own expense to wait until the material has dried sufficiently for acceptance again as suitable material, run such material to spoil and provide an equal volume of material suitable for filling, both without extra charge.

Work on the compaction of non-plastic materials in embankments shall be carried out only when the material has such a moisture content as is within the range from 1 per cent, wetter to 2 per cent drier than the moisture content of the material in cuttings or borrow pits when measured on samples obtained from at least 30 cm above the level of the water table as indicated by the presence of free water in the excavation. Nevertheless, if with any material the Engineer doubts whether satisfaction will be obtained within the above moisture limits, he may require compaction to proceed only when the limits of moisture content for the compaction of non-plastic materials are within the range of the optimum moisture content as determined by the laboratory compaction test method described in BS 1377. Method of Test for Soil Classification and Compaction.

If any such non-plastic material on excavation is too wet for satisfactory compaction and the Engineer orders the moisture content to be lowered or raised, such Work shall be treated as included in the rates. All adjustments of moisture content shall be carried out in such a way that the specified moisture content remains uniform throughout compaction.

If the Contractor allows the moisture content of suitable non-plastic materials to change after excavation to a value unsuitable for compaction, he shall raise or lower the moisture content as required above, or the Contractor shall, if so directed by the Engineer, run the material to spoil and replace it with an equal quantity of material suitable for compaction.

Work shall be continued until a state of compaction is reached throughout the embankments, including especially the slopes of embankments (and the immediate approaches to bridge abutments) such that at least 9 out of every 10 consecutive samples taken of the compacted material have a relative compaction determined according to BS 1377 of at least the following percentage of the maximum density of optimum moisture content:

- (i) For the topmost 15 cm below formation level a maximum density of 100 per cent.
- (ii) For the remainder below formation a density of at least 95 as mentioned in the Bills of Quantities and as directed by the Engineer.

If with non-plastic material, the compacted material has become dry in the interval between the completion of compaction and the measurement of the state of compaction, then the moisture content to be used for the calculation of the air content shall be the mean moisture content for the compaction of such materials as specified above.

Each layer of rock used as rock-fill in embankments shall be systematically compacted by at least 8 passes of towed vibrating roller weighing not less than 3 tons or a grid roller weighing not less than 13 tons dead weight or other approved plant. Where however, it is established that rock can be compacted to the requirements for common excavation, the rock shall be compacted to such latter requirements.

## **211. EXCAVATIONS FOR FOUNDATION PITS AND TRENCHES**

Pits and trenches for foundations shall be taken out to the levels and dimensions shown on the Drawings or to such other levels and dimensions as the Engineer may direct. The bottoms of all excavations shall be carefully levelled and if necessary stepped or benched horizontally. Any pockets of soft material or loose rock and fissures in the bottoms of pits and trenches shall be removed and the cavities so formed, filled with concrete of the appropriate Class. When any excavation has been taken out and trimmed to the levels and dimensions shown on the Drawings or directed by the Engineer, the Engineer shall be informed accordingly so that he may inspect the completed pit or trench and no excavation shall be filled in or covered with concrete until it has been authorised to proceed with the work. All surplus excavated materials from such excavations not required for refilling shall be deposited in embankments, or otherwise disposed off, as directed. All excavations shall be kept dry, and all bailing and pumping, timbering, shoring and supporting of sides that may be required, and any refilling, ramming and disposal of surplus materials necessary in carrying out the excavations for foundation pits and trenches shall be included in the prices for excavation.

## **212. COMPLETION OF EARTHWORKS**

The formation shall be properly shaped and regulated and compacted. When completed the formation shall be at the required level and generally parallel to the required finished surface.

## **213. DISPOSAL AND STORING OF EXCAVATED MATERIAL**

All surplus material arising from excavation shall be disposed off to a tip or tips to be provided by the Contractor unless otherwise stated. The disposal tip and manner of disposal shall be to the approval of the Engineer.

Where spoil from excavation is required for re-use as refill or for the formation of embankments, the various types of material shall be kept separately and stored in convenient and approved places.

## **214. BORROW CUTTINGS AND PITS**

Where for any reason, it becomes necessary to form borrow cuttings or borrow pits, these shall be located by the Contractor and approved by the Engineer and the Work executed in all respects to the instructions of the Engineer. They shall be properly graded and drained and finished with neatly trimmed slopes.

## **215. MAKING GOOD SUBSIDENCES AFTER REFILLING**

All refilling whether over foundations or in pipe trenches shall be thoroughly compacted by ramming and any subsidence due to consolidation shall be made up by the Contractor at his own expense with extra compacted material. Should subsidence occur after any topsoil has been replaced, the topsoil shall first be removed before any hollows are made up before being re-laid.

## **216. REINSTATEMENT OF SURFACES**

- i. All surfaces of roads, fields, paths, gardens, verges, etc. whether public or private which are affected by the operations of the Contractor shall be temporarily restored by him in the first instance and permanently reinstated in the second instance when the ground has consolidated fully. Separate payment for reinstatement shall be made only for surfaced roads (e.g. tarmac, concrete, paving bricks or similar material), for official designated dirt roads of at least 6m width, grassland, cultivated lands and sports fields. Any other reinstatements are deemed to be covered by the pipe installation rates.
- ii. The Contractor shall be responsible for the temporary reinstatement and permanent reinstatement of all surfaces whether or not the area requiring restoration is within the limits of his excavations if the necessity for the restoration arises from causes due to the operations of the Contractor. The Contractor's prices shall include for restoring all surfaces so damaged to their original condition as no extra payment will be made for any such work. The Contractor shall take all necessary measures to ensure that no toxic materials which may cause damage to vegetation or livestock or pollute streams or watercourses are used in any temporary restoration or permanent reinstatement

and shall indemnify the Employer against any claims arising out of the use of such materials.

- iii. Temporary restoration shall be carried out immediately after the excavations have been refilled by returning the excavated material to the position from which it was removed and adding such suitable materials as may be required and consolidating the various materials as the Work proceeds in order to provide a surface that is adequate for the purpose that the original surface fulfilled. Temporary surfaces shall be maintained in a condition satisfactory to the Engineer and/or responsible Authority until the permanent reinstatement is made. In the case of roads and streets the surface shall be necessary to consolidate the filling and keep the surface fit for traffic, suitable material being added to all placed which have sunk or become rough.
- iv. Permanent reinstatement shall not be made until the ground has consolidated permanently and until sanction to do so is received from the Engineer. It shall be carried out with materials similar to those which were used in the original Work to the entire satisfaction of the Engineer and/or responsible Authority.
- v. In verges and other grass surfaces the topsoil shall be removed, stored and replaced after consolidation of the filling and planted or seeded with approved grass. Should subsidence occur, it shall be made good with additional topsoil and be replanted with grass or re- seeded. New grass shall be planted if for any reason the grass fails to grow or is destroyed.
- vi. The trenches, channels, gutters and kerbs shall be reinstated to the condition in which they were before excavation was commenced. The final surface of the trench shall be flush with the surrounding ground.
- vii. If the work of restoration or reinstatement as carried out by the Contractor is not to the satisfaction of the Engineer and/or the responsible Authority and should the Contractor not remedy the defect forthwith, any remedial work considered necessary may be undertaken by the Engineer and/or the responsible Authority and the cost thereof shall be borne by the Contractor.
- viii. If at any time any trench becomes dangerous, the Engineer shall be at liberty to call upon the Contractor to restore it to a proper condition at three hours' notice and should the Contractor fail to carry out the work, have it done at the Contractor's expense.
- ix. The Contractor shall include in his price for all materials and labour which he may have to employ in reinstating the trenches and surfaces to their original condition to the satisfaction of the responsible Authority.

**217. SUPPORTS FOR FOUNDATION PITS AND TRENCHES**

The sides of pits and trenches shall where necessary, be adequately supported to the satisfaction of the Engineer by timber or other approved means. The costs of this work shall be included in the rates inserted in the Bills of Quantities.

**218. REFILLING OF FOUNDATION PITS AND TRENCHES AND REMOVAL OF EXCAVATION SUPPORTS**

Refilling of foundation pits and trenches shall be carried out only after the foundation and structural works within the excavation have been inspected and approved by the Engineer. Unless otherwise directed by the Engineer, all filling shall consist of approved excavated materials which shall be deposited and compacted, using approved Plant, in layers not exceeding 25 cm loose depth, to a dry density not less than that of the adjoining soil. Timber sheeting and other excavation supports, shall be carefully removed as the filling proceeds except as otherwise specified, but the removal of such supports will not relieve the Contractor of his responsibility for the stability of the Works. The number of separate layers deposited and compacted at any one time shall be subject to the approval of the Engineer.

**219. USE OF VIBRATORY COMPACTION PLANT**

Where vibratory rollers or other vibratory compaction Plant are used, the mechanism and vibration shall be kept working continuously during compaction operations, except during period when the Engineer permits or directs discontinuance of vibration.

Unless otherwise permitted by the Engineer, the frequency of vibration shall be maintained within the range of amplitude and frequency recommended by the manufacturers of the Plant for the material to be compacted. The frequency shall be recorded by a tachometer indicating speed of rotation of any shaft producing vibration.

**220. PROVISION OF SPOIL HEAPS**

The Contractor shall provide spoil heaps at his own expense for the disposal of surplus materials and all rubbish collected when clearing the site and during the Construction of the Works. The Sites for these shall be approved by the Engineer.

**221. TOPSOILING**

Topsoil for planting grass shall be selected topsoil from approved stockpiles or materials from excavation for embankment foundations or from stripping from borrow areas or other approved sources. The material shall contain the most fertile loam available and shall be free from excessive quantities of grass, roots, weeds, sticks, stones or other objectionable materials.

Areas to receive the topsoil shall be brought to within 100 mm of the prescribed final cross-section at all points and finished smooth and uniform before topsoil is applied. Topsoil shall be evenly placed and spread over the graded area in one layer and shall be placed at locations shown on the Drawings or designated by the Engineer.

**222. GRASSING**

It is expected that it will be necessary to water the areas with newly planted grass to ensure germination and establishment of plants. The Contractor shall provide for a temporary sprinkler irrigation system to the approval of the Engineer and shall irrigate the newly planted grass at such times as the Engineer instructs. The Contractor shall repair at his own expense any damage to the slopes or any part of the work caused by excessive or irregular application of irrigation water. Planting shall consist of ground preparation, furnishing approved grass, planting and covering the planted grass and shall be completed on areas shown on the Drawings or as designated by the Engineer.

When the topsoil has been placed on the areas to be planted with grass, levelled and compacted to finished grade, it shall be brought to a friable condition by harrowing or otherwise loosening to a depth of maximum 100 mm. All lumps and clods shall be thoroughly broken by approved means.

**223. MEASUREMENT OF TOPSOILING AND GRASSING**

Measurement for topsoiling and grassing shall be made according to the amount of square metres of topsoiled areas measured in place to the lines and grades on the Drawings or as established by the Engineer and paid for at the rates per m<sup>2</sup> tendered in the Bills of Quantities, which rate shall include for all as specified, including supplying the grass seeds or sprigs.

**224. HARDCORE**

Hard-core, shall be sound hard stone, rock or broken concrete not less than 10 cm in size unless otherwise directed. Sufficient but not excessive blinding material of smaller sizes may be permitted at the discretion of the Engineer.

**225. RUBBLE**

Rubble for use in drains and backing to walls shall be of durable natural stone or large sized gravel. It shall be of a size that will pass a 5 cm mesh-sieve and retained on a 2.5 cm mesh-sieve and it shall be free from earth clay vegetation or other organic matter and shall contain no rubbish.



## **CHAPTER 3**

### **CONCRETE, REINFORCEMENT AND SHUTTERING**

### **CHAPTER 3 - CONCRETE, REINFORCEMENT & SHUTTERING**

#### **301. GENERAL**

- (i) The standard of materials and of workmanship shall be not inferior to the recommendations of the current: -
  - a) A code of Practice dealing with the Structural Use of Reinforced Concrete in Buildings, BS 8110: 1992 whichever is applicable to the particular structure,

OR –

A code of Practice dealing with the Design and Construction of Reinforced Concrete Structures for the storage of liquids, BS 8007: 1992,

AND

- b) Appropriate Standard Specifications herein referred to.

The requirements outlined in the above documents must be read with those of this section of the Specification and where any conflict exists between the recommendations of the above and of this Specification, the requirements of this Specification shall prevail.

- (ii) As and when required by the Engineer, the Contractor shall prepare and submit, before commencing the work, a Time Chart (additional to the General Programme) detailing the various operations for concrete work.
- (iii) No material shall be used in the work until prior approval for its use has been given by the Engineer; neither shall any change in the nature, quality, kind, type, source of supply or manufacture be made without the Engineer's permission.
- (iv) Names of manufacturers and test certificates, shall be supplied as soon as possible to the Engineer.
- (v) The prices inserted in the Bill of Quantities shall include for the provision of all samples and for all costs incurred in the execution of the tests specified or referred to herein in accordance with the General Conditions of Contract; the prices shall include also for transport of samples of cement, sand, concrete, aggregates, and similar materials to an approved material testing laboratory. Results of laboratory and Site tests shall be kept on Site and copies of all test Reports shall be forwarded in duplicate to the Engineer.
- (vi) Frequency of tests and number of samples required will be governed by the results of previous tests, the quality of the materials revealed during the tests and the uniformity of that quality. Should it become evident that the quality of the concrete is deteriorating the Engineer may require additional samples to be taken and test cubes to be made and tested to determine the cause.
- (vii) During the progress of the works, consignment notes shall be supplied to the Engineer giving details of each consignment of each concreting material.

- (viii) The use of the word "approved" in this Specification refers to the approval by the Engineer.

### **302. STEEL REINFORCEMENT**

The reinforcement shall be of the type specified and shall comply with the appropriate BS codes as follows:

- Mild Steel Bars BS 4449
- Cold-Twisted Steel Bars BS 4449
- Reinforcing Fabric BS 4482/83

### **303. WATER FOR USE IN CONCRETE**

All water used in mixing concrete shall be obtained by the Contractor and comply with BS EN 1008: 2002.

The water for each batch shall be just sufficient to ensure the production of concrete of the required consistency and shall be measured in a small tank, and the quantity shall be varied from time to time as required by the Engineer.

### **304. CEMENT**

- (i) All cement used (unless otherwise ordered) shall be ordinary Portland Cement or if required or allowed by the Engineer, rapid-hardening Portland Cement of the best quality and of a brand or brands to be approved by the Engineer and shall comply in every respect with the conditions, analyses and tests laid down in BS EN 197: 2000 for Portland Cement.
- (ii) Cement shall be obtained from one manufacturer unless otherwise authorised by the Engineer. Should the use of cement from different manufacturers be authorised, the different supplies of cement shall be stored separately and shall not be mixed.
- (iii) The Contractor shall supply to the Engineer copies of the manufacturer's test certificates certifying that each consignment of cement has been tested and analysed, and that the results comply in all respects with the above standards. Each certificate shall state clearly the date of despatch and the number of bags despatched in each consignment.
- (iv) Bagged cement shall be delivered in sealed 50 kg paper sacks. Cement shall not be delivered in bags of less than 5 ply. Each bag shall be marked with the parcel number of the cement contained. Bagged cement shall be transported so that at no time is it exposed to damp and so that moisture cannot be absorbed from the atmosphere. Cement in bulk shall be transported in totally enclosed water tight and sealed containers.
- (v) Sulphate Resisting or High Alumina Cement

- (vi) Where a sulphate-resisting cement or a high alumina cement is specified or ordered, it shall be of the best quality and of brand or brands approved by the Engineer. The cement shall comply in every respect with BS EN 197: 2000.
- (vii) Cement Storage
- (viii) The cement shall be delivered on the site of the works in such consignments as shall ensure satisfactory progress of the work, each bag or container being sealed to the satisfaction of the Engineer. The cement shall be stored on the Site in a dry store or in approved bulk containers, large enough to contain the required quantities. The store shall be provided by the Contractor and shall have sufficient sub-division of such sizes as the Engineer may approve, it shall be properly roofed and perfectly watertight, and it shall have a dry wooden floor above ground level with an air space at least 15 cm in depth below it. The cost of all work specified in this Clause shall be borne by the Contractor.
- (ix) Cement of different consignments shall be stored separately and consignments shall be used in the same order as they are delivered to the site. No cement shall be stored on the site for longer than three months from the date of despatch by the manufacturer. If not used within that period, the cement shall be removed from the site.
- (x) Any bag of cement which is damaged or found to contain cement which has set or partly set, shall be discarded and not used in the Permanent Works.
- (xi) The Engineer may cause samples to be taken from any consignment of cement for testing by the Engineer's Representative at the Ministry of Works, Testing Station. If the results of these tests show that the samples do not conform to this Specification, the whole consignment will be rejected as unfit for use and must forthwith be removed from the Site by the Contractor at his own expense. The various consignments must be brought to the Site in ample time to allow the above tests to be carried out before the cement is required for use.
- (xii) Later Tests
- (xiii) Although the Engineer may have passed any consignment of cement, he shall nevertheless, have the power at any subsequent time to reject such consignment if he finds that any deterioration in the quality thereof has taken place. Any package of cement in which there are hardened lumps or cakes of cement, shall be rejected.
- (xiv) Cement Containing Hardening or Waterproofing Compounds
- (xv) No cement containing hardening or waterproofing compounds shall be used nor shall calcium chloride or other chemicals be added to cement or to concrete except on the instructions of the Engineer. Any cement so treated shall be stored separately and clearly marked and shall only be used in accordance with the requirements of the Engineer.

### **305. SAND**

Sand used for mortar shall comply with BS 1200: 1998 and sand for rendering with BS 1199: 2005.

### **306. COARSE AND FINE AGGREGATES**

- (i) Mixed ballast for mass concrete shall comply with the requirements for "all-in" aggregates of 40 mm maximum size in BS 12620: 2002 unless otherwise specified by the Engineer.
- (ii) All aggregates for graded concrete, except granolithic and fine concrete, shall comply with BS 12620: 2002. Coarse aggregate shall be "graded aggregates" of 20 mm to 5 mm nominal size as specified in Table 3 - 1 unless otherwise ordered.

Fine aggregates shall be natural sand, in grading zone 2, as specified in Table 3-2. Approved coarse and fine aggregates, mixed before the addition of cement, in volumes to be approved by the Engineer, and may be used in lieu of "all-in" aggregates for mass concrete.

They shall conform to the moisture absorption requirements of BS 812: 1995. Otherwise the Contractor shall prove the durability of the finished concrete by approved tests when used for making concrete required for liquid retaining structures.

Aggregates of rounded shape or otherwise capable of procuring a concrete of good workability with the minimum addition of water, shall be preferred.

The Contractor shall ensure that the nature and grading of aggregates remain reasonably consistent, and shall, if necessary, stockpile and include different grading to ensure that the overall grading remains constant for each section of the work.

Dust or flour resulting from crushing the aggregate shall not be allowed to contaminate the stockpiles. When, in the opinion of the Engineer such contamination has taken place to the detriment of the finished concrete, it shall be removed by an approved means, otherwise the aggregate shall be rejected.

For mass concrete, dust or flour resulting from crushing the aggregate may be included in controlled quantities to supplement the fine aggregate in order to improve the consistency of the mix.

#### **(iii) Aggregates for Fine Concrete**

Coarse aggregate for fine concrete shall comply with BS 1260, but shall have a grading which shall be 10 mm to No. 7 sieve size. Fine aggregates shall be as specified in (ii).

#### **(iv) Source of Supply of aggregates**

Aggregates shall be obtained from a source to be approved by the Engineer. Coarse and fine aggregates shall be delivered and stored separately on to a clean, hard base, in separate compartments or into approved hoppers.

#### **(v) Samples of Aggregates**

Samples of aggregates and sand for use on the works shall be submitted to the Ministry of Works, Materials Branch, for approval and no materials will be accepted for use unless they comply with the requirements stated.

(vi) Defective Aggregates

If any aggregate is defective in grading or other respect, the Contractor shall remedy the defect at his own expense and to the satisfaction of the Engineer.

### 307. GRADING OF AGGREGATES

The combined grading of aggregates shall be a smooth curve approximately parallel to the grading envelope limits, given in the following Table, and to the approval of the Engineer.

**TABLE 3.1: COMBINED GRADING CURVES FOR CONCRETE**

SIEVE SIZES	PERCENTAGE BY WEIGHT PASSING SIEVE NOMINAL MAXIMUM SIZE OF AGGREGATE (mm)		
	40	20	10
1½"	100		
¾"	50-75	100	
3/8"	36-60	45-75	100
3/16"	24-47	30-48	30-75
No. 7	18-38	23-42	20-60
No. 14	12-30	16-34	16-46
No. 25	7-23	9-27	4-20
No. 52	3-15	2-12	4-20
No. 100	0-5	0-2	0-6

### 308. COMPOSITION OF CONCRETE

All concrete shall be dense, impermeable, durable, consistent and cast accurately to the lines and dimensions shown on the drawings and shall present a uniform surface free from blemishes, cracks and honeycombing, resistant to wear and mild chemical attack. Concrete mixes are to be such as to enable the concrete to fill the formwork completely with intimate

contact between concrete and reinforcement and the concrete is to be thoroughly and uniformly vibrated throughout.

The cement, aggregates and water for concrete shall be as specified. Samples of cement and aggregate shall be submitted to the Engineer for testing as early as possible prior to the commencement of concreting works.

Water for mixing concrete, mortar and cement grout and for use during curing, shall be taken from a source approved by the Engineer, shall be clean, fresh and free from matter in solution or suspension in such amounts that may impair the strength or appearance of the concrete, mortar, rendering or grout.

Seawater or brackish water containing more than 1000 milligrams per litre of chloride ion or 2000 milligrams per litre of sulphate ion shall not be used for mixing or curing concrete.

### **309. CLASS AND STRENGTH OF CONCRETE**

The concrete shall be of the Classes shown on the Drawings, described in the Bills of Quantities or ordered by the Engineer, which will be one or more of the Classes described and tabulated below, with the appropriate specified maximum size of aggregate.

#### Description

The concrete mixes, as described, are "guaranteed strength" mixes in the sense that no proportions are given but the required concrete strength is shown and the Contractor will be required to design a suitable mix with the given grading to fulfil the requirements as laid down hereunder for relevant Classes shown.

The mixes will be composed of the following Classes: 10, 15, 20, 25 and 30. These figures represent the minimum 28-day strength in N/mm<sup>2</sup> of the Works Cubes.

The maximum size of aggregate shall be as shown on the Drawings or as ordered by the Engineer and may be indicated in brackets after the mix Class, for example 'Class 30(20)'.

All reinforced and graded concrete shall be composed of cement and fine and coarse aggregates gauged separately and in the following proportions:

**TABLE 3.2: CLASSES OF CONCRETE**

CHARACTERIS TIC COMPRESSIVE STRENGTH AT 28 DAYS	NOMINAL MIX CEMENT, SAND & AGGREGATE	LIMIT OF COMBINED WEIGHT OF DRY AGGREGATE TO 50 KG CEMENT		MAX VALUE OF WATER CEMENT RATIO FOR VIBRATED CONCRETE
		MAX. KG	MIN. KG	
N/mm <sup>2</sup>				

				(BY WEIGHT)
10	1:3:6			
15	1:2½:5	450		
20	1:2:4	400	230	0.55
25	1:1½:3	360	180	
30	1:1:2	320	160	

Before any concreting commences, trial mixes shall be made and cube tests performed as described in the Specification and these cubes shall obtain strengths at least 30% greater than the works cubes shown in Table 3.2 before the mix is approved by the Engineer.

If required or allowed by the Engineer, the relative proportions of fine and coarse aggregates shall be varied to obtain a denser mixer and to reduce shrinkage and such change shall not affect the price so long as the sum of the volumes of fine and coarse aggregates remain unchanged. Where sulphate-resisting cement is used, the water cement ratio shall not exceed 0.55.

Aggregate shall be batched by weight and the weighing hopper shall be of an approved adjustable type. Volume batching will not be allowed for concrete work except under special circumstances such as for small pipe culvert headwalls, pipe surrounds, and other isolated minor works.

When aggregates are batched by volume, the approval of the Engineer shall first be obtained before the use of this method of batching. With volume batching, stout gauge boxes approved by the Engineer, shall be used.

When cement in bags is used, the total volume or weight of aggregate per batch shall be such that a whole number of bags of cement is used and the use of cement from broken bags will not be permitted.

Once the proportions of the mixes have been agreed by the Engineer, they shall not be amended without his consent.

### **310. TESTS FOR CRUSHINGSTRENGTH**

The Contractor shall be held responsible for ensuring that the crushing strength for the respective classes of graded concrete is not less than the following for concrete made with ordinary Portland cement or sulphate-resisting cement.



**TABLE 3.3: CRUSHING STRENGTHS**

CLAS S MIX	NOMINA L	MINIMUM CRUSHING STRENGTH ON 150 mm WORKS CUBES				MIX AVERAGE MINIMUM TRIAL STRENGTH			
		AT 7 DAYS		AT 28 DAYS		AT 7 DAYS		AT 28 DAYS	
		N/m m2	Kg/c m2	N/m m2	Kg/c m2	N/m m2	Kg/c m2	N/m m2	Kg/c m2
10	1:3:6	7.7	78	11.4	116				
15	1:2½:5	10	102	15	153	13	133	19.5	200
20	1:2:4	15	153	20	204	20	204	26	265
25	1:1½:3	19	194	25	255	25	255	32.5	332
30	1:1:2	24	245	30	306	32	326	39	400

Cubes made with rapid-hardening Portland Cement must attain at 3 and 7 days after casting a crushing strength equal to that specified for ordinary Portland Cement or sulphate- resisting cement at 7 and 28 days respectively after casting.

Test cubes shall be numbered and dated in a conspicuous manner and shall be delivered to the Ministry of Works, Materials Branch at least 24 hours before the date when they are due to be tested. Four cubes shall be made at least 14- days before concreting is to be commenced, from a batch of concrete made on Site with the aggregates, cement and water proposed to be used on the works and at least two additional cubes shall be made for each 25 cubic metre of concrete mixed or when otherwise required by the Engineer. Should the crushing strength fall below the figure specified, the Contractor shall, without extra charge, adopt a richer mix or make other changes in proportion or otherwise as the Engineer may direct or approve, so as to bring the concrete up to the required strength.

### **311. CEMENT CONTENT AND WATER-CEMENT RATIOS**

Notwithstanding the strength requirements of this Specification, in order to ensure adequate durability of the finished concrete while at the same time limiting the shrinkage characteristics, the following limits shall not be exceeded:

**TABLE 3.4: LIMITS TO WATER**

			<b>CEMENT IN kg/m<sup>3</sup> FINISHED CONCRETE</b>	
			<b>MAXIMUM</b>	<b>MINIMUM</b>
15	0.60	29.60	356	252
20	0.55	27.30	415	296
25	0.50	25.00	475	475
30	0.45	22.75	534	341

In all cases of mix proportioning, the added water shall be included with due allowance for the moisture contained in the aggregates and shall be the minimum consistent with the workability requirements.

Where aggregates do not conform to the moisture requirements of BS 8007 (iii) 2006 but are permitted for use, the above maximum water cement ratios shall be reduced by 0.05 (or 2.25 litres of water per 50 kg of cement).

Where the concrete is to be used in structures, protected from the elements, or not exposed to constant wetting and drying, the above maximum water-cement ratios may be increased by 0.05 (or 2.25 litres of water per 50 kg of cement).

### **312. DESIGN MIX**

The mix should be designed for a mean strength that exceeds the specified works Cube Strength plus 30%.

The mix design shall follow the method explained in BS 5328: 2000.

For the purpose of determining the "design strength" of the concrete, an allowance shall be added to the works Cube Strength indicated in Table 3 - 3 for the particular Class of concrete. This allowance shall be assessed on the degree of control reasonably to be expected in manufacturing the concrete and shall not be less than twice the Standard Deviation as defined in BS EN 12390: 2000. Until such time as it has been determined, the Standard Deviation shall be assumed to be not less than 7 N/mm<sup>2</sup>.

Details of the design mix shall be forwarded to the Engineer for his approval. However, such approval by the Engineer, shall not relieve the Contractor of his obligations.

**313. TRIAL MIXES**

**314. COMPACTION AND SLUMP TESTS**

The Contractor shall as and whenever require by the Engineer carry out slump or any other tests to determine the consistency of the mixed concrete and gauge, by measure, the amount of water prescribed by the Engineer for each mixing of concrete.

The tests of concrete shall not show a greater slump or compaction factor than the Engineer shall decide for each part of the work, but generally the slump for mass concrete must not exceed 25 mm and for reinforced concrete work 50 mm.

The compaction factor of vibrated concrete shall not exceed 0.91.

**315. MIXING OF CONCRETE**

The concrete shall only be mixed in approved power-driven concrete mixers for all Classes of Concrete, except that small batches of Class 15 and Class 10 may be mixed by hand with the approval of the Engineer.

The concrete shall be mixed continuously in the mixer for not less than 2 minutes after the whole of the ingredients are present in the drum. When a concrete mixer has been out of use for more than 20 minutes, or when the type of cement is changed, the mixer shall be thoroughly cleaned before a fresh batch of concrete is made in it.

The Engineer may prohibit concreting if in his opinion the number and/or sizes of the mixers available, or the quantity of materials in stock, is insufficient; or where he feels that the haulage of concrete from the mixer to the point of application of concrete is not near enough to guarantee quality.

**316. WEIGHING, BATCHING AND MIXING**

Aggregates and cement shall be proportioned by weigh-batching and water shall be proportioned by volume. Subject to the prior approval of the Engineer, volume-batching of aggregates may be used when weigh-batching is not possible, but volume-batching of cement will in no case be accepted. The contractor may, however, so mix his concrete that such batch shall use a whole bag or bags of cement, the weight of which is known precisely.

Gauge boxes for volume-batching shall be strongly constructed and where necessary due allowance shall be made for bulking of the aggregates.

The aggregates and the cement shall be thoroughly mixed in a clean mechanical mixer for a period of time agreed with the Engineer and the water added on the basis of the approved design.

The amount of water added shall conform to the requirements as given in Table 3 - 4.

Batch-mixing machines shall comply with the requirements of BS 1305: 1974. They shall be provided in such numbers and of such capacity as to ensure a continuous supply of freshly mixed concrete at all times during construction.

Continuous mixing machines shall be used only with the written permission of the Engineer.

When small quantities of concrete are to be mixed the Engineer may approve hand-mixing. In such cases, the cement content for all mixes shall be increased by 10% and the Contractor shall allow for this in his rates and prices.

Where concrete is mixed by hand, the fine aggregate and the cement shall be thoroughly mixed first and the coarse aggregate added. Mixing in the dry shall be carried out at least twice then water be added and the concrete again thoroughly mixed.

### **317. HAND MIXING**

If hand-mixing is permitted, the quantity of cement to be used shall be increased by 10 per cent. Hand-mixing shall be carried out on an approved water-tight platform, the aggregate and cement being turned over three times in a dry state and thoroughly mixed by means of shovels. The water shall then be added through approved hoses fitted to watering cans, and the mixture shall be worked together until a uniform consistency is obtained.

During windy weather, protection shall be provided by screens or otherwise as directed to prevent cement from being blown away.

### **318. TRANSPORTING AND PLACING OF CONCRETE**

No concrete shall be placed until the Engineer has approved the formwork and reinforcement. The Contractor shall provide all facilities for inspection.

The Contractor shall give at least 48-hours' notice to the Engineer of the times he proposes to concrete and the Engineer may order that no concreting shall take place until either he or his Representative is present.

Concrete shall be transported in watertight containers in such a manner that will avoid the segregation of the constituent materials. The time elapsing between the initial mixing of the concrete and finally placing in the works shall not exceed 30 minutes when Portland cement is used. Where other cements are used, the Engineer will stipulate the maximum time allowed. Concrete remaining unplaced at the end of this period shall not be placed in the work but shall be removed from the Site and disposed off at the Contractor's expense. Should there be need for the use of rapid hardening cement at tie-ins particularly for expediting the completion of the works thereby the Contractor shall inform the Engineer who will when he deems it necessary approve such use.

Concrete shall not be dropped through a height exceeding 1.5 m. For lowering concrete through heights in excess of 1.5 m, special methods shall be used, such as chutes, tremies, bottom dumping hoppers, or bagged placing, and then only with the approval of the Engineer. All containers, troughs and chutes and apparatus through and in which concrete is passed, shall be kept clean and entirely free from hardened concrete or cement and free from contamination by extraneous material.

The concrete shall be placed in position in lifts not exceeding the heights to be agreed by the Engineer, and the excessive heights which may cause segregation of the aggregate at the working edge, shall be avoided.

Concreting of any unit or section of the work shall be carried out in one continuous operation, and no interruption will be allowed without the approval of the Engineer.

A competent steel fixer shall be in attendance the whole-time concrete is being cast around reinforcement. Proper bridging arrangements for traffic over reinforcement shall be provided so that the reinforcement is not distorted, damaged or displaced.

Where approval is obtained for concrete to be conveyed by chutes, these shall have a slope (not exceeding 1 vertical to 2 horizontal) in order to ensure a continuous flow of concrete. Additional water shall not be introduced to assist the flow of concrete down the chute, deposition is to be intermittent and chutes shall be arranged to discharge into a storage hopper. Under no circumstances should a clear fall of more than 1.0 m be permitted at the discharge end of the chute.

The pumping of concrete shall be used only for such parts of the work as the Engineer considers suitable, and will be subject to the size, design, layout, and siting of the whole concreting plant including pumps, pipelines, water and air supply and all ancillary gear and apparatus and the conditions and methods of its operation and maintenance being to the entire satisfaction and approval of the Engineer.

Whenever transport of concrete is interrupted for any length of time (periods of over 30 minutes shall be treated as such), the chutes, pumps, pipes and any other means of distribution shall be thoroughly flushed out and cleaned. These shall also be flushed out immediately prior to resumption of concreting and shall be kept free from hardening concrete.

All wash water used shall be discharged outside the shuttering and clearing of any freshly placed concrete.

### **319. HOT WEATHER CONCRETING**

- a) Concreting shall not be permitted if its temperature at placing is in excess of 38°C. In order to maintain the temperature of the concrete below this value the following precautions shall be taken wholly or in part as instructed by the Engineer.
  - (i) All aggregates stockpiles, water lines and tanks as well as the mixer shall be protected from the direct rays of the sun.
  - (ii) Coarse aggregate shall be cooled by constant watering where possible.
  - (iii) Mixing water shall be cooled by the addition of ice to the storage tanks where necessary.
  - (iv) Rapid hardening cement shall not be used.
  - (v) Where the above precautions are inadequate concreting shall be carried out during the cooler parts of the day or during the night as may be directed by the Engineer.
- b) When the air temperature is above 20 degrees centigrade loss of mixing water by evaporation shall be considered in arriving at the amount of water to be added to the mix. In order to maintain the water/cement ratio within

permissible limits an approved water-reducing agent shall be included in the mix.

- c) The maximum water/cement ratios may be increased with the Engineer's permission by 0.05 (or 2.25 litres to 50 kilograms of cement) during mixing, but on no account shall water be added to concrete directly or indirectly once it has left the mixer.
- d) In order to reduce premature drying of the concrete during transporting and placing, all chutes, shuttering and reinforcement shall be cooled by watering when possible, or shall otherwise be protected from the direct rays of the sun. Any water so used shall be removed by jetting with compressed air before placing the concrete in close contact.
- e) As soon as possible after concreting, the shuttering shall be stripped and the surface of the concrete shall be kept moist for a period of 7 days by covering with wetted Hessian or sand or shall otherwise be treated with an approved curing membrane.

Where drying winds are encountered, wind shields shall be positioned as directed by the Engineer to protect exposed surface of the curing concrete.

### **320. WET WEATHER CONCRETING**

Concreting during periods of constant rain shall not be permitted unless aggregate stockpiles, mixers and transporting equipment and the areas to be concreted are adequately covered.

During showery weather, the Contractor shall ensure that work can be concluded at short notice by the provision of stop ends. On no account shall work be terminated before completion of each section, between one stop and another. Adequate covering shall be provided to protect newly placed concrete from the rain.

### **321. PROTECTION AND CURING OF CONCRETE**

Immediately after placing, the surface of the finished concrete shall be protected from the harmful effects of sun, drying winds, rains, running or surface water and against any shocks. It shall be cured by keeping it covered with damp material for a minimum period of seven days after placing. The formwork shall also be kept damp and if struck earlier than 7 days, shall be replaced for the remaining period with some other approved damp material.

In the case of concrete made with high alumina cement, the whole of the concrete shall be kept thoroughly saturated with water for at least 24-hours after casting.

The Contractor shall protect and cure the concrete works as soon as practicable after completion by one or more of the following methods:

- a) The concrete shall be covered with a layer of sacking, canvas, Hessian, straw mats, or similar absorbent material or a layer of sand and kept constantly wet for 7 days.
- b) Except in the case of surfaces to which concrete has subsequently to be bonded, the concrete shall be cured by application of an approved liquid-

curing membrane. On horizontal surfaces, the curing membrane shall be applied immediately after placing the concrete, and on vertical surface immediately after removing the formwork.

No traffic or constructional loads shall be permitted on newly placed concrete until it has hardened sufficiently to take such traffic or load without surface damage or deformation.

If directed by the Engineer, the finished concrete works shall be fenced in such a manner as to prevent the access of traffic, unauthorized persons or animals on the surface of the newly paved concrete, until such time when the concrete will have hardened not to show any imprints or defects caused by any interference.

### **322.       LOADING**

No loads shall be placed on beams, slabs or walls without the permission of the Engineer.

### **323.       PLACING OF CONCRETE IN FOUNDATIONS**

Before placing concrete in foundations, the bottom shall be thoroughly rammed and cleaned up to a neat horizontal plane, or such profile as is shown on the Drawings. No steps or batters will be permitted unless shown on the Drawings or approved by the Engineer.

Where shown on the Drawings or ordered by the Engineer that the sides of the concrete shall be cast against the existing ground without using shuttering, the faces of the earth shall be trimmed neat and true to line. Where such a hole is over- excavated due to the Contractor's method of working, the void shall be filled with concrete, at the Contractor's expense of the same Class as specified for the foundation.

Where pumping from the foundation is necessary, sumps and drains shall be provided outside of the area to be concreted. Where it is likely that there will be standing water in the foundation after excavation, the final 0.1 to 0.15 m of the soil shall not be excavated until immediately before the concreting. Where, in the opinion of the Engineer, the bottom of the excavation has become unsuitable for bearing due to the Contractor's method of working, the soft material shall be excavated to such a level as the Engineer may direct and replaced with concrete Class 15 at the Contractor's expense.

No concrete shall be placed in the foundation until the excavation has been approved by the Engineer.

### **324.       BENDING, PLACING AND FIXING OF STEEL REINFORCEMENT**

The Contractor shall provide on Site, facilities for cutting and bending reinforcement whether he is ordering his reinforcement bent or not and shall ensure that a token amount of straight bar is available on Site for bending as and when directed by the Engineer.

Reinforcement shall be wire-brushed and cleaned at the Contractor's expense, before and/or after it is placed in position, if required by the Engineer.

The bars shall be cold bent in strict accordance with the bending schedules and the Contractor shall be responsible for the accuracy of bending. Bending dimensions shall be worked to the tolerance indicated in BS ISO 4066: 2000 except for binders and links which shall be bent to a tolerance of 1.5 mm. Bars in which any errors in bending are beyond the limits of the foregoing tolerances, shall be replaced at the Contractor's cost by correctly bent new bars, or, may be straightened and re-bent cold, subject to the Engineer's prior approval.

Steel reinforcement shall be bent accurately to the shape and dimensions shown on the Drawings. The Contractor shall satisfy himself as to the accuracy of any bar bending schedule supplied and shall provide all steelwork in accordance with the detailed reinforcement Drawings.

Any discrepancy or inaccuracy found in the bending schedule shall be notified to the Engineer immediately.

After bending, reinforcement shall be securely bundled and labelled with weatherproof tags or shall be marked with other approved signs by which it can readily be identified.

Before assembling or placing the reinforcement the dimensions to which it has been bent shall be checked with the bending schedules by the Contractor.

The reinforcement shall be fixed in strict accordance with the Drawings as regards cover, spacing and position and suitable precautions shall be taken by the Contractor to prevent the displacement of reinforcement during the placing and compaction of concrete.

Where required to support and retain the reinforcement in its correct position, the Contractor shall provide templates, stools and other supports at his own cost.

Precast concrete support blocks for reinforcement shall be manufactured from Class 25 fine concrete to ensure the correct thickness. They shall be well cured before use and carefully stored on Site to avoid contamination. Plastic and metal supports, chairs, etc, may be used subject to the Engineer's prior approval.

A lap of not less than forty-four diameters of the large bar shall be provided at the junction of two bars for which the lap is not specifically detailed on the Drawings.

Fabric reinforcement shall be lapped at least 40 diameters or two squares whichever is the greater.

Additional splicers, other than those shown on the Drawings, may be permitted by the Engineer, but will not be paid for. All splices shall be staggered and the length shall be as directed by the Engineer.

All intersection of bars in walls and slabs and all connections between binders and links and main bars in columns or beams shall be tied with soft iron wire ties or with fixing clips which shall not be allowed to make contact with the shuttering or to project into the specified cover

Unless permitted by the Engineer, welding of bar reinforcement at intersections or for the joining of bars is prohibited. Where permission is granted, welding shall be carried out in



accordance with the recommendations "Welding of Mild and Cold-worked Steel Bars for Reinforced Concrete Construction" as issued by the Institute of Welding, UK.

### **325. FORMS AND FORMWORK FOR CONCRETE: DEFINITIONS**

"Forms, formwork or shuttering" shall include all temporary moulds for forming the concrete to the required shape, together with all temporary construction such as false-work, props and struts required for the support of such moulds, together with any special lining that may be required to produce a special concrete finish.

"Wrot" or "Wrought" formwork or shuttering shall mean formwork where the internal timber face in contact with the concrete is planed smooth, and the Contractor is to take particular care with the surface of the shuttering, and with the floating of unshuttered surfaces, it being the intention that a very smooth face will result when the shuttering is struck.

"Unwrought" formwork or shuttering shall mean formwork when the internal timber face in contact with the concrete is left "as sawn".

### **326. FORMS AND FORMWORK FOR CONCRETE: CONSTRUCTION**

All forms shall be constructed so as to facilitate the accurate placing and proper compaction of the concrete. Timber forms shall be constructed of sound, well-seasoned timber of such quality and strength as will ensure rigidity throughout the placing, ramming, vibration and setting of the concrete without visible deflection or warping. They shall be so constructed that they can be removed without shock, vibration or damage to the concrete. All joints shall be tongued and grooved, unless otherwise required, and shall be made sufficiently tight to prevent any leakage of grout. Internal ties shall be avoided as far as possible, and if used, shall be metal. They shall be capable of removal without injury to the concrete, but if permitted by the Engineer to be permanently embedded in the concrete, shall be cut back after the concrete is cast to at least 25 mm below the concrete.

Formwork for columns and small concrete sections, or where directed by the Engineer, shall be fitted with trap doors through which saw-dust, shaving and other debris can be removed.

Steel forms of other materials may be used with the approval of the Engineer. Travelling forms will only be permitted in special circumstances, and with the written approval of the Engineer.

Struts and props shall, where required by the Engineer, be fitted with double hardwood wedges or other approved devices, so that the moulds may be adjusted as required and eased gradually after casting the concrete. Wedges shall be spiked into position, and any adjusting device locked before the concrete is cast.

All formwork shall be approved by the Engineer before concrete is placed within it. The Contractor shall, if required by the Engineer, provide the latter with copies of his calculations of the strength and stability of the formwork of falsework, but notwithstanding the Engineer's approval of these calculations, nothing shall relieve the Contractor of his responsibility for the safety or adequacy of the formwork.

Top shuttering shall be counter-weighted or otherwise anchored against floatation.

### **327. FORMWORK FOR MOULD VIBRATED PRECAST CONCRETE**

Where precast concrete is to be cast in vibrating moulds, special care shall be taken to maintain the rigidity of the mould and supports against the action of the vibrators. Form vibrators shall be rigidly attached to the forms to ensure the transmission of the vibrations to the concrete, all wedges and clamps shall be fitted with locking devices to ensure they are kept tight during the vibrating operation.

### **328. PREPARATION OF FORMS BEFORE CONCRETING**

Before the concrete is deposited, the forms shall be thoroughly cleaned of sawdust, shaving and other debris and hosed down with water. The face of the forms shall be coated with lime-wash or painted with an approved mould oil. Where reinforcement has been accidentally coated, it shall be cleaned with a wire brush, and a suitable solvent.

### **329. SPECIAL METHODS OF WORKING**

Should working, the Contractor propose to use special methods of working not included in these Specifications, such as pumping concrete or using vacuum moulds, he shall obtain the Engineer's approval before commencing work, and comply with any subsequent specification made by the Engineer for this special method of working.

### **330. FORMWORK LEFT IN**

Where the striking of formwork would in the opinion of the Engineer, cause damage to or prejudice the safety of the structure, the formwork shall be left in. If, in the opinion of the Engineer, the necessity for leaving in the formwork arises from the Contractor's method of working, then that loss shall be borne by the Contractor but if it is due to circumstances beyond his control, the timber left in will be paid for at rates set out in the Dayworks Schedule of the Bills of Quantities.

### **331. MEASUREMENT AND PAYMENT FOR FORMWORK**

Formwork shall be measured as the area of the concrete actually in contact with the mould, except that in the case of small fillets and chamfers of size 30 x 30 mm and less, the overall area of the concrete shall be taken as though the fillets and chamfers had been omitted. Formwork for Construction Joints will not be paid for and will be deemed to be included in the Contractor's rates for concreting.

The rates for formwork shall include for all timber or metal moulds inclusive of all necessary supports and stagings, bolts, nuts, straps, clamps, wedges and other fittings, also all cutting and waste and the cost of all labour transport and materials in making, erecting and removing the formwork and for any other work required to construct the forms to the shapes and dimensions shown on the Drawings, or as directed by the Engineer.

The rates shall also include for all cut outs, rebates, slots, etc., trimming and sealing, cutting and shaping.

The formwork for in situ concrete will be paid for separately according to whether it is vertical, horizontal or inclined, and whether it is unwrot, wrot or special facing, as set out in the Bill of

Quantities. Formwork for precast units will not be paid for separately and the cost of the moulds will be deemed to be included in the cost of the concrete or completed product.

Where external shuttering is employed in excavations and is measured the cost of any additional excavation necessary for the shuttering shall be included in the rates for the shuttering.

Where an item for shuttering is given, the areas indicated are only approximate and the Contractor should check the areas before pricing the Tender. No formwork will be paid for where foundations are shown on the Drawings or are required by the Engineer to be cast against the existing ground.

The Contractor shall be responsible for the co-ordination of all requirements of his Sub-Contractor(s) (if any) as regards provision of holes, chases, cavities and fixings and shall, if required by the Engineer, prepare Drawings giving details of his and his Sub-Contractors' requirements and shall send copies of such Drawings to the Engineer prior to Construction.

Holes, etc. shall be accurately marked and boxed-out for before concreting operations commence and without the Engineer's prior approval, no such holes, etc, shall be formed after the concrete has set.

Where bars, if placed to the specified spacing would foul holes of size less than 230 x 230 mm, the full length of the bar shall be moved to one side, and in the case of holes exceeding 230 x 230 mm, the bars shall be cut on site and lapped with additional bars.

Wherever possible, the Contractor shall build in all pipework, ironwork, etc. which passes through walls and floors and the pipework, ironwork, etc. shall first be thoroughly cleaned and freed from any deleterious matter, and every care shall be taken to ensure that it is thoroughly encased in concrete.

Bolts, hooks and other fixings shall be embedded in concrete, or holes shall be drilled and fitted with threaded expanding anchors to receive the bolts. The Contractor shall ensure that bolts, hooks, etc. are accurately positioned. Holding-down bolts for machinery shall be set to template.

Where brick or stonework is to form a facing to the concrete or where the end of a brick or stone wall butts against a concrete face, 16-gauge 25 mm x 230 mm galvanized metal ties of approved manufacture to BS EN 845+A1 (i): 2003 shall be incorporated. The distance between ties shall be gauged with due regard for the bonding of the Walls, at intervals required by the Engineer.

The rates for fixing pipes, manholes, covers, steelwork, ladders, etc and the associated bolts and lugs shall include for cutting the shuttering, building-in, grouting-up and making good adjacent concrete, blockwork or stone surfaces.

### **332. REMOVAL OF FORMS**

Forms shall be removed in such a manner as will not injure the concrete, and no formwork shall be removed before the concrete has sufficiently set and hardened. The minimum periods which shall elapse between the placing and compacting of Ordinary Portland cement concrete for the various parts of the structure are given in the following schedule, but compliance with these requirements shall not relieve the Contractor of obligation to delay the removal of the forms if the concrete has not set sufficiently hard:

Beam sides, walls, unloaded columns	4 days
Soffit of secondary slabs (props left in)	7 days
Soffit of main slabs (props left in)	14 days
Removal of props - slabs	17 days
Bottom boards of piles (Intermediate support left in)	21 days
Soffit of beams under 6 m span	21 days
Soffit of beams over 6 m span	21 days
Plus 1 day per 0.6 m in excess of 6 m with maximum of 28 days.	

### **333. MAKING GOOD**

Honeycombing or damaged surfaces of concrete which in the opinion of the Engineer are not such as to warrant cutting out and replacement of the Concrete shall be made good as soon as possible after removal of the shuttering as follows: -

- A Portland Cement and sand mixture shall be worked into the pores over the whole surface with a fine Carborundum float in such a manner that no more material is left on the concrete face than is necessary completely to fill the pores so that a uniformly smooth and dense surface of uniform colour is finally presented.

### **334. PROTECTION OF CONCRETE AFTER REMOVAL OF SHUTTERING**

Any concrete surfaces, rises and treads of stairways which might be damaged during the construction of the works, shall be adequately protected.

### **335. REMOVAL AND REPLACEMENT OF UNSATISFACTORY CONCRETE**

The Contractor shall on the Engineer's instruction so to do, cut and replace any concrete in any part of the structure if in the Engineer's opinion: -

- a) the concrete does not conform to the Specifications; or
- b) deleterious materials or materials are likely to produce harmful effects have been included in the concrete; or
- c) the honeycombed or damaged surfaces are too extensive; or
- d) the finished concrete sizes are not in accordance with the Drawings within permissible tolerances; or
- e) the setting-out is incorrect; or
- f) the steel cover has not been maintained; or
- g) the protection, including curing of the concrete during the Construction was inadequate, resulting in damage; or
- h) the work of making or other remedial measures the Engineer may indicate are not carried out to his satisfaction; or
- i) undue deformation of or damage to the works has taken place due to inadequate shuttering, or to premature traffic and loading; or
- j) Any combination of the above points has taken place resulting in unsatisfactory work.

### **336. CONSTRUCTION JOINTS**

The details of the Construction Joints and their positions shall be submitted by the Contractor for approval together with the order of concreting.

Joints shall be made at right angles to the member. Stop end shutters shall be removed as soon as practicable after the concrete has set, but without moving the main shuttering. Exposed horizontal or vertical concrete shall be thoroughly cleaned to expose the coarse aggregate, being hacked, well brushed and washed with high pressure air and water jetting or by other approved method. Before fresh concrete is placed against the joint, the surfaces shall be cleaned to remove any laitance, loose material or dirt. Horizontal surfaces shall be coated with 1 to 12/3 cement mortar 12 mm thick, moistened and of approved consistency, and the concrete shall be deposited and rammed hard against the existing concrete before the coating has set.

In Construction Joints of water-retaining structures, and elsewhere as may be ordered by the Engineer, 200 mm "Dumbbell" PVC water bars shall be provided. Unless otherwise ordered by the Engineer, Construction Joints shall be rebated to an approved form.

The cost of water stops required at Construction Joints is to be included in the rates for concrete and formwork if not specifically itemised in the Bills of Quantities.

### **337. FAULTY WORK**

The Contractor shall on being requested in writing by the Engineer, remove and reconstruct any structural members or portions of the work which gives evidence of any fault, or injury which may affect the strength, durability of water tightness of the Construction. No concrete or steel shall be cut in any way except on such request and with permission in writing.

### **338. PRECAST CONCRETE**

The foregoing requirements relating to ordinary and reinforced concrete generally shall be observed in the case of precast concrete so far as they are applicable as well as the following requirements relating to precast work in particular.

The precast concrete work shall comply with the requirements of BS 5642:2; 1983.

The Contractor shall submit for the approval of the Engineer samples of all aggregates for use in the precast concrete.

Where holes or recesses are required for bolts, covers, etc. they shall be cast in the units. Where reinforcement is required, the requirements of the Specification regarding holding of the bars or fabric firmly in position shall be strictly adhered to.

### **339. RATES FOR PRECAST CONCRETE**

The price for each description of precast concrete shall include for all shuttering, moulds, fillets, for forming the tops to proper shapes, for finishing all exposed surfaces to a very smooth face and for fixing and building in place complete.

### **340. CONCRETE WORK – TOLERANCES**

#### **a) Cover to Reinforcement**

The cover to the reinforcement bars in concrete shall be as shown upon the drawings, or as ordered by the Engineer, with the following variations permitted:

Least Dimension on Concrete Structure - Permitted variation

Less than 0.25 m + 4% to - 2%

Greater than 0.25 m +10% to - 5 mm.

#### **b) Shuttering**

Shuttering shall be of such accuracy, strength and rigidity as to carry the weight and pressure from the concrete to be placed on or against it, together with all constructional, wind or other loads likely to be imparted to it, without producing deformation of the finished concrete in excess of the tolerances outlined below: -

Overall dimensions and levels	+/- 5 mm
Column sizes	+/- 5 mm
Beam sizes	+/- 5 mm

Slab thickness	+/- 5 mm
Wall thickness	+/- 10 mm
Vertical lines out of plumb	+/- 5 mm
+ 12 mm in every 30 metres	

Except that in the case of "sawn" shuttering the dimensions of the finished concrete shall be no less than those shown on the Drawings.

Beam soffit shall be erected with an upward chamfer of 6 mm per 3 metre spans.

### 341. TESTING OF CONCRETE DURING PRODUCTION

#### a) Consistency

The consistency of concrete shall be frequently checked by means of a slump test performed by the Engineer or his Representative. The maximum and minimum slump for each Class of concrete used shall be as directed by the Engineer, and any concrete represented by the slump test which fails to comply with these specifications, shall be removed from the Site and disposed off at the Contractor's expense.

#### b) Slump Test

Slump tests shall be performed in accordance with BS 1881:125; 1986, during the progress of the work to ensure consistency of the concrete and carried out at such frequency and on such concrete as the Engineer shall direct.

The Contractor shall keep a record of slump tests showing: -

- (i) Date and time of test;
- (ii) Class of concrete and position of batch in the Works;
- (iii) Amount of slump;
- (iv) Remedial measures taken to correct mix.

A copy of this record shall be given to the Engineer at the end of each day's work.

#### c) Method of Making Test Cubes

Test cubes shall be made by or under the supervision of the Engineer or his Representative from concrete placed in or about to be placed in the works.

Test cubes shall be made, stored and cured and tested in accordance with BS 12390; 2000 'Method of Testing Concrete', except that no 100 mm cubes

will be permitted. The method of compaction (by hand or vibrator) will be at the Engineer's discretion.

Test cubes shall be marked with the date of casting and a reference number, and the Contractor shall keep a record and provide the Engineer with a duplicate copy showing the date cast, reference number of cube, Class of concrete and position in the works of the concrete tested.

After approval of the trial mix by the Engineer, production of concrete for the works may commence.

The proportions of materials used in the works shall follow the proportions found to be acceptable in the trial mixes. The concrete shall be prepared under the control of a competent person, and close control kept over quantities and water content, care being taken to make due allowances for variations in the moisture content of the materials. Regular testing of the moisture content of the aggregates shall be carried out. All measurements of materials (except water) must be done by weight.

Immediately on starting production on Site, samples of concrete shall be taken as follows: -

On each of the first 4 days of concreting, for each Class of Concrete shall be made 6 No. test cubes from 2 No. separate samples. Three test cubes from each sample to be tested at 7 days, the other 3 at 28 days.

One test result shall be the average crushing strength from the three cubes in the sample tested either at 7 days or at 28 days.

For the concrete to be acceptable the following conditions must be satisfied:

- (i) No more than one individual result in the same test shall fall below the specified works Cube Strength.
- (ii) No individual result to fall below 0.9 x the specified works Cube Strength.
- (iii) No test result (average of three cubes in one sample) to fall below the specified works Cube Strength.

When at least 4 consecutive working days concrete production has been proved satisfactory, the frequency of testing may be reduced at the Engineer's discretion.

d) Transport of Test Cubes

Test cubes shall if required by the Engineer, be transported by the Contractor to a testing laboratory nominated by the Engineer so as to arrive not later than 6 days after casting but shall not be despatched earlier than 72-hours after casting.



### **342. FREQUENCY OF TESTS**

Frequency of tests and the number of samples required will be governed by the results of previous test, the quality of the materials revealed during the tests and the uniformity of that quality.

In case of crushing tests to be made on concrete when Construction commences, the Engineer may require up to 12 test cubes to be cast each day for each Class of concrete (6 cubes to be tested at 7 days and 6 cubes at 28 days) until he is satisfied that the materials and the method of mixing used are such as to produce a concrete which complies with the requirements of BS 12390; 2000 in the case of "Mix Design" and in the case of "Nominal" and "Standard" Mixes. The number of test cubes to be made for routine testing shall be 3 for each and every 38 m<sup>3</sup> or part thereof per working day or as otherwise required by the Engineer. These cubes shall normally be tested 7 and 28 days after casting.

Should it become evident that quality of the concrete is deteriorating, the Engineer may require additional samples to be made and tested to determine the cause.

### **343. REFERENCE AND RECORD BOOKS TO BE KEPT ON SITE**

A triplicate book shall be provided by the Contractor wherein all instructions on concrete work given by the Engineer shall be entered. This book shall be kept on the Site and one copy of all entries shall be forwarded to the Engineer.

A continuous entry diary shall be kept permanently on Site by the Contractor wherein he shall record details of shuttering, construction, placing or reinforcement, concreting and curing operations, striking or shuttering, making good, daily temperature and weather conditions. The diary shall always be available for the Engineer's inspection.

The Contractor shall provide and keep permanently on Site all the Standard Specifications referred to herein.

### **344. TESTING EQUIPMENT**

The Contractor shall provide the following equipment for carrying out control tests on the Site:

-

- (a) Straight edges (3.00 metres and 1.25 metres long) for testing the accuracy of the finished concrete.
- (b) A glass graduated cylinder for use in the silt test for organic impurities in the sand.
- (c) Slump test apparatus
- (d) A sufficient number of 152.4 mm steel cube moulds with base plates and tamping rods to BS 12390; 2000.

### 345. FINISHES ON UNFORMED SURFACES

Horizontal or nearly horizontal surfaces which are not cast against formwork shall be finished to the class shown on the drawings and defined hereunder.

#### UF 1 Finish

All surfaces on which no higher class of finish is called for on the drawings or instructed by the Engineer shall be given a UF 1 finish.

The concrete shall be levelled and screeded to produce a uniform plain or ridged surface, surplus concrete being struck off by a straight edge immediately after compaction.

#### UF 2 Finish

This is a floated finish for roof or floor slabs and other surfaces where a hard-trowelled surface is not required.

The surface shall first be treated as a Class UF 1 finish and after the concrete has hardened sufficiently, it shall be floated by hand or machine sufficiently only to produce a uniform surface free from screed marks.

#### UF 3 Finish

This is a hard-trowelled surface for use where weather resistance or appearance is important, or which is subject to high velocity water flow.

The surface shall be floated as for a UF 2 finish but to the tolerance stated below. When the moisture film has disappeared and the concrete has hardened sufficiently to prevent laitance from being worked to the surface, it shall be steel trowelled under firm pressure to produce a dense, smooth uniform surface free from trowel marks.

**TABLE 3.5: SURFACE TOLERANCES**

Class of Finish	Tolerance in mm. See notes		
	A	B	C
UF 1	N/A	10	+ 20 or - 10
UF 2	Nil	10	+ 20 or - 10
UF 3	Nil	5	+ 12.5 or -7.5

#### Notes:

1. Col. A is the maximum allowable value of any sudden change of level in the surface.
2. Col. B is the maximum allowable value of any gradual irregularity of the surface, as indicated by the gap between the surface and a

three-metre-long straight edge or correctly shaped template placed on the surface.

3. Col. C is the maximum allowable value of the difference in level or position between a three-metre-long straight edge or correctly shaped template placed on the surface and the specified level or position of that surface.

Where dimensional tolerances are given on the drawings or in this Special Specification, they shall take precedence over those given in Table 3.5.

## **CHAPTER 4**

### **BUILDINGS AND ASSOCIATED WORKS**

## **CHAPTER 4 - BUILDINGS AND APPURTENANCES**

### **4001. GENERAL**

- (a) Throughout the Drawings, Standard Specification and their Special Specification, all references to Standard Specifications shall be deemed to be to the latest Edition of the Standard to which the Clause refers at the time of Tendering.
- (b) No allowance shall be made for the Contractor's lack of knowledge in this particular respect.
- (c) This Special Specification is to be read in conjunction with other parts covering the Works.
- (d) Details on Drawings and in the Bills of Quantities and instructions given on site by the Engineer will take precedence over the Specifications given herein.

### **4002. EXCAVATION AND EARTHWORKS**

- (a) The Contractor is advised to visit the Site and ascertain the nature of the soil to be excavated, as no claim will be allowed on account of the soil being of a different nature from that for which he allowed in his Tender.
- (b) All grass, vegetable matter, etc. must be removed or burned on Site at the commencement of the Contract over the area of the buildings plus an area (3.0 m) distance all round or as directed by the Engineer. The line of all paths, roads, etc. shall also be cleared in the same manner. On no account will earth containing vegetable matter be used for backfilling.
- (c) The foundation trenches for all walls, etc. shall be excavated to the width and diameter shown on the Drawings and to the depths below existing ground level as directed by the Engineer in order to obtain satisfactory foundations or sanitary conditions.

If, however, the Contractor excavates to any widths, diameter or depths greater than those shown on the Drawings or as instructed by the Engineer, he shall at his own expense fill in such depth, diameter or width with concrete (1:3:6) to the satisfaction of the Engineer.

All excavations are to be measured net as before digging. The Contractor shall be deemed to have allowed in his prices in the Schedule of Rates, for increase in the bulk after digging.

- (d) Where buildings are to be erected upon a sloping ground, the ground shall be excavated to a minimum of 250 mm below finished floor level on the topmost sides of the slope for a horizontal distance of 3.0 m from the external wall of the building or buildings and the ground left sloping slightly away from the building. All banks formed by this excavation shall be cut to slope at an angle of 45 degrees or to the angle of natural repose of the excavated material and a natural earth drain formed to carry off surplus water around the foot of the slope so formed.

On the lower sides of the slope the ground shall be made up where necessary to form a similar slight slope 3.0 m wide from the external walls.

In all cases the finished floor level shall be at a minimum height of 250 mm above ground level unless otherwise specified or indicated on the Drawings.

**4003. PRECAST CONCRETE**

The mixes for Precast Concrete units shall be as follows: -

Lintels	1:2:4 (19 mm nominal aggregate)
Units less than 40 mm thick	1:2:2 (6.4 mm nominal aggregate)
All other units	1:2:4 (12.5 mm nominal aggregate)

The concrete shall be cast in suitable moulds true to shape and size, thoroughly tamped into the moulds (and round / twisted reinforcement where applicable) and shall be vibrated where specified herein. Moulds shall not be removed until 7 days after pouring and shall be protected by covering them with wet hemp sacks or other suitable material kept wet throughout that time. The cast work shall be seasoned for a further 7 days under cover and a further 7 days in the open before fixing. Unless otherwise described, faces are to be left rough for sawn moulds.

Where precast concrete is described as "finished fine" the moulds are to be made of metal or are to have linings which will produce a smooth dense fine face to the finished concrete free from all shutter marks, protuberances and pinnacles, so as to make them suitable to receive a direct painted finish.

Unless otherwise described prices of all precast concrete shall include for all moulds, finishing fine where so described, including rubbing down if required, hoisting and fixing, at the required levels, bedding and jointing in cement and sand (1:5) mortar and pointing beds and joints in exposed faces flush in cement; also, for casting or cutting to the exact lengths required and any waste resulting from much cutting. The sizes of weathered or moulded items stated are extreme sizes.

**4004. CONCRETE APRON**

Concrete aprons where directed, shall comprise a 50 mm thick concrete (1:3:6), 1.0-metre-wide round the perimeter of the building, laid on a 100 mm bed of hard-core.

**4005. ENTRANCE STEPS**

Entrance steps as required to suit ground and floor levels shall be formed in concrete (1:3:6), with suitable underneath foundations as directed by the Engineer. Treads shall be not less than 300 mm wide and risers not more than 175 mm high. All exposed surfaces shall be finished in cement and sand (1:4) trowelled smooth with a wood float 18 mm thick on treads and 12 mm thick on risers or finished with Carborundum dust.

**4006. CONCRETE SHELVES**

All suspended precast or in situ concrete shelves, pot slabs, etc, shall be reinforced with weld mesh to BS 4483; 2005 as directed by the Engineer and/or shown on the Drawings and in the Bills of Quantities.

**4007. PAVING**

Precast concrete paving slabs shall conform to relevant BS Standards where required, these shall be size 609.6 mm x 609.6 mm x 50.8 mm thick of vibrated 1:2:4 concrete finished on top with a wood float, clean cut edges and free from all cracks, chips or broken corners. The slabs shall be laid on a 75 mm consolidated bed of sand or stone dust, in cement mortar 1:4. The jointing mortar shall be worked well down into the joints, the pointing to the key-drawn and all excess mortar cleaned off.

#### **4008. ATTENDANCE UPON SUB-CONTRACTORS**

Particular care shall be exercised by the Contractor to ensure that all pipes, ducts, drains, conduits, junction boxes, anti-static installation, etc. are laid before the concrete for the floor and roof slabs is poured. The Contractor will be held responsible for the cost of any additional cutting, etc. and making good which becomes necessary through his failure to make proper arrangements for all Sub-Contractors work to be undertaken in close cooperation with his own, or under his strict attendance.

#### **4009. WALLING**

All block walls throughout the work shall be carried up evenly with no part allowed to be carried up more than 1.0 m higher at one time than any other part, and in such cases, the jointing shall be made in long steps so as to prevent cracks arising, and all walls shall be levelled round at each stage. All faces of walls to be plastered shall have all projections dressed off and joints raked out as key for plaster.

The blocks shall be bedded and jointed in cement mortar 1:5 with beds and joints not more than 20 mm or less than 12 mm thick, all flushed up and grouted solid as the work proceeds. All walling shall be properly protected as the mortar is setting.

Ends of lintels, sills, joints, roof trusses etc., are to be pinned up to the underside of concrete beams and slabs with cement mortar.

Timber frames are to be built in with holdfasts and bedded solid and pointed both sides in cement mortar. Lugs of window, door and louver frames are to be built in or cut and pinned to block work. Frames are to be bedded solid in mortar and pointed in approved mastic applied externally.

#### **4010. SILLS**

Sills to windows shall comply with BS EN 459: 1; 2001. They shall measure 105 mm deep, showing 70 mm at the front edge, by 175 mm wide and be of appropriate length as indicated on the Drawings. All sills shall be cast with a recessed throating under the front edge and shall bear 150 mm on supports.

#### **4011. LINTELS**

Lintels to windows, louver and door openings where these are separate from the reinforced concrete ring beam shall be of precast concrete complying in all respects with BS 1239: 2; 2003. They shall bear 300 mm on supports and shall be cast with a recessed throating under the front edge. Design calculations for lintels shall be submitted to the Engineer for approval before casting is commenced.

#### **4012. SAND**

All sand for making mortar shall be cleaned well, graded siliceous sand of good, sharp, hard quality equal to samples which shall be deposited with the Engineer for prior approval before use for the Works.

The sand shall be free from lumps of stone, earth, loam, dust, salt, organic matter and any other deleterious substance, and shall be sieved through a fine sieve and washed as necessary or when directed by the Engineer.

#### **4013. LIME**

Lime for mortar shall be non-hydraulic or semi-hydraulic quicklime or hydrated lime in accordance with SSRN 801.

Quick lime shall be run to putty in a pit dug on the Site or in an approved container immediately after delivery to Site. The water to be first run into the pit or container and the lime shall be added until it is

completely submerged and stirred until all lumps are disintegrated. The resulting milk-lime shall then be run through a 3 mm square-mesh sieve and run into a pit or other container and kept clean and moist for not less than 4 weeks before use.

Hydrated lime shall be added to water in a clean receptacle thoroughly mixed to the consistency of thick cream. The lime shall then be allowed to stand and kept clean and moist for not less than 16 hours before use.

#### **4014. CEMENT MORTAR**

Cement mortar shall be to ratio 1:5. This will be achieved by addition of 50.0 kg of Portland cement to 0.15 cu. metre of sand. The mortar shall be measured in specially prepared gauge boxes and thoroughly mixed in an approved mechanical mixer or mixed dry on clean and approved mixing platforms, with water added afterwards until all parts are completely incorporated and brought to a proper consistency. The use of re-tempering of wholly or partially set mortar will not be allowed.

#### **4015. PROTECTION**

All walling shall be properly protected while mortar is setting, as the Engineer shall direct.

#### **4016. SETTING OUT RODS**

The Contractor shall provide setting out rods and set out all Works on same courses, openings, heights, etc. and shall build the walls, piers, etc. to widths, depths and heights indicated on the Drawings. Setting out rods shall be gauged to allow an average height of 225 mm for each course.

#### **4017. BONDING**

The blocks or stone for general walling shall be bedded and jointed as described. Stones or blocks shall be properly bonded together and, in such manner, that no vertical joint in any one course shall be within 125 mm approximately of a similar joint in the courses immediately above or below. All walling of 300 mm thickness or less shall be built in single thickness of blocks or stone.

Walling exceeding 300 mm in thickness shall be built in two thicknesses of blocks or stone with through blocks or stone not more than 1.0 m (approximately) apart in each course or as directed by the Engineer.

Alternate courses of walling at all angles and inter-sections shall be carried through the full thickness of the adjoining wall.

All walling shall be built entirely solid in blocks, without voids.

All perpend, reveals and angles of the walling shall be built strictly true and square.

Stone blocks shall be wetted before being laid and the walling shall be kept wet while the mortar is setting and the top of the walling where left off shall be well wetted before recommencing building as the Engineer shall direct.

All walling shall be flushed up and grounded solid as the work proceeds.

#### **4018. DAMP PROOF COURSE**

The bituminous felt sheeting for damp proof courses shall be three-ply approved membrane in accordance with BS 8215; 1991 weighing not less than 3.175 kg per 8361 sq.m the sheeting is to be lapped 152.4 mm at running joints and the full width of walls and angles. It shall protrude beyond the outer face of the wall for a minimum of 25 mm, the last 10 mm of which shall be turned down at an approved profile to form an anti-rat lip and laid on a cement screed trowelled smooth. At all angles, intersections etc., the sheeting must



be lapped not less than 75 mm. The net area covered is measured and the Contractor shall allow in his prices for all cutting and waste and extra material in laps at joints, angles, etc.

#### **4019. REINFORCED WALLING**

Walls of less than 225 mm thickness shall be reinforced with one row of 20-gauge hoop iron built into every third course, well lapped at junctions and joints and carried at least 115.0 mm into abutting walls at intersections.

#### **4020. FIXING OF TIMBER DOOR FRAMES**

All door frames are to be bedded and pointed in mortar (as described for walling).

All frames shall be securely fixed to reveals by means of 22.5 mm mild steel cramps 300 mm long, bent and screwed to backs of frames and with flanged and built 225 mm into joints of walling, three cramps to each side frame of each door. Where the door is provided with fanlights, etc. four cramps are to be used to each side frame.

#### **4021. HOLES FOR TIMBERS IN WALLING**

Holes for timber-built into or passing through a wall, shall be square out to suit the timber size and angle and lined with 3 ply roofing felt cut flush to finished wall surfaces.

#### **4022. CONCRETE BLOCKS**

Concrete blocks shall be solid, hard, true to size and shape with sharp arises in accordance with BS 6073:2; 2008 and approved by the Engineer.

They shall be obtained from an approved manufacturer or manufactured on Site in an approved block-making machine. The mix used shall be not less than (1:9) by volume and the maximum size of aggregate shall not exceed 12 mm.

All solid and hollow concrete blocks used in the walling must be capable of withstanding a crushing pressure of not less than 0.280 kg/mm<sup>2</sup> after 28 days.

The blocks on removal from the machine shall be carefully deposited on edge on racks under sheds erected by the Contractor and left for 3 days during which period they shall be kept constantly wet after which they shall be placed on edge in the open on racks and protected by sacking or other approved covering and kept wet for a further 5 days. Thereafter, the blocks shall be left in the same position without wetting for a further 20 days.

No blocks will be allowed to be used in the work until they are 28 days old and until samples have been taken and approved by the Engineer.

They shall be laid dry except for the top surface which shall be wetted immediately before mortar is spread on. After laying, no further water shall be applied.

#### **4023. INTERNAL FACINGS**

Except where plaster finish is required internally, the internal faces of walls shall be finished fair with beds and joints neatly flush pointed as the work proceeds.

#### **4024. WALLS LEFT FOR PLASTER**

All walls to be plastered shall have the joints raked out 12 mm deep as key for plaster.

**4025. JOINTS**

The concrete blocks shall be bedded and jointed in gauged lime mortar as described with beds and joints not more than 12 mm or less than 6 mm thick, all flushed up and grouted solid as the work proceeds or pointed as required.

**4026. STONE WALLING**

The stone for wall shall be sound and hard throughout, free from all defects, and shall be obtained from a quarry approved by the Engineer. It shall be chisel dressed into true rectangular blocks, with each surface even and at right- angles to all adjoining surfaces.

**4027. STONE SIZES**

Stone blocks for general walling shall nominally be 225mm high and 100 mm, 150 mm, 225mm or 300 mm thick as required for the works, the maximum permissible variation of any of the foregoing dimensions being 2.0 mm.

**4028. JOINTS**

The stone blocks shall be bedded and jointed in cement mortar as described with beds and joints not more than 12 mm or less than 6 mm thick, all flushed up and grouted solid as the work proceeds or pointed as required.

**4029. FIBRE CEMENT ROOF SHEETING**

Fibre Cement roof sheeting and accessories shall be of approved manufacture in general accordance with BS EN 494; 2004, except that asbestos fibre shall not be used. The type of sheeting shall be as shown in the Drawings and of an approved colour and shall be laid and fixed strictly in accordance with the manufacturer's printed instructions. The fibre type shall be approved by the Engineer prior to the supply of such fibre cement roof sheeting.

**4030. LAPS**

Sheeting shall be laid with end laps of 150 mm and side laps of one corrugation of the side away from the prevailing wind.

**4031. FIXING TO PURLINS**

The sheets shall be fixed to timber purlins with 8 mm Galvanized gimlet pointed screws 115 mm long and to steel angle purlins with 8 mm diameter Galvanized hook bolts and nuts 50 mm longer in the shank than the depth of the steel purlin to which they are fixed and all screw and bolt fixings shall have "selawasher" plastic washers or other equal and approved.

**4032. HOLES**

Holes shall be drilled through the ridges of corrugations not in the hollows.

**4033. INTERSECTIONS**

Where four sheets meet, two sheets shall be cut and measured for the full length of the end lap and the full width of the side lap at the appropriate corners to ensure three thicknesses of sheeting at this point.

**4034. RIDGES**

Ridges and other accessories shall be supplied as shown in the Drawings and shall be fixed to timber and steel purlins as above described.

**4035. FIXING BOLTS**

All fixing bolts and screws shall comply with SSRN 808.

**4036. QUALITY TIMBER**

Softwood shall generally be Podocarpus or Cedar complying with BS 1186: Part 1 or other equal approved timber.

All softwood for carpentry shall be treated by the "Celcure" process or other equal approved process carried out by an approved firm. Joints in timber for carpentry shall only be in the positions shown on the Drawings or approved by the Engineer.

Softwood for joinery shall be kiln dried to moisture content between 10% and 12%. Hardwoods may, if approved by the Engineer, be used for joinery in place of softwoods but any additional costs arising shall be borne by the Contractor.

The qualities of timber are stated hereunder:

All timber described as "sawn podo" shall be Grade II (Select Grade) sawn podocarpus. All timber described as "wrot podo" shall be Grade I (Prime Grade) wrot podocarpus.

All timber described as "wrot cedar" shall be first (Prime Grade) wrot cedar.

All Musharagi, Mvuli, Mahogany and any other hardwood shall be selected quality kiln seasoned or air dried and when delivered to Site, shall have a moisture content of not more than 14% of its dry weight.

All timber for permanent work in the building shall before use, be approved by the Engineer for quality in accordance with the foregoing Specification for its respective grade.

**4037. CARPENTRY**

All carpentry work shall be left with sawn surface except where particularly specified to be wrote. Scantlings and boarding shall be accurately sawn and shall be accurately set out and in strict accordance with the Drawings and shall be framed together and securely fixed in the best possible manner with properly made joints. Provide all beads, nails, screws, etc. as necessary and as directed and approved.

**4038. NAILS AND SCREWS**

Nails for joinery are to be oval lost head nails.

Screws are to be countersunk wood screws. Steel screws shall be used only in concealed positions, or where the work is to be painted. Steel screws in contact with aluminium shall be dipped in zinc chromate solution before fixing. Ironmongery is to be fixed with chromium plated brass screws.

**4039. TOLERANCE OF SCANTLINGS**

Variations from specified dimensions of scantlings shall not exceed the tolerance stated in the Grading Rules. Boards 25.4 mm thicker or less shall hold up to the specified sizes. All timber shall be as long as possible and practicable to eliminate joints.

**4040. TREATMENT OF TIMBER**

All structural timber used in the works shall be treated with an approved preservative. Such timbers shall be impregnated under pressure before fixing with Tanalith, Celcure or other approved medium, toxic to

termites, cryptoterms and other timber pests. All cut ends of timber so impregnated are to be treated with two coats of "B" crystals or other approved method.

**4041. SIZES AND THICKNESSES**

Sizes and thicknesses of wrot carpentry and joinery are nominal that is to say 3 mm reduction off specified sizes will be allowed for each wrot face, except where described as finished sizes in which case no reduction from the stated thickness or size will be permitted.

**4042. FASCIA AND BARGE BOARDS**

Fascia and barge boards shall be in wrot cedar or as specified and to detailed Drawing.

**4043. GANG BOARDING**

Gang boarding 25.4 mm thick, butt jointed and securely nailed to ceiling joints shall be provided to form access floor 457 mm wide between ceiling opening and water storage cisterns unless otherwise specified.

**4044. WALLPLATES**

The wall plates shall be bedded on walls in cement mortar and secured with 12 mm diameter bolts 304.8 mm long at 914.4 mm centres built 228.6 mm deep into walling. Plates to be in long lengths, halved and spiked at joints and angles.

**4045. JOINTS WITH SPLIT RING CONNECTORS**

Where timbers of trussed rafters are connected at joints with split ring connectors, they shall be grooved as required to take split ring connectors and bored for and bolted together with 12 mm diameter mild steel bolts all in accordance with structural engineer's drawings.

**4046. VALLEY RAFTERS**

Valley rafters shall be fixed double and bolted or spiked together as directed or shown on Drawings.

**4047. ENDS OF TIMBERS**

Ends of timbers such as purlins, etc. required to be built into or through inner and outer walls shall have 12 mm air space between same and walling.

**4048. JOINERY**

All joinery shall be executed with workmanship of the best quality and in strict accordance with the detailed Drawings. All mouldings shall be accurately run and all work planned, sandpapered and finished to the approval of the Engineer. All finishes shall be slightly rounded. All framed work shall be cut out, properly tendoned, shouldered, etc. and framed together as soon after commencement of the works as is practicable but should not be wedged up until required for fixing in positioning. Any portions that warp, get in winding, develop shakes or other defects shall be replaced with new ones. Whenever required for fixing in position, the framing shall be glued together with best quality glue and properly wedged or pinned, etc. as described.

All timber is to be sound, straight, of matured growth, square edge and free from whitewood, shakes, large loose or dead knots, cracks, wavey edges or other defects and blemishes except to the extent to which the Engineer considers that the timber is not rendered unsuitable for its intended use.

Oval or round brads or nails shall be used for fixing all face work and in each case, all heads shall be properly punched in and puttied.

The quality of all workmanship shall conform to BS 1186.

**4049. PLUGS**

All fixing for joinery, etc. shall be approved and plugging fixed into holes of a recommended size. The holes shall be drilled with special masonry drills and not cut with a cold chisel and hammer. Under no circumstances shall wooden plugs be permitted. The expression "plugged" shall be taken to mean fixed with and including plugs as last described to stone or concrete.

**4050. PROTECTION**

Any fixed joinery which in the opinion of the Engineer is liable to become bruised or damaged in any way, shall be properly cased and protected by the Contractor until the completion of the works.

**4051. SETTING OUT**

All joinery work shall be accurately set out on boards to full size for information and guidance of artisans before commencing the respective works with all joints, ironwork and other connections therewith fully delineated. All setting out details shall be submitted to the Engineer and approved before such respective works are commenced. All joinery work shall be wrought unless otherwise described.

**4052. INSULATION BOARD**

Insulation Board shall be 12.5 mm thick, of an approved type of fibreboard in accordance with BS EN 622 & 316. Insulation board ceilings shall be fixed to a symmetrical pattern in each room.\

**4053. SOFT BOARD**

This board is similar to insulation board but having high moisture absorbing properties.

**4054. BLOCK BOARD**

Block board shall be of approved local or imported manufacture, to BS ISO 12466: 2; 2007 and shall be made up of softwood or hardwood faced as hereinafter specified. A sample of the proposed blockboard shall be deposited with the Engineer for approval and which when so approved, shall form the standard for the works.

**4055. PLYWOOD**

Plywood shall be approved local or imported manufacture, in accordance with BS EN 635; 1995 and of approved first or second grade softwood faced, unless otherwise described. "Exterior Quality" plywood shall be exterior moisture resistant type.

**4056. HARDBOARD**

Hardboard shall be suitable for painting and in accordance with BS EN 622 and shall be used, prepared and fixed strictly in accordance with the manufacturer's printed instructions.

**4057. CHIPBOARD**

Chipboard shall be approved imported or local softwood and shall be used and fixed strictly in accordance with the manufacturer's printed instructions.

**4058. PLASTIC SHEETS**

Laminated plastic sheeting shall be of a type approved by the Engineer, in accordance with BS EN 435;2005 and of the type and grade specified. The sheeting shall be prepared, fixed and used strictly in accordance with the manufacturer's printed instructions.

**4059. WOOD WOOL SLABS**

Wood wool slabs shall be of approved Normal Quality to BS EN 13168; 2008. The slabs shall be and fixed in accordance with the manufacturer's printed instructions.

**4060. DEFECTS**

Should any of the Carpentry or Joinery shrink, warp, wind or develop any other defects within six months after the completion of the works or within the maintenance period, the same shall be removed and new fixed in its place together with all other work which may be affected thereby all at the Contractor's cost and expense.

**4061. CEILING JOINTS**

Where ceilings are shown on the Drawings, ceiling joints shall be fixed at 600 mm centres and round walls and the underside shall be perfectly level.

**4062. BRANDERING**

The brandering shall be 50 x 50 mm fixed to and level with the underside of ceiling joints, at 600 mm centres maximum in both directions. The Contractor shall include for cutting and fitting at trusses.

**4063. PRIMING**

Where intended to be in contact with stone, concrete blocks, concrete, cement or plaster, the backs and other surfaces of all door, window or other frames and linings, posts, architraves, skirting, fillets and fascias and cornices, etc. shall be treated with one coat of aluminium priming paint applied before fixing.

**4064. CEILINGS**

Where shown on the Drawings, ceilings to all rooms shall be formed of approved insulation board not less than 12.5 mm thick.

Ceilings shall be fixed to brandering in symmetrical pattern with edges chamfered to form 'V' joints, all to the approval of the Engineer.

**4065. FLUSH DOORS**

The materials used in the Construction of all flush doors shall be in accordance with BS 4787:1 1991. Flush doors shall be obtained from an approved manufacturer. The size of members and method of Construction shall be to the approval of the Engineer.

Flush doors shall be 45 mm (finished) thick to the sizes specified on the Drawings. Internal doors shall be faced both sides with 4 mm plywood and lipped on all edges with 10 mm (minimum) hardwood. External doors shall be faced both sides with 4 mm exterior quality plywood assembled with a waterproof adhesive to BS 1203; 2001. They shall be lipped on all edges with 10 mm (minimum) hardwood. All doors shall have suitable blocking pieces to take door furniture.

**4066. FRAMED, LEDGED AND BRACED DOORS**

Framed, ledged and braced doors shall be 50 mm (Nominal) thick 838.2 x 1032 mm overall or to sizes specified on the Drawings and shall consist of 101.6 x 50.8 mm stiles and top rail, 228.6 x 25.4 mm lock and bottom rails and 101.6 x 25.4 mm diagonal braces filled in with 25.4 mm tongued, grooved and "V" jointed both sides boarding in matched widths and shall include chamfer on edge of stiles and adjacent boarding to form "V" joint.

**4067. LEDGED AND BRACED DOORS**

Ledged and braced doors shall be 50 mm (Nominal) thick (838.2 x 1032 mm overall) or to sizes stated on the Drawings and shall consist of 101.6 x 25.4 mm top rail and diagonal braces.

228.6 x 25.4 mm lock and bottom rails and covered on one face with 25.4 mm thick tongued grooved and "V" jointed both sides boarding in matched widths.

**4068. WARDROBE DOORS**

Wardrobe doors shall be 25.4 mm thick flush doors constructed of approved blockboard and hardwood lipped on all edges.

**4069. DOOR FRAMES**

Door frames shall be cedar 101.6 x 76.2 mm rebated and moulded frames. Door frames shall be secured to the concrete stone or brickwork with hold fasts built into the stone or brickwork and grouted into the concrete, all in accordance with first class practice.

**4070. WARDROBE DOOR FRAMES**

Wardrobe door frames shall be cedar 76.2 x 50.8 mm rebated frames.

**4071. CUPBOARD DOOR FRAMES**

Cupboard door frames shall be cedar 50.8 x 38.1 mm rebated frames.

**4072. DOOR FURNITURE**

Doors shall be provided complete with all hinges, locks, keys, knobs, handles, bolts, floor stops, etc., and all necessary screws, bolts or other fixings including mortices in concrete for bolt sockets, sinking for boxes etc. Ironmongery and locks shall be to the approval of the Engineer.

**4073. ARCHITRAVES**

The finishings to door frames to all doors shall consist of 76.2 x 19 mm wrought cedar splayed architraves plugged to walling and measured at all angles. Where the door frame is set against the face of the wall or where there is insufficient room for architrave, the finishing shall consist of 19 mm wrought cedar quadrant moulding planted on the frame.

**4074. WOODEN SHELVES**

Slatted shelving shall consist of 50.8 x 25.4 mm wrought podo slats 19 mm apart screwed to bearers.

All board shelving exceeding 225 mm wide shall be cross- tongued.

Blockboard shelving shall be 25.4 mm thick with hardboard or softwood veneer as stated or shown on Drawings and with 12.7 x 25.4 mm softwood or hardwood edge strip on all edges. The shelving shall be screwed to bearers.

**4075. TRAP DOORS**

Where shown or directed in fibreboard ceilings trim ceiling joints and bandering shall be used to form access door in ceiling. Where directed the trap door overall size shall be 1000 x 850 mm. At hanging side of opening 75.0 x 50.0 mm splayed frame shall be provided 75.0 x 50.0 mm stop on top of trimmer planted. The door shall be formed with 50.0 x 25.0 mm frame covered with fibreboard to match ceilings, to hang on

a pair of approved strong 96.2 mm steel butts and finish around opening with 38.1 x 25.4 mm rebated fillet which shall be screwed to trimmers to form stop.

**4076. BAT PROOFING**

The underside of projecting eaves to buildings with ceilings shall be bat proofed by means of 50.0 x 25.4 mm wrought podo framing filled in with stout Galvanized coffee tray-mesh. The framing shall be nailed on one edge to ends of rafters to butt up against fascia board and on other edge 50.0 x 25.4 mm sawn podo bearers plugged to wall.

**4077. IRONMONGERY - QUALITY**

All ironmongery shall be of the description and manufacture described and shall be fitted and fixed in an approved manner. All locks shall be provided with two keys and shall have a sufficient number of differs to ensure that no two external locks of the same contract may be opened with the same key. The Contractor shall include for all cutting, sinking, boring, mortising and fitting and for supplying all necessary and suitable matching screws. The Contractor shall also include for removing door furniture etc. during painting operations and afterwards re-fixing and for labelling all keys with door references and handing to the Engineer on completion.

Master keys shall be provided and properly labelled where directed. Face plates with all locks shall match the door furniture.

All finishes shall be in satin chrome or silver anodised aluminium unless otherwise stated.

**4078. IRONMONGERY - MOVEABLE PARTS**

All locks, springs and other items of ironmongery with moveable parts shall be properly tested, cleaned and adjusted where necessary to ensure proper working order by the time of completion of the works and shall be left in perfect working order by the Contractor.

**4079. IRONMONGERY - SAMPLES**

Samples of all ironmongery specified shall be submitted to the Engineer for approval, and the approved samples shall thereafter be regarded as the standard for the work. Ironmongery which in the opinion of the Engineer does not conform to this standard shall be removed from the Site.

Alternatively, ironmongery of an equal standard will be acceptable providing samples are submitted and approved by the Engineer before orders for such ironmongery are placed.

**4080. W.C. FITTINGS AT OFFICES**

The following shall be provided and fixed with matching screws in the positions shown:

- (i) One chromium plated toilet rolls holder of approved pattern screwed to door or plugged to wall.
- (ii) One C.P. hat and coat hook plugged to wall.
- (iii) One C.P. towel rail 600 mm long with brackets plugged to wall.

**4081. DOOR STOPS**

40.0 mm diameter rubber door stops shall be provided to all doors and securely plugged and screwed to floors with screws 40.0 mm long.



**4082. STRUCTURAL STEEL AND METALWORK**

Mild steel shall be sound, of approved manufacture and shall comply with the requirements of SSRN 819 and full threads to all screw work. Welds shall be neatly executed, filed smooth and left clean.

Prices for all mild steel shall include for removing all rust and scale and applying one coat of red oxide or other approved priming paint to all surfaces before fixing.

Cast Iron shall be best quality cast clean and sharp and free from all cracks, vents, holes and other defects.

**4083. SPLIT RING CONNECTORS**

Split ring timber connectors shall be of approved manufacture, in accordance with BS EN 912; 2000, or may be manufactured locally from Galvanized mild steel water tubing, to the approval of the Engineer.

**4084. METAL WINDOWS**

These shall be as shown on the Drawings.

**4085. PLASTERWORK AND OTHER FLOOR, WALL AND CEILING FINISHINGS**

The cement and sand pavings and finishings shall include for finishing of the surface to a perfectly smooth and hard standard with a steel trowel to deal level or true falls if so described. This shall apply for all temporary rules, formwork to stop pavings at openings or edges as required, for preparing concrete beds to receive paving by thoroughly brushing clean the surface with a steel wire-brush, and well wetting and painting the same with cement and sand (1:1) grout immediately before paving is laid, for any additional thickness of paving beyond the thickness specified required due to irregularities in the concrete bed to receive such paving, and for keeping paving damp for at least 7 days after laying.

**4086. PAVING GENERALLY**

All pavings shall be laid with joints set out in accordance with a detailed pattern approved by the Engineer.

**4087. PROTECTION OF FLOOR FINISHES**

The Contractor shall protect the floor finish with heavy quality building paper or sheeting or sawdust to the satisfaction of the Engineer as each area is completed.

**4088. PLASTERING**

All surfaces to be plastered or rendered shall be brushed clean and be well wetted before the plaster is applied. All plaster and rendering shall be kept continuously damp for seven days after application.

All concrete surfaces which are to be plastered are to be hacked or otherwise suitably roughened to provide a key. All surfaces to receive plaster are to have the suction correctly adjusted by the application of clean water.

All arises shall be finished true and slightly rounded except where otherwise stated and shall be run at the same time as the adjoining plaster. No partially or wholly set plaster or rendering will be allowed to be used or re-mixed.

**4089. SAMPLES OF PLASTERWORK**

The Contractor shall prepare samples of the plastering and rendering as directed until the quality, texture and finish required is obtained and approved by the Engineer after which all plastering executed in the work shall conform to the respective approved samples.

**4090. DEFECTS IN PLASTERWORK**

The Contractor shall cut and make good all cracks, blisters and other defects and leave the whole of the work perfect on completion. When making good defects the plaster or rendering shall be cut to a rectangular shape with edges undercut to form dovetailed key, all finished flush with face of surrounding plaster or rendering. 'Gypsum' or other equal and approved plaster shall be used when carrying out defective work.

**4091. GAUGED (CEMENT LIME) PLASTER INTERNALLY**

Gauged plaster internally shall consist of a first (or rendering) coat composed of one-part cement, two parts lime and nine parts sand and a finishing coat composed of one-part cement, three parts lime and six parts sands. The first or rendering coat shall be laid to a uniform surface, finished with a wood float, well cured and allowed to dry out for at least 7 days before applying the finishing coat. The second or finishing coat shall be thoroughly worked and finished hard and smooth with a steel trowel.

Great care shall be taken in applying the finishing coat to obtain uniformity of the surface, smoothness and hardness. The total finished thickness of plaster shall not be less than 12 mm.

**4092. CEMENT PLASTER-INTERNALLY**

Unless otherwise indicated internally applied cement plaster shall be composed of one-part cement to five parts sands applied in two coats. The first coat shall be well scratched to form key and allowed to dry out at least 24 hours before applying the second coat. The second coat shall be finished with a steel trowel.

**4093. CEMENT RENDER-EXTERNALLY**

Unless otherwise indicated, this shall be as described for internal plaster but the second coat shall be finished hard and smooth with a wood float and the total finished thickness of render shall not be less than 12 mm thick.

**4094. PLASTER OVER WALLPLATES**

Where the wall plaster is carried over wallplates, a strip of expanded metal shall be spiked to the wallplate to form a key.

**4095. PLASTER AROUND INSTALLATIONS**

Make good plaster around Plumber's water, soil and waste pipes and around Electrician's conduit fittings and switches.

**4096. DUBBING OUT, ETC.**

The Contractor shall include in his Tender for dubbing out as necessary in cement and sand (1:7) hacking concrete to form key and for all internal angles, arises, other labours and for making good up to windows or door frames.

**4097. GLAZING**

All glass shall be of approved manufacture in accordance with BS 952; 1995 free from flaws, bubbles, specks and other imperfections cut to size to fit the opening for which it is required with not more than 1.6 mm play all round.

The glass for glazing generally shall be clear sheet and flat drawn sheet and shall be Ordinary Quality (O.Q) sheet glass of the required thickness to suit the size of sheet and position.

4.8 mm semi-obscured glass shall be fitted to windows of lavatories, bathrooms and W.C.'s.

**4098. PUTTY**

The putty for glazing shall be tropical putty of approved manufacture suitable for glazing to metal or wood frames as hereinafter specified.

All putty shall be delivered on Site in the original manufacturer's sealed cans or drums and used direct therefrom with the addition only of pure linseed oil if necessary. No mineral or other oils may be used.

The rebates of all windows shall be painted one undercoat before puttying. Before glazing the rebates of all windows shall be adequately back puttied.

The putty shall within 14 days dry and harden without wrinkling of the surface or caking and shall adhere satisfactorily to the surface of the glass and the frame.

**4099. GLAZING WORKMANSHIP**

All glazing to wood frames shall be sprunged while that to metal frames shall be fixed with clips. All glass shall be properly back-putted, and the front putty finished neatly and cleanly in line with back putty.

Glass to the glazed doors shall be fixed with glazing beads, secured with brass cups and screws and bedded in approved proprietary strip cut to fit the exact line of the beads.

The inside and outside of glass shall be cleaned to remove all paint and putty marks. Any broken scratched or cracked panes shall be replaced so as to leave all glazing sound and perfect at completion.

**4100. PAINTING AND DECORATING TO BUILDINGS AND NON-METALLIC STRUCTURES**

The Contractor may arrange for the painting work to be executed complete by an approved Sub-Contractor and he shall state the name of the Sub-Contractor he proposes to employ on the Form provided and included in this Tender Document in the list of approved Sub-Contractors. The Contractor shall not employ any other Sub- Contractor without the express permission of the Engineer in writing.

Before commencing the painting work, the Contractor shall submit to the Engineer for approval, a list of all the brands of paints and finishings including the necessary primers and undercoats to be used and immediately upon being approved orders shall be placed and total requirements obtained for the works.

Once approved, no other brand of material shall be used without the express permission of the Engineer in writing.

**4101. MIXING OF PAINTS**

All materials shall be delivered on Site intact in the original containers and shall be mixed and applied strictly in accordance with the manufacturer's printed instructions. No addition will be allowed to be made locally without the express permission of the Engineer.

**4102. COLOURS OF PAINTS**

The priming, undercoats and finishing coats shall each be of different tints, the printing and undercoats shall be the correct brands and tints to suit the respective finishing coats, in accordance with the manufacturer's instructions. All finishing coats shall be of the colours and types specified by the Engineer.

**4103. PREPARATION PRIOR TO PAINTING**

The Contractor shall include for the preparation of surfaces, rubbing-down between each coat, stopping, knotting and all other work in connection as previously described and as necessary to obtain a first-class finish.

Plaster finished with a steel trowel and fair face concrete surfaces shall be well rubbed- down, filled and made good as necessary and thoroughly cleaned down immediately before decoration is applied.

Plaster finished with a wood float or other rough textured surfaces of a similar nature shall be made good as necessary and thoroughly brushed clean immediately before decoration is applied.

Cast-in-situ concrete with a rough textured surface shall be made good as necessary and thoroughly wire-brushed clean immediately before decoration is applied.

Insulation board or similar surfaces shall be filled and made good as necessary and lightly brushed-down to remove all dirt, dust and loose particles.

**4104. PRIMING PAINT**

All exposed cast iron or asbestos cement soil, waste and vent pipes shall be primed with two coats approved aluminium metal primer before further treatment.

Woodwork to be painted shall be well rubbed down and primed with aluminium wood primer well-brushed into the wood. All knots shall be covered with good shellac knotting before priming and all defects be filled with hard stopping after priming.

Plywood shall be filled over the entire surface, with an approved brush filler.

Woodwork to receive finishes other than paint shall have all stains removed, be well rubbed-down and have all defects levelled up with hard stopping or a colour to match the adjoining surfaces.

**4105. METHOD OF PAINT APPLICATION**

After each coat the work shall be allowed to dry and shall then be well rubbed-down with fine glass paper on blocks or other means as required for the particular work before the next coat is applied. The paintwork shall be finished smooth and free from brush marks.

**4106. IRONMONGERY AND OTHER PROTECTION DURING PAINTING**

All door furniture and other ironmongery shall during painting operations be removed and afterwards refixed as herein before described in the Ironmongery Preamble.

All metallic window and door frames shall be protected by drafting tape or other approved means before adjacent or adjoining surfaces are primed and painted.

**4107. DISTEMPER**

Distemper shall be oil-bonded or casein bonded washable distemper.

Distemper shall be thinned only with petrifying liquid made by the manufacturer of the approved distemper to be used, and in accordance with their printed instructions.

**4108. EXTERNAL PAINTING WORK**

All materials for external use shall be of exterior quality recommended by their manufacturers for external use.

**4109. LIMEWASH**

Limewash shall consist of slaked lime and coarse salt mixed in the following manner. To 25.0 kg of slaked lime add water into which has been dissolved (1 kg approximately) of coarse salt. Add clean water until the required consistency is obtained.

**4110. COVERING UP DURING PAINTING**

The floors, etc shall be swept cleaned and covered up with dust sheets when executing all printing and decorating work.

Paint splashes, spots and stains, shall be removed from floors, woodwork, etc. Any damaged surfaces shall be touched up and the whole of the work left clean and perfect upon completion.

**4111. PAINTWORK TREATMENT FOR BUILDINGS**

1	Fibreboard ceiling	Three coats distemper
2	Plastered Walls	Three coats plastic emulsion internally and two coats exterior water paint externally
3	Metal Work	Prime and paint one undercoat and two finishing coats gloss-paint. Only approved systems to be used.
4	Copper, Galvanized and coated Metal	Treat with approved calcium plumbate solution, prime paint two undercoats and one coat gloss- paint.
5	Galvanized corrugated	Apply two coats of approved roof - Iron Roofing paint.

6	Woodwork	Knot, prime, stop and paint one undercoat and two finishing coats gloss-paint. Only approved systems to be used.
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**4112. PLUMBING**

Pipes and tubes shall be cut by hacksaw or other method which does not reduce the diameter of the pipe or form a bead or feather which might restrict the flow of water.

Bends shall be formed on an approved machine and in no case to an internal radius of less than eight times the outside diameter of the pipe.

Elbows may only be used on pipes of 12 mm and 19 mm diameters and not on hot water systems of any description.

All tubing exposed on faces of walls shall be fixed at least 25.4 mm clear of adjacent surfaces with approved holder bolts built into walls not more than 1.288 metres apart. Polythene tubing must be supported throughout the entire length in horizontal positions as directed.

Pipes fixed in roof spaces or to joinery shall be fixed with approved clips screwed to timber members, not more than 1.30 metres apart. Easy bends in the line of piping shall be made with an approved bending machine, no firebrands will be permitted. Where elbows are allowed, they will be of round pattern.

**4113. PIPE MATERIAL FOR PLUMBING**

All Galvanized mild steel tubing shall be of MEDIUM thickness in accordance with BS EN 10255; 2004.

Fittings for the same shall be Galvanized malleable iron in accordance with BS 1256; 2000. Joints are to be screwed and socketted and put together in approved jointing compound. Long screws and any other untapered threads shall have yarn as well as jointing compound incorporated in the joints.

Polythene tubing for cold water services shall be normal or heavy gauge as required or specified in accordance with BS 7291; 2001. Joints and fittings shall be in accordance with the manufacturer's printed instructions.

All brass work and fittings shall be in accordance with BS 1010;1973 for draw-off taps and stop-valves and BS 1212; 1990 for ball- valves (and plastic-floats in accordance with SSRN 828) and shall be high or low pressure as directed by the Engineer.

The soil, waste and vent pipes and their fittings shall be coated MEDIUM grade cast iron spigot and socket pipes. Pipes, fittings and accessories shall be in accordance with BS 6956; 1992.

**4114. PLUMBING WORKMANSHIP**

Where directed, pipes shall be fixed in chases in walling and secured with approved holder bolts built into wall, not more than 1.30 metres apart.

All surface fixings, unless otherwise specified herein shall be carried out with "Philplug" or "Rawlplugs". The fixing holes shall be drilled with special masonry drills and not cut with a chisel. Under no circumstances will wooden plugs be permitted.

Lavatory basin brackets shall be fixed to solid walls with 6 mm diameter bolts 100 mm long with head nut and washer.

The tubing for the hot and cold-water services, waste and overflow pipes, etc. is hereinafter described as Galvanized mild steel tubing.

#### **4115. STOP COCK PIT**

The stop-valve pit shall be constructed to size 250 x 250 x 600 mm deep internally and shall consist of 100 mm stone sides, 75.0 mm concrete base size 600 x 600 x 50 mm thick precast concrete cover slab of size 450 x 450 mm reinforced with 75 mm mesh, No. 10 gauge "Weldmesh" or other equal and approved fabric reinforcement and two 10 mm diameter mild steel rod lifting handles cast in the cover slab. Allowance shall be made for holes through the sides for pipes.

#### **4116. CONNECTION OF PLUMBING PIPES AND TANKS**

Each connection of tubing to cold water storage tank shall be made by drilling a hole on tank side and using a long screw, union and two backnuts all well screwed-up in red lead. Joints of tubing to flanged and bossed connections of hot water cylinders or boilers shall be made with a boiler screw, union and backnut screwed-up in red lead.

Connections to sanitary fittings shall be made with good flexible metal tubing with the required length. Copper to iron couplings shall be provided at each end, together with red lead joints to union of fitting and tubing.

#### **4117. SANITARY FITTINGS**

Where indicated on the Drawings or in the particular Specification, the supply, assembling and fixing of Sanitary fittings in the positions shown on the drawings shall allow for the provision of jointing material, mortises, plugs, screws, etc.

Sanitary fittings shall be manufactured by a manufacturer approved by the Engineer.

##### **(a) Pedestal Type W.C. Suite (Low Level)**

Pedestal type W.C. suite shall comprise white glazed vitreous china pan to BS EN 33,37,997; 1999, hinged black plastic seat to BS 1254; 1981, complete with rubber buffers white glazed vitreous china 14.0 litres cistern with valveless siphon for normal flushing supported on pair of white porcelain enamelled brackets, 40.0 mm diameter white porcelain enamelled iron flush pipe with "Adaptors" or other equal rubber cone joint to pan and C.P. union connection to cistern.

##### **(b) Pedestal Type W.C. Suite (High Level)**

This shall be as (a) above but with 'P' trap, white glazed vitreous china pans and approved 9.0 litres plastic or other type cistern and all necessary fittings as directed by the Engineer.

##### **(c) W.C. Suites**

The pedestal type pan will be fitted above the floor level in ALL cases.

W.C. pans will NOT be placed in sinking below floor level unless specifically directed in writing by the Engineer.

##### **(d) Lavatory Basins**

The lavatory basin shall be glazed vitreous china lavatory type to BS 1188;1974 with combined waste and overflow complete with one 12.7 mm C.P. pillar valve to BS EN 33,37,997; 1999 fixed in tap hole provided, with fibre washer, C.P. waste, rubber plug and C.P. chain and stay, supported on a pair of porcelain enamelled towel rail brackets.

(e) Stainless Steel Sinks

Stainless steel sink shall be to BS 1244; 1956 complete with draining board, work slab and back ledge overall size as in the Bills of Quantities with combined waste and overflow, complete with 19 mm diameter C.P. pillar valve to BS EN 33,37,997; 1999 marked "cold", fixed in tap hole and provided with fibre washer, rubber plug and C.P. chain stay, fixed on angle iron brackets.

**4118. WASTE FITTINGS**

All waste fittings shall be provided with brass 'S' or 'P' traps to BS EN 274; 2002 with 40.0 mm (minimum) seals. They shall be properly connected to tails of waste fittings with screwed red lead joints and be complete with cleaning eyes. Traps to sinks shall be unpolished while those to lavatory basins shall have a chromium-plated finish.

**4119. BRACKETS AND SUPPORTS FOR SANITARY FITTINGS**

Brackets and supports for lavatory basins and sinks shall be to BS 1255:1953.

**4120. WASTE PIPES**

The sink shall be provided with a 40.0 mm diameter waste pipe the lavatory basin shall be provided with 30.0 mm diameter waste pipe. Waste pipe shall be run to falls through external walls to discharge over trapped gullies and shall be finished with splay cut-ends.

**4121. OVERFLOW TO W.C. CISTERNS**

The internal overflow arrangement shall be achieved by the siphon flushing mechanism, where a lever is included internally to regulate overflow. The cistern shall be 6/7/9 litres complete with a ball valve, siphon and 355 x 230 mm flush pipe.

**4122. SOIL AND VENTILATING PIPES**

Where shown on the Site Plan, the head of each main drain shall be provided with a 110 mm diameter PVC ventilating pipe as described with open-end finishing at least 450 mm above the level of the eaves, and not less than 3.0 metres from any permanent opening into the building, terminated with approved quality Galvanized wire-balloon grating. Where the ventilating pipe passes through the roof, a 24-gauge Galvanized sheet metal flashing of approved size to suit roof shall be provided and dressed tightly against pipe and over and under roof finish and sealed to Engineer's approval.

**4123. TESTING OF PLUMBING WORK**

On completion, the whole of the plumbing work shall be tested to the satisfaction of the Engineer and in accordance with his instructions. Any materials or workmanship not to his satisfaction shall be replaced or re-executed at the Contractor's own expense.

**4124. PVC DRAIN PIPES**

PVC drain pipes and fittings shall be spigot and socket pipes of approved manufacture in accordance with BS 4660: 2010.



#### **4125. CONCRETE DRAIN PIPES**

Concrete drain pipes shall be spigot and socket pipes of approved manufacture in accordance with BS 5911: 2002 and shall be totally immersed in water for at least 3 hours immediately preceding laying.

#### **4126. JOINTING FOR PVC AND CONCRETE DRAIN PIPES**

The joints for PVC and concrete drain pipes shall be made by first inserting three turns of cement slurried yarn, caulked well home to the end of the socket so that the consolidated width of the yarn does not exceed one quarter of the depth of the socket. The yarn shall be best quality white-spun long staple yarn, soaked in water for 24- hours before use and inserted in the joint while still wet.

The remaining portions of the socket shall be filled solidly and homogeneously with cement mortar (1:2) and finished with a neat cement fillet on the outside at an angle of 30 degrees. Immediately after jointing a tight-fitting wad or scraper shall be drawn several times through the bore of the pipe to ensure that it is left clean and free from obstruction. The joints shall be protected from injury until they have set hard.

#### **4127. PITCH FIBRE DRAIN PIPES**

Pitch fibre pipes, coupling and fittings shall be of approved manufacture in accordance with BS 2760: 1973 for pitch impregnated fibre drain and sewage pipes. The laying, cutting and jointing of pitch fibre pipes and the jointing to pipes of other materials shall be carried out strictly in accordance with the manufacturer's printed instructions.

#### **4128. CAST IRON DRAIN PIPES**

The cast iron drain pipes shall be coated spigot and socket pipes of approved manufacture in accordance with BS 437: 2008. All joints shall be made with P.C. 3 or other similar and approved jointing compound in accordance with BS 6956: 1992.

#### **4129. CAST IRON FITTINGS**

The cast iron fittings shall comply in all respects with BS 416: 1990 and those of spigot and socket type for drains with BS 437 2008 and will be used as drain connector to first manhole.

#### **4130. CONCRETE BEDS FOR DRAIN PIPES**

All drain pipes shall be laid on a concrete bed or blinding as directed by the Engineer. Beds shall first be laid to correct falls and levels with recesses formed in same for the pipe sockets so that the whole of the soffit of the pipe barrel bears evenly on the bed. When the concrete has set a thin layer of mortar (1:5) shall be spread on the bed to receive the pipe barrel, sufficient to ensure that a surplus is squeezed out when the pipe is laid, and finally adjusted to level. After jointing, the recesses around sockets shall be filled with concrete of the same mix as the bed and the haunching or surrounding completed.

Where pipes are laid under driveways and parking areas, the pipes shall be bedded and surrounded with beds if the cover on the pipe is less than 1.0 m deep.

#### **4131. LAYING OF DRAIN PIPES**

Drain pipes shall be laid in straight lines to even gradients and to the required depths commencing at the lowest end.

Before each pipe is laid, it shall be examined to ensure that the bore is clean, all foreign material removed and any cracked or damaged pipes shall be rejected.

#### **4132. TESTING OF DRAINS AND MANHOLES**

Each length of drain and manhole shall be tested as described hereinafter and approved by the Engineer before any backfilling of the trench takes place.

Testing shall not be carried out until after at least 24 hours following completion of jointing.

The test shall be as follows: -

- (i) The lower end of the pipe and all junctions shall be securely stoppered and the whole length under test filled with water.
- (ii) When full, a further stopper shall be inserted at the top leaving a pipe attached to the drain plug. This pipe shall be bent through 90 degrees and shall terminate in a header tank 250 mm square. The vertical distance between the centre-line of the drain plug and the top of the header tank, shall be not less than 900 mm.
- (iii) Water shall then be poured into the header tank which shall be kept full for a minimum period of 3 hours to allow absorption to take place. At the expiration of this period the header tank shall be topped-up and the testing of the drain commenced. If, after a further period of 30 minutes the water level in the header tank has not fallen by more than 12 mm, the test shall be considered satisfactory.
- (iv) In the event of a pipe failing to withstand the test, the point of failure shall be completely surrounded, at the Contractor's expense, with concrete (1:3:6-19 mm maximum aggregate) to achieve a minimum cover of 150 mm in all directions. The length affected shall then be re-tested.
- (v) Immediately a length of drain has been approved, the trench shall be backfilled to a depth of at least 300 mm above the top of the pipes.

#### **4133. ELECTRICAL INSTALLATION**

All work in connection with the electrical installations shall be carried out by an approved Sub-Contractor under supervision of a qualified, competent and experienced supervisor. The finished work shall be to the satisfaction of the Engineer and in accordance with requirements of the local electricity supply company.

#### **4134. GALVANIZED SHEET IRON**

Galvanized sheet iron shall be at least Gauge 28 of approved manufacture, free from all defects and shall hold up to the gauge as specified.

Sheets shall be fixed with one and a half-corrugated side laps and minimum 225 mm end laps secured to purlins by galvanised iron bolts and iron and lead washers spaced not more than 300 mm apart horizontally on each purlin.

Ridges, hips and valleys shall be at least 28-gauge galvanised sheet, minimum 450 mm girth with roll tops and fixed with galvanised iron screws and iron and lead washers spaced not more than 300 mm apart, lapped 150 mm at junction of lengths and with edges close dressed into corrugations of sheeting.

Valleys are to be inverted, lapped 150 mm at ends of lengths close welded and securely fixed under edges of roof sheeting. Flashings, gutters etc. Shall be lapped 75 mm minimum at joints and shall be rivetted and soldered at joints where required.

Where applied to walls the side overlaps shall be seam bolted at 300 mm centres maximum with 6 mm diameter seam bolts 19 mm long each with diamond shaped bitumen washer, Galvanized steel washer and Galvanized steel nut.

**4135. POLISHED TERRAZZO**

Polished terrazzo shall be laid by an approved Sub-Contractor and shall consist of a screed or backing coat and a finishing coat of “Snowcrete” and marble chippings (1:2) mixed with “Cemantone No. 1” colouring compound in accordance with the manufacturer’s instructions in the proportions of 10 lbs. compound to 100 lbs. cement. Overall thicknesses are to be as specified.

The finishing coat shall be a minimum of 12 mm thick for pavings trowelled to a smooth and even finish and well rubbed and polished with carborundum.

**4136. TILES**

Glazed and eggshell ceramic wall tiles shall comply with BS EN 14411: 2012 and shall be of the colours described. Samples of tiles shall be submitted to the Engineer’s Representative for approval.

Adhesive for fixing wall tiles shall be approved adhesive.

Tiles shall be wiped clean and fixed dry with the approved adhesive all in accordance with manufacturer’s recommendations with straight joints 1.6mm wide, pointed in white cement.

Ceramic floor tiles shall be fully vitrified clay tiles complying with BS EN 14411: 2012 and having a water absorption not exceeding 0.3%.

For laying of floor tiles the surface of the compacted bedding shall be spread with a 3mm thick cement and sand (1:1) slurry. Floor tiles shall be wiped clean and laid dry, in a square pattern with 3mm wide joints and tapped into the grout. Pointing shall be in an approved proprietary tile grout, tinted to match floor tiles.

## **CHAPTER 5**

### **PIPEWORK**

## **CHAPTER 5 – PIPEWORK**

### **PART I – ALL PIPES, VALVES & FITTINGS DURING DESIGN, MANUFACTURE, WORKS TESTING AND SUPPLY**

#### **501. PREFACE**

This specification applies in particular to water supply pipework. Pipes, valves and fittings shall comply with the relevant Standard Specifications as stated hereinafter.

The pipe materials and installation methods specified are aimed at balancing capital investment cost, the operation and maintenance cost, the social implications and the environmental health implications in the supply and installation of water pipelines.

The specifications have been prepared with the intention of ensuring that adherence to the specifications meet the following criteria:

- Unless specifically prohibited, or constrained by socio-environmental consequences as hereinafter indicated, manufacturers and contractors are free to bid for any of the four-pipe material against all pipeline diameters and the market price at the time of bidding shall be allowed to determine what material is used;
- The specifications should be performance based with guidance given to design requirements, acceptable grade, trenching conditions, etc. for each material likely to be bid;
- There should be one general approach to specifying pipeline materials and this should only be varied for specific design situations such as a major transmission main, unusually high working pressures, etc.;
- Specifications should not unduly prejudice local manufacturers but neither should they ignore international best practice in regards to the standards of design and construction
- Unless specifically indicated or allowed otherwise, e.g. hot dipped zinc (galvanised) steel pipes of diameter less than DN 80, the minimum design working life shall be 40 years and pipe manufacturers shall provide a written guarantee to this effect which shall nevertheless be conditional upon the installation requirements of this specification being complied with.

As far as it has been possible, these specifications balance the rigorous requirements across the board for all pipe materials in conformance to their international standard and best practice. This also takes account of the issue of equivalent pressure rating for thermoplastic pipes to meet both hydraulic and area specific conditions such as temperature, loading, impact fatigue and the like and the issue of durable and long-lasting coating and lining for ferrous pipes. In case of any doubts, respective international standards shall apply, strengthened where indicated by National Standards.

The specifications on pipe materials presented in this section shall therefore have precedence over other clauses that discuss the same issues elsewhere in this Specification Volume. The preferred standard specification is clearly indicated in every case. However, possible alternatives known to be available in certified English translation are acceptable. Whilst every effort has been made to quote the latest available version of the Standard Specifications mentioned herein as at the date of this edition (May 2016), due to

continuous research and development on enhancing asset useful life, these standards are frequently being updated, revised or replaced, and in all cases, the editions current at the time of bidding shall be applicable.

Design, whether it be prior to bidding or for variations or additions during construction shall meet the requirements of the design standards as indicated herein.

The recommendations contained in BS 6700: 2006 with regards to pipework and its installation shall be followed, in so far as they are relevant to the prevailing soil and climatic conditions.

## **502. GENERAL**

In general, the recommendations contained in BS EN 1295: 1997 with regards to pipe design), and BS 8010: 2011 and BS EN 752: 2008, or their equal (with regards to general pipe work and its installation) shall be followed in so far as they are relevant to the prevailing conditions. For design recommendations not covered by BS EN 1295: 1997, reference should be made to BS EN 545: 2006 for ductile iron pipes; BS 2035: 2007 for steel pipes; BS EN 1452: 2010, BS 3505: 2010 and BS EN 1167:2007, for PVCu (uPVC); and BS 5114: 1975 for HDPE (PE100) pipes. Other related standards listed in Chapter 11 of these specifications are also relevant and pipe materials and their installation shall conform to them as well. At all times latest editions and updated standards and procedures for design and installation shall be used and adopted. This will ensure that the employer benefits from superior materials with enhanced useful life. In the same context the Contractor may provide, with the approval of the Engineer, superior materials using other standards not listed here provided they can demonstrate this to be the case through tests, examples and guarantee certifications.

Except where otherwise specifically indicated, all ferrous pipes of DN 80 and above shall be barrier coated.

The Contractor shall be wary of the worst-case scenarios making their pipes unsuitable and these can be caused by such things as unsuitable soils, shallow depths, bedding types and extraordinary traffic loads among other things and the Contractor shall inform the Engineer when they occur. Such incidences shall be remedied by using a higher class of pipe (wall thickness and/or yield stress) and / or bedding as shall be directed.

As a general guidance, the pipes proposed for the Contract shall conform to the following international and national standards unless a superior quality is demonstrated.

### **Standards for Pipes and Pipelines**

#### **Pipeline general**

BS EN 1295: 1997 – Structural Design of Buried Pipelines, saving that where the Specification is silent on any pertinent matter, then the alternative relevant part of the BS Code indicated shall be complied with

BS 8010-1: 2011 British Standard Code of Practice for Pipelines

BS 8010-1: 2011 Pipeline on land: Design, construction and installation

BS 8010-1: 2011 – Ductile Iron

	BS 8010: 1989 - Glass reinforced and thermosetting plastics
	BS 8010-3: 2011 – Pipelines subsea – design, construction and installation
	BS CP 2010: 1970 – Design and Construction of Steel Pipeline Inland
Steel pipes & fittings	<p>Pipes BS 3601: 2002</p> <p>Standard steel grades, BS EN 10224: 2002 (higher grades may be specified or allowed only with the written authorisation of the Engineer.</p> <p>Wall thickness BS EN 10224: 2002 as a minimum, unless otherwise indicated or specifically authorised following a design certified by the manufacturer</p> <p>Flanges BS EN 1092: 2007</p> <p>Coating and Lining for Type III soils (unless detailed field tests have proven Type I and II soils to be exclusively present).</p>
Ductile Iron pipes and Fittings	<p>Pipes and joints BS EN 545: 2006</p> <p>Flanges BS EN 1759: 2003</p> <p>Coating and Lining for Type III soil (unless detailed field tests have proven Type I and II soils to be exclusively present), and BS EN 14628: 2006</p>
PVC pipes	<p>BS 3505: 2010</p> <p>Fittings shall in general be steel or ductile iron. Injection moulded PVCu bends and tees shall be allowed.</p>
HDPE pipes & fittings	<p>BS 864: 1975</p> <p>Fittings shall in general be steel or ductile iron whilst electro-fusion jointed bends and tees shall be allowed providing these are not formed by bending straight pipe below the minimum radius specified.</p>

These and other specific standard specifications are listed in the BS Codes.

### **Design Criteria for All Pipelines**

Ductile iron pipes are classified as semi-rigid pipes whilst steel and thermoplastic pipes are classified as flexible and any design must take the different requirements between the two into account.

Materials data for all pipes is required to enable structural design to proceed. Common to all is the internal diameter, excluding lining (if any) and where applicable including lining as well as the wall thickness being considered. All flexible pipes also require the stiffness,  $[S=E \times I/D^3]$  to be taken into account.

In addition, steel requires knowledge of the maximum allowable working pressure, the maximum allowable surge pressure, the allowable stress and the allowable deflection, whilst PVCu and pipes comprising PE require knowledge of long-term ring bending modulus of elasticity, the allowable deflection, cyclic fatigue and the allowable long term combined stress.

In all cases, hydraulic design shall be based on the actual internal diameter and NOT the Nominal Diameter (DN) as well as the appropriate roughness (k) in mm.

Except where otherwise indicated, pipes have been designed to allow for the conditions listed in the Table below (these shall be changed to suit the actual situation). Where in the opinion of the Engineer, actual site conditions result in loads and stresses greater than allowed for, the Engineer may require the pipe design to be modified to account for such changes in design assumptions. Unless authorised otherwise in writing by the Engineer, these criteria shall also be used for any design undertaken during the construction stage.

Criteria	Units	Value	Specific Design Necessary
Minimum Pipe Cover Thermoplastic Pipes Ferrous Pipes Transmission Mains (all)	mm mm mm	900 600 900	May be increased for road crossings
Minimum Trench Width DN < 125 DN 125 to < 300 DN 300 to < 600 Diameter > 600	mm	600	General minimum trench widths OD + 450 OD + 600 OD + 900 OD + 1200
Soil Type Expected Native Soil Modulus E'	MPa	2.5	Clayey silty sand, loose condition
Trench Type for Pipe Material Thermoplastic Steel cement mortar lined	Class	S1 / S2 S3 / S4 S3 / S4 S3 / S4	With Project Engineer's approval or direction S2 S3



Steel other linings			S4
Ductile Iron			S3
Minimum Surround Compaction	% MPD	90	MPD
Operating Temperature  Secondary and Tertiary  Primary Transmission	°C		27 29 29
Operating Pressures Secondary & Tertiary Distribution Primary Distribution Transmission Mains	Bars	7 7 10,12,16 or 25	So as to suit operating pressure
Traffic Loading Vehicle Axle Load Vehicle Overload Risk Factor Vehicle Impact Factor	kPa %	73 25 1.5	May be increased for field & major road conditions and designs adjusted at the Engineer's discretion.
Partial Vacuum in Pipes Secondary & Tertiary Primary Distribution Transmission Mains		No Yes Yes	No Yes Yes

Specific design (supported by properly documented calculations) and Engineer's written approval will be required for the following situations: -

- Thermoplastic pipes with nominal diameter greater than 250 mm for which, apart from soil and surcharge loads, loads due to partial vacuum and cyclic fatigue shall be taken into account.
- Road crossings for which, apart from soil and surcharge loads, loads due to cyclic fatigue shall be taken into account.

- Transmission mains for which specific conditions may apply. The use of PVCu pipes in Pumping Mains is strictly forbidden.

Thermoplastic pipes less than OD 110 may be affected if the native soil modulus is less than the MPa value indicated above and the Engineer may require the pipe grade to be increased. Trench widths for pipes greater than DN 300 may be varied with the approval of the Engineer to suit actual site conditions and approved working methods provided that the Contractor has proven that the minimum compaction specified is being continually bettered.

For ferrous pipes of diameter less than DN 80 and where a non-barrier, (that is a metallic type coating) such as zinc has been specified or approved as part of the protection system, additional on-site protection as indicated herein for buried screwed joints and joints incorporating bolts must be strictly complied with and no exceptions whatsoever will be allowed.

### **503. CERTIFICATE AND SAMPLES FROM PIPE MANUFACTURERS**

Where specifically required by the Bidding Document, samples shall have been provided by the Contractor at the time of Bidding and these, if accepted, shall be used for the purpose of comparison with all components of a similar nature delivered subsequently.

Any subsequent goods supplied that do not meet the standards of the sample shall be liable to rejection with all consequences to the cost of the Contractor.

The Contractor shall within 42 days of award, supply to the Engineer a signed certificate from the pipe manufacturer(s) stating that the pipes and fittings comply in all respects with the provisions of these Specification and the indicated National or International Standards, and that the material(s) from which they are to be manufactured conform to the required standards for all raw materials, processes, quality control, manufacturing, while for fully manufactured products this includes where appropriate, the handling to shipment. The pipe and fittings manufacturer's key personnel shall have at least three (3) years relevant manufacturing experience especially in regards to plant management, quality control / quality assurance, application of the coating and lining systems offered in the bid, and selection/batching/mixing of raw materials, and in the case of thermoplastic pipes, the manufacturer (or licensor in the case of local manufacture under license) shall certify that the requirements of British Standards have been complied with. The Contractor shall have submitted reasonable documentary evidence with its bid to support statements made in the bid documents in this regard. The manufacturer shall also state that they have the ability to carry out the necessary tests during the manufacturing process and tests on the finished products as required by the respective standards.

If the manufacturer of any pipe, valve or fitting supplied under this Contract has a Quality Assurance (QA) System complying with ISO 9000/9001/9002, he shall submit a notarised copy of a fully independent 3rd Party certification to that effect together with sufficient information from his Quality Assurance Plan (in English) to enable the Engineer and the Employer to understand the levels of performance he has undertaken to honour. Where a manufacturer is not ISO QA certified, then a full copy of his Quality Assurance Plan (in English), shall be submitted.

The Contractor shall furnish the Engineer with a manufacturer's certificate in respect of every consignment of the pipeline materials, confirming that all the items of the consignment comply in all respects with the requirement of the specified standards and of this specification. The original and one copy of such manufacturer's certificate shall be delivered to the Engineer prior to shipment in the case of imported pipes and prior to despatch from the factory in the case of local manufacture.

#### **504. ACCEPTANCE OF PIPES, VALVES AND FITTINGS**

Only pipes, valves and fittings that are manufactured using acceptable materials, tested and delivered by firms which had been proven at the time of tender to be listed under the ISO standards hereinabove provided for, or alternatively, pipes, valves and fittings, which have been certified as acceptable subsequent to Third Party Inspection as herein provided for, shall be accepted as conforming to the Contract. Any other pipes, valves and fittings, shall be liable for rejection at the Contractor's risk, cost and responsibility.

Compliance with the provision of this Clause shall be separate and additional to the Contractor's compliance with the requirements of local customs authorities for pre- or post- shipment inspection of imports into the country. The costs for such inspection shall also be fully borne by the Contractor.

#### **505. MANUFACTURER'S WARRANTY AND MANUALS**

The Manufacturer shall specify the warranty period for the various supply items.

Valves and meters shall be guaranteed against faulty design, materials and workmanship for a period of at least 2 years from the date of acceptance subject to their being used only under normal conditions of flow, pressure and temperature specified in this tender for the type and size of meters and also as recommended by the manufacturer. In the event of failure within the guaranteed period, replacement component parts shall be supplied free of charge, including specialised fitment, or the item shall be replaced free of charge.

The Supplier shall state the manufacturer's warranty for replacement of meters due to poor material or bad workmanship or failure to meet the accuracy levels as specified for the class of meter specified.

The Manufacturer shall at his own expenses replace or adjust all meters and valves rejected which can be shown to fail to comply with the specifications or with technical characteristics claimed by the manufacturer.

The Supplier being the Manufacturer's agent shall be held responsible to initiate the necessary claims with the Manufacturer for any meters and valves found defective by the Employer.

Three complete sets of maintenance manuals, spare parts lists, drawings wall charts etc. (in English) required in carrying out tests are to be provided with the valves and meters.

### **PART II – FERROUS PIPES DURING MANUFACTURE, SUPPLY, INSTALLATION COMMISSIONING & TESTING**

For ferrous pipes, emphasis is laid on corrosion protection and therefore no compromise will be accepted in pipe wall thickness, lining and coating, such that as far as possible the asset life is at least 40 years. Unlike thermoplastic pipes, ferrous pipes can withstand higher external pressure and therefore the bedding class requirements are less stringent provided they do not negatively affect the coating. It is pertinently important therefore for the Contractor to ensure that their ferrous pipe manufacturers are able to supply

pipes and fittings with the specified lining and coating materials in compliance with the required recognised national or international standards. The manufacturer shall also be able to demonstrate that the lining and coating materials and application provided withstand all the necessary tests as detailed in this specification.

In lieu of this emphasis, it is important that all international and latest updated standards are applicable for ferrous pipes so that the asset useful lives are enhanced by providing more robustness and superior lining and coating materials. Standards that provide superior materials shall therefore apply.

**506. JOINING TO STEEL PIPES WITH BARE STEEL ENDS, ABOVE GROUND PIPELINES AND FITTINGS AND PIPELINES IN BACKFILLED TRENCHES BOLTED BY FLEXIBLE COUPLINGS (MOULDING METHOD)**

Where exposed ends of existing sheathed steel pipes have not been factory coated with epoxy as indicated in Clause 509 then the external protection to sheathed pipes and fittings jointed by mechanical couplings shall be completed by moulding the couplings with an enamel composition compatible with the enamel used for the pipe sheathing i.e. a bituminous composition shall be used on pipes and fittings sheathed with bitumen (asphalt) enamel, and a coal tar composition shall be used on pipes and fittings sheathed with coal tar enamel.

The exposed end of the pipe shall be thoroughly cleaned (including removing whitewash from that portion of the sheathing adjacent to the joint) and dried together with that portion of the pipe that will come within the moulding box and the whole shall be painted with the quick drying primer supplied.

The inside of the moulding box and externally around the pouring gate shall be coated with a thick wash of lime of similar material to prevent any possibility of the moulding box sticking and shall be dried thoroughly before use.

The moulding box shall be fitted around the coupling so that the pouring gate is at the top and the flanges and bolts of the coupling sit centrally in the recesses provided for them in the moulding box. The clip or bolts of the box shall be fitted and tightened and all joints sealed, including the joints between the box and pipes, with clay or similar material to prevent the hot composition from running out.

The enamel composition shall be heated in an approved boiler (to be provided by the Contractor complete with an accurate thermometer) to the temperature recommended by the supplier and stirred during melting to prevent overheating and the filler settling to the bottom.

The fluid enamel composition shall be slowly poured (at the temperature recommended by the supplier), taking care to prevent air-locks, until the gate is filled. The gate shall be kept filled by toppling up as necessary to allow for cooling shrinkage.

The moulding box shall be removed as soon as it is cool enough to handle by which time the enamel will have set. The moulding may be cooled with water to make the enamel set more quickly.

Any defective part of the moulding shall be immediately repaired by applying hot enamel composition with a trowel.

It may be necessary to support the moulding box on larger diameter sheathing pipes to avoid the box from sinking into the pipe sheathing which may have become softened by the hot enamel in the box. The moulding box must be re-coated with lime wash before being re-used.

The Contractor shall provide all other materials required for completion of external protection by the moulding method, and if the pipes and fittings are supplied under this contract, then the full costs of meeting these requirements shall be at the cost of the contractor

#### **507. PACKING FOR TRANSPORT – FERROUS PIPES**

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

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

At the time of tendering the Contractor shall also have stated the approximate areas of land required for the off- loading and stacking of the pipes and for the storage of the fittings and of any special protection/storage facilities needed for any particular item(s) of his goods. The following table indicates the maximum stacking height allowable:

Nominal Pipe. Diameter in mm	Maximum number of layers in stack, ferrous pipes
Up to 100	16
150	14
200	12
250	10
300	8
350	7
400- 450	6
500- 600	4
700- 800	3

#### Distribution of Materials from Storage

The Contractor shall make his own arrangement for storage including for temporary occupation of the necessary land, provision of suitable fencing, preparation of site and security.

The selected storage areas shall be suitably close to the final pipeline alignment.

When pipes are being loaded into vehicles care shall be taken to avoid their coming into contact with any sharp corners such as cope irons, loose nail heads, etc. Whilst in transit, pipes shall be well secured over their entire length and not allowed to project unsecured over the tailboard of the lorry. Pipes may not be offloaded from lorries by rolling them. Pipes shall not be rolled or dragged along the ground.

#### **508. FLANGED JOINTS FOR FERROUS PIPES AND FITTINGS**

Where specifically called for or deemed appropriate, flanged joints shall be utilised. They shall conform to SSRN 207, drilled to NP 10 except where otherwise indicated on drawings or bills of quantities, with gaskets made of reinforced elastomer rubber to SSRN 208 and of minimum thickness of 3 mm. They shall be stored in accordance with SSRN 238.

Bolts for flanged joints shall be SSRN 938 threaded to SSRN 923, nuts to SSRN 939 and washers to SSRN 925. Bolts, nuts and washers shall be protected to SSRN 921 for above ground installation and to SSRN 922 for below ground installation and in chambers. Nuts for use with self-sealing joints for steel pipes shall be as described under the section for service connections. Exposed threads of all bolts shall be fitted with a tight plastic cap after flange assembly along the full exposed length.

#### **509. FLEXIBLE JOINTS**

Where specifically called for or deemed appropriate flexible couplings shall be used and shall be coated with fusion bonded epoxy layer 350 microns thick. Flexible couplings shall be of a mechanical type coupling consisting of a centre sleeve, two end ring flanges, two wedge shaped sealing rings of grade T Nitrile rubber, and with galvanised nuts and bolts. The main components shall be made from hot rolled steel for larger diameters and malleable cast iron to SSRN 911 or ductile iron for smaller diameters. If specifically called for, couplings shall be provided with a suitably sized screw plugged hole in the sleeve to allow for the introduction of molten bitumen for additional internal protection. The manufacturer shall then include the necessary removable internal backing-up rings of rubber composition and shall further include for all materials for in-situ jointing and protecting both for remedial works and for internal and external protection at such joints. After jointing, the exposed part of the bolt shall be provided with a tight-fitting polythene protection cap unless capped nuts are used.

#### **510. COMPLETION OF EXTERNAL PROTECTION AT FLEXIBLE JOINTS ON FERROUS PIPELINES**

The completion of the external protection at flexible joints on ferrous pipes and fittings (other than hot dipped zinc steel pipes) shall be carried out as detailed below as appropriate and shall be to the satisfaction of the Engineer's Representative. The costs thereof shall be deemed to be allowed for within the Tender.

- (i) Above ground pipelines and fittings and in backfilled trenches Bolted by Flexible Joints  
In all cases where the pipe joint has involved the use of nuts and bolts, the exposed threads of every bolt shall first be thoroughly cleaned and then coated with an approved zinc-rich paint allowed to dry for not less than 24 hours before proceeding with further protection as indicated below.

(ii) Above ground pipelines and fitting and in backfilled trenches Bolted by Flexible Couplings for Coal Tar or Bitumen coated Pipes and fittings supplied without epoxy coating (Moulding Method)

Where for whatever reason, any such flexible couplings have not been factory epoxy coated then the external protection to such mechanical couplings shall be completed by moulding the couplings with an enamel composition compatible with the enamel used for the pipe sheathing; i.e. a bituminous composition shall be used on pipes and fittings sheathed with bitumen (asphalt) enamel, and a coal tar composition shall be used on pipes and fittings sheathed with coal tar enamel.

The assembled coupling shall be thoroughly cleaned (including removing whitewash from that portion of the sheathing adjacent to the joint) and dried together with that portion of the pipe that will come within the moulding box and the whole shall be painted with the quick drying primer supplied.

The inside of the moulding box and externally around the pouring gate shall be coated with a thick wash of lime of similar material to prevent any possibility of the moulding box sticking and shall be dried thoroughly before use.

The moulding box shall be fitted around the coupling so that the pouring gate is at the top and the flanges and bolts of the coupling sit centrally in the recesses provided for them in the moulding box. The clip or bolts of the box shall be fitted and tightened and all joints sealed, including the joints between the box and pipes, with clay or similar material to prevent the hot composition from running out.

The enamel composition shall be heated in an approved boiler (to be provided by the Contractor complete with an accurate thermometer) to the temperature recommended by the supplier and stirred during melting to prevent overheating and the filler settling to the bottom.

The fluid enamel composition shall be slowly poured (at the temperature recommended by the supplier), taking care to prevent air-locks, until the gate is filled. The gate shall be kept filled by toppling up as necessary to allow for cooling shrinkage.

The moulding box shall be removed as soon as it is cool enough to handle by which time the enamel will have set. The moulding may be cooled with water to make the enamel set more quickly.

Any defective part of the moulding shall be immediately repaired by applying hot enamel composition with a trowel.

It may be necessary to support the moulding box on larger diameter sheathing pipes to avoid the box from sinking into the pipe sheathing which may have become softened by the hot enamel in the box. The moulding box must be re-coated with lime wash before being re-used.

The Contractor shall provide all other materials required for completion of external protection by the moulding method.

(iii) Where pipes and fittings are to be concreted in (Wrapping Method)

The external protection to pipes and fittings jointed by mechanical couplings, flanged joints, "Tyton", type or Bolted Gland joint, or similar shall be completed by wrapping the joint with approved petrolatum tape prior to which the area shall have been cleaned by an approved proprietary paste and the area protected by an approved proprietary mastic. It shall then be wrapped in PVC 'outerwrap' or similar material.

The whole joint shall be thoroughly cleaned removing all loose rust and extraneous matter and the approved paste rubbed well over the whole of the joint and for a few centimetres either side of the joint over the pipe sheathing. A liberal amount of paste shall be left around all bolt heads, narrow cavities, etc.

The approved mastic shall be applied to cover all bolt heads and nuts, forced into the annular gap between the spigot and socket in the case of 'Tyton' type or bolted gland joints, formed as a triangular fillet against the face of socket or flanges and filled in all gaps and abrupt change in contour to provide an even contour for wrapping.

The approved tape shall be applied circumferentially, starting and finishing at the top of the joint care being taken to smooth and eliminate any air pockets and to form the tape well into all angles and changes in contour. The tape should extend on to the pipe sheathing on either side of the joint by at least 50 mm and the tape should be applied with a minimum overlap of 25 mm.

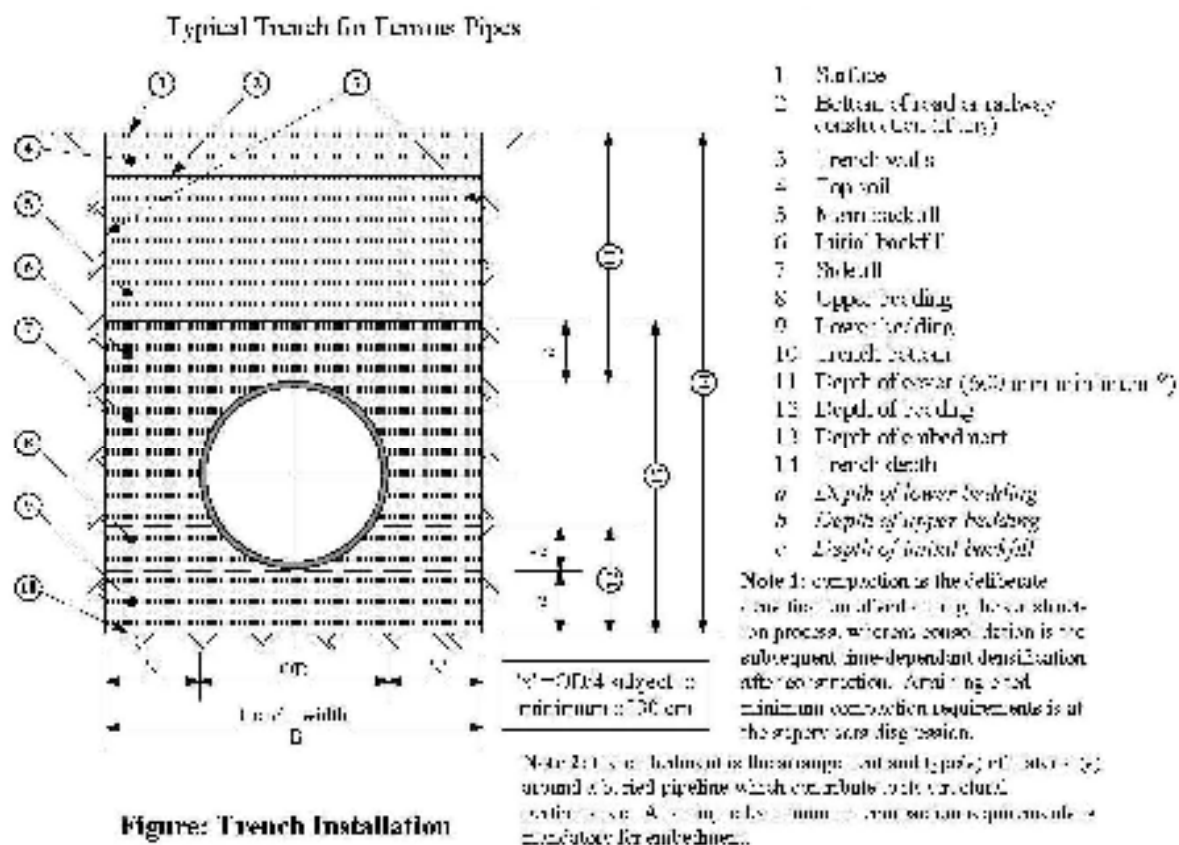
An outer wrapping of 'PVC Outerwrap' shall be finally applied over the approved tape'. This wrapping should extend at least 500 mm on to the pipe sheathing and should be applied with a minimum lap of 50 mm.

All the above-mentioned materials shall be provided by the Contractor and deemed covered in his rates.

#### **511. BACKFILLING OF PIPE TRENCHES- FERROUS PIPES**

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





\* Minimum cover 600mm, except for Transmission mains, where minimum cover shall be 900mm.

### Minimum Trench Width

Pipe Size DN	Trench Width
General	Minimum 600mm
<125 mm	D + 450
150–300	D + 600
>300	To suit site condition and to the approval of the Engineer

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

In areas prone to waterlogging or where specifically called for on the Drawings or in the Bills of Materials class S1 or S2 material shall be used for lower bedding in accordance with the following gradings:

### *Embedment for Flexible and Semi Rigid Pipes Ferrous*

Embedment Class	Embedment Material Allowed	Notes
S1 and S2	Class S1: Gravel—single size Class S2: Gravel—graded	Normally processed granular materials where specified as bedding for ferrous pipes

S3–S4	<p>Class S3: Sand and coarse-grained soil with less than 12% fines;</p> <p>Class S4: Coarse grained soil with more than 12% fines OR</p> <p>Fine grained soil, liquid limit less than 50%, medium to</p>	<p>These represent “as dug” soils but require particularly close control when used with low stiffness pipes. Class S3 shall be used for epoxy lined steel pipes whilst class S4 is suitable for cement mortar lined ferrous pipes</p>
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*S1 and S2 Material for Lower Bedding of Ferrous pipes where specified*

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

- (i) The placing and compaction of pipe embedment shall only be undertaken in the presence of an Engineer's representative unless written authority from the Engineer has been granted.
- (ii) No pipes shall be laid nor lower bedding introduced and no excavation filled in or covered with concrete until the formation has been inspected and the permission to proceed with the Work obtained.
- (iii) In every instance, embedment material (consisting of bedding, side fill and initial backfill) filled around the pipe and for 300 mm over the top of the pipes shall be free from stones, tree roots or similar objects which through impact or by concentrating imposed loads might damage the pipes and shall not include black cotton type soil. The filling shall be carried out with utmost care, special attention being paid to tamping of material around the pipes and to joint holes so as to obtain the greatest possible compactness and solidity. The material shall if necessary, be screened to exclude material which would damage the pipes. The material shall be in accordance with the relevant pipe bedding drawing but no worse than a class S3 material for epoxy lined steel pipes (sand and coarse-grained soil with not more than 12% fines) or an S4 material for cement-mortar

lined ferrous pipes and the source and material shall be approved by the Engineer's Representative before excavation commences. Any delays as a result of not seeking this approval in good time shall be entirely to the Contractor's account.

- (iv) Where the 'as-dug' trench material contains material, which meets the bedding class requirements as specified and providing that this is carefully screened to the sizes indicated above, and segregated from material that does not, the Contractor may, at his discretion, use it as such or incorporate such material into the imported embedment material being used.
- (v) The lower bedding for the pipes shall have a minimum thickness of 75 mm in normal trenches, and 125 mm where rock/stones are present and at designated road crossings. In trenches where there is a continuous accumulation of groundwater, the trench shall after obtain the approval of the Engineer's Representative, be over-excavated by 150 mm and shall be backfilled using compacted granular material. Bedding material shall be compacted in layers not exceeding 50 mm thickness. Compaction of fill around the pipe shall be in layer thickness not exceeding half the pipe diameter or 75 mm whichever is the lesser. Layer thickness is however subject to consistently achieving 90% MPD (Modified Proctor Density) or better, failing which layers shall be reduced in depth as necessary to achieve the % compaction.
- (vi) The upper bedding shall be introduced as carefully and thoroughly as practicable to the underside or haunch of the pipe such that no large spaces remain before it is compacted.
- (vii) The sidefill and backfill material within the embedment shall be placed in layers of not more than 150 mm thickness when compacted and where hand ramming is employed the number of men filling shall not be more than half the number of men ramming. Sidefill shall be placed simultaneously on both sides of the pipe. Where mechanical-ramming of the remaining backfill is employed, the machines shall be to the approval of the Engineer's Representative and soil shall be replaced and well rammed down by hand for a depth of not less than 500 mm to give sufficient cover to the pipes and obviate risk of damage to them before the mechanical rammer is brought into operation. The rammer shall not cease to be used on any length of trench until thorough compaction has been obtained. All backfill soil shall be free from clay lumps, boulders stones and rock fragments greater than 20 mm and 90% MPD shall be attained in all instances. All backfill soil above the embedment shall be free from clay lumps, boulders and rock fragments greater than 50 mm and as far as practicable 90% MPD shall be attained, but this may be relaxed (e.g. in fields and open areas) by the Engineer's Representative.
- (viii) The Contractor in excavating shall ensure that materials from strata containing no stones and suitable for filling around the pipes as described above, shall be kept separately and used for this purpose. The Contractor shall not be entitled to claim for any extra costs (as provided for below) for screening if this requirement is not complied with. If no such strata occur in the

excavation, the excavated material shall either be screened or suitable material transported to the Site from other excavations as the Engineer's Representative shall direct. The cost of such work shall be paid for according to the rates in the Bills of Quantities.

- (ix) Before commencing the placing of embedment in the trenches, the Contractor shall obtain approval from the Engineer's Representative as to the methods he proposes to use and he shall demonstrate by means of tests that the specified compaction can be achieved (according to SSRN 601 using the "sand replacement" method). The method of compaction and the testing thereof shall be at all times to the approval of the Project Engineer's Representative and in general at a frequency of once every 30 metres unless this is specifically relaxed based on continuously good in-situ test results.
- (x) Where pipes are joined by rigid joint (flanges or welded), the pipe trench shall be backfilled entirely without leaving out areas around and at pipe joints uncovered, for subsequent filling. To facilitate the subsequent location of any suspected leaking joints during pipe testing, should this become necessary, the Contractor shall provide marker pegs at regular intervals and/or use a handheld GPS to be able to relocate joint positions.
- (xi) Where for pipes a minimum cover of 600 mm (or 900 mm for transmission lines) cannot be maintained, including highways and trafficked areas then the pipe must either be laid in a protective ferrous sleeve or be protected by a 150 mm thick reinforced concrete slab above the pipe. A minimum of a 150 mm layer of appropriate grade bedding material must first be placed and lightly compacted as a cushion above the crown of the pipe before the slab is laid, and the slab must extend at least 150 mm out beyond either side of the trench.

### **PART III – THERMOPLASTIC PIPES DURING MANUFACTURE, SUPPLY, INSTALLATION, COMMISSIONING & TESTING**

#### **512. MATERIALS AND STANDARDS, UNPLASTICISED PVC PIPES AND JOINTS**

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

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

To ensure that the Employer benefits from superior materials with enhanced useful life, at all times, latest and updated standards and procedures for design and installation shall be used and adopted but governed by cost effectiveness. In the same context the Contractor may provide, with the approval of the Engineer,

superior materials using other standards not listed here provided that they do not affect costs or programme and that they can demonstrate the superiority of the materials through tests and guarantee certifications.

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

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

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

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

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

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

Nom.Diameter (mm)	MinimumPressureRating (bars)	MinimumCover (m)	Pipe Bedding
≤125	10	0.9	S1,(orS2if approvedby the Engineer)
150–275	12.5	0.9	
≥300	Tosuit specificdesign calculations,agreeddesign criteria, usingSSRN 267designcodeofpractice, and with theapproval oftheEngineer		
Transmission Mains and off- takes			
All pumping mains	NotPermitted		

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

a) Manufacture of PVCu Pipes and Fittings

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

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

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

c) Quality Control Records

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

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

PVC material silos shall be equipped with appropriate sized sieves.

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

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

d) Polymer Certification

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

e) Inspection and Testing during Production

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

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

f) Inspection of pipes and pipe fittings

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

- grooving
- blistering
- scoring (scratches)
- cavities

- impurities
- other surface defects which will be deleterious defects

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

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

g) Testing of Pipes and Fittings

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

h) Marking of Pipes and Fittings

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

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

i) Release from manufacturers works

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

j) Determination of pipe and socket wall thickness

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

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

k) Pipe Lengths

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

l) Pressure Classification

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

m) Protection of Fittings used with PVCu Pipes

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

- (i) Protection of extruded PVCu fittings - Protection shall be in conformance with SSRN 301 and their other respective standards.
- (ii) Protection of Steel Fittings: - Steel fittings shall be coated and lined with fusion bonded epoxy to SSRN 241(a) with a thickness of between 305 to 406 microns. In addition, for transport, fittings shall be shrink wrapped in 0.2 mm polythene packing to reduce the risk of transport damage.
- (iii) Protection of DI fittings: - DI fittings shall be coated and lined with fusion bonded epoxy to a thickness as for the steel fittings above and shall similarly be shrink wrapped in 0.2 mm polythene packing for transport.

n) Packing for Shipment – PVCu Pipes

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

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

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

At the time of tendering the Contractor shall also have stated the approximate areas of land required for the off- loading, and stacking of the pipes and for the storage of the



fittings and of any special protection/storage facilities needed for any particular item(s) of his goods

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

(i) Storage Areas

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

(ii) Pipe Stacking and Storage

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

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

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

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

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

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

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

The following table indicates the maximum stacking heights allowable:

Pipe OutsideDiameter(OD)in mm	Maximumnumber oflayersinstack,PVCu pipes
Up to 100	7
150	7
200	5
250	5
300	4

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

- (iii) Vehicle used to transport PVCu pipes shall have flat beds free from projections. Pipes shall be uniformly supported along their entire length and shall not overhang the end of the vehicle. Upright side supports on vehicles shall be flat, at 2m spacing and free of sharp edges. Socket and spigot pipes shall be stacked on vehicles in alternate layers so that the socket carries no load. Thicker wall pipes shall always be loaded before thin wall pipes.
- (iv) Where PVCu pipes are delivered from abroad in containers, such containers shall not be exposed to sunlight on their upper surface during either dockside storage or shipment and all pipes shall be immediately removed and stored as indicated in e (ii) above upon arrival on site. Site storage in the supply containers is not permitted, unless all pipes are first removed and then stored in accordance with e (ii) above. Care shall be exercised in the transporting, handling, off-loading and loading of the pipes. For PVCu pipes, a minimum of two persons per pipe shall assist in the loading and offloading and pipes shall be neither thrown down nor dropped or rolled

p) Distribution of PVCu Pipes from Storage

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

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

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

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

### **513. MATERIALS & STANDARDS, HIGH DENSITY POLYETHYLENE PIPES AND FITTINGS**

HDPE (PE100 and PE100 layer) pipes and fittings shall meet the requirements of SSRN

307 and SSRN 317 All manufacturing materials used shall be in conformance with SSRN 320.

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

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

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

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

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

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

#### *Maximum Allowable Deflection of HDPE (PE100) Thermoplastic Pipes*

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

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

Nom.Diameter (mm)	Pipe thickness and SDR to suit following minimum Pressure Rating (bars)	Minimum Cover (m)	Pipe Bedding
0–125	10	0.9	
150–275	12.5	0.9	
≥300			

Transmission Mains And off- takes	To suit specific design calculations, agreed design criteria, using SSRN 267 design code of practice, and with the approval of the Engineer	S1, S2 if approved by the Engineer
All pumping mains		

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

a) Inspection and Testing during Production

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

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

b) Electro-fusion Fittings

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

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

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

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

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

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

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

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

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

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

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

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

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

c) Product training and Technical Information

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

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

d) Manufacturing, Testing, Handling, Transport and Storage

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

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

- (i) Before transporting HDPE pressure pipes, the loading surface of the vehicle must be cleaned and free from projecting nails, screws or other sharp objects. The bottom layer of all pipes must as far as possible be in contact with the loading surface throughout their entire length and not project beyond it. The pipes must be secured from slipping and shall not be pulled over sharp edges when loading and offloading. Pipes shall not be dragged along the ground.
- (ii) Pipes, fittings and coils of HDPE pipes shall be stored in such a way that they are completely protected from direct sunlight. When covered they must be well ventilated to avoid accumulation of heat and resultant deformation. Transparent coverings shall not be used. The storage location shall be flat and shall, for pipes, support the pipes throughout their length. Stones and sharp objects shall not be present. Pipes shall not be stacked to a height exceeding 1 m. The pipes must be secured at the sides to prevent them from rolling. Contact with harmful

materials shall be avoided. As far as possible, coils shall be stored in a horizontal position. The area shall be free of stones and sharp objects. If stored upright they must be secured to avoid tilting.

- (iii) HDPE Pipes supplied in coils of up to 63 mm diameter may be unrolled with the coil in the vertical position. For larger diameters an unwinding device shall be used. A turnstile can be used with the coil laid in a horizontal position on it or with the coil mounted vertically on a slow-moving lorry. The pipe shall never be removed from a coil in a spiral manner as this may cause kinking. Should kinking nevertheless occur the Contractor shall cut the pipe on either side of the kink, prepare the ends, and then use an approved joint after laying. All costs of dealing with kinking shall be to the Contractor's expense. A minimum bending radius of  $35 \times$  the diameter shall be observed.

f) Distribution of Materials from Storage

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

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

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

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

## **514. PIPE LAYING FOR THERMOPLASTIC PIPES**

### **Individual Pipes not supplied in Coils**

- (a) Pipes shall only be laid in the presence of the Engineer's Representative unless written authority from the Engineer has been granted.
- (b) Pipes generally shall be laid and jointed in accordance with the manufacturer's or his licensor's instructions. Extra excavation must not be carried out so as to avoid backfill, excessive deviation in joints and other irregularities. Otherwise, the pipe grade will follow the Drawings, with a continuous (but not necessarily uniform) fall towards washout-valves and rise towards air-valves.
- (c) Every pipe shall be laid separately and shall bear evenly upon the lower bedding or concrete for its full length, holes to receive sockets, couplings or flanges being cut in the

bottom of the trench of such size and depth as to allow the joints to be properly made. The pipes shall be laid to true inverts, straight lines and falls, each pipe being separately boned between sight rails. The pipes shall be thoroughly brushed inside insofar as is practicable and outside prior to laying, and no foreign matter shall be allowed to enter the pipe during or after laying. At the end of each working day the exposed pipe end shall be stoppered up with a stopper plug of appropriate diameter and not merely covered in polythene sheet tied around the end.

- (d) Trenches shall be bottomed up only immediately in advance of pipe laying, although at least 15 metres shall be prepared in advance of any given pipe. Trenches and joint holes shall be kept free from water, until the pipes are laid and the joints completed and no ground water shall be allowed to enter the new pipes.
- (e) Prior to laying in trench, the lower bedding in the trench must provide support throughout the entire length of the pipe. The pipe shall never be laid directly on cohesive, rocky or stony material. Where the natural trench bottom meets the bedding class required, this shall initially be loosened to a depth of 100 mm and then re-compacted to at least 90% MPD and then the surface loosened on the day of and prior to laying
- (f) In rock excavation, the pipes shall be bedded on concrete or selected granular fill, e.g. gravel, to a minimum thickness of 150 mm and the exclusion of rocks and other hard material to at least 300 mm around the pipe, leaving proper joint holes and subsequently making good with selected materials to the Engineer's Representative's approval.
- (g) All flanged joints shall be made with jointing rings, which shall be carefully inserted concentric to the bore of the pipe, so that undue stresses shall not be caused in any of the bolts or on the flanges when bolting up. The joint ring shall be compressed gradually and evenly by taking a few turns on each diagonal bolt in succession. Manufacturers' recommendations on the maximum tightening torque shall be followed, and over-tightening shall be avoided. Where one or both of the flanges is itself of plastic, torque-wrenches shall always be used, and the bolts shall first be hand tightened and then diagonally tightened progressively to achieve 5%, 20%, 50%, 75% and finally 100% torque. For metal to metal flanges and if the Engineer is dissatisfied with the degree of care being taken, the Contractor shall provide and use torque-wrenches for this purpose at no extra cost.
- (h) Mechanical joints shall be made in accordance with the manufacturer's instructions. After successful testing of pipelines, the joints will receive external protection as specified or to the Engineer's Representative's approval.
- (i) The threads of any screw connections shall be coated with red lead before the joint is made.
- (j) Concrete anchor blocks shall be provided at bends, tees, stopped ends, etc as shown on the drawings or as directed by the Engineer's Representative.
- (k) Where a pipeline crosses under roads or railway lines, the pipe shall be sleeved or surrounded with concrete or protected by reinforced concrete slabs as instructed by the Engineer's Representative, and Tenderers shall have been deemed to have made allowance in their rates for compliance with the requirements of the relevant authority. Where roadside verges are liable to receive traffic, this protection shall be extended under

the areas concerned and Tenderers shall have been deemed to have made allowance in their rates for compliance with this requirement.

- (l) For the insertion of valves and other fittings into existing pipelines, pipes may need to be cut. Approved tools and machines specially made for the purpose, shall be provided and used by the Contractor.
- (m) The Contractor shall provide and fix wooden drumheads to the open ends of the mains, and similar drumheads shall be used to close the ends of any pipes to exclude dirt and stones, etc. when the pipe laying is not actually in progress. Wooden markers properly inscribed, shall be left projecting out of the ground to indicate the ends of all pipes, where these are buried in the ground in open country. In public highways, a danger sign or other suitable means as approved by the Engineer's Representative shall be adopted.
- (n) At every point of loading or unloading, pipes must be handled by approved lifting tackle. (Unloading by rolling them down planks of any form or including ramp will not be allowed except with the special consent of the Engineer's Representative).
- (o) The stacking of pipes shall be used such as to prevent damage during storage. Timber runners shall be laid to keep the upper row separated from the lower and the bottom row shall be staked to prevent any rolling. The whole arrangement shall be subject to the approval of the Engineer's Representative.
- (p) Care should be taken to minimise the risk of bush fires damaging any pipes laid out along the line of the mains.
- (q) Refilling of pipe trenches shall conform to the specifications provided in Clause 530.
- (r) The requirements for making good subsidence after refilling are provided for in Clause 531.
- (s) Reinstatement of surfaces shall conform to the specifications provided for in Clause 532.
- (t) For Thermoplastic Pipes Laid in Trenches:
  - i. The soil cover shall be a minimum of 900 mm. and the embedment material shall be S1 or S2 (single size or graded gravel). For details of the trench specifications and backfill material sizes and grading refer to Clause 530. Tenderers shall allow for the price of such trenching and importation of necessary backfill material and compaction as part of the pipe installation price.
  - ii. For all bedding classes, compaction shall be 90% MPD minimum.
  - iii. Marker tapes made of a pigmented low-density polyethylene and aluminium foil in a bright colour or other approved material not less than 100 mm wide and 0.15 mm thick shall be placed in the ground above the PVCu and HDPE pipelines laid underground as a measure to detect the pipe and at the same time to reduce the risk of accidental damage which may be caused by future excavations. The tape shall be laid about 300 mm above the crown of the pipe. The tape shall be continuously labelled with black printing "DANGER- PLASTIC PIPE. The price tape shall be deemed included in the price for the supply and installation of the pipe.



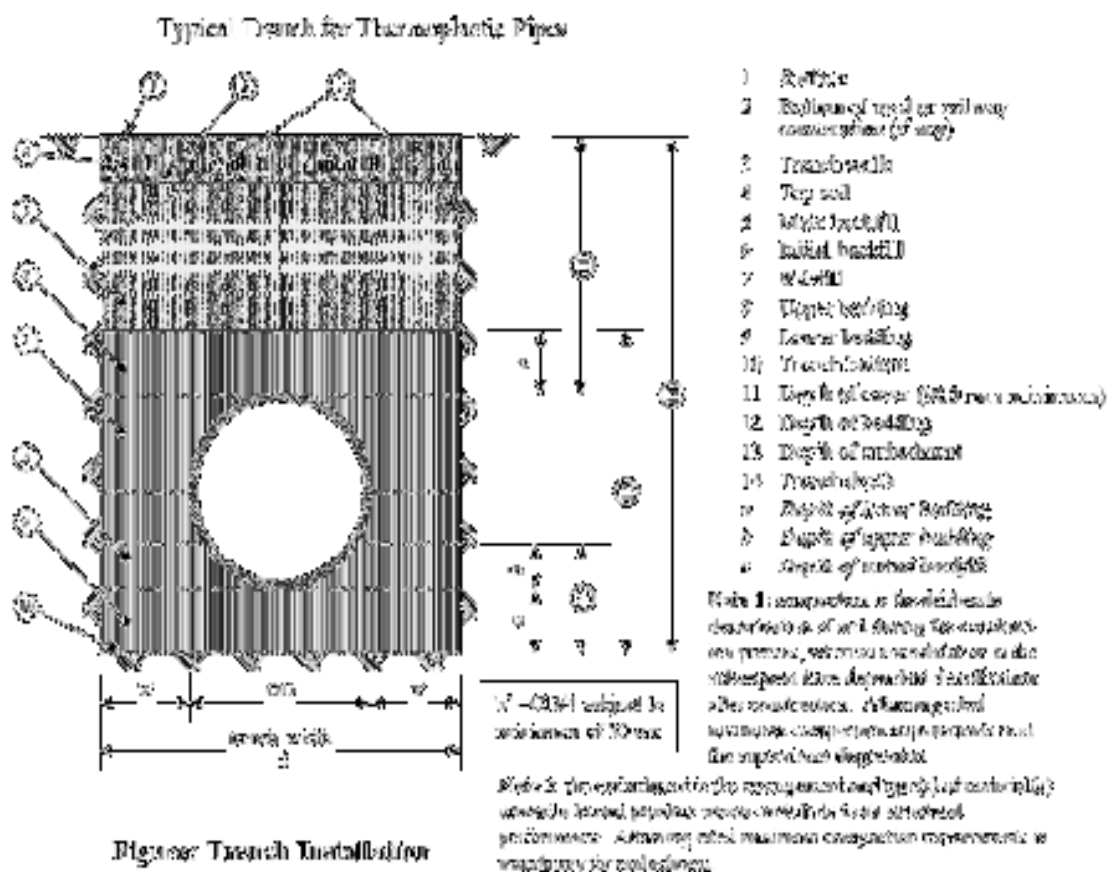
**Pipes supplied in Coils**

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

The Contractor shall provide electrofusion control units as recommended by the HDPE pipe manufacturer and confirming to EN 60335, EN 5008, EN 55014 and EN 61000. The workmanship shall be in accordance to the manufacturer's recommended procedure and quality.

**515. BACKFILLING OF PIPE TRENCHES FOR THERMOPLASTIC PIPES**

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



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

*Minimum Trench Width*

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

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

*Embedment for PVCu and HDPE (PE100) Thermoplastic Pipes*

Embedment Class	Bedding, Side fill & Initial Backfill Material Allowed	Notes
S1 and S2	Class S1: Gravel—single size Class S2: Gravel—graded	Processed granular materials Required for all plastic pipes

*S1 and S2 Embedment Material for Thermoplastic Pipes*

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

- (i) The placing and compaction of pipe embedment shall only be undertaken in the presence of the Engineer's representative unless written authority from the Engineer has been granted.
- (ii) No pipes shall be laid nor lower bedding introduced and no excavation filled in or covered with concrete until the formation has been inspected and the permission to proceed with the Work obtained.
- (iii) In every instance, embedment material (consisting of bedding, side fill and initial backfill) filled around the pipe and for 300 mm over the top of the pipes shall be totally

free from stones, rock fragments, tree roots or similar objects which through impact or by concentrating imposed loads might damage the pipes and shall not include black cotton type soil. The filling shall be carried out with utmost care, special attention being paid to tamping of material around the pipes and to joint holes so as to obtain the greatest possible compactness and solidity. The material shall if necessary, be screened to exclude material which would damage the pipes. The embedment material shall be in accordance with the relevant pipe embedment drawing but shall be no less stringent than a class S2 material for thermoplastic pipes and the source and any material brought to the site from elsewhere shall be approved in writing by the Engineer's Representative before excavation commences. Any delays as a result of not seeking this approval in good time shall be entirely to the Contractor's account.

- (iv) Where the 'as-dug' trench material contains material, which meets the bedding class requirements as specified and providing that this is carefully screened to the sizes indicated above, and segregated from material that does not, the Contractor may, at his discretion, use it as such or incorporate such material into the imported embedment material being used.
- (v) The lower bedding for the pipes shall have a minimum thickness of 100 mm in normal trenches, and 150 mm where rock/stones are present and at designated road crossings. In trenches where there is a continuous accumulation of groundwater, the trench shall after obtain the approval of the Engineer's Representative, be over-excavated by 150 mm and shall be backfilled using compacted granular material. Bedding material shall be compacted in layers not exceeding 50 mm thickness. Compaction of fill around the pipe shall be in layer thickness not exceeding half the pipe diameter or 75 mm whichever is the lesser. Layer thickness is however subject to consistently achieving 90% MPD (Modified Proctor Density) or better, failing which layers shall be reduced in depth as necessary to achieve the % compaction.
- (vi) The upper bedding shall be introduced as carefully and thoroughly as practicable to the underside or haunch of the pipe such that no large spaces remain before it is compacted.
- (vii) The sidefill and backfill material within the embedment shall be placed in layers of not more than 150 mm thickness when compacted and where hand ramming is employed the number of men filling shall not be more than half the number of men ramming. Sidefill shall be placed simultaneously on both sides of the pipe. Where mechanical-ramming of the remaining backfill is employed, the machines shall be to the approval of the Engineer's Representative and soil shall be replaced and well rammed down by hand for a depth of not less than 600 mm to give sufficient cover to the pipes and obviate risk of damage to them before the mechanical rammer is brought into operation. The rammer shall not cease to be used on any length of trench until thorough compaction has been obtained. All backfill soil shall be free from clay lumps, boulders stones and rock fragments greater than 20 mm and 90% MPD shall be attained in all instances. All backfill soil above the embedment shall be free from clay lumps, boulders and rock fragments greater than 50 mm and as far as practicable 90% MPD shall be attained, but this may be relaxed (e.g. in fields and open areas) by the Engineer's Representative.

- (viii) The Contractor in excavating the trench from which he wishes to use ‘as-dug’ material for bedding shall ensure that materials from strata containing no stones or rock-fragments and suitable for filling around the pipes as described above, shall be kept separately and used for this purpose. The Contractor shall not be entitled to claim for any extra costs (as provided for below) for screening if this requirement is not complied with. If no such strata occur in the excavation, the excavated material shall either be screened or suitable material transported to the Site from other excavations as the Engineer’s Representative shall direct. The cost of such work shall be paid for according to the rates in the Bills of Quantities.
- (ix) Before commencing the placing of embedment in the trenches, the Contractor shall obtain approval from the Engineer’s Representative as to the methods he proposes to use and he shall demonstrate by means of tests that the specified compaction can be achieved (according to SSRN 601 using the “sand replacement” method). The method of compaction and the testing thereof shall be at all times to the approval of the Engineer’s Representative and in general at a frequency of once every 30 metres unless this is specifically relaxed based on continuously good in-situ test results.
- (x) The pipe trench shall be backfilled entirely without leaving out areas around and at pipe joints uncovered, for subsequent filling. To facilitate the subsequent location of any suspected leaking joints during pipe testing, should this become necessary, the Contractor shall provide marker pegs at regular intervals and/or use a handheld GPS to be able to relocate joint positions.
- (xi) Where for pipes other than those used for service connections a minimum cover of 900 mm cannot be maintained, including highways and trafficked areas then the pipe must either be laid in a protective ferrous sleeve or be protected by a 150 mm thick reinforced concrete slab above the pipe. A minimum of a 150 mm layer of appropriate grade granular bedding material must first be placed and lightly compacted as a cushion above the crown of the pipe before the slab is laid, and the slab must extend at least 150 mm out beyond either side of the trench.

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

### **516. ON-SITE INSPECTION**

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

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

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

**517. HANDLING FROM STORAGE TO TRENCH**

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

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

**518. MEASUREMENT FOR PIPE LAYING**

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

**519. WORKING WIDTH**

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

**520. LOCATION OF UNDERGROUND SERVICES ETC.**

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

**521. CONCRETE PROTECTION**

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

- (a) Water mains with less than 0.6 m or more than 6.0 m of soil cover over the pipes.
- (b) Water mains under carriageways if depth of soil cover is less than 1.30 m
- (c) In the places where shown on the Drawings or directed by the Engineer. All concrete for beds and surrounds shall be class 15 concrete.

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

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

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

## **522. ANCHOR BLOCKS**

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

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

## **523. INDICATOR PLATES AND MARKER POSTS**

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

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

## **524. IN-SITU WELDING OF STEEL FITTINGS AND FLANGES**

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

Welding procedures used shall comply with SSRN 670.

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

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

**525. PIPE SUPPORTS**

Pipe supports shall meet the requirements of SSRN 406.

**526. SERVICE PIPE CONNECTIONS**

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

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

The customer connection tapping clamp shall have following features:

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

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

**527. HYDROSTATIC TESTING OF PIPELINES**

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

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

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

1 km.



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

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

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

The pressure shall then be increased steadily in increments of 1.0 kg/cm<sup>2</sup> with a pause of one minute between each increment to the specified test pressure for the section. Unless otherwise specifically mentioned, the applied test pressure shall be measured at the lowest point along the section being tested.

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

After a period of half an hour, the fall in test pressure shall be recorded and sufficient water again pumped into the line under test to bring the pressure back to the test pressure. The procedure shall be repeated every half-an-hour for a total period of 3 hours, or longer, if the Engineer so directs, and the amount of water pumped in recorded.

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

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

## **528. FLUSHING AND STERILISATION**

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

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

## **529. GATE VALVES**

Unless otherwise specified gate valves of nominal diameters up to and including DN 300 shall be made of epoxy coated cast ductile iron in accordance with SSRN 501. The epoxy coating shall be not less than 150 microns thickness. The gate shall be completely rubber encapsulated, the gate valve being of

pocketless type with a straight through port. Gate valves shall be capable of sustaining a maximum permissible working pressure of 16 bar except where otherwise indicated on drawings or in bills of quantities. Gate valves shall be provided with integral flanged ends unless otherwise indicated on drawings or in bills of quantities.

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

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

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

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

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

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

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

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

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

### **530. PREPAID CONSUMER WATER METER**

#### General

This specification covers supply and installation of cold-water consumer meters complete with equipment, materials, software, installations and training and other technical services for the implementation of prepaid water metering system for prepaid consumer meters and standpipes.

The Bidder shall demonstrate that the hardware/ software package that he is proposing meets the minimum functionality requirements laid out. To do this the Bidder shall include with his bid:

- Catalogues and specification sheets for all equipment proposed.
- Details of software packages, their functionality and capabilities, sample inputs, outputs etc.
- Details of currently operating systems based on the proposed equipment & software or its predecessors. These shall include details of the community types, housing types, customer numbers, pay point numbers method of commercial operation implementation problems encountered and solutions developed.

### Metering

Except as otherwise modified or supplemented herein, SSRN 510 Class C for cold-water meters or the latest revision thereof shall govern the materials, design, manufacture, and testing of all meters furnished under this specification. The metering unit shall comply in all aspects with Clause 565 of these specifications.

In addition, the meter should have the following capabilities:

- The meter should have a leak detection installation system
- The meter should have provision for a pulse output with possibility to link to AMR system

### Display

The unit shall have a simple LCD or similar display capable of informing the customer of the balance remaining and reporting fault codes.

### Power Supply

The unit shall draw power from an internal battery power supply and shall not require any mains power feed. Battery life shall be guaranteed for at least 10 years under normal operating conditions.

### Prepayment Component

The hardware and software part of the prepaid meter shall as a minimum comprise of;

- Smart card for each prepaid water meter with a service life of at least 10 years
- Credit dispensing unit (CDU) software + PC
- System Master Station (SMS) +PC
- Security spanner for yard meter
- Credit dispensing unit (CDU) software
- Printer POS TM-U210

The supplier will be required to offer the following services:

- Meter Installation
- Installation of master station
- Provide training to client's Staff in the use of the metering system. The training shall be conducted immediately after delivery of the units. The supplier shall propose a training plan for approval by the Engineer. The bidder will include in his bid costs related to venue and transport.

### Performance Warranties

The prepaid meters and associated equipment must come with a minimum of 1-year direct guarantee from the contractor/tenderer. All costs associated with offering such a guarantee are to be built in the rates for supply and installation of the equipment.

### Tariff System

The proposed tariff system calls for a rate per m<sup>3</sup> of water which shall take into account the applicable tariff bands. In addition, there shall be different rates for different customers as per the Client's Tariff structure. For example:

- The services billed for include water, sewerage, sanitation levy.
- The system should be capable of tracking arrears for recovery on an agreed percentage of the current consumption.
- The meter rentals shall be included in the Tariff System.
- The technology shall be able to add other charges as the Client may decide on, at very short notice.

### Billing and Management

The billing system to be implemented shall consist of a prepayment centre where consumers go to pay for their water and are issued with a token or card which can transfer the units purchased to the meter unit. The units uploaded shall be non-transferable from one-meter unit to another.

The system shall utilise rechargeable tokens or cards which the metering units shall be capable of reading. Systems requiring scratch cards and any form of keyboard entry on the meter unit or vending unit shall not be accepted.

The tokens or cards to be used shall be capable of not only transferring units bought to the meter but also of reading consumption data from the meter for transfer back to the management software. The software should seamlessly integrate with the existing Client billing system. The bidder may need to familiarize himself with existing billing system prior to tendering.

### Prepayment Centre

The Client shall make an office available for the installation of the equipment for the prepayment centre. The Supplier under this contract will be limited to:

- Supply and installation of all management and billing software and all other software required for the correct operation of the system on the PCs.
- Supply and installation of the token or card reader/ writer hardware.
- Supply of all other necessary equipment for the management of the system, including but not limited to:
- Additional specialised tokens /cards for configuration, testing and tariff setting of meters and vending units.
- The system must not be limited to billing the number of consumers indicated in the Bidding Documents but must accommodate any expansion in the customer base.

Management Software Capability

The software to be provided with the system shall have the following capabilities:

- Secure Management and reconciliation of payments and recharges
- Upload of consumption data from tokens/cards brought for recharge
- Receipt printing showing amount of recharge, deductions for debt collection etc.
- Recovery for arrears on the account
- Any other services as the customer would require, as specified from time to time on the tariff sheet.
- Configurable to local currency
- Automatically synchronize arrears on the client computer, Server, and token or smartcards
- Keep a record of initial arrears and subsequent payment towards arrears
- Handle variable tariff bands according to tariff category which should be alterable as and when necessity arises
- Handle accumulated customer water consumptions weekly and monthly and the related payments for the consumptions
- Generate various reports (Financial and technical reports) that can be exported to excel or PDF and flexibility to create additional reports when need arises
- The system should have a customer complaint resolution module
- Operate on both Windows XP Professional and Windows 7 Professional or higher
- Determine battery status on customer meter and customer interface unit
- The server side of the system should run on Microsoft SQL 2005 SP3 or higher as a database and should have report writer. The server side of the management system should be supported by Window Server 2003 and Windows Server 2008 or higher operating system
- Be able to categorise customers as either Domestic (Institutional, Government, Private) or Commercial (Institutional, Government, Private)
- The system should be able to categorise properties according to Town, Branch, Townships, Walk routes
- Should be able to integrate with other computer applications running on SQL 2005 or higher such as SAGE Accpac and other systems
- The management system should be able to accommodate mobile payment systems/solutions
- Client machines should be able to run without a stable dedicated connection to server for a predefined period and be able to re-establish connection and synchronise with the server
- System should handle payments by cash, cheque or other means

Token/Card Reader and Control Unit

Meters shall be capable of reading tokens/cards issued for metered customers, transferring balance from the token/card to the meter and writing to the token/card the consumer's consumption pattern information for use in system management.

Meter units shall automatically disconnect supply when the balance is exhausted. The control unit shall handle all of the billing and tariff functionality laid out in this specification.

### **531. STRUCTURAL STEEL**

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

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

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

### **532. BOLTS, NUTS AND WASHERS**

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

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

### **533. HOT DIP GALVANIZING**

All hot dip galvanizing shall conform to SSRN 903.

### **534. HANDRAIL**

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

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

### **535. FENCING**

The fencing shall be as detailed on the Drawings, and in general shall follow the recommendations set out in SSRN 849, unless otherwise indicated.

Straining posts shall be 100 mm x 100 mm x 3 m long of reinforced concrete, and struts shall be 100 mm x 100 mm x 2.6 m long of reinforced concrete.

Straining posts to be provided at all ends, corners and changes of direction or acute changes of level and at intervals not exceeding 60 m in straight lengths, each shall be strutted in each line of fence.

Holes for straining posts shall be 450 mm square in plan and for struts 500 mm x 300 mm. All straining posts shall be set in foundation concrete for the full size of hole in plan and half the depth of the hole.

#### **536. GATES**

The gates shall be as detailed on the Drawings. They shall be complete with a sliding padbolt locking device and gate stops.

The gates shall be primed with calcium plumbate and painted with three coats of approved oil paint.

#### **537. CHEMICAL WATERPROOFING OF CONCRETE**

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

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

#### **538. SITE PAINTING**

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

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

#### **539. TYPES OF PAINT PROTECTION**

##### **TYPE A** (Hot Dip Galvanized)

- (a) Blast clean to first quality finish to SSRN 933.
- (b) Hot-dip galvanized to give a minimum coating weight of 610 g/m<sup>2</sup> in accordance with SSRN 903.

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

##### **NOTE:**

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

##### **TYPE B** (Zinc Rich 2-Pack Epoxy Primer and Heavy-Duty Epoxy Coal Tar)

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

- (d) Apply by airless spray two coats of high build epoxy coal tar, to a final finished dry film thickness of not less than 350 microns.

#### TYPE C

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

#### TYPE D (2-Pack Zinc Rich Epoxy Paint)

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

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

#### TYPE E (Epoxy Paint)

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

#### TYPE F (Epoxy Primer and Chlorinated Rubber Paint)

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

#### TYPE G (Chlorinated Rubber Paint) - Brush Application

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

#### TYPE H (Chlorinated Rubber Paint) - Airless Spray Application



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

TYPE J (Lead Primer and Epoxy Paint)

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

TYPE K (Lead Primer and Epoxy Paint for Galvanized Metal)

- (a) Thoroughly clean and degrease.
- (b) Apply one coat of 2-pack epoxy metallic lead primer to give a finished dry film thickness of 50 microns.
- (c) Apply one coat of 2-pack epoxy micaceous iron ore undercoat to give a finished dry film thickness of 120 microns.
- (d) Apply one coat of 2-pack epoxy gloss finish of approved shade to give a total dry film thickness of not less than 155 microns.

TYPE L (Bitumen Coating)

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

TYPE M (Electro-zinc Plated and Stove Enamelled)

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

TYPE N (Clean and Degrease)

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

TYPE P (Lead Primer)

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

TYPE Q (Bitumen Enamel or Coal Tar Enamel Wrappings)

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

TYPE R (Sealed Sprayed Aluminium Coating)

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

TYPE S (Sealed Sprayed Zinc Coating)

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

TYPE T (Decorative Painting)

Decorative paint (when specified) shall be compatible with the final finish paint or coating. The final shade shall be as recommended by the Engineer.

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

**540. REPAIR OF DAMAGED PAINTWORK COATINGS**

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

#### **541. METALWORK SURFACE PREPARATION PRIOR TO PAINTING**

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

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

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

#### **542. SITE PAINTING DURING ERECTION OF METALWORK**

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

#### **543. PAINTING OF STEEL TANKS AND TOWER SUPPORTS**

##### **a. General**

This clause shall be read in conjunction with the following sub-clauses described above, Cl. 613 “Painting of Metalwork”, Cl. 617 “Repair of damaged paintwork coatings”, Cl. 618 “Metalwork surface preparation prior to painting”, Cl. 619 “Site painting during erection of metalwork”

##### **b. Painting internal tank surfaces with bitumen-based paints**

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

##### **c. Painting surfaces with epoxy paints**

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

##### **d. Painting of steel tower frames with aluminium paint**

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

**e. Painting surfaces with oil-based gloss paint**

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

**544. AUTOMATIC SURFACE WATER LEVEL RECORDER**

Automatic water level recorder shall be a datalogger with a submersible pressure transducer for remote monitoring and recording of water level data. It shall be able to record at least 10,000 readings and be programmable for one reading per minute to one reading per day. The installation setting shall be for one reading per hour. The measuring range for the recorder shall be 0 to 10 m of water column.

The recorder shall be suitable for the water environment and for the ambient temperatures and have a maximum measurement error of 1 cm. It shall have automatic barometric pressure and temperature compensation. The data-logger shall be installed inside a secure, lockable and vandal proof metal housing but be readily accessible for readings.

The recorder shall be provided complete with a portable handheld computer for downloading the data and with the necessary software, which should be able to open in a PC spreadsheet programme for analysis (such as MS Excel).

## **CHAPTER 6**

### **SEWERAGE, DRAINAGE AND ROAD PAVEMENT WORKS**

## 601 DEFINITIONS

For the purposes of these Specifications, the following definitions shall apply: -

### (a) Sewerage Systems

Sewerage systems include the structures, devices, equipment and appurtenances intended for the collection, transportation and pumping of sewage and other liquid wastes, e.g. gravity pipelines, manholes, pumping stations, rising mains, etc.

### (b) Culverts

A culvert is defined as any single structure composed of steel and/or concrete, the internal cross-sectional area of which, measured in a place perpendicular to the culvert centreline, is less than 12 m<sup>2</sup>. Multiple pipes or boxes whose total area exceeds 12 m<sup>2</sup>, will be deemed as culverts providing the units of which they are composed do not exceed 12 m<sup>2</sup> cross-section area each. These definitions, though arbitrary, are aimed at providing a reasonable basis for the separation of different types of construction work, namely the installation of minor cross drainage and major pipe structures or bridges.

### (c) Surface Water Drainage Systems

Surface water drainage systems include structures, devices, equipment and appurtenances intended for the collection, transportation and pumping of storm water, e.g. street gullies, street side drains, sandtraps, manholes, gravity pipelines, pumping stations, rising mains, open channels, etc.

### (d) Access Roads

These are roads within the boundaries of the Site and/or roads connecting the Site to the public highway system.

## 602 ORDER OF WORK

### a. Culverts, Sewerage and Surface Water Drainage Systems in Embankments.

The Contractor shall, wherever practicable, construct all culverts, pipelines or any structure of the sewerage or surface water drainage systems, required under embankments or fill ahead of the earthworks.

The Engineer may, however, permit this work to be inserted after the construction of an embankment or fills subject to the following conditions: -

- i. that this concession shall apply only to concrete pipes not surrounded by concrete and to corrugated metal pipes;
- ii. that the Contractor will be responsible for any damage or delays caused by the temporary omission of these works;
- iii. that the construction of these works shall follow immediately upon the substantial completion of the earthworks above it;
- iv. that the Contractor will be paid only for the volume of trench excavated, calculated from the height of trench excavated from commencing surface to the final surface; any additional excavation and backfilling will be at the Contractor's expense;
- v. that, should the Engineer consider the Contractor is causing delay to the work or inadequately compacting the trenches, this concession may be revoked and the Contractor required to construct all the work ahead of the embankments or fills and bear all additional expenses arising therefrom.

b. Drainage Work in Cuttings

Where drainage and culvert work are to be constructed under a road formation in cutting, it shall generally be excavated after the earthwork is completed. The Engineer may permit the culverts to be excavated before the earthwork is completed; but payment for the excavation of the trench will only be made upon the volume excavated below the final surface of the cutting.

### 603 EXCAVATION

Excavation and backfilling of trenches and the classification of excavated material shall be in accordance with the methods elsewhere described in these Specifications.

### 604 EXCAVATION OF TRENCHES

Trenches for pipes shall be to the lines and depth shown on the Drawings, or as directed by the Engineer, and of sufficient widths to give an equal clearance on both sides of the barrel of the pipe. The nominal and minimum trench width for different diameters shall be as shown in the following tables.

a. PVC PIPES

NOMINAL DIAMETER	100	160	200	250	315	400	500
WIDTH OF TRENCH	0.6	0.6	0.80	0.85	0.90	1.00	1.10

b. CONCRETE PIPES

INTERNAL DIAMETER (mm)	100	150	225	300	375	450
WIDTH OF TRENCH (mm)	0.85	0.90	1.00	1.05	1.10	1.20

c. D.I. PIPES: The width of trench shall be the nominal pipe diameter plus 600 mm.

Excavation for manholes, head walls or any drainage structures, shall be carried out to the levels and outlines of such structures shown on the Drawings or as directed by the Engineer, to give clearance to construct the works efficiently. Quantities will be measured net, excluding working space.

### 605 LAYING OF PIPES

The methods of laying, jointing, bedding, backfilling trenches and reinstatement shall be in accordance with that elsewhere described in these specifications.

Unless otherwise approved by the Engineer, pipes shall be laid in an upstream direction and the socket of the pipes shall face upstream and every pipe shall be concentric with the previous one.

### 606 JOINTING AND TESTING OF PIPELINES

a) General

No pipes shall be laid until the floor of the trench has been cleared of all stones and other debris to the approval of the Engineer. Prior to placing in the trench, all pipes shall be inspected for

damage. Damaged pipes which in the opinion of the Engineer, cannot satisfactorily be made good shall not be used in the Permanent Works.

All concrete pipes shall be saturated with water, before jointing, and the inside of the joint flushed up with mortar, as specified. Surplus jointing material shall be removed and the pipes scraped and cleaned internally. Pipes shall be firmly bedded throughout their length to the required alignment and level so that they are concentric at each joint. All pipes shall be suitably wedged, shored or otherwise restrained to prevent movement during testing and backfilling but such restraints shall not be left in place permanently unless so instructed or agreed by the Engineer

Unless otherwise agreed by the Engineer, a close-fitting brush or swab shall be placed in pipelines having nominal diameters of 650 mm or less and shall be drawn forward progressively as pipelaying proceeds by means of a suitable rope which shall be threaded through each pipe as it is laid.

Pipelines having nominal diameters greater than 650 mm shall be kept clean by suitable means as pipelaying proceeds. No debris of any kind shall be allowed to remain in the pipeline. Where the pipeline has internal lining, persons entering shall wear rubber boots and equipment trolleys shall have rubber tyred wheels.

Pipes and joints shall be kept free of dirt, mud and other deleterious matter at all times. If pipelaying is stopped at any time, a cap shall immediately be placed on the end of the last pipe laid to exclude dirt.

#### b) Rigid Spigot and Socket Pipes

When laying rigidly jointed pipelines with pipes having integral sockets, before entering a pipe spigot into its socket, both spigot and socket shall be clean and free from mud, oil, grease or other deleterious matter.

The spigot shall be entered into the socket of the previously laid pipe until it bears on the back face of the socket and is centred in it. Tared yarn shall then, in two turns, be firmly caulked into the back of the socket, using an approved caulking tool, to a depth between 10 and 20 mm. The joint shall be completed by pressing 1:2 cement mortar firmly into the joint, finishing with a neat 45° fillet from the outside of the socket. The pipes shall not be pressure tested or disturbed in any way for at least 48 hours after jointing.

#### c) Pipes with Ogee or Butt Joints

The joint faces shall be thickly covered with 1:2 cement/sand mortar and the newly laid pipe shall be driven hard up to the previously laid pipes. Excess mortar squeezed out of the joint shall be removed from both the inside and outside of the joint.

The outside of the joint shall be pointed up with a band of 1:2 cement/sand mortar, 75 mm wide and 25 mm thick, all the way round the barrel and central over the joint.

#### d) All other Pipes

All other pipes shall be jointed as specified in Part 4 of these Specifications.

#### e) Testing of Pipelines and Manholes



Before testing commences the Contractor shall ensure that all anchor and thrust blocks are complete or that temporary supports have been installed. Thrust from temporary pipe ends or branch pipes shall be adequately strutted and the section under test closed off with stop ends, blank flanges or other closure fittings. All pipes shall be cleaned before testing by flushing or as agreed by the Engineer. All tests shall be carried out in the presence of the Engineer and for this purpose the Contractor shall give the Engineer 24 hours' notice in writing of any tests which he intends to carry out.

A water test shall be applied, as specified in BS 8301, after laying and jointing the pipeline and before backfilling or placing the concrete surround or bedding concrete, to reveal cracked or porous pipes and faulty joints. Any visible leakage and excessive sweating, which causes a drop in test water level, will be rectified by the Contractor at his expense. Wherever possible, testing shall be carried out from manhole to manhole. Short branch drains, connected to a main sewer between manholes, shall be tested as one system. Long branches shall be tested separately.

The tests shall be carried out by inserting suitable strutted plugs in the lower end of the pipelines and in the connections, if necessary, and by filling the system with water. A period of one hour shall be allowed for absorption.

For small pipes, a knuckle bend may be temporarily jointed in at the top end and a sufficient length of vertical pipe jointed to it in order to provide the required test head. Alternatively, the required test head may be applied by means of a small-bore pipe leading from a suitable container and connected to a plug. Precautions shall be taken, by strutting or otherwise, to prevent any movement of the pipeline during the test.

A test pressure of 1.2 m. head of water above the soffit of the drain shall be applied at the higher end but not more than 2.4 m. at the lower end. Steeply graded drains shall be tested in stages where the above maximum head would be exceeded if the whole section were tested at once.

The loss of water over a period of 30 minutes, is to be measured by adding water from a measuring vessel at regular intervals of 10 minutes and noting the quantity required to maintain the original water level in the stand-pipe. The average quantity of water added shall not exceed 0.06 litre per hour per 100 linear metres per millimetre of nominal bore of the pipe for diameters up to 300mm. For larger diameter pipes, the average quantity of water to be added shall not exceed 0.12 l/hr/100 m/mm of normal bore.

On completion of the work, or at suitable intervals during construction, infiltration tests shall be carried out. The permissible amount of infiltration shall be 2 litres of water per minute per kilometre of pipeline of any diameter. All water for testing shall be provided at the Contractor's expense.

## **607PIPE BEDDING MATERIAL FOR FOUL AND SURFACE WATER DRAINS**

Unless otherwise approved, materials for pipe bedding or surround shall be a nominal single size granular material, natural crushed gravel or rock. The water-soluble sulphate content shall

not exceed 1.9 g of sulphate (expressed as SO<sub>3</sub>) per litre when tested in accordance with BS 1377 Part 3 and the material shall be graded within the following range:

**TABLE 7.1: PIPE BEDDING MATERIAL (FOUL AND SURFACE WATER)**

BS SIEVE SIZE	PERCENTAGE BY MASS PASSING
37.5mm	100
20.0mm	95–100
10.0mm	0 -10

### **608BEDDING, LAYING AND SURROUNDING OF PIPES**

Immediately following the excavation of the trench, the pipes shall be laid and jointed on the pipe bed. Pipes shall be laid so that each one is in contact with the bed throughout the length of the barrel. The bed shall be cut away and removed at each socket or sleeve in the case of socketed or sleeved jointed pipes to give a clearance of at least 50 mm so that the socket or sleeve does not bear on the bed. Brick or other hard material shall not be used as temporary support.

Except where a concrete bed and surround is specified, pipe-bedding material shall be a granular material complying with relevant Clause.

After jointing the pipes, the bedding shall be brought up equally on both sides of the pipe to the level of the centre of the pipeline. Only after inspection and testing, as required by the Engineer, shall the bedding material be brought to a level 150mm above the top of the pipe collars. The remainder of the trench shall then be backfilled with backfill material as specified in relevant Clause.

### **609CONCRETE BEDS, SURROUNDS AND HAUNCHES**

The floor of the trench shall be cleaned, trimmed and compacted before any concrete bed is laid. The concrete bed shall be thoroughly cleaned before any surround or haunch is laid. No concreting shall commence until the previous work has been approved by the Engineer.

All concrete for beds, surrounds and haunches shall be Class 15 concrete, formed to the dimensions shown on the Drawings or as directed by the Engineer.

Unless otherwise written in the Specifications or Bills of Quantities or, directed by the Engineer, a 0.15 m. thick concrete surround shall be provided to pipes in the following circumstances: -

Pipes up to and including 600 mm diameter with less than 0.60 m. cover or more than 6.00 m cover.

### **610SUBSOIL DRAINS**

A subsoil drain includes any type of drain designed to collect groundwater whether this is rising from below or percolating from the surface and may or may not include a pipe. It may also include impermeable membranes above or below the pipe or permeable filter membranes all as detailed on the drawings.

Trenches for subsoil drains shall not be less than 0.3 m wide or the outside diameter of the pipe plus 0.15 m whichever is the greater.

Perforated uPVC pipes shall be used for subsoil drains and shall be laid with no gaps between their ends.

The trench shall be filled with approved stone of size not less than 10 mm nor greater than 40 mm and the grading of the stone between these limits shall be a reasonable curve and to the satisfaction of the Engineer.

### **611BLOCKWORK WALLS**

Blockwork walls shall have the outside joints pointed flush and the inside joints shall be raked out as work proceeds to receive rendering.

Unless otherwise specified, blockwork wall thickness shall be as follows: -

Walls up to 3 metres below ground level 200 mm

Between - 3 and 6 metres below ground level 400 mm

Walls of more than 7 metres below ground level should be of precast elements to BS 5911 or cast in situ of concrete of specified class.

Relieving arches of concrete shall be arranged in blockwork walls over large sized pipes. Pipes passing walls shall generally be cast in or built in monolithically in one operation flush with the inside face of the wall.

Pipes for future connections shall also be placed as work proceeds and the external end sealed off with completely watertight temporary stoppers.

The pipes passing walls shall be as short as practicable and when jointed in and outgoing pipes no strain shall occur in rigid joints. The distance from the inside wall face to external joint may not exceed 600 mm for walls up to 400 mm thick.

Where boxing out for pipes passing walls has been allowed, jointing to outside pipelines shall be made before concreting into walls is finally carried out.

### **612STONE FOR RIP-RAP**

The stone used for rip-rap shall be obtained from approved quarries. It shall be free from impurities, overburden, mudstone, cracks, sandholes, veins, lamination or other imperfections. The stone shall be left irregular, when stone pitching is done, for dissipating the water energy in open channels or water courses. It will be laid in mortar 1:2 or dry without mortar as shown on the Drawings.

### **613CEMENT MORTAR**

Cement mortar for jointing pipes, masonry, slabs and plastering shall consist of cement and clean sharp fine sand all as specified and mixed in the required proportion by volume.

Mortar for use in connection with foul water shall be made with sulphate-resisting cement while that for use in connection with surface water drainage shall be made with Ordinary Portland cement. All mortar shall be conveyed fresh to the work as required for use. No mortar after setting shall be re-used or remixed for use.

#### **614MANHOLE WATER TIGHTNESS TESTS**

Where so required, manholes shall be tested for water tightness by filling with water. The Engineer will then decide whether the tightness is acceptable or not.

#### **615OPEN CHANNELS**

Open channels shall be constructed of precast components - invert block drains or half round concrete channel and side slabs - as specified and shown on the Drawings.

The precast components shall be manufactured of specified concrete class and according to applicable specifications in relevant clause. Cube test certificate shall be submitted to the Engineer if so required.

Excavation to receive precast components shall be true to line and gradient and allow for bedding material as specified on the Drawings. Earth sides shall be given a slope of 1:1 or as otherwise specified or directed by the Engineer. The formation of the excavation shall give a firm base for the channel components.

Where required, sight rails shall be used to bone in channel with traveller.

Invert blocks, channels and side slabs shall be neatly jointed in cement sand mortar 1:3. Ends to be jointed shall be thoroughly soaked with water before jointing. Jointing shall be carried out as the work proceeds, all joints being trowelled to a smooth finish. Joints shall be protected from sun, wind and rain by approved covering kept constantly damp for a period of at least 3 days after forming.

## **CHAPTER 7**

### **ELECTRO - MECHANICAL WORKS (GENERAL SPECIFICATIONS)**

## CHAPTER 7 – GENERAL ELECTRICAL AND MECHANICAL WORKS

### GENERAL

#### 701 DEFINITIONS

In the Specification (as hereinafter defined) the following words and expressions shall have the meanings hereby assigned to them:

- a) **“Specification”** means this Specification together with the technical details given in the Bill of Quantities and, subject to the Engineer’s approval, the Contractor’s Drawings, Specifications and technical details.
- b) **“Supply”** and its derivatives means the complete design, manufacture, delivery to site, inclusive of such ancillary services as inspection and witnessed testing at the places of manufacture and shipment, workshop painting and of all such other services as are noted in the Specification or reasonably necessary for the safe, reliable and efficient completion of the Contract.
- c) **“Install”** and its derivatives means complete installation, on site painting and adjustments, testing and commissioning of the works and of all such other services as are noted in the Specification or reasonably for the safe, reliable and efficient completion of the Contract.
- d) **“Replacement”** and its derivatives means exchange of equipment, parts or similar with the latest model of the installed equipment or technically equivalent one of another manufacturer, inclusive of dismantling and removal of the existing equipment to the employer’s central store or off site as directed and all such other services as are noted in the Specification or reasonably necessary for the safe, reliable and efficient completion of the Contract.
- e) **“Overhaul”** and its derivatives where not detailed for specific items of plant, means dismantling, checking and testing to identify defective components, replacement of defective components, reassembly, commissioning and testing. Overhaul shall include the item covered under “servicing”.
- f) **“Repair”** and its derivatives where not detailed for specific items of plant, means, in addition to an overhaul, additional works such as diagnosis, machining, welding, etc.
- g) **“Service”** and its derivatives where not detailed for specific items of plant, means the cleaning with high pressure air, water and or steam; oiling and greasing; the adjustments of gaps, injectors, torques to ensure efficient operation of the machine; and the replacement of normally wearing items such as bearings, bushes, seals, gland packings, gaskets, voltmeters, ammeters, drive belts, etc.
- h) **“Spares”** and its derivatives where not detailed for specific items of plant, mean replaceable wearing parts and lubricants as required for normal maintenance of the plant.
- i) **“Rehabilitation”** and its derivatives where not detailed for specific items of plant means the reinstatement of plant by overhaul, repair and service to put the plant in its original working state.
- j) **“Quantities”** the quantities required for each item specified herein shall be as stipulated in the relevant BOQ.

- k) **“Painting”** and its derivatives means the surface treatment with wire brush or sand blasting and application of the primer and finishing coats as per the specifications.

#### **702MANUFACTURER’ S DEALERSHIPS**

There shall be established manufacturer’s dealers in Kenya for the proposed pumps and other equipment. The dealership shall have facilities for workshops and stores with sizeable inventories of commonly required spare parts. For pump suppliers in particular, it will be deemed mandatory for the dealer to have such a facility in Kenya. Bids shall contain official evidence of such a facility. Bids offering pumps from manufacturers which do not have the abovementioned dealership shall be rejected.

The Local Agent shall be expected to either have in his stores spare parts for the equipment or be in a position to expeditiously acquire the required parts.

Details (name, physical and postal address, telephone number, and email address of the Local Agent shall be provided by the Bidder in his bid.

#### **703CENTRAL STORES**

All existing and surplus equipment and material which is removed from the WTP’s and from the intakes shall be transported and delivered to the Client’s stores, situated at the water treatment plant. The prices for removal shall include the costs for lifting by crane, handling, transport and documentation thereof.

#### **704AUDIT OF QUALITY ASSURANCE**

An audit of the applicable Quality Assurance Procedures shall be carried out by an independent inspectorate prior to the commencement of any work, which is to be executed by a firm for which exemption from third party exemption in accordance with Clause 9.1.6 is applicable. Such an Audit shall consist of the examination of the implementation of the applicable standard within the premises of the firm concerned, including the examination of relevant quality manuals, procedures, instruction sheets, records and the like, and interviews with relevant management and work staff. The Audit shall be carried out without prior notification.

The Audit inspectorate shall be chosen by the Contract from a list of three inspectorates proposed by the Engineer. The inspection and reporting shall be done directly by the personnel of the chosen inspectorate, and the inspectorate shall not be permitted to subcontract any of the services save for the employment of specialist consultants with the approval of the Engineer.

The report of the inspectorate shall be made available to the Employer, Engineer, and the Contractor within 42 days of the acceptance of the Bid. Such a report shall state whether, in opinion of the inspectorate, the firm or firms concerned have in place Quality Assurance Procedures that comply with the relevant standard. The costs of the inspectorate in executing this Audit shall be born by the Contractor. Where the Audit inspectorate does not find the Quality Assurance Procedures to be in accordance with the relevant standards, then the inspectorate shall provide in its report clear and concise requirements for the improvements, changes or modifications necessary for conformity to be achieved.

The Contractor shall be responsible for ensuring that the inspectorate’s recommendations are implemented and shall thereafter arrange for a re-Audit of the concerned procedures, and a report on the re-audit. The costs of such re-Audit and the new reporting shall be borne by the Contractor.

No work in the manufacture, erection, testing and commissioning of Plant shall commence prior to the receipt by the Engineer of a report by the approved inspectorate of satisfaction with the Quality Assurance Procedures in use by the relevant firm.

The Contractor shall have full responsibility in ensuring the compliance by the manufacturers of Plant and his Sub-Contractors with the requirements of this clause.

Failure:

- (i) To provide the Audit inspectorate with access for inspection as required, or
- (ii) To implement any requirements of the Audit inspectorate,

shall result in the rejection of any Plant manufactured or works carried out by the relevant firm. In this regard, the provisions of Conditions of Contract Clauses 37, 39 and 63 will be applied.

### **705DRAWINGS, OPERATION AND MAINTENANCE MANUAL**

The bid drawings for this Contract are in the Book of Drawings.

At the time of the bid, the Bidder shall submit details of Plant and materials and drawings of the completed installation such as will demonstrate that the bid is based upon anticipated works, which it is expected would fulfil the intended purposes. These Bid Drawings shall also serve to illustrate the Bidder's intentions if the Bid is accepted. The acceptance of the Bid shall not be deemed to be acceptance of the Bid Drawings.

Within 45 days of the Contract becoming effective through the Letter of Acceptance the Contractor shall inspect the Site and shall submit for the Engineer's approval four paper copies of full and detailed designs of the Works (Principle Contractor's Drawings) including but not limited to:

- (i) Calculations, design criteria, design assumptions and the like to support the sizes, ratings, and essential components of the Works;
- (ii) Detailed drawings showing the location arrangement, dimensions, layout etc. of all of the Works, including circuit diagrams, dimensioned drawings of Plant, and fixing details to associated civil works;
- (iii) The quantities of materials which the Contractor intends to procure such as to enable completion of the Works;
- (iv) The requirements, specifications, sizes and other information required for the completion of foundations, supports, access works and other civil works associated with the Works;
- (v) Specifications and manufacturer's information regarding the Plant and materials to be provided; and
- (vi) Procedure for switching on the starters
- (vii) Fault finding
- (viii) Logic diagram for mechanical checks before starting pumps
- (ix) Logic diagrams for electrical checks before starting pumps
- (x) Normal starting and shutdown procedures
- (xi) Over current and earth fault settings
- (xii) Dosing procedures: solution strengths and adjustments;
- (xiii) Such samples and models as shall be necessary to amplify upon the information provided as above.



The Engineer shall provide his approval or otherwise within 28 days of submission of the Principle Contractor's Drawings. Any Contractor's drawings, which the Engineer disapproves, shall be modified and resubmitted within 14 days of the Engineer's notice of disapproval. Upon approval, the Contractor shall resubmit the approved drawings in one transparency copy to the Engineer within 14 days of approval and he may utilise these Drawings as the basis of ordering Plant and materials for the Works.

Subsequently and from time to time for the duration of the Contract, the Contractor shall submit further drawings to amplify or modify the Drawings as shall be required by the Engineer or shall be considered by the Contractor as necessary or desirable.

The Contractor shall provide three draft copies of the Operation and Maintenance manuals and the drawings of the Works as built at the time of submitting the notice of readiness to make the Tests on Completion.

The Contractor shall give to the Engineer 21 days' notice of the date after which he will be ready to make the Tests on Completion for the Plant. The Tests shall then take place within 14 days after the said date.

Upon approval of the manuals, three copies shall be submitted. Of the approved drawings, three transparency and three paper copies shall be provided.

The satisfactory completion and submission of the Operation and Maintenance manuals and as-built drawings shall be one of the conditions, which the Contractor shall fulfil before the Hand-Over certificate is released.

#### **706STANDARD SPECIFICATIONS REFERENCE NUMBERS (SSRN)**

The Standard Specifications Reference Numbers (SSRN) is a list compiled to provide cross-reference of international standards. In these specifications, the standards required are given by an SSRN, which indicates all the known standards for the particular item of equipment, etc. An SSRN list is provided at the end of these specifications.

#### **707SCHEDULES OF PARTICULARS**

Schedules of Particulars for mechanical and electrical equipment are provided at the end of these specifications.

The Bidder shall complete these schedules with full details of the equipment and materials proposed and submit them in his bid.

Bids which do not contain the above duly completed schedules will be ruled as non- response and will be rejected.

#### **708ELECTRICAL DISTRIBUTION SYSTEMS**

#### **709REGULATIONS AND STANDARDS**

The electrical installation shall comply with all relevant statutory regulations and standards current at date of tender, unless otherwise indicated within this Specification. In general, the following shall apply:

- a) The IEE Regulations for Electrical Installations, 17th Edition
- b) The Health and Safety at Work Act, etc.

- c) Factories Act (UK)
- d) British Standards (BS) and International Standards stipulated in SSRN (Standard Specifications Reference Numbers)
- e) British Standards Codes of Practice (CP)
- f) International Electrotechnical Commission (IEC)
- g) Regulations under the Electricity Acts

If no standard is specified, the relevant British Standard or, in the absence of such standard, International standard shall apply.

Note: A list of the Standard Specifications Reference Numbers (SSRN) is provided at the end of these Electrical and Mechanical specifications.

### **710 ABBREVIATIONS OF ELECTRICAL ITEMS**

R - red phase

Y - yellow phase

B - blue phase

N - neutral

AC - alternative current

DC - direct current

A - amp

mA - milliamp

V - volt

kW - kilowatt

kWH - kilowatt hour

kVAr - kilovar

MVA - megavolt amp

Hz - hertz (cycles per second)

SP - single pole

SPN - single pole and neutral

DP - double pole

TP - triple pole

TPN - triple pole and neutral

SPSwN - single pole and switched neutral

TPSwN - triple pole and switched neutral

MCB - miniature circuit breaker

MCCB - moulded case circuit breaker

RCD - residual current device

MCC - motor control centre

### **711POLARITY**

The polarity of all electrical apparatus used for the Works specified shall be arranged as follows:

- for two pole apparatus the phase of 'live' pole at the top (or left-hand side) and the neutral or 'earthed' pole at the bottom (or right-hand side),
- For three or four pole apparatus the phases in order of red, yellow, blue and neutral reading from top to bottom or left to right in the case of vertical and horizontal layouts respectively and as viewed from the front.

All non-flexible cables shall be so connected between main switchboards, distribution boards, plant and accessories so that the correct sequence or phase colours are preserved throughout the system.

All non-flexible cable cores shall be identified with phase colours for three and four wire circuits. Single phase circuits shall be red and black.

### **712VOLTAGES AND FREQUENCIES**

Unless otherwise indicated, all apparatus and wiring shall be suitable for use with a 3 phase, 4 wire, 400/230 volt, 50Hz earthed neutral supply. The supply waveform shall be a sine wave.

Supplies for control, tripping, alarm and indication circuits shall be 24 V DC. Circuit breaker spring charging motors shall also operate at 24 V DC.

Control voltage within motor starters shall be 240 V AC. Extension of 110 V circuits outside the starter shall not be permitted except for the circuit to the emergency stop button, where fitted.

Tap changer motors and electrical panel heating and lighting shall operate at 230 V, single phase. All equipment operating at 230 V shall be fully shrouded and clearly labelled.

Where 230 V lighting and heating is used within a panel which otherwise contains equipment with a nominal operating voltage of 24 V, the 230 V equipment shall be insulated, sheathed and protected in accordance with standard practice for installing such equipment in buildings. No live terminals shall be accessible without the use of tools, no single-insulated wires shall be used, and no 230 V cables shall share cable trays or other routes with 24 V circuits.

All references to voltages shall relate to the nominal, or rated value of the supply.

### **713UNITS OF MEASUREMENT**

All information shall be in SI units. Where plant design exists in imperial units, the dimensions and tolerances of layouts and terminal points shall be presented in SI units to a degree of accuracy which permits the precise matching of existing components.

### **714ELECTRICITY SUPPLIES**

The Contractor shall arrange with the KPLC to undertake any testing and inspection necessary for the electricity supplies to be connected when required. On completion of the tests and inspections, not less than two weeks prior to the power supply being required, the Contractor shall supply to the Engineer a copy of his Electrical Installation Completion Certificate and of the KPLC test certificates.

The Contractor shall ascertain the system earth arrangements which are normally classified as TT, TN-S, TN-C-S, TN-C and IT.

The Contractor shall also make enquiries from the Supply Authority on the declared Prospective Fault Current at the origin of the installation and take the value in to consideration for the proposed electrical installation design.

### **715ELECTRICAL SAFETY**

The Contractor shall be responsible for the electrical safety of all equipment supplied and installed. Whilst any equipment is being installed or tested, the Contractor shall ensure that all necessary precautions are taken to safeguard personnel working on site. If necessary, this shall include erecting warning notices and fencing off areas which are considered to pose a risk.

The Contractor shall be responsible for ensuring that the electrical installation is carried out by competent personnel and that the work is carried out in accordance with standard procedures and test requirements. Before any piece of apparatus is energised it shall be thoroughly examined for the presence of dirt, water or other foreign bodies.

### **716SWITCHBOARD CONSTRUCTION**

#### **a. General**

This section shall apply to the construction of all panels housing electrical apparatus, including but not limited to the following:

- i. switchboards
- ii. motor control centres
- iii. circuit breakers
- iv. control panels
- v. monitoring or supervising panels
- vi. distribution boards – control panels
- vii. marshalling panels
- viii. interface panels
- ix. local control panels

#### **b. Safety**

Access to any enclosure of compartment shall be possible only;

- i. when the circuit switch-disconnector is open and connections within the compartment are isolated or;
- ii. when connections within the compartmental including any on the door or access cover, are fully shrouded to prevent accidental contact or;
- iii. when connections within the compartment operate at a voltage not greater than 55 volts.

Where a test facility is provided for use with the door or cover open the provisions of (b) shall apply. Connections which may be live with the door or cover open shall be suitably labelled.

Bolted covers on compartments incorporating live connections shall bear a suitable warning label.

Labelled isolators, fuses or links shall be provided so that relays, controls and instruments may be isolated but keep other essential circuits energised.

### **c. General Construction Standard**

The switchboard and all components shall be constructed to withstand fault currents as specified or required under the relevant standards and regulations.

Switchboards, cubicles and enclosures for electrical equipment shall be constructed in sheet steel not less than 2.0 mm thick and suitably braced to form a rigid structure. Exterior edges and corners shall be rounded and the use of externally visible assembly bolts or similar shall be avoided.

The design shall provide protection against dust, damp and entry of vermin. Gaskets shall be fitted to doors and removable panels. Ventilation and cooling shall be by natural air circulation under the ambient conditions specified or to be expected.

Unless specified otherwise, switchboards, cubicles and enclosures shall be floor-standing with lockable hinged front doors and bolted removable rear panels for access to live equipment such as busbars and terminals.

The switchboard shall fit in the space as stated or indicated on the drawings. If there is any reason will not fit into the space, the attention of the Engineer shall be drawn in good time to enable alternate arrangements to be made either to the board or to its fixing position. It shall be the responsibility of the electrical contractor to verify the suitability of the space provided before commencement of installation.

Each section shall be separately accessible without disturbance to other sections for maintenance and inspection. Live parts with voltages greater than 55 V to earth within the section shall either be isolated automatically when the section door is opened or be fitted with insulating barriers to prevent accidental contact by personnel. Parts still live when the unit is isolated shall be labelled "Danger Live". Where integral fuse or MCB distribution boards are incorporated, access to fuse carriers and MCB's shall be possible without isolating the fuse or MCB distribution board. With the operator's door open and with fuses and MCB's in place, the degree of protection of such distribution boards shall be not less than IP20.

A clear access of not less than 1000 mm, and preferably 1500 mm, shall be given at the rear and both ends of the panel.

Controls and switches mounted on any control panel section of a switchboard shall be installed in the height range 750 mm to 2000 mm; indicating instruments 900 mm to 1800 mm; recorders 900 mm to 1400 mm. This requirement shall not be applied to starters or feeder sections.

Switchboards shall be equipped with a power transformer and 2 No. 15 A, 110 Vac ( $\pm 55$  V) RCCB protected sockets, suitable for use with electric hand tools. Switchboards shall additionally have 2 No. 13 A, 240 Vac RCCB protected sockets.

Each section of cubicle of the board shall be clearly labelled with circuit name and number, and the reference number of the section. The panel shall have a name plate carrying the manufacturer's name, address, reference and year of construction of the panel.

Cubicles and enclosures shall be earthed. Where a number of cubicles are bolted together, earthing shall be provided via a continuous high conductivity copper bar of minimum cross section 25 mm x 6 mm running the length of the panel. Terminals shall be provided for the connection of earthing from the metal cladding or armouring of incoming and outgoing cables. Holes shall be left at each end of the

bar for connection to the main station earth and future extension. The bar shall be fault rated at not less than that of the associated equipment. Warning labels and instructions for earthing and isolating shall be fitted in each switch compartment. Front access doors shall open not less than 120° and shall be fitted with a locking handle and non-ferrous lift-off hinges which shall be captive when the door is closed. Locking combinations requiring different keys shall be approved before manufacture. The door shall be secured by captive screws or locking handles of sufficient number to ensure firm pressure on the door seal around the whole periphery. The door shall be mechanically prevented from opening before isolation of the live parts within. All doors shall be separately earthed to the main frame. Earthing via the door hinge will not be accepted.

Cables shall enter through 3 mm thick undrilled removable steel or brass (for single core cables) gland plates mounted at least 250 mm above switchboard base level. Access to both sides of gland plates for gland tightening shall be readily available. Gland plate knockouts will only be accepted for individually mounted starters and small power distribution boards.

Lifting eyeholes shall be provided at each top corner at each section of the switchboard and shall be removed and replaced with blanking bolts after installation.

Cubicles and enclosures for outdoor locations shall be fitted with lockable outside doors and a housing so designed that all controls, instruments and such like are fully enclosed and the whole assembly is weatherproof and vandal proof. The doors shall be fitted with stays to prevent overstraining of the hinge fixing and allow fixing of the doors in the open position. Switchboards inside cubicles shall also be weatherproof to allow operation of the controls when the outside cubicle doors are open during inclement weather.

When specified, a double skin roof shall be fitted over the whole assembly to give added protection against direct sunlight.

LV enclosures shall be constructed to comply with SSRN 038 and have IP ratings of at least the following;

- for outdoor installation IP 65
- for indoor installation IP 54

Switchboard, cubicle and enclosure construction shall be capable of withstanding without damage the fault current of the system. HV enclosures shall be constructed to standards under SSRN 061 with IP ratings equal to those for LV enclosures.

Protective coatings shall be applied at the place of manufacture and before installation of its internal electrical fittings.

#### **d. Switchboard Small Wiring**

Switchboard wiring shall be carried out in 600/1000 V PVC insulated cable to comply with SSRN 041. The conductors shall be stranded or flexible (where applicable); solid cores will not be accepted. The conductor size shall be not less than 1.5 mm<sup>2</sup> for control and indication circuits and not less than 2.5 mm<sup>2</sup> for CT secondary circuits.

Wiring within the switchboard shall be marked with ferrules at each end for identification. The letters and numbers used shall correspond with the switchboard wiring diagram.

The wiring colour code shall be as follows:

Phases - red, yellow, blue

Neutral - black

Control - grey/black

Earth - green/yellow

The wiring shall be neatly laced and cleated to the switchboard structure or contained within purpose designed plastic trunking and arranged so that access to equipment is not impeded. Where trunking is used the ratio of effective cross-sectional area of the cables shall be not greater than 40% of the trunking area. Where wiring passes through metalwork the access hole shall be fitted with a suitable grommet.

Every wire shall be identified by indelibly marked circular ferrules at each end. Slip-on, 'u' type ferrules will not be accepted. Identification shall correspond with the wiring diagram.

Wiring between cubicles or panel sections shall be terminated on terminal blocks at each end.

Wiring onto hinged doors or plates which is subject to movement shall be run in flexible circular section trunking and shall be supported securely at both ends of the moving section. Adhesive fixings of the ends of the trunking will not be accepted.

Crimped flat blades shall be applied to all wire ends to ensure sound connection to terminal blocks and all circuit components.

Small wiring used for control, extra low voltage and instrument signals which are likely to be affected by interference shall be screened and/or spaced from each other and power cables to ensure no distortion or mal-operation.

#### **e. Switchboards Busbars and Primary Connections**

All busbars and primary connections shall be of high conductivity copper to comply with SSRN 020 and SSRN 069. The mechanical and dielectric strengths of busbars and connection supports shall be able to withstand without damage the worst conditions of electrical surge which can occur on the installation. The busbars shall be capable of carrying full rated current continuously without exceeding temperature rise limits indicated in the above SSRNs.

The busbars, assemblies and connections of equipment shall be of a type which does not rely solely on air for insulation purposes. The covering material shall be non-deteriorating at the rated short-time maximum temperature of the busbars and shall have such thickness as is required to withstand rated line to line voltage between busbar and a conducting object on the exterior of the covering material for a period of not less than 60 seconds.

Where independent certification of busbar withstands and continuous rating is not available the Contractor shall include tests to demonstrate the suitability of the equipment.

Busbars and primary connections shall be housed in an air insulated enclosure segregated by barriers. Direct access to live bars shall not be possible. Access to busbars and connections shall be only by removal of bolted covers. Suitable warning labels shall be provided externally on covers and internally on shutters. Busbars shall be identified by coloured bands opened at not more than 1,000 mm and in each compartment.

Baffles shall be provided to prevent the accidental entry of tools, etc. whilst maintenance work is being carried out in the vicinity of the chambers.

Busbars systems shall have a short time rating not less than that of the associated switchgear.

Busbars shall be extensive at both ends.

The conductors shall be separated and supported with the appropriate clearances in air or shall be otherwise adequately insulated or encapsulated.

### **717HIGH VOLTAGE CIRCUIT BREAKERS**

Circuit breakers shall be vacuum or SF6 type as specified. The equipment shall comply with SSRN 004 as appropriate and be fully rated for the ambient conditions specified.

Circuit breakers shall be capable of clearing any fault condition which may occur on the system without damage to equipment or personnel.

Circuit breakers of the same pattern and rating shall be interchangeable.

Vacuum circuit breakers shall comprise separate vacuum interrupters designed to prevent welding of contacts and sharp current chopping during fault interruption or switching or motor loads.

- independent manual spring
- hand charged spring with electrical or manual release
- motor charged spring with electrical release
- DC solenoid

All operating mechanisms shall have mechanical 'ON' and 'OFF' indicators and a manual trip device fitted with means for locking. Hand charged and motor charged spring mechanisms shall have mechanical indicators to show 'SPRINGS CHARGED' and 'SPRINGS DISCHARGED'.

The operating mechanisms of hand charged and motor charged spring types shall be arranged so that release of the springs to close the circuit breaker can only be achieved by a deliberate action. It shall not be possible for vibration or mechanical shocks to release the charged springs. Motor charged spring mechanisms shall be arranged so that charging is initiated automatically following a discharge. The necessary limit stops and switches for the automatic control of the charging shall form an integral part of the mechanism. The facility shall be provided to hand charge a motor charged spring mechanism.

Spring operated mechanisms shall be provided with volt-free contacts to give indication that the springs are charged.

Solenoid closing mechanisms shall be suitable for operation down to 80% of the nominal control voltage. They shall not mal-operate or cause excessive vibration when energised either from the voltage of the closing battery with the charging rate set at maximum, or from the voltage of a full wave rectified source designed for multiple simultaneous operation. Unless otherwise specified, this higher voltage shall be not less than 120% of the nominal control voltage.

To facilitate maintenance and the adjustment of contacts, it shall be possible to 'slow- close' the circuit breaker but this operation shall only be possible in the fully withdrawn position. Any operating handle or lever necessary shall be supplied.

All circuit breakers shall be provided with interlocks to ensure that:

- (a) the circuit breaker cannot be racked into or out of the service or earth position whilst it is closed. Attempts to rack out a closed-circuit breaker shall not cause it to trip.



- (b) the circuit breaker can only be closed when fully engaged in the service, earth, or fully isolated positions
- (c) the circuit breaker cannot be closed in the service position without completing the auxiliary circuits between the fixed and moving portions.
- (d) The circuit breaker cannot be 'slow-closed' except in the fully isolated position.
- (e) with hand charged or motor charged spring mechanisms, the springs cannot be discharged until they have been fully charged or until the means for charging has been fully removed and disconnected.
- (f) when the circuit breaker is closed in the earth position, tripping can be affected only by the manual device in the operating mechanism.

Where mechanical key interlocking is employed, tripping of a closed-circuit breaker shall not occur if any attempt is made to remove the trapped key from the mechanism.

Circuit and/or busbar earthing shall be by the transfer circuit-breaker method without the requirements of any loose attachments. The earthing operation shall be completed by the closing of the circuit breaker by its normal operating means using local control. Selection of either circuit or busbar earthing shall be possible only after the circuit breaker has been fully isolated. Mechanical key interlocks shall remain operative when the circuit breaker is in either earthing position.

Facilities shall be provided on all incoming and feeder circuit breakers for earthing the circuit side. On at least one circuit breaker panel in any section of busbars, facilities shall be provided for busbar earthing.

A set of safety shutters shall be provided to cover each three-phase group of stationary isolating contacts. The shutters shall be opened automatically by a positive drive from the circuit breaker moving portion and when closed shall prevent access to the stationary isolating contacts. When the circuit breaker is withdrawn each set shall be capable of being individually operated and of being padlocked in the closed position.

To facilitate high voltage and current injection testing via the isolating contacts, a device shall be provided for fixing (not locking) the shutters in the open position and for releasing them into the closed position. The device shall be arranged to be cancelled by the moving portion to ensure the restoration of the automatic feature of the shutters.

Busbar shutter shall be coloured red and labelled 'BUSBARS' in large white letters.

Circuit shutters shall be coloured yellow.

Shutters in bus-section units shall be coloured red and shall be labelled with a large white arrow pointing in the direction of the section of busbars to which the contacts are connected.

Circuit breaker moving portions shall be fitted with positive guides to ensure correct alignment of the isolating contacts in both the service and the earth positions.

## **718LOW VOLTAGE CIRCUIT BREAKERS**

All 400 V circuit breakers for incoming circuits, and bus section circuits on 400 V switchboards and interconnector circuits shall be of the air break metal clad type complying with the requirements of SSRN 020 and SSRN 040.

Circuit breakers shall switch three phase poles. The neutral pole shall either be switched or established through a bolted link. Access to the link shall not be possible when the equipment is in the “Service Position”.

Provision shall be made for easy access to the circuit breaker contacts for maintenance purposes.

Arc chutes shall be so arranged that the emission of hot glasses shall not damage any part of the equipment.

## **719 FUSED-SWITCHES AND DISCONNECTOR COMBINATION DEVICES**

### **a. General**

Fused switch disconnectors, switch-disconnectors and disconnectors, shall be rated at 500 V and shall be to the standards in SSRN 007.

Fuse switch disconnectors shall be of the air break triple pole or single pole and neutral type. They shall have not more than one fuse in any one pole. The neutral shall be either switched or taken through a removable link. If a switched neutral is required, the neutral shall be arranged to make first and break. A separate brass earth terminal shall be provided.

Operating mechanisms shall be of the independent spring type and fitted with mechanical ON and OFF indicators. Operating handles shall be of semi-flush or telescopic pattern to reduce front projection to a minimum.

Disconnectors shall be identical for fuse-switches but the fuse links shall be replaced by hard drawn high conductivity copper links.

Facilities for locking the operating handles by padlock shall be provided.

All switch-disconnectors shall be rated to make the full short circuit current of the system. Units used on distribution circuits shall be rated to break full load current and units used in motor starters shall be rated to break stalled motor current.

### **b. Fuse and Links**

Fuses shall comply with SSRN 058 (LV) or SSRN 060 (HV) as appropriate.

Fuses and links shall be provided to enable any circuit to be isolated as necessary for maintenance and test purposes without isolating the whole panel. All fuses shall be of the cartridge type. Fuse carriers and solid link carriers and bases shall be made of plastic moulded insulating materials; ceramic materials will not be accepted. Accessible live connections shall be effectively shrouded and it shall be possible to change fuses and remove links with the circuit alive without danger of contact with live metal. The fuses shall be rated to give maximum protection to the apparatus in circuit and the rating shall be inscribed on the fuse label.

Earthing and neutral links in main supply circuits shall be solid copper and bolted pattern. Fuses and links functionally associated with the same circuit shall be mounted side by side.

## **720 MOULDED CASE CIRCUIT BREAKERS**

Moulded case circuit breakers (MCCBs) shall be manufactured to SSRN 040.

MCCBs shall have thermal overload and adjustable magnetic short circuit tripping devices with a trip-free mechanism to ensure that the contacts cannot be held closed against a fault. Contacts shall be silver

tungsten tipped and shall operate with a wiping, arc resisting material and incorporate arc chutes based on the de-ionising principle.

MCCBs shall have a factory calibrated and sealed trip unit, interchangeable with similar units for varying the rating of the circuit breaker.

Where dust and damp-proof enclosures are to be used, then the circuit breakers shall be fully enclosed in a case with a gasketed door. Circuit breakers mounted in a composite control panel shall be segregated from other equipment and have a matching purpose-made cover plate. Where possible, circuit breakers shall be mounted vertically and be arranged so that one breaker can be removed without interfering with other circuit breakers. The switch dolly and protruding face shall be engraved with the circuit rating and the ON and OFF positions.

Tripping due to overload or short-circuit shall be clearly indicated by the handle automatically assuming a position midway between the manual ON and OFF positions. To reset from the 'tripped' position, the dolly shall first pass through the OFF position. All phase poles shall operate simultaneously.

MCCB's used for short circuit protection (only) in motor starters shall provide instantaneous short circuit protection by means of an adjustable magnetic element on each pole. The adjustment knob(s) shall have the end and mid-setting points marked and adjustment shall follow a linear scale so that each point has a significant value with calibration tolerances. MCCB's shall not be used to provide thermal protection or switching of motors.

MCCB's shall be ambient temperature compensated. Compensation shall allow the breaker to carry rated current between 25°C and 50°C with tripping characteristics that are approximately the same throughout this temperature range.

#### **721 MINIATURE CIRCUIT BREAKERS**

Miniature circuit breakers (MCBs) shall be manufactured and tested to SSRN 052.

MCBs shall have a short circuit rating of at least M4 and shall be Type 2 unless otherwise specified.

The fault capacity of the MCB shall be not less than that of the switchboard. If this is not the case, back up HRC fuses shall be fitted.

#### **722 EARTH LEAKAGE CIRCUIT BREAKERS**

Earth leakage circuit breakers (ELCBs) shall be of the current operated type complete with current balance transformer, test push button, trip coil and thermal overloads. They shall be double pole for single phase and four pole for three phases and neutral circuits. ELCBs shall comply with the requirements of SSRN 006.

The out of balance current shall not exceed 30 mA for circuit breakers up to 60-amp rating and 500 mA for above this rating.

Current operated ELCBs shall not be used where the product of the operating current and the earth loop impedance exceeds 40.

## **723EARTHING**

### **a. Submissions by the Contractor**

Submissions which the Contractor is required to make in relation to earthing installations shall include, where relevant, the following;

#### **(a) Drawings**

Diagrams detailing the complete earthing installation, including connections to all items of electrical plant and extraneous metalwork.

Earthing conductor route and layout giving:

- Location of all test links
- Location of all earth electrodes and connecting chambers

#### **(b) Data**

Manufacturers catalogues, data sheets and specifications for all fittings and materials.

#### **(c) Calculations**

Calculations for:

- Earth resistance
- Potential rise
- Step and touch potentials

#### **(d) Test Certificates**

Certificates for tests carried out at site including:

- Earth electrode resistance
- Continuity of protective and equipotential bonding conductors
- Earth loop impedance

### **b. General**

Earthing systems shall comply with SSRN 065 (a) and IEE Wiring Regulations (16<sup>th</sup> Edition) as stipulated under SSRN 065 (b).

For general earthing the KPLC terminal shall be used. The Contractor shall be responsible for obtaining and complying with KPLC earthing requirements.

The Contractor shall obtain Earthing Declaration forms where required by KPLC and shall be responsible for its completion and submission to KPLC when the installation is complete and ready for bonding to the earth terminal. A copy of this form or any other documents pertaining to earthing shall be sent to the Engineer.

In view of the hazards associated with earth leakage current, particular attention is to be directed to careful bonding and earthing of all electrical apparatus. In general, the following principles which apply to all surface plant and items shall be adopted.

The metalwork of all items of electrical plant, electrical system neutral points, power and control cable armouring and screens, and extraneous metalwork, including structural steelwork, pipework, fences and gates, shall be connected to the earthing installation.

Earth continuity in non-electrical plant shall normally be achieved via metal to metal faces, pipe flanges, metal hinges, and metal fixings. Earth straps to bond pipework sections shall be supplied where earth resistance is high or there is risk of corrosion or similar which could in the future increase resistance and affect earth continuity.

Perimeter fences shall be either bonded to the earthing system. Metal gates shall be bonded to the fence using flexible connections.

### **c. Installation**

The earthing installation shall comprise an earth terminal, earth busbars, circuit earthing conductors, equipotential bonding conductors, main earthing conductor and earth electrodes. The circuit earthing and equipotential bonding conductors shall be of the radial, grid or ring form as dictated by the plant layout.

The earthing installation shall be protected from mechanical damage and corrosion.

Joints in tape conductors shall be riveted and soldered, brazed, clamped, bolted or exothermically welded. Non-corrosive flux shall be used for soldered joints. Clamped and bolted type joints shall be tinned and shall only be used above ground.

The interconnection of conductors below ground shall be by means of exothermic welding or brazing. Compression type lugs shall be provided for the termination of cables.

Earthing conductors shall be buried directly in the ground or secured to building structures, cable racks and trays using propriety fixings.

Where the soil is aggressive to copper, buried earthing conductors and joints shall be protected by an approved serving.

An equipotential bond shall be provided to all buried metal pipework at the point of entry into a building or chamber where electrical apparatus is installed. Electrical continuity across all pipe joints within the structure shall be ensured. Normally the connection of the pipe flanges will suffice, but where pipework incorporates a compression coupling (e.g. Viking-Johnson coupling), a bond shall be provided to any otherwise isolated section.

Cable armouring and screens shall be bonded to earth at both ends unless otherwise specified. Cable armour shall not be used as the sole earth protective conductor.

### **d. Substation Earthing**

Two 240 mm x 16 mm earth electrodes shall be driven in to the ground in the immediate vicinity of the substation at least 3m apart with their tops below ground level (and accessible via an earth manhole). The electrodes shall be interconnected with a 70 mm<sup>2</sup> bare copper conductor buried 600mm below ground level. A 70mm<sup>2</sup> earth conductor shall be taken from each of the two electrodes, one to the transformer neutral terminal and the other to the main earthing bar in the transformer room.

The earthing point in the transformer room shall be connected to the substation main earth bar (50 x 6 mm) by a minimum of 2 x 70 mm<sup>2</sup> insulated copper conductors. Details of the main earth bar are provided under (F) below. All earth wires shall be secured to the earth bar by means of M10 brass bolts. Locknuts shall be provided for all the terminals. The point of origin of each earth conductor must be

clearly indicated by means of a metal strip tag attached to the conductor in such a way that the conductors can be easily identified.

The HV switchboard, transformer earthing terminal and cable supports shall be bonded to the main earth bar by means of 70 mm<sup>2</sup> earth conductors. The neutral busbar and the earth bar in the main LV switchboard shall be bonded to the main earth bar with an earth conductor having a cross-sectional area of not less than half the size of the phase conductor between the transformer and the main LV switchboard. A bolted test link shall be provided between the bar and the connection to the earth mat or rods.

#### **e. Ring Main Earth System**

A 70 mm<sup>2</sup> bare stranded copper conductor is to be run as a ring main system throughout the plant and must be connected to all substation earth bars and distribution pillar earth bars.

Individual items of apparatus are to be bonded to this ring by bare copper conductors as detailed below:

For any apparatus, by a bare stranded conductor having a conductor cross-sectional area of not less than half of the phase conductor except that:

- it need not exceed 70 mm<sup>2</sup>;
- it shall not be less than 2.5 mm<sup>2</sup> except for circuits with phase conductors below 2.5 mm<sup>2</sup> in which case, it shall be the size of the phase conductor;
- the earth conductor shall be run as a separate cable or wire for the feeder cables;
- for conduit installations, a separate PVC insulated earth conductor shall be run together with the phase conductors as sized above.

#### **f. Conductors: General**

Circuit and main earthing and equipotential bonding conductors shall be high conductivity copper tape or 1000 V grade PVC insulated multi-stranded cable. PVC cable insulation shall be stripped green/yellow. Cable lengths shall be continuous and intermediate jointing is not permitted.

The main bonding conductor shall be not less than 16 mm<sup>2</sup> and supplementary bonding of non-electrical plant not less than 10 mm<sup>2</sup>. All connections shall be made using compression type cable lugs, taped on completion to completely seal the lug and any bare copper from the atmosphere. Soldered lugs are not permitted. Earth conductor terminations and connections shall be as follows:

- Copper Tape: rivetted and brazed, or thermite type weld;
- Stranded Conductor: crimped lugs bolted to the equipment or earth bar;
- Connections between Stranded Conductors: brazed, thermite type weld or crimped.

The surface to which earthing bonds are fixed shall be cleaned free from paint and other non-conducting material and coated with petroleum jelly.

#### **g. Conductors: System with Neutral Earthed Solidly**

For systems where the neutral is solidly bonded to earth on the secondary side of the transformer as distinct from those earthed through an earthing transformer or resistor, where the earth fault current is limited, the fault level must be taken in to account when making the following connections:

- System neutral to main earth bar: conductor to be insulated;
- Transformer frame to main earth bar;

- Main switchboard frame to main earth bar.

#### **h. Earthing of Cable Armouring**

All cables provided with metal sheaths, screens and /or armour shall be terminated in approved glands.

Unless otherwise specified, the gland shall form a good electrical connection with the gland plate. The electrical continuity shall be assured if required by additional connections.

#### **i. Earth Electrodes**

Earth electrodes where used shall be solid copper or copper clad high tensile steel rods with a copper plate thickness of not less than 0.25 mm. The outer diameter shall be not less than 16 mm. The rod shall penetrate a minimum of one metre below ground level. Where multiple rods are used they shall be separated by a distance of not less than the driven length.

Earth rods shall have hardened tips and caps and be extendable.

Where soil conditions make the use of rod type electrodes impracticable a grid configuration may be used comprising horizontally buried bare high conductivity copper tape of dimensions 15 mm x 4 mm minimum. Tape shall be buried at a minimum depth of 600 mm.

Each earth rod shall be provided with a clamp fabricated from non-ferrous metal for the connection of the earthing conductor. The connection shall be made in a concrete inspection chamber set flush with the finished ground level. The inspection chamber shall be permanently marked "ELECTRICAL EARTH".

Marker posts and plates shall be provided to mark the position of the electrodes and buried connections. The markers shall be similar to those provided for cable routes.

#### **j. Earth Resistance Measurements**

The Electrical Contractor shall carry out earth resistance measurements on completion of the installation of the earthing system and the results shall be submitted to the Engineer Should the earth resistance exceed the value given by the formula: -

$$Z = A/B; \text{ where: -}$$

$$Z = \text{Earth Impedance}$$

$$A = \text{Protective Device System Phase to Neutral Voltage;}$$

$$B = \text{Protective Device Maximum Rated Current} \times 2$$

the Engineer may request the Electrical Contractor to install additional earth electrodes or trench earths and/or separation of the neutral and/or installation of a earth leakage device.

Generally, the resistance to earth of each complete earthing network shall not exceed 1 ohm.

#### **k. Main Earth Bar**

Where specified, a main earth bar shall be installed in a convenient location. This shall comprise a high conductivity copper bar of sectional area at least that of the main earthing conductor. The earth bar shall be wall mounted, supported on insulators. The earth bar shall be complete with disconnecting links for test purposes, and connection points for the outgoing and incoming earth cables and tapes.

Earth studs shall have a minimum size of M10.

## **l. Earthing of Buildings**

Earthing of all the electrical equipment, circuits and outlets shall be carried out in accordance with the requirements of the local supply authority and the relevant wiring regulations. All metal conduits and metal sheaths of cables shall be bonded to the metalwork of their termination gear. Each building shall have an associated terminal to which all metal bodies required to be earthed shall be connected. The earth terminal shall be connected by an earthing lead to an effective earth electrode situated as near the building as practicable (TT System); to the neutral conductor (TN-C-S/PME System); or to the PEN conductor (TN-C System).

The earth lead shall not be smaller than 25 mm<sup>2</sup> of stranded copper conductor.

The resistance from the earthed end of the earthing lead to any earth continuity conductor in a building installation shall not exceed 0.2 ohm.

All metal water pipes, drain pipes, down pipes, conduit and guttering shall be securely earthed, contact surface being thoroughly cleaned. Wire used shall be stranded copper of not less than 4 mm<sup>2</sup> or 12 x 0.8 mm perforated or solid strapping. The earthing conductor shall be fixed to the pipework with brass nuts and bolts; and against walls with brass screws at 300 mm centres. In all cases where metal water pipes, downpipes, flues etc are positioned within 1.6 m of switchboards, an earth connection shall be installed between the pipework and the board. In vertical building ducts accommodating both metal water pipes and electrical cables, all the pipes shall be earthed at each distribution board.

## **m. Miniature Substation Earthing**

The earthing of mini-substations is similar to the earthing requirements of substations described above except that a main earth bar is not required. The earthing bar in the LV compartment shall become the main earth bar. The HV switch, transformer earth terminal and neutral busbar shall be bonded to the earthing bar in the LV compartment described for substations.

## **n. Switch Rooms**

The earthing of switch rooms utilising earth electrodes is similar to the earthing requirements of substations described above. A main earth bar is required to which the earthing electrodes and the HV switchboard shall be bonded by means of 70 mm<sup>2</sup> earth wires.

## **o. Outdoor Equipment**

In cases where substation contain transformers or switchgear installed outdoors, the fence shall be earthed as follows if no other method is specified:

- i. A 70 mm<sup>2</sup> earth wire shall be installed 400 mm below ground level and 500 mm from the fence on the outside of the substation along the entire length of the fence. This earth conductor shall be earthed at each corner by means of a 2400 x 16 mm earth electrode. Both the electrode and the earth conductor bonded to the fence. The earth conductor shall also be bonded, at least at two points, to the main earthing system.
- ii. A 70 mm<sup>2</sup> earth wire shall also be buried at a depth of 400 mm around each transformer and switch and bonded to the main earthing system.



## **724LIGHTNING PROTECTION**

Where buildings or sections of the plant are to be protected against lightning or static charges, an earthing system shall be provided. The installations shall be carried out in accordance with SSRN 073.

The down connectors shall be of hard conductivity copper of 25 mm x 3 mm section. One down conductor within a length of 30 m shall be provided. The tape shall be fixed to the outside of the structure by means of standoff saddles. Where indicated, connections shall be made to the concrete reinforcing. The route of the tapes and the fixings shall be approved by the Engineer before installation.

Where the framework of a building is constructed of structural steel columns, these may be used in place of down conductors provided that the separation distance between them does not exceed 30 m. The upper ends of the columns shall be bonded to the roof conductors and the lower ends to the earth system.

The reinforcing steel of a building may be used as a down conductor provided it is adequately bonded to the earthing system.

The reinforcing system of prefabricated buildings shall not be used unless special provision is made for bonding the various prefabricated sections together, or to the reinforcing steel of an in situ cast section of the building.

Where the conductors specified shall be PVC insulated to prevent corrosion and to blend with the building fabric.

A test link shall be installed in each down conductor adjacent to the earth rod at a height of 1200 mm above ground level. The overall resistance of the earth termination system to earth shall not exceed 10 ohms. If this requirement is not met the number of earth electrodes shall be increased or they shall be interconnected until a value of 10 is attained. After this resistance value is obtained, the lightning protection system shall be bonded to the main earthing system.

Each earth termination shall comprise a tinned copper plate of size 900 x 900 x 3 mm, one of which shall be riveted and soldered to each down conductor. Alternately, copper weld earth spikes 10 x 2400 mm may be used, or a trench earth comprising 70 mm<sup>2</sup> diameter rods.

Earth plates shall be installed at a depth of 1800 mm below finished grade and at a minimum distance of 3 m from the building. The soil shall be reinstated in 250 mm layers and thoroughly mixed with rock salt.

Care shall be taken when bonding dissimilar metal to prevent electrolytic corrosion. All bi-metallic joints shall be sealed with an inert, tenacious, waterproof compound.

Air terminals shall be of medium/hard-drawn phosphor bronze rod of 12.5 mm diameter with single or multi point heads, with suitable means for connecting to the roof (horizontal) conductors. The minimum height shall be 900 mm.

Roof or horizontal conductors shall be of soft annealed copper strip having a cross-sectional area of 20 x 3 mm and shall run as directly as possible between the air terminal and the earthing system.

## **725CABLES AND WIRES**

### **a. General**

Cables and wires shall be supplied by an approved manufacturer and where possible the same manufacturer shall be used for all cables and wires. Each drum or coil of cable shall be accompanied by a certificate stating the manufacturer's name, rating of cable, result and date of tests. Cables manufactured more than 12 months before delivery will not be accepted.

All cables shall be delivered with cable ends effectively sealed. When a cable is cut from a drum both ends shall be immediately sealed to prevent ingress of moisture. Cables shall not be transported to site in loose coils but a number of short lengths of cable may be transported on the same drum. The Contractor shall be wholly responsible for the purchase and/or hire costs of all cable drums.

Cables and wires shall be adequately rated for current carrying capacity under normal and short time fault conditions at the specified voltage.

When assessing the rating and cross section of any cable or wire, the following factors shall be taken into account:

- Maximum voltage drops permissible
- Type and magnitude of load
- Fault level and duration related to circuit protection relays and fuses
- Over-current setting of relays
- Route length and disposition of cables
- Ambient temperature
- Method of laying

The Contractor shall submit cable schedules for approval detailing ratings, sizes, lengths, method of installation and function of all individual cables.

### **b. Cable Types**

Cables complying with the relevant standards stipulated in the SSRN will be accepted provided that all cables which are supplied for a specific operating voltage are to the same national standard. Each cable shall be in accordance with a standard which relates to its application.

Standards specified in the following clauses indicate the type of cables which may be used in the design. If the Contractor wishes to use cables to an alternative standard then details of current carrying capacity, derating factors, etc. shall be submitted to the Engineer for approval.

#### **(i) High Voltage Power Cables**

XLPE/SWA/PVC—semi-conducting conductor screen, cross linked polyethylene insulation, stranded copper conductors, core screen of semi-conducting compound, semi- conducting tape, and metallic layer, extruded PVC bedding, galvanised steel wire armoured, flame retardant red PVC sheathed overall, suitable for use on an earthed system of the voltage specified. Cables shall comply with the relevant requirements of

(ii) Medium/Low Voltage Power Cables

XLPE/SWA/PVC – cross linked low density, polythylene insulated, stranded copper conductors, extruded PVC bedding, galvanised steel wire armoured, flame retardant black PVC sheathed overall, suitable for use on an earthed system at a rated voltage of 0.6/1kV or 1.9/3.3kV as specified. Conductor temperature shall not exceed 90°C for continuous operation and 250°C for short circuit.

PVC/SWA/PVC – PVC insulated, extruded PVC bedding, galvanised steel wire armoured, flame retardant black PVC sheathed overall, stranded copper conductors suitable for operation on a system at a rated voltage of 0.6/1 kV. Conductor temperature shall not exceed 70°C for continuous operation. Cables shall comply with SSRN 024.

PVC/PVC – PVC insulated extruded PVC bedding, flame retardant PVC sheathed overall, stranded copper conductors suitable for operation on a system at a rated voltage of 0.6/1 kV. Maximum conductor temperature shall not exceed 70°C. Cables shall comply with SSRN 024.

PVC – PVC insulated single core copper conductor rated at 450/750 V. Insulation shall be phase coloured. Conductor temperature shall not exceed 70°C for continuous operation. Cables shall comply with the appropriate specifications given in SSRN 074.

(iii) Submersible Borehole Pump

PVC/PVC – PVC insulated, tough rubber sheathed overall, stranded copper conductors suitable for operation on a system at a rated voltage of 0.6/1kV. The cables shall be four core, 3 phase and earth without any armouring wires or screen. The cable format shall either be circular or flat.

(iv) Flexible Cables and Cords

General purpose – PVC insulated stranded copper conductors white PVC sheathed overall, rated at 300/500 V in accordance with SSRN 075.

(v) Instrumentation and Control Cables

(vi) Analogue Signal Cables

Cables shall be PVC or polyethylene insulated, twisted pair laid with individual or collective screen, tape bound with extruded PVC bedding, galvanised steel wire armouring and overall PVC sheath. Conductors shall be multistrand copper, 24/0.2 mm (0.75 mm<sup>2</sup>) or as specified. Solid cores shall not be permitted. The cables shall be rated at 300/500 V and shall comply with the relevant section of SSRN 074.

Cables with a collective screen only are permitted for use where the signal is a high-level carrier (e.g. 4 - 20 mA dc) and the route length is not greater than 30 m. Where the route length exceeds 30 m or the signal is low level (e.g. from a strain gauge) cables shall have both individual and collective screens.

a. Digital Signal and Control Cables

Where the signal is based on a supply not greater than 24 V DC and the maximum ON- state loop current does not exceed 20 mA, then analogue type cables shall be used. Where the voltage and/or current exceeds these limits, the cables shall comply with one of the following specifications.

PVC/SWA/PVC – PVC insulated, extruded PVC bedding, galvanised steel wire armoured, flame retardant black PVC sheathed overall, stranded copper conductors suitable for operation on a system

at a rated voltage of 0.6/1 kV. Conductor temperature shall not exceed 70°C for continuous operation. Cables shall comply with SSRN 024.

PVC/PVC – PVC insulated, extruded PVC bedding, flame retardant PVC sheathed overall, stranded copper conductors suitable for operation on a system at a rated voltage of 0.6/1 kV. Conductor temperature shall not exceed 70°C for continuous operation. Cables shall comply with SSRN 041.

### **c. Cable Labelling**

At each end of each cable, in a uniform and visible position a label shall be fixed on the cable to indicate that site cable number and route, and the number of size of conductors. Labels shall be made of brass, aluminium, lead or copper strip, engraved and retained by suitable non-rusting or non-corroding binding wire passing through two fixing holes, one at either end of the label. If the cable gland is not normally visible, then the label shall be fixed inside the panel by means of screws.

Three phase power cable cores shall be identified A, B, C or colour coded red, yellow, and blue so that the correct three phase sequence is preserved throughout the system. Single phase power cable cores shall be colour coded red, black.

On rotating plant where, to achieve the required direction of rotation it is not possible to connect the phase cores to the appropriately identified terminals, additional core ferrules shall be fitted to identify each core with the terminal to which it is finally connected.

Control cables shall have individual cores identified by means of suitable permanent ferrules bearing the same number at both ends.

Core identification shall occur at every point of termination using an approved system of ferrule markers. The size of the ferrule markers shall be such as to match the overall diameter of conductor plus insulation. Numbering shall read from the termination outwards on all cores.

Each cable and core shall bear the same number at both ends of the cable and core respectively.

Terminals shall bear permanent identification as follows:

- Power terminations - colour, number of letter
- Control terminations - letter or number or both

## **726CABLE INSTALLATION**

### **(a) General**

Non-sheathed single insulated wire shall only be installed in galvanised steel conduit or trunking.

Cables with sheaths but without any form of armouring shall only be installed in protected indoor locations such as floor ducts, conduits, or covered cables trays and ladders.

Cables with underground quality PVC sheaths and steel wire armouring may be installed in all locations including being direct buried in the ground, pulled into underground ducts or clipped direct to a surface or uncovered cable tray.

Single core cables shall not be used unless absolutely necessary (e.g. feeder cables from transformers to switchboards). Where the installation method requires armouring, this shall be of the non-magnetic type formed from hard drawn aluminium strip or wire. No single core cables shall be direct buried in the ground.

Where cables are run together in the same tray, trench or conduit they shall be suitably derated or spaced to maintain current rating. Crossovers shall be avoided where possible. Large power cables (e.g. those carrying in excess of 50 A), and signal cables shall be run separately to minimise interference.

Where a number of cables are terminated in equipment, they shall finally approach the equipment from a common direction. Top and bottom entry methods shall not be mixed in the same panel.

Cables shall be complete with all saddles, cleats, hangers, brackets, trays, ladders, ties, nuts, bolts, screws, washers, packing, ducts, sand, concrete covers, marker tape and route marker posts as may be necessary to complete the installation.

Marker tape shall be placed in the ground above cables laid underground either direct buried or in ducts. The tape shall be 150 mm wide, yellow with black printing "DANGER- ELECTRIC CABLES".

All cables of less than a complete drum length shall be installed without joints except where approved by the Engineer.

Unless unavoidable, cables shall not be installed in areas of direct sunlight. Where it is necessary, sunshields constructed to the approval of the Engineer shall be supplied and installed.

#### **(b) Submissions by the Contractor**

Submissions which the Contractor is required to make in relation to the cable installation shall include, where relevant, the following:

##### *a. Drawings and Schedules*

Block diagrams to show control cabling systems with each cable and terminal equipment being identified as in the cable schedules.

Cable route and layout drawings.

For those items which are underground these drawings shall include the following:

- Route plans for all cables, cable ducts and cable trenches.
- Sectional views of all cable ducts, trenches etc. for each different section throughout the route.
- The position of all marker posts, joints, drawpits etc.

Route plans and section views for all cable trays and cable runs.

Cable schedules, which shall detail the cable number, type, voltage, size, route, length, and number of cores. Control cable schedules shall detail the connected and spare core numbers, diagram numbers of connected equipment, core ferrule and terminal reference numbers.

##### *b. Data and Calculations*

Manufactures catalogues and data sheets for all cables and fittings. Cable sizing calculations.

##### *c. Test Certificates*

Test certificates for all witnessed and routine tests carried out at the manufacturer's works and at site.

### **(c) Installation Direct in the Ground**

A cable buried in the ground shall be of a construction incorporating an earthed armour or metal sheath or both or be of insulated concentric construction in accordance with the relevant section of SSRN 065.

Power cables of rated voltage up to 1000 V shall be buried at a depth of 500 mm to the cable centre. Power cables of rated voltage above 1000 V up to and including 12 kV shall be buried at a depth of 800 mm to the cable centre. The depth of laying shall only be varied due to the presence of other cables or services. The laying of cables at excessive depth will not be accepted. Unless avoidable, cables shall not be routed below pipes.

The bottom of excavated trenches shall be free of sharp stones and other obstacles and shall be covered with sand or fine sifted soil compacted to a depth of 50 mm.

Cables shall be unrolled from the drums in such a manner as to avoid loops and kinks, and care shall be taken when laying or pulling into ducts to avoid damage to the outer sheath by drawing over sharp obstacles, edges, or stones. Cables pulled in either by machine or by hand shall be pulled in using rollers to prevent contact between the cable and the ground.

Cables shall be snaked into the trenches to avoid tension in the cables during backfilling or from subsequent settlement. After laying, cables shall be covered to a minimum depth of 100 mm of compacted sand or sifted soil and shall have a layer of protective concrete cable tiles laid above. The tiles shall be overlaid with marker tape.

Where cables of different voltages are laid together at the same depth, vertical cable tiles shall be used to segregate the cables.

Control, instrumentation and communication cables shall be laid not closer than 1000 mm to high voltage cables.

### **(d) Installation in Underground Ducts**

Underground ducts shall be constructed of impact resistant uPVC and shall be laid at a minimum depth of 500 mm (to the duct centre). The duct shall be surrounded by not less than 75 mm of sieved sand on all sides. At road crossings, uPVC ducts of minimum diameter 100 mm shall be laid at a minimum depth of 1000 mm (to the duct centre). The duct shall be surrounded by not less than 150 mm of concrete on all sides.

When installing cables in ducts the following measures shall be observed;

- cables shall be pulled in a straight line
- rollers shall be positioned at the ends of the ducts both at the drawing in and drawing out points over which the cables are to be drawn
- uPVC ducts and cables sheaths shall be coated with an approved lubricant
- the maximum distance between draw-pits shall be the guaranteed minimum length of cable on each drum, making allowance for jointing.
- adequate space shall be allowed in each draw-pit for the installation and jointing of cables
- the pulling rope shall be guided by rollers
- only one large scale shall be drawn into each duct

- where more than one small cable is to be pulled into the duct, all cables shall be pulled simultaneously.

Whenever a duct is laid in the ground, a draw wire or man-made fibre rope shall be pulled in and at least 1,000 mm excess length shall be left at each end.

#### **(e) Sealing Cable Entries into Buildings**

Where cables pass in or out of duct entries into or within buildings, these entries together with any spare ducts shall be effectively sealed against the ingress of moisture. The sealing method shall have a fire resistance of not less than 30 minutes.

#### **(f) Marking of Underground Cables**

The location of all underground cables shall be identified by:

- engraved plates fixed to the exterior surface of the walls of buildings 300 mm above ground level, directly above the point where cables pass through the wall
- marker posts on road verges, etc. at intervals of not more than 100 m and at all junctions and changes of direction along the route
- marker posts at 10 m intervals within an enclosed site and at all junctions and changes of direction along the route

Marker posts shall be of concrete, not less than 200 mm high and shall have an enamelled metal plate affixed giving the details of the cable the below including the depth and voltage rating. A drawing or sample of a typical marker post shall be submitted to the Engineer for approval.

#### **(g) Installation in Cable Trunking**

Cable trunking shall be manufactured from hot dipped galvanised mild steel of thickness not less than 1.25 mm. The trunking shall have two return flanges for rigidity. Where necessary, additional strengthening straps shall be fitted internally. The cover shall overlap the trunking and be made of the same gauge steel. All bends, tees and intersections shall be of the gusset type and shall, where possible, be purpose made by the manufacturer and of a matching design to the main trunking. Retaining straps shall be fitted to hold cables within the trunking when the cover is removed. Barriers formed from continuous sheet steel with the bottom edge welded to the trunking shall be installed where it is necessary to segregate cables.

The size of the trunking shall be adequate for the number of cables to be installed together with 50% spare capacity. Trunking shall have minimum dimensions of 50 mm x 50 mm.

Internal connecting sleeves shall be fitted across joints in the trunking and earth continuity ensured by bonding each section of trunking to a continuous earth wire.

Non-flammable fire barriers shall be inserted where the trunking passes through walls or floors.

Conduit connections to trunking shall be made by flanged couplers and internal brass bushes.

Trunking shall be supported at intervals not greater than 2 m horizontally or 2.5 m vertically.

Crossings over expansion joints shall be made in flexible conduit.

Whenever trunking is cut or drilled the bared sections shall immediately be given a coat of zinc rich cold galvanising paint.

Cable and trunking runs shall be determined by the Contractor and agreed by the Engineer before any work is started. A clearance of not less than 150 mm shall be maintained between the trunking and plumbing or mechanical services.

Trunking systems erected outside a building shall be weatherproof.

#### **(h) Installation in troughs and trenches**

Where the building structure incorporates purpose built covered trench systems, power distribution cables may be laid on the floor of the trench. Control and instrumentation cables shall be segregated and installed on cable trays or ladders fixed to the walls of the trench.

Where the building structure incorporates general service trenches containing pipework, chemical lines and other services, all cabling shall be segregated from other services and run on cable tray or ladder fixed to the trench walls. Crossovers shall be kept to a minimum and cabling shall be taking above wet service pipework.

#### **(i) Cable tray and ladder**

Cable tray and ladder shall be of hot dip galvanised perforated steel of thickness not less than 1 mm for trays up to 100 mm width, not less than 1.25 mm for trays from 100 mm to 150 mm width, and not less than 1.5 mm for trays from 150mm to 300mm width. Cable tray and supports shall be manufactured in accordance with the relevant requirement of SSRN 076.

Cable tray and ladder supports shall be of ample strength to maintain rigid support to the fully laden cable tray along its entire length. All brackets and traywork shall be suitable for withstanding the normal weight of the cables fixed to it together with a temporary weight of 125 kg.

Wherever possible, cable tray shall be installed in full lengths without cutting. Where tray is cut or drilled the bared sections shall be dressed and immediately be given a coat of zinc rich cold galvanising paint. Similarly, for PVC coated trays, the bared sections shall be immediately sprayed using a PVC aerosol.

#### **(j) Installation in buildings**

Cables to be run on walls, ceilings, or other structures shall be supported on tray or ladder racks or enclosed in conduit or trunking.

All cables shall be neatly run vertically or horizontally parallel to adjacent walls, beams or other structural members.

Cable hangers, cleats, saddles, brackets and similar supporting devices shall be of an approved type and of adequate strength for the cables they are supporting. They shall be treated to withstand site conditions without corroding. Self-locking plastic buckle clips and strapping shall not be used.

Hangers shall be spaced according to recommendations in the IEE Wiring Regulations. Allowance shall be made for expansion and contraction of the cables.



**(k) Cable installation in conduit**

a) General

Conduits shall be either galvanised heavy gauge steel screwed type or light-gauge steel non-screwed type, steel or PVC. Accessories shall either be malleable cast iron or pressed steel.

Conduits and fittings shall comply with the appropriate standards stipulated in SSRN 076 as appropriate.

A space factor of 40% shall not be exceeded, and in any case conduit of less than 20 mm diameter will not be permitted. The tubing is to be perfectly smooth inside and out and free from imperfections. Both ends of every length of tubing shall be reamed with all sharp edges removed before erection.

Where conduits converge, adaptor boxes shall be used. Conduits shall be connected by means of male brass bushes and couplings. Where conduits are greater than 25 mm, straight through joint boxes shall be of the trough type.

Where conduit or fittings are attached to equipment casings, the material of the casing shall be tapped for a depth of not less than 10 mm or male bushes and flanged couplings may be used.

Hexagonal lock nuts shall be used at running joints and shall seat firmly and evenly onto mating faces. Lock nuts shall not be used at non-running joints.

All junction boxes, draw-in boxes, and inspection fittings shall be placed so that the cables can be inspected, withdrawn and re-wired during the life of the installation.

Generally, not more than two bends or offsets or one coupling will be permitted without a suitable inspection accessory. Fish wires shall not be left in conduits during erection. The whole of the installation shall be arranged for a loop-in type of system with joints being carried out at switches, isolators or appliance fittings.

Ends of conduits which are liable to be left open for any length of time during building operations shall be plugged to prevent the ingress of dirt and covers shall be fitted on all boxes.

Generally, conduits shall not cross expansion joints of buildings. Where they cannot be installed in any other manner, a galvanised flexible conduit shall be used across the expansion joint. A total of 150 mm movement shall be allowed.

In all spare (empty) unwired conduits and conduits for the services of others, such as telephones, aerial systems etc., the electrical contractor shall install suitable rust proof draw wires and leave ready for use by others. Empty conduit boxes, telephone boxes, etc. are to be provided with blank plates.

b) Surface installation

Surface conduits shall be secured and fixed by means of distance spacing saddles or clips which allow the conduits to be taken directly into accessories without sets or bends. Conduits shall be run in a square and symmetrical manner. Runs shall be properly ventilated and allow for drainage of condensation. All surface conduit runs shall be marked out for approval by the Engineer before the installation is carried out. Where large multiple parallel conduit runs occur, galvanised trunking may be used instead.

Conduits installed on structural steelwork shall be secured by girder clips, drilled and tapped to the metalwork. Power driven fixings shall be used only with the approval of the Engineer. Any drilling or

access which is required through any structural member of the building shall be agreed with the Engineer before carrying out the work.

Exposed threads and plates where galvanising has been damaged shall be cleaned and then painted with two coats of an approved metallic zinc-based paint. This treatment shall be applied as the work proceeds.

c) Concealed installation

Concealed conduits shall be securely fixed to prevent movement before laying of screed, floating of plaster, casting of columns or other building operations necessary after the conduit installation. Crampets or similar fixings shall be used for attaching the conduit to blockwork, etc. Building nails will not be accepted.

At least 15 mm shall be allowed for finishes over the conduit. Where this cover cannot be maintained then expanded metal shall be fitted over the conduit. Conduit cast into reinforced concrete floors shall be fixed to the steel reinforcing. Concrete shall be prevented from entering conduit boxes when being poured. Where possible, the conduit boxes shall be fixed to shuttering to give a flush finish.

Conduit installed in voids, false ceilings, and other concealed routes shall be installed as specified for surface conduits. Draw-in wires shall not be pulled into the conduits during erection. Wiring shall be carried out after the false ceiling or permanent ducts have been completed. Conduit installed in floors shall be sealed against ingress of moisture.

The conduit installation shall be inspected by the Engineer before the building operation conceals the work.

d) Flexible conduits

Flexible conduit shall be of the waterproof galvanised type of PVC wire-wound type with cadmium plated mild steel couplings. Lengths of flexible conduit shall be sufficient to permit withdrawal, adjustment or movement of the equipment to which it is attached and shall have a minimum length of 300 mm. Flexible conduit shall not be used as a means of providing earth continuity. A single earth conductor of adequate size shall be installed external to the conduit complete with earth terminations.

Where conversion from rigid conduit to flexible metallic conduit is to be made, the rigid conduit shall terminate in a trough type box. The flexible conduit shall extend from this box to the equipment, the earth continuity cable shall be secured to the box and to the piece of equipment. The use of lid facing screws, etc. will not be permitted. Adaptors shall incorporate a grub screw or a gland to prevent the flexible conduit becoming loose.

e) PVC conduit

Where galvanised conduit is liable to corrosion, PVC conduit shall be installed.

PVC conduit shall be of the oval or round high impact non-flame propagating type as specified and self-extinguishing, to SSRN 082. Surface and concealed installations shall be generally as described for steel conduit.

PVC conduit fittings shall comply with SSRN 081. They shall all be white unless specified otherwise.

Jointing shall be carried out using a PVC solvent and socketed accessories. Expansion couplers shall be fitted in straight surface rings every 12 m. The free end shall be sealed with non-setting mastic to form a waterproof seal.

Purpose made bends may be used providing that the cable bending radius is maintained. Cracked or crinkled conduit will be rejected.

The conduit shall be suitable for use in ambient temperatures of between -5°C and 60°C and shall not be installed in areas that receive direct sunlight. A separate protective conductor (earth continuity conductor) shall be installed.

Adaptable boxes and accessories shall be made from heat resistant insulating material. The minimum wall thickness of boxes having a nominal internal depth of 16 mm or less shall be 1.5 mm. For deeper boxes the minimum wall thickness shall be 1.5 mm. For deeper boxes the minimum wall thickness shall be 2 mm. All boxes which are intended to support luminaries or other heat sources shall have either external fixing lugs rivetted to the metal fixing inserts or utilise steel insert clips.

## **727CABLE TERMINATIONS AND JOINTS**

### **a. Power cable terminations**

Power cables shall be terminated in suitable boxes arranged for bolting to switchgear, motor starters and motors. Each cable entry into a terminal box shall be made through a suitable gland.

Boxes shall be of adequate proportions to accommodate all cable fittings including stress cones or other means of insulation grading. Boxes shall be openable for inspection without disturbing the gland plate, cable or termination.

Where air insulated terminations are used, the cable crutch shall be protected by a heat- shrink trifurcating sleeve.

Cores shall have either crimped lugs or sleeves to match either post terminals or bolted clamp terminals.

Glands for armoured cables shall provide a positive armour clamp to the box or switchgear coating. This clamp shall completely support the cable weight so that no tension is applied to the termination. The clamp shall also provide earth continuity and be of adequate size to withstand the full fault current of the system for one second.

Where single core glands are required, these shall be non-magnetic. The gland plate shall also be of a non-magnetic material. Removable connections for bonding across the gland insulation shall be provided. The gland insulation shall withstand a test of 2 kV AC for one minute.

Glands shall comply with SSRN 078 as appropriate. They shall seal the inner and outer cable sheaths against ingress or dirt and moisture and provide mechanical support. All glands shall be provided with an earthing tag.

Where cable glands are exposed to the weather these shall be protected by heat shrink or purpose moulded sleeves covering the gland continuously from the cable sheath to the gland neck.

Where the apparatus enclosure classification requires sealed cable gland entries, sealing shall be achieved by using threaded cable gland holes and polytetrafluoroethylene (PTFE) tape.

#### **b. Multicore or Control Cable Terminations**

A sufficient number of terminals shall be provided to terminate all cable cores. For control and auxiliary wiring an additional 20% of this number shall be provided as spares.

Terminal blocks for terminating up to and including 35 mm<sup>2</sup> cable shall securely clamp the conductor, without damage, between two plates by means of a captive screw; pinch screw type terminal blocks shall not be used.

For cables above 35 mm<sup>2</sup>, stud or bolted terminals shall be used, each cable core being fitted with a suitable lug.

Not more than one core of internal or external wiring shall be connected on any one terminal. Where duplication of terminal blocks is necessary, purpose made solid links shall be incorporated in the design of the terminal blocks.

Terminals which remain energised when the main equipment is isolated shall be suitably screened and labelled.

Terminal blocks for different voltages or circuit type shall be segregated into groups and distinctively labelled.

Plant which has to be dismantled for maintenance shall have multicore cable terminations made of through glands onto an adaptable box. The box shall have terminal blocks, and connections shall be made to the equipment by single core wires and flexible waterproof plastic conduit. A separate earth core shall link the box to the equipment.

#### **c. Joints**

Through joints shall only be allowed on long cable runs outside buildings. Where such joints are necessary in thermoplastic and elastomeric cables, the cables shall be jointed with epoxy or acrylic raisin cold setting compound, which has been pre-measured and pre-packed ready for use. The boxes shall be of split, moulded plastic type with filling vents for compound. Bonding straps shall be fitted with armour clamps across the joint and inspected by the Engineer prior to filling the box with compound. Wrapped pressure type joints will not be accepted.

Conductor cores shall be jointed number to number or colour to colour.

### **728SMALL POWER AND LIGHTING INSTALLATIONS**

#### **a) Distribution Boards**

Distribution boards shall be of folded sheet steel enclosed construction, braced to form a rigid structure. Doors shall be lockable, hinged and gasketed to give a damp and dustproof enclosure. The degree of protection shall be IP43 (indoors and IP55 (outdoors). The boards shall conform to SSRN 020.

The busbars shall be mounted on non-hygroscopic insulators, completely shrouded or PVC insulated, coloured to denote the appropriate phase. The current rating of the busbars shall be not less than the sum of the maximum current rating of all outgoing circuits. A neutral bar shall be provided with a separate terminal for each circuit.

A separate earth terminal block shall be provided with a separate terminal for each circuit. Distribution boards shall have a fault rating at least that of the system for one second. Removable top and bottom undrilled gland plates shall be provided with a brass earthing stud.

A switchfuse or isolator shall be connected on the incoming side of the board. The device shall be triple pole and neutral with over-current protection.

Each outgoing circuit including spare ways shall be protected by an HRC fuse or miniature circuit breaker (MCB). HRC fuse bases and carriers shall be of non- hygroscopic insulation.

Barriers shall be fitted over all live parts and spaces between phases. Each distribution board shall have a permanent circuit identification chart mounted on the inside of the front door.

Boards for use on DC systems shall be double pole types with fuses on the incomer.

#### **b) Bulk switching contactors**

Bulk switching contactors (e.g. for large lighting or heating loads controlled from a single switch) shall be of the air break electromagnetic type and shall comply with SSRN 007 and SSRN 008. The contactors shall be continuously rated for the duty specified, shall have a utilisation category ACi, and an ~intermittent duty class 0.3 with the characteristic mechanical endurance of that class. The current ratings specified shall be eight hour rated duty.

Contactors shall be single or triple pole as required, each type with a neutral terminal. Contactors shall be fitted with a continuously rated operating coil having both terminals brought out.

Enclosures shall be similar to those of distribution boards and shall have a degree of protection not less than IP52 to SSRN 012.

#### **c) Socket outlets**

Domestic and Industrial pattern socket outlets shall comply with SSRN 079 as appropriate.

In areas having plaster, tiled or other decorative finish, socket outlets shall be fitted flush with the finished area. In all other areas fittings shall, unless otherwise specified, be surface mounted.

Unless otherwise stated or indicated on the drawing, the mounting height of the bottom line of the outlet to:

- the working surface shall be 250 mm;
- the finished floor level in office areas shall be 400 mm;
- the finished floor level in garages and vehicle storage area shall be 1,350 mm.

#### **d) Lighting switches**

Internal lighting switches shall comply with SSRN 080 and the relevant section of SSRN 065 and installed in the positions shown on the drawings. They shall be supplied complete with box, cover plate and fixing screws. They shall be surface mounted metal clad type with aluminium or steel finished box.

At multi-switch positions, the switches shall be contained in multi-gang boxes.

External lighting switches shall be of the metal clad, galvanised and weatherproof pattern with rotary action. They shall be surface mounted.

Where operation of a lamp or group of lamps is required from two separate locations, two-way switches shall be fitted.

**e) Internal lighting**

Luminaires shall be complete with all supports, suspensions, flexible cables, pendants and plugs. They shall be connected to the main circuit wiring with heat resisting flexible cables of a minimum core size of 24/0.20 mm.

Protective classification shall be IP42.

The earthing of all luminaires shall be by a separate core in the connecting flex or cable, securely bonding the earth terminal on the fitting to that of the interconnecting cables.

Where adjacent luminaires are connected to different phases of the supply, a label shall be fitted internally, warning of the presence of the phase to phase voltage.

Luminaires shall not transmit load to suspended ceilings unless the ceiling and lighting is of integrated design with the appropriate supports.

Where high bay discharge luminaires are suspended from the structural ceiling, the connection between the fitting and fixed wiring shall be by plug and socket.

Lamp holders for flexible pendants shall be of the all-insulated skirted pattern with cord grips.

The fixings, connection boxes and other parts of the luminaires shall be erected at times to suit the building programme. The glassware, diffusers, shades, lamps and tubes shall not be fitted until all building work is complete. Fittings shall be left clean inside and outside and ready for use.

**f) Types of luminaires**

**a. Fluorescent**

Diffusers shall be of flame retardant extruded acrylic or GRP material. They shall be either opal or prismatic pattern as specified.

A gasket shall be fitted between the diffuser and the body to form an effective seal.

The luminaires shall comply with SSRN 081 as appropriate for ordinary, indoor normal atmospheres and for chemically corrosive atmospheres, where appropriate.

Fluorescent luminaires shall have two suspension or fixing points

**b. Incandescent luminaires**

Recessed downlighter luminaires shall be constructed from an aluminium alloy reflector and housing with adequate top ventilation holes. An adjustable position, porcelain lampholder shall be incorporated, pre-wired with heat resistant cable. Re-lamping shall be from below only.

Surface incandescent luminaires shall be of the white opal glass type suitable for wall or ceiling mountings.

**c. External lighting**

All external luminaires shall be of the totally enclosed fully weatherproof pattern with vandal-proof polycarbonate diffusers having a minimum degree of protection IP65 to SSRN 038.

Security lighting systems shall be designed to be inaccessible to intruders. Bulkhead luminaires shall have a cast aluminium alloy body, polycarbonate diffuser, gasket and porcelain lampholder.

d. Emergency lighting

Emergency lighting luminaires shall be of the self-contained or slave type as specified.

The luminaires shall be fully automatic in operation, providing instant illumination in the event of a mains failure. The battery capacity shall be sufficient to operate all luminaires connected to the emergency lighting system for a period of 3 hours.

**g) Lamps**

(a) General

All lamp holders shall be fitted with a lamp of a type and size specified by the manufacturer or as stated on the drawings.

(b) Fluorescent lamps (Designations MCFE/U and MCFAV/U)

Fluorescent lamps shall comply with the appropriate section of SSRN 081. Unless otherwise specified, lamps shall be coloured 'white' for industrial use and 'warm white' for commercial and domestic lighting. Lamp caps shall be of the bi-pin type. The guaranteed minimum life shall be not less than 3000 hours.

Metal strip lamps (MCFE/U) shall be used in glass reinforced polyester luminaires or where the metalwork is not within 20 mm of the lamp.

(c) Incandescent lamps

Incandescent lamps shall comply with the relevant standards in SSRN 081. General lighting service lamps shall have a coiled coil up to 150 W and single coil above this wattage. The lamps shall have standard bayonet cap and have an internally frosted glass envelope.

General lighting service lamps used for emergency lighting or lamps operating at a voltage different from the normal mains voltage, shall be fitted with an Edison screw cap. Lamps rated at 300 W and above shall have a Goliath Edison screw cap.

Guaranteed minimum life shall be not less than 2000 hours for lamps rated at 300 W and above and 1000 hours below 300 W.

(d) Mercury Discharge Lamp Fittings

Mercury discharge lamp fittings shall have combined parabolic reflector and control gear unit. Control gear shall be complete with power factor correction capacitor, high temperature 30 A connection terminals and choke. Fittings shall be suitable for connection to conduit and shall have slots in the top of the reflector to allow a flow of air to pass over the lamp and reflecting surfaces.

(e) High Pressure Sodium Lamp Fittings

High pressure sodium vapour lamp fittings shall have combined parabolic reflector and control gear unit. Control gear shall be complete with power factor correction capacitor, high temperature 30 A connection terminals and choke. Fittings shall be suitable for connection to conduit and shall have slots in the top of the reflector to allow a flow of air to pass over the lamp and reflecting surfaces.

**h) Low and Extra Low Voltage Supply Transformers**

Low and extra low voltage supply transformers shall comply with SSRN 028 and shall, unless otherwise specified, be of the single-phase type. Transformers shall be supplied complete with fixing bracket.

The rated output voltage and VA shall be as specified.

**729POWER/MANUALLY OPERATED OVERHEAD CRANES**

Cranes shall be manufactured in accordance with SSRN 087 medium duty class 2. For a generating station crane, its lifting capacity shall be 50% in excess of the weight of either the generator crankshaft, or the alternator, or of any other item which it could reasonable be required to lift, whichever is the heaviest. For a pumping station crane its lifting capacity shall be 50% in excess of the weight of either the heaviest main pump, or the motor which drives it, whichever is the heavier.

The winch shall be either of wire rope or chain as specified and the hook shall be provided with a safety latch.

The crane shall be complete with the gantry, angle support irons, columns, rails, end stops, holding down bolts and all other items required for a complete installation.

Sufficient slings, ropes, shackles, lifting beams etc. shall be supplied to allow the lifting of all the items plant served by the crane. In accordance with the safety mode, these shall be marked with their safe working load and the purpose for which they are intended.

The crane shall not be operated unless the Contractor obtains a test certificate after a statutory inspection of the crane by a person approved by the relevant authority to undertake such statutory inspections.



## **CHAPTER 8**

### **ELECTRO-MECHANICAL WORKS**

## **CHAPTER 8 - PARTICULAR SPECIFICATIONS ELECTRICAL AND MECHANICAL WORKS**

### **8001. PARTICULAR SPECIFICATIONS**

These Particular Specifications are to be read in conjunction with the General Specifications.

Specific technical data is provided under the Particular Specifications, which shall be supplemented by the particulars contained under General Specifications.

### **8002. DEFINITIONS**

In the Specification (as hereinafter defined) the following words and expressions shall have the meanings hereby assigned to them:

- a) **“Specification”** means this Specification together with the technical details given in the Bill of Quantities and, subject to the Engineer’s approval, the Contractor’s Drawings, Specifications and technical details.
- b) **“Supply”** and its derivatives means the complete design, manufacture, delivery to site, inclusive of such ancillary services as inspection and witnessed testing at the places of manufacture and shipment, workshop painting and of all such other services as are noted in the Specification or reasonably necessary for the safe, reliable and efficient completion of the Contract.
- c) **“Install”** and its derivatives means complete installation, on site painting and adjustments, testing and commissioning of the works and of all such other services as are noted in the Specification or reasonably for the safe, reliable and efficient completion of the Contract.
- d) **“Replacement”** and its derivatives means exchange of equipment, parts or similar with the latest model of the installed equipment or technically equivalent one of another manufacturer, inclusive of dismantling and removal of the existing equipment to the employer’s central store or off site as directed and all such other services as are noted in the Specification or reasonably necessary for the safe, reliable and efficient completion of the Contract.
- e) **“Overhaul”** and its derivatives where not detailed for specific items of plant, means dismantling, checking and testing to identify defective components, replacement of defective components, reassembly, commissioning and testing. Overhaul shall include the item covered under “servicing”.
- f) **“Repair”** and its derivatives where not detailed for specific items of plant, means, in addition to an overhaul, additional works such as diagnosis, machining, welding, etc.
- g) **“Service”** and its derivatives where not detailed for specific items of plant, means the cleaning with high pressure air, water and or steam; oiling and greasing; the adjustments of gaps, injectors, torques to ensure efficient operation of the machine; and the replacement of normally wearing items such as bearings, bushes, seals, gland packings, gaskets, voltmeters, ammeters, drive belts, etc.
- h) **“Spares”** and its derivatives where not detailed for specific items of plant, mean replaceable wearing parts and lubricants as required for normal maintenance of the plant.

- i) “**Rehabilitation**” and its derivatives where not detailed for specific items of plant means the reinstatement of plant by overhaul, repair and service to put the plant in its original working state.
- j) “**Quantities**” the quantities required for each item specified herein shall be as stipulated in the relevant BOQ.
- k) “**Painting**” and its derivatives means the surface treatment with wire brush or sand blasting and application of the primer and finishing coats as per the specifications.