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**Lake Victoria Basin Integrated Water Resource Management  
Programme (LVB-IWRMP)**

**NCB No. TR184/2025/2026/513719/W/01**

# **Procurement of Construction Works Mwanza Sewer Connection Upgrade**

## **BID DOCUMENT VOLUME II: TECHNICAL SPECIFICATIONS**

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#### **TECHNICAL SPECIFICATIONS**

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# LAKE VICTORIA BASIN INTEGRATED WATER RESOURCES MANAGEMENT PROGRAMME

## MWANZA SEWER CONNECTION UPGRADE

**NCB No. TR184/2025/2026/513719/W/01**

### **SPECIFICATIONS**

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## 1. GENERAL

All materials, equipment, and testing apparatus etc. to be furnished and Works to be executed by the Contractor in this Contract shall conform to the requirements of the latest Tanzania Standards, International Standards Organization (ISO), European Norm (EN), Deutsches Institut für Normung (DIN), British Standards (BS), or other approved applicable Standards in Tanzania.

Equipment to be purchased shall be from well recognized manufacturers whose products are standardized and controlled by any recognized Standards Organization.

All dimensions and measurement units shall be in S.I. units.

The equipment to be employed by the Contractor shall have sufficient performance capacity and durability as to secure the completion of the Works within the construction period stipulated under the Contract. All materials and equipment shall be subject to inspections or tests by the Engineer at any time and in any state of completion both off-site and on-site as he deems necessary. **The Contractor shall furnish promptly, without additional charge, all facilities, labour, and materials reasonably needed for performing such inspections and tests as may be required by the Engineer.**

The Contractor shall make diligent efforts to procure the specified materials, but when the materials specified are unavailable, for reasons beyond the control of the Contractor, substitutes may be used with prior written approval of the Engineer.

### 101. OFFICE FOR THE RESIDENT ENGINEER

The Contractor shall construct and maintain 1Nr. Site Office for the Resident Engineer's exclusive use, for the duration of the contract and the Defects Notification Period. The Office is to be constructed within the Project Area at a site to be identified by the Employer. This Office will be handed over to MWAUWASA at the end of the Defects Notification Period.

The New Office shall have a floor area of at least 200 square metres and shall be constructed within the initial 10 weeks. The Office shall be constructed to National Building By-laws for permanent buildings approved by the Engineer and shall be constructed of strong, durable, and weatherproof materials with walls, ceilings and floors adequately insulated against heat and cold.

The Office shall be provided with equipment and furniture detailed under the following Clauses. The Office shall have burglar proofing to all windows and external doors.

The Office shall always be provided with adequate and safe electricity supply with lighting and a minimum of two 13-amp double-sockets in each room. The electrical cabling and switches will be installed using three compartment plastic / metal trunking. The office shall have 24-hour Internet connections with hard wired networking between workstations.

The Office shall be provided with a graded, free-draining, and covered parking area with space for at least three vehicles. Rolled gravel pedestrian access shall be provided between the Office and parking area which shall be maintained in a clean and accessible condition. The Office shall be provided with continuous supply of running water.

Should the need arise to increase or decrease the floor area of the Office, then a cost adjustment (upwards or downwards) will be made to compensate for the increase or

decrease in size of the Office. This will be made under the appropriate item in the Bills of Quantities and shall be calculated on a pro-rata floor area basis.

**The Contractor shall rent temporary Office or construct Prefab Office at an agreed location for the initial 10 weeks and shall be positioned at a location to be approved by Resident Engineer.**

**101.(a) MAINTENANCE AND ATTENDANCE TO THE RESIDENT ENGINEER'S OFFICES**

Stationery required **per month** as follows (Stationery to be approved every month by the Engineer's Representative before ordering):

| <b>Stationery</b>                                | <b>Quantity</b> |
|--|-----------------|
| Photocopy paper A4                               | 4 Reams         |
| A3 paper   | 2 Ream          |
| Biro pens blue/black                             | ½ Doz.          |
| Clutch Pencils                                   | ½ Doz.          |
| Box files  | 6 Nr            |
| Spring Files                                     | 6 Nr            |
| Document Wallets                                 | 6 Nr            |
| Spirals (various sizes of Reports)               | 2 Doz.          |
| Embossed (hardback cover)                        | 2 Doz.          |
| Perspex covers                                   | 2 Doz.          |
| Cello tape (medium)                              | 1 Nr            |
| Masking tape (medium)                            | 1 Nr            |
| Staples  | 2 Pac.          |
| Paper clips (various sizes)                      | 2 Pac.          |
| Pencil leads (0.5/0.7)                           | 2 Sets          |
| C-DR (Pack of 12)                                | 1 Pac.          |
| CD-RW (Pack of 12)                               | 1 Pac.          |
| Highlighters (set of all colours)                | 2 Sets          |
| A6 hardcover notebooks                           | 2 Nr            |
| Soft Pencil Erasers (Staedtler or equivalent)    | 3 Nr            |
| Envelopes (all sizes)                            | 3 Doz.          |
| Batteries for flashlights                        | 3 Sets          |
| Black ink cartridge/ toner for the A4/A3 printer | 1 Set           |
| Colour cartridges/toner for the A4/A3 printer    | 1 Set           |

In addition, the Contractor to supply clean towels every day, soap, lavatory paper, disinfectant and cleaning materials, coffee/tea, milk, sugar, drinking water, etc. is to be provided and maintained throughout the Contract Period, adequate for 6 Supervision Staff and 12 additional guests. The List of Provisions and Consumables to be given by the Resident Engineer every month.

The Contractor will also be responsible for the following services for the Office:

- i) Payment for all services including water, electricity, sewerage, Telephone & Internet
- ii) Guarding of the premises (24-hour security services).
- iii) Maintaining insurance against theft of equipment and other materials from the offices.
- iv) Service, maintain / repair office equipment and appliances.

The cost of all the above services shall be included by the Contractor under the relevant item in Bill No. 1 – Preliminaries and General for Maintenance and Attendance for the Resident Engineer's Offices. Apart from the consumables, the rest of equipment will revert to the Employer at the end of the Contract.

**101.(b) STAFF FOR THE RESIDENT ENGINEER'S OFFICE**

The Contractor shall provide an Office Assistant (messenger / tea boy / office cleaner) exclusively for the Resident Engineer's Office.

The Contractor shall provide Chainmen for the sole use of the Resident Engineer for the whole period of the Contract.

**101.(c) PROJECT VEHICLES**

The Contractor shall provide, service and maintain the vehicles to be used for supervision of the Contract by the Resident Engineer and his staff.

The Contractor shall ensure Project Vehicles are licensed, comprehensively insured, serviced, and maintained in good condition to the satisfaction of the Resident Engineer or his authorized representative, to always ensure that the vehicles are available for use in good serviceable condition. In the event of the vehicles being unserviceable for whatsoever reason, the Contractor shall provide alternative vehicles at his own cost of the same model in compliance with the provisions of this clause. The cost for such replacement vehicle to be covered by his rates.

Payments for maintenance shall include for provision of fuels, lubricants and tyres, all regular maintenance, minor and major repairs, including those occasioned by accidental damage from whatever cause arising, and everything else necessary to satisfy fully the requirements of this Clause.

The makes, models and colours of the vehicles shall be subject to the specifications outlined in the Bill No. 1 – Preliminaries and General and shall be approved by the Resident Engineer prior to ordering while purchasing New Vehicles.

The Contractor shall, at completion bring the vehicle to the appropriate dealers for testing. The dealers shall recommend to the Engineer's Authorized Representative what repairs in addition to the ordinary service are required to be carried out on the vehicle. The Contractor shall then ensure the necessary service/repairs are done. A certificate of road worthiness and satisfactory mechanical condition to be obtained from the Dealer.

The following will be carried out:

- i. Inspection by the Government Inspection Unit, if applicable
- ii. Inspection and Valuation by the Automobile Association (AA) of Tanzania or equivalent approved body

The Contractor shall hand over the respective Inspection / Valuation Reports to the Employer together with the vehicles. The costs for Inspection and Valuation Reports are deemed to be covered in the Contractor's Rates. The vehicles will revert to the Employer at the end of the Contract.

**101.(d) DRIVERS**

The Contractor shall provide licensed drivers for the exclusive use of the Resident Engineer or his authorized representative. The drivers shall be available at all times during normal working hours and when specifically required by the Resident Engineer or his authorized representative, outside these hours.

The drivers shall have a minimum 10 years of clean driving record and a Certificate of Good Conduct from the Tanzania Police Force. The drivers are to be employed and paid by the Contractor (including all overtime, NSSF, NHIF, etc) but will report directly to the Resident Engineer for day-to-day instructions. The Resident Engineer will interview, test, and approve the drivers prior to their deployment on the Works.

Each driver shall be provided with uniform as follows, as a minimum, to be replenished / replaced as and when necessary, as directed by the Resident Engineer. The cost of uniform is deemed to be covered by the Contractor's monthly rate for the drivers.

- 2 Nr good quality Trousers - Navy Blue
- 3 Nr Shirts - Sky Blue
- 2 Nr woollen Sweaters - Navy Blue
- 1 Nr pair Hard Toe Shoes - Black
- 3 Nr Pairs of Socks - Black

**101.(e) SURVEY EQUIPMENT**

Listed below are the principal survey equipment to be made available for use by the Resident Engineer and his staff during the duration of Project Implementation. All equipment shall be new and with all necessary carrying containers, manuals, insurances, etc. The Equipment to revert to Contractor at completion of all Works.

| <b><u>Equipment</u></b>  | <b><u>Quantity</u></b> |
|--|------------------------|
| Total Station including tripods, complete with reflectors, poles, brackets and carrying case (Wild or similar) | 1Nr                    |
| Real Time Kinematic (RTK) GPS Machine with Base Station and 2Nr. Rovers (CHC or equivalent)                    | 1 Nr                   |
| Automatic Level (Wild or Similar) with legs and metric staff, complete with carrying case                      | 2 Nr                   |
| Metric extending levelling staffs with vertical bubble   | 2 Nr                   |
| 30m (enamelled or otherwise protected) steel bands   | 2 Nr                   |
| 3 metre ranging rods   | 15 Nr                  |
| Survey umbrellas with stand  | 4 Nr                   |
| Work boots   | 8 sets                 |
| Rain Gear (trousers and jacket type, complete with rain hat)   | 8 sets                 |
| Hard hats  | 12 sets                |
| 5 metre retractable pocket steel tapes   | 8 Nr                   |
| 30 metre metal tapes   | 3Nr                    |
| 100 metre metal tapes  | 3Nr                    |

| <b>Equipment</b>                   | <b>Quantity</b> |
|------------------------------------|-----------------|
| Builders spirit levels 1000mm long | 4 Nr            |
| Hammers 3 kg each                  | 4 Nr            |

The Contractor shall also supply pegs, crayons, spray paint, nails and all other items required for setting out and measuring the work.

The Contractor shall be responsible for maintaining the survey and field equipment throughout the Contract Period, including replacement of items damaged during the normal course of the Works.

The Contractor shall provide all such labour and assistance as may be required by the Senior Engineer for checking the Contractor's setting out and/or survey.

The Contractor shall make available such labour, materials, equipment and consumables as the Engineer may require from time to time, for inspections and tests in connection with the Works.

## **102. OFFICE FOR CONTRACTOR**

The Contractor shall have an office on Site to be approved by the Senior Engineer and which shall be open and attended to at all hours during which work is in progress.

## **103. CLIMATE CONDITIONS**

The Contractor to verify on his own the climate conditions in the Project Area with the Tanzania Meteorological Authority including rainfall, temperature, etc. and make his Work Plan accordingly.

## **104. LEVEL DATUM**

Before the commencement of Constructional Work, the Contractor shall establish, in a position to the approval of the Senior Engineer, a benchmark comprising of steel datum pegs which shall be securely concreted in. The level of these pegs shall be established and agreed with the Senior Engineer and all levels used in the construction of the Works shall be referred to these established datum points. The correctness of this datum shall be checked at regular intervals during the construction period as agreed with the Senior Engineer.

Where possible construction drawings and all levels used for construction shall be referred to the national height datum as defined by the Mapping Division of Tanzania (SMD). The Contractor shall be responsible for obtaining the location and values of the permanent benchmarks. In cases where such benchmarks do not exist, the site datum shall be agreed with the Senior Engineer.

## **105. SETTING OUT OF THE WORKS**

The Site Layout Drawings show indicative Site Layouts. Prior to commencing construction, the Senior Engineer will agree with the Contractor the basic information supplementary to that shown on the Drawings such as the position of manholes, chambers, centrelines, and base-lines sufficient for the Contractor to locate the Works.

The Contractor shall prepare detailed Setting Out Drawings and Data Sheets as necessary and submit them to the Engineer in triplicate for approval. Any modifications to the Setting Out Drawings or Data Sheets required by the Senior Engineer shall be made by the Contractor and resubmitted for final approval. Should it be necessary during setting out or during construction for the approved setting out details to be amended, the Contractor

shall amend the Drawings or Data Sheets or make new ones for approval as required by the Senior Engineer.

For sewers, the Contractor shall in the presence of the Senior Engineer set-out the pipeline alignments in accordance with the indicative alignments shown on the drawings taking into account physical features on the ground, any existing services, any requirements of relevant Authorities and any changes deemed necessary by the Senior Engineer, confirming the locations of all manholes, Chambers, etc.

The Contractor shall prepare and submit to the Senior Engineer, at an approved scale, Plans of the Sewer line Routes and profiles of ground levels after any initial clearing of the wayleave or easement showing the proposed pipe invert levels and precise chainages for all manholes, etc. for approval. Following approval, the Contractor shall submit to the Engineer two copies of the agreed alignment and profiles.

The Contractor shall also be required to carry out Site / Engineering Survey of demarcated land where permanent structures / appurtenances will be constructed as directed by the Engineer after initial clearance of sites. The Contractor shall prepare an updated layout plan with contours at 0.5m interval. The contours shall be generated from a topographic survey with gridline interval of 10m.

#### **106. CONTROL OF TRAFFIC**

In the event of single way traffic becoming necessary on any particular section of the Works, or on the approaches to the Works, the Contractor shall, in maintaining through traffic routes, provide a width of at least 3 metres for single way traffic. He shall also provide approved electrically operated signals for traffic control on each of the affected sections and any additional traffic signs as may be directed in accordance with Clause 108. Signal lights are to be operated by competent operators provided by the Contractor, if and when required by the Senior Engineer. Manually operated "Stop-Go" signs will only be permitted if approved by the Senior Engineer, and shall be of the size, colour and type authorized. The Contractor shall be responsible for liaison with Police.

#### **107. TEMPORARY DIVERSION OF TRAFFIC**

Temporary diversion ways, including those listed in any schedule to the Bill of Quantities shall be constructed whenever the site is intersected by existing public and private roads, footpaths, cycle tracks, farm accesses, temporary and accommodation roads.

Any diversion way shall be of such a standard of construction that it is suitable in all respects for the class or classes of traffic requiring to use it. It shall be constructed in advance of the taking up of the existing way and regularly maintained for so long as required in a satisfactory condition all to the approval of the Senior Engineer.

#### **108. TEMPORARY TRAFFIC SIGNS**

The Contractor shall erect and maintain on the Works and at prescribed points on the approaches to the Works, all traffic signs necessary for the warning, direction and control of traffic and the size of all such signs and the lettering and wording thereon shall be reflectorised or adequately illuminated at night by approved means.

#### **109. PROTECTION OF WORKS**

The Contractor shall carefully protect from injury by weather all work and materials which may be affected thereby.

### **110. 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 authorize 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, the Contractor shall forthwith report the damage to the Engineer and to the Director of Surveys and shall be held liable for the cost of reinstatement thereof.

### **111. DAMAGE TO LAND**

The Employer shall provide the Site upon which the Permanent Works are to be constructed. Where a drain or pipeline is to be within an existing road or track reserve or is otherwise located in land designated Public Domain, the Site width will be restricted to the limit of the public land. The existing boundary fences and walls shall not be disturbed without prior approval of the Engineer and, unless road diversions and closure notices are approved and posted, carriageways shall be left available for the safe passage of traffic.

Except where specified 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 of such interference, the Contractor shall make good to the satisfaction of the owner and the Engineer and shall pay to the owner such damages as the Engineer may determine.

The Contractor shall not enter upon or occupy with men, tools, equipment, or materials any land other than the site without the written consent of the owner of such land. On occupation of the Site, the Contractor shall provide such fencing, as required.

### **112. RIVERS AND DRAINS**

The Contractor shall at all times maintain the free flow of rivers and drains and prevent excavated material from the Works from being deposited in them.

### **113. REINSTATEMENT OF ROADS AND FOOTWAYS FOR SEWER CROSSINGS**

The Contractor shall allow in his rates for liaison with the relevant Roads Authority and obtain a Road Crossing / Opening Permit. Statutory fee for road crossings will be paid under relevant Item in the Bills of Quantity.

The road crossings shall be constructed in the following specifications and any other requirement stipulated by the Road Authority:

- Excavated width of the trench shall not be less than 1m to ensure compaction to required standard.
- Protective concrete raft slab shall be constructed for sewer pipes as per details given in the drawings.
- Backfilling shall be carried out with suitable selected excavated material up to the top 300mm, in layer thickness not exceeding 150mm at optimum moisture content.
- The top 300mm layer shall be backfilled in two layers of 150mm each comprising of well graded stabilized gravel with 3% cement content at optimum moisture content.
- Tarmac roads shall be reinstated to the original condition using approved asphalt from a recommended supplier.

The Contractor shall be responsible for all liaison with the Police for traffic control during execution of the works.

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

The Contractor shall provide, maintain, and remove on completion of the Works all temporary Works including roadways, sleeper tracks and stagings etc., over roads, footpaths, 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 and the approval shall not relieve the Contractor of complete responsibility for their safety and satisfactory operation.

#### **115. LIGHTING AND GUARDING OF OBSTRUCTIONS**

The details of the method of signing and guarding an obstruction to traffic caused in the course of the execution of the Works shall be submitted to the Engineer for approval before that portion of the Works is commenced.

No greater area of the road than the Engineer considers necessary shall be closed at any one time.

Temporary traffic signs shall comply with Clause 108. Generally, the following precautions will be required: -

##### **Signing**

An advance warning sign at least 1.22m x 0.92m in size and 70 metres in advance of the obstruction will be required, and where an appreciable change of direction is necessary at the obstruction, a sign (of the arrow or chevron type) at the obstruction itself. At particular danger points more comprehensive signing may be required.

##### **Guarding**

The obstruction shall be marked by posts carrying red flags or reflective red markers and by red lamps. The latter shall be spaced at 6 metres intervals in the direction of traffic flow and at 0.9 metres intervals across this direction. At least 3 lamps shall be placed across this direction of traffic flow. The flags and lamps on the traffic side of the obstruction shall be at least 5 metres from it.

##### **Footpaths**

Where a footpath is affected by an obstruction in any way it shall be separated from both obstruction and traffic by effective banners and red lamps spaced at 0.9 metres intervals.

#### **116. EXISTING SERVICES**

Before commencing Works, which include excavation or ground levelling, the Contractor shall at his own expenses ascertain in writing from Tanzania Telecommunications Company Limited (TTCL), Tanzania Electric Supply Company Limited (TANESCO). and all other relevant Public Utilities, Companies and persons who may be affected, the position and depth of their respective ducts, cables, mains, pipes, or other appurtenances. He shall thereupon search for and locate such services.

The Contractor shall at his own expense arrange to have effectively propped, protected, underpinned, altered, diverted, restored, and made as may be necessary, all water courses, pipes, cables or ducts, poles or wires or their appurtenances disturbed or damaged during the progress of the Works, or in consequence thereof.

Except that such services as required to be removed or altered by virtue of the layout of the permanent work and not the manner in which the work is carried out, shall be so removed, or altered at the direction and at the expense of the Employer.

The Contractor shall be liable for the cost of repairs to any services damaged as a result of carrying out the Works and execution of these Works.

#### **117. CONNECTIONS TO EXISTING PIPES AND EQUIPMENT**

The Contractor shall be responsible for joining up and making connections between water pipes, sewer pipes, etc. equipment installed by him and existing facilities. The Contractor shall submit to the Engineer, a drawing showing the details of the connection and shall state the date on which the particular connection is required, and the work shall not proceed until the Engineer's approval has been given.

The Contractor shall be responsible for ensuring the compatibility of new pipes with existing pipework, cables, tubing, equipment, etc.

#### **118. PRIVATELY OWNED OR PUBLIC SERVICES**

If any privately owned or public services passing through the site will be affected by the Works, the Contractor shall provide at his own expense a satisfactory alternative service in full working order to the satisfaction of the owner of the services and the Engineer before the cutting of the existing service. Any damage to private or public services shall be made good by the Contractor at his cost.

In case the remedial work is not executed promptly by the Contractor, the Engineer may make alternative arrangements for the execution of the work and debit the costs to the Contractor.

#### **119. WATER SUPPLY**

The Contractor shall provide for all purposes of the work, an adequate supply of water from a suitable source or sources approved by the Engineer. He must pay the water charges, if any, and make arrangements for supply, transport, and distribution.

#### **120. ADDITIONAL LAND**

The Contractor shall select and arrange at his own expenses 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.

#### **121. USE OF HEAVY PLANT**

In the event of the Contractor desiring to use heavy machinery or plant, he shall first satisfy the Engineer that they will be of such size and used in such a manner as not to cause any disturbance or damage in particular to water, electricity, Post Office or other mains, cables and connections or to sewers, culverts etc. or interfere with the line or position of any overhead wires and cables of any sort, telegraph poles, power poles etc.

The Contractor will be held liable for any such damage or disturbance and shall pay the full costs of any reinstatement, relaying, repairing, or refixing as may be required, as agreed between the Engineer and the owner affected.

#### **122. PROVISION OF INSTRUMENTS AND LABOUR**

The Contractor shall provide at his own expenses all instruments, materials, tools, and other things which the Engineer considers necessary for his proper supervision of the Works and shall maintain the same in good order. He shall also provide materials, an

experienced Surveyor and labour for attendance on the Engineer and his representatives in carrying out supervision of the Works. All charges arising out of such services shall be deemed to be included in his rates in the Bill of Quantities.

### **123. ACCESS TO SITES**

The Contractor shall construct and maintain all temporary accesses required for the execution of the Works. Access roads shall be constructed and maintained up to the Site Offices if required. The cost of all these Works shall be deemed to be covered by rates and prices quoted by the Contractor.

### **124. POLLUTION**

The Contractor shall ensure that during the course of his operations, no pollution of the atmosphere, rivers, reservoir catchment areas or groundwater is allowed to take place.

### **125. TREE PROTECTION**

Trees within the permanent and temporary easement are the property of owners. Specific trees will be identified by the Engineer, prior to construction, and the Contractor shall neither remove nor cut their roots unless otherwise directed by the Engineer. If the roots of such trees appear within the trench areas, the Contractor shall handle the roots with maximum care so that no portion of the roots will be damaged. During the excavation of the trench, the exposed roots may be removed to a position that will not damage the roots and will not interfere with the pipelaying. During the construction, the roots shall be thoroughly protected by appropriate cover and wetted as directed. After the pipes are laid, the moved roots shall be placed back to the original locations and backfilled carefully by selected soft soil which can support vegetation.

### **126. GEOLOGICAL DATA**

Any geological data that is made available to the Contractor and is relevant to the Works, will be for his guidance only, and no guarantee is given that other ground conditions will not be encountered. No claims based on the geological data provided shall be entertained by the Engineer. The Contractor shall be deemed to have made any additional investigations required before submission of his Bid.

### **127. WATCHING, FENCING AND LIGHTING**

The Contractor shall employ watchmen to guard the Works both during the day and night from the commencement of the Works until the substantial completion of the Works.

Any excavation or other obstruction likely to cause injury or damage to any person or domestic animals must be fenced off as directed by the Engineer.

### **128. TIPS**

The Contractor shall be responsible for provision of all tips, at his own expense, for disposal of all spoil or other rubbish collected during the construction of the Works. Any surplus excavated material not required shall also be carted away to these tips. The Contractor to liaise with the local Authorities for approval of location of tips.

### **129. TROPICALISATION**

In choosing materials and their finishes, due regard shall be given to the tropical conditions of the site to which they will be subjected. The Contractor shall submit details of his practices which have proven satisfactory and which he recommends for application on the parts of the Works which may be affected by the tropical conditions.

### **130. MONTHLY SITE MEETINGS**

Throughout the project period, site meetings will be held at the Engineer's Representative's Office once every calendar month to discuss the progress of the work, schedule for the ensuing month, methods of construction, procurement, transportation, labours, etc. These meetings can be called at any other time intervals at the request of the Contractor or as directed by the Engineer.

### **131. INSPECTION BY ENGINEER DURING DEFECTS NOTIFICATION-PERIOD**

The Engineer will give the Contractor due notice of his intention to carry out 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.

### **132. SUBMISSION OF SAMPLES**

Before incorporating in the finished work any materials or articles which he supplies under the terms of the Contract, the Contractor shall submit to the Engineer's 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. 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 which it represents. The Engineer's Representative may decide the method by which each sample to be taken from the bulk material shall be obtained. Any costs related to adhere to above to be covered in Bidder's Rates.

### **133. RESPONSIBILITY FOR ORDERING MATERIALS AND MANUFACTURED ARTICLES AND SAMPLES FOR TESTING**

The responsibility for so ordering and delivering materials and manufactured articles and samples that they may be tested sufficiently far in advance of the work 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 effect payment of any costs he may incur as a result thereof.

With regard to any item in the Bill of Quantities which is the subject of a P.C. Sum, the Contractor shall notify the Engineer of his requirements as early as possible leaving ample time for the Engineer to make any necessary arrangements so that no delay occurs in the progress of the work.

### **134. TESTS OF MATERIALS AND MANUFACTURED ARTICLES BEFORE USE**

Any or all the materials and manufactured articles supplied by the Contractor for use on any of the Works throughout this Contract shall be subject in advance to tests as may be specified in the relevant Standard Specification as may from time to time be deemed necessary by the Engineer. Samples of all such materials and manufactured articles, together with all the necessary labour, materials, plant, and apparatus for sampling and for carrying out of tests on the site on all such materials and manufactured articles shall be supplied by the Contractor at his own expenses. 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 Contractor.

### **135. REJECTED MATERIALS**

Should any material or manufactured articles be brought on to the site of the Works which are in the judgement of the Engineer is unsound or of inferior quality or in any way unsuited for the work 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.

### **136. 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 words "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.

### **137. TEST RUNNING OF THE SCHEME**

Upon substantial completion of the scheme and official inspection which agrees to this, the Contractor shall operate the entire scheme for the test period indicated in the Bill of Quantities.

The Contractor shall supply all necessary personnel, electricity, fuels, oils, and chemicals for the test running and together with the Engineer's Representative shall compile a list of detailed operating instructions that shall be incorporated into the Operation and Maintenance Manual. The Contractor shall further bring to the attention of the Engineer's Representative and of the Employer's operational staff any problem or defects he encounters during this period of test running so that solutions may be found, and any necessary alterations made.

The Contractor shall make provision for the on-site training of up to 3 of the Employer's staff.

### **138. PERSONAL PROTECTIVE EQUIPMENT (PPE) FOR THE RESIDENT ENGINEER**

The Contractor shall provide for the Engineer, his Representative, and assistants any additional protective clothing and safety equipment necessary for the proper discharge of their duties on the Site.

The Contractor shall provide any necessary protective clothing and safety equipment for the use of authorized visitors to the site including the Employer and his staff and representatives and those of any relevant Authority who have reason to visit the Site.

### **139. OPERATION AND MAINTENANCE MANUAL**

Draft Operation and Maintenance Manuals will be compiled by the Contractor prior to substantial completion and Handing Over of the Works.

The Manuals must be revised and brought to a final draft state prior to the test running of the Schemes. The Contractor's rates should include for provision in triplicate, and in English, details of all the different manufactured plant and components incorporated in the Works including but not limited to all pertinent Manufacturers' Brochures, 'As-Built' Drawings prepared by the Contractor, Digital Progress Report Photographs, etc.

Substantial completion of the Schemes will not be considered until such detailed information as is required in triplicate has been submitted by the Contractor to and accepted by the Engineer.

### **140. CONSTRUCTION PROGRAMME**

The Contractor shall submit to the Engineer for approval, a revision of the Construction Programme attached in four (4) copies and after approval to the Employer in two (2) copies in the following manner:

- (1) Within thirty (30) days after receiving the Letter of Acceptance, the Contractor shall submit to the Engineer for approval, a detailed Programme based on the key date stated hereinafter or other dates which are given in the Letter of Acceptance in the form of a Critical Path Method (hereinafter referred to as CPM Network) showing the order of procedure in which he proposes to carry out the Works including design, manufacture, delivery to the site, transport, storage, survey, construction, commissioning and maintenance. This Programme shall clearly indicate all activities and its duration along with the earliest and the latest event, times and the first and last dates of the submission of the Drawings and each date of shop inspection by the Engineer for the section or portion of the Works.

The Programme so prepared shall be rearranged in the form of a Time Bar-chart Schedule of which size shall be 841mm x 594mm (A-1 size). This Time Bar-chart Schedule shall be submitted to the Engineer together with the CPM Network.

- (2) The CPM Network shall be in accordance with commonly accepted practices and shall show graphically the chain of activities / sub-activities and their sequential relationship with each other from the start of construction to the completion of the Contract. The Time Bar-chart Schedule shown in weeks shall list all main activities and its applicable sub-activities.
- (3) In preparing the CPM Network and the Time Bar-chart Schedule the Contractor shall make due allowances for possible delays. Under no circumstances shall the CPM Network or the Time Bar-chart Schedule show a completion in excess of the "Time for Completion" stated in the Form of Bid.
- (4) The Programme once approved by the Engineer shall thereafter be referred to as the Contractual Programme. The Engineer's approval of such programme shall not relieve the Contractor of any of his duties or responsibilities under the Contract.

The Contractual Programme approved shall supersede all other Programmes and shall be deemed to be the Programme on which the Contractor has based his Contract Sum and in accordance with which he will undertake the execution of the Works. This Programme shall become part of the Contract.

The Contractor shall ensure that all the Works especially Electrical and Mechanical Works which may be carried out by the Electrical / Mechanical Sub-Contractor, are well coordinated with the overall Works under the Contract for the efficient execution of the Works and shall clearly indicate them on the construction Programme.

The Contractor shall also describe the conditions of working shifts, if necessary, to execute the Works and whether work needs to be carried out at night and/or on Sundays and holidays. The Contractor should also indicate which particular Works are subject to these timings in his construction Programme.

Whenever the Contractor proposes to change the Contractual Programme, approval of the revision shall be obtained in writing from the Engineer.

If the Contractor has fallen behind the approved Contractual Programme or can foresee delay(s) therein, he shall, immediately after such default or event occurred or foreseen or at the request of the Engineer submit a revision of the Contractual Programme showing the reasons of such a delay and the proposed measures to recover such delay or to complete the Works on time, for the approval of the Engineer.

#### **141. PROGRESS REPORTS**

The Contractor shall submit a monthly progress report to the Engineer. The format, content and level of detail shall be determined and agreed by the Engineer.

The Reports submitted by the Contractor shall include a section on Environment and Social Performance Reporting, under which the Contractor shall report on the aspects included in the ESMP and HSMP (Ref. Clauses 141 and 142).

If the Engineer considers it necessary, the frequency of reporting may be increased. Alternatively, the Contractor may be instructed to provide a special progress report for a particular section of works (that is significantly delayed for example), on a more frequent basis (e.g., weekly, or even daily). The Contractor's rates in his Bid are deemed to cover these costs.

#### **142. DAILY LOGS**

The Contractor shall maintain a daily site log. The logbook entries shall be prepared in triplicate, with one copy being delivered each day to the Engineer.

The content and format of the Daily Log shall be agreed with the Engineer upon commencement of the contract. However, typically the log shall include the date, weather, numbers/movement of plant and labour, main areas of work and daily activity/progress, deliveries of plant and materials to site, tests, issues, shut-downs, key instructions, accidents, among others.

In addition, the log sheet shall have a space designated for comments by the Engineer. The Engineer may, at his discretion, instruct the Contractor to provide daily labour and plant returns. Alternatively, the Engineer may request to review such information.

In addition, the Contractor shall provide the Engineer with copies of all delivery notes of plant and materials delivered to site. The Contractor's rates in his Bid are deemed to cover these costs.

#### **143. TEST FORMS**

The Contractor shall prepare, to the satisfaction of the Engineer, test forms to be used for the various components of the works.

All test forms shall be completed, signed, and dated by the appropriate persons conducting the tests. The original copy of all test forms shall be submitted to the Engineer. The Contractor's rates in his Bid are deemed to cover these costs.

Test forms shall be submitted to the Engineer regardless of whether the test passes or fails.

#### **144. CONTRACT DOCUMENTS**

Without affecting the provisions in the Conditions of Contract, the Contractor shall print and submit at his own cost to the Employer at least ten (10) bound copies of the Contract Documents except Volume III (Drawings) in the form and manner approved by the Employer. The Contractor's rates are deemed to cover these costs.

#### **145. AS BUILT AND RECORD DRAWINGS**

The Contractor shall prepare, and keep up to date, a complete set of "as-built" records of the execution of the works, showing the exact "as-built" locations, sizes and details of the work as executed, with cross references to relevant specifications and data sheets. These records shall be kept on the Site and shall be used exclusively for the purposes of this specification. Two copies shall be submitted to the Engineers Representative prior to the commencement of the Tests on Completion of Works.

In addition, the Contractor shall prepare and submit to the Engineer's Representative "as-built-drawings" of the works, showing all works as executed. The drawings shall be

prepared as the works proceed and shall be submitted to the Engineers Representative for his inspection. The Contractor shall obtain the consent of the Engineers Representative as to their size, the referring system, and other pertinent details.

Prior to substantial completion and Handing Over of the Works, the Contractor shall deliver to the Engineer one complete set of record ("as built") drawings of all works constructed under the Contract, including all underground works such as pipes, services, cables, and conduits.

The Engineer shall review and comment on the draft Record Drawings, and within a further two (2) weeks of receiving the comments, the Contractor shall produce a final set of drawings.

If, during the Defects Notification Period, the Contractor modifies any of the Works, the modifications shall be included as amendments to the As-Built Drawings and all other affected documentation.

Prior to the issue of any Taking-Over Certificate, the contractor shall submit to the Engineer's Representative one full-size original copy, six printed copies of the relevant "as-built-drawings" and the corresponding computer files (AutoCAD, Excel, MS Word, etc.) on CD-ROM and any further Construction Documents specified in the Specifications. The works shall not be considered to be completed for the purposes of Taking-Over until such documents have been submitted to the Engineer's Representative.

**The compliance of this Clause by the Contractor is deemed to be covered in his rates as quoted in the Bid.**

## **2. PROJECT SPECIFIC INFORMATION AND CONTRACTOR'S GENERAL RESPONSIBILITY**

### **201. PROJECT LOCATION**

The Project Site is within Mwanza City in Tanzania.

### **202. SCOPE OF WORKS**

**The Proposed Works for the Mwanza Sewer Connection Upgrade involves:**

1. Construction of 25.5km of sewers in the Project Areas (size 110 - 200 D<sub>ia</sub>) and installation of 1,600 new consumer connections comprising of the following:
  - i) Infill Sewers and Sewer Connections – Kirumba Ward
    - Conventional Gravity Sewers (OD 200; Total length – 2.3km)
    - Household Connections to Conventional Sewers (350Nr)
  - ii) Infill Sewers and Sewer Connections – Kitangiri Ward
    - Conventional Gravity Sewers (OD 200; Total length – 5.4km)
    - Simplified Sewers (OD 200; Total length – 0.4km)
    - Household Connections to Conventional Sewers (250Nr)
    - Household Connections to Simplified Sewers (100Nr)
  - iii) Infill Sewers and Sewer Connections – Pasiansi Ward
    - Conventional Gravity Sewers (OD 200; Total length – 0.5km)
    - Simplified Sewers (OD 200; Total length – 0.3km)
    - Household Connections to Conventional Sewers (50Nr)
    - Household Connections to Simplified Sewers (50Nr)
  - iv) Infill Sewers and Sewer Connections – Nyamanoro Ward
    - Conventional Gravity Sewers (OD 200; Total length – 4.1km)
    - Simplified Sewers (OD 200; Total length – 1.7km)
    - Household Connections to Conventional Sewers (200Nr)
    - Household Connections to Simplified Sewers (100Nr)
  - v) Infill Sewers and Sewer Connections – Nyakato Ward
    - Conventional Gravity Sewers (OD 200; Total length – 7.3km)
    - Household Connections to Conventional Sewers (350Nr)
  - vi) Infill Sewers and Sewer Connections – Igogo Ward
    - Conventional Gravity Sewers (OD 200; Total length – 2.6km)
    - Simplified Sewers (OD 200; Total length – 1.1km)
    - Household Connections to Conventional Sewers (50Nr)
    - Household Connections to Simplified Sewers (100Nr)
2. Rehabilitation of Existing Sewers
3. Rehabilitation of 3Nr. Existing Pumping Stations
4. Rehabilitation of Ilemela Wastewater Treatment Works.

Details on the rehabilitation works can be found in the BoQs and for electro-mechanical works of the Pumping Stations in these Technical Specifications. The Contractor will be required to prepare method statements for the rehabilitation works.

### **203. ADDITIONAL CONTRACTOR'S RESPONSIBILITIES**

The proposed sewer lines will be laid within highly built up and congested areas in Mwanza City, including densely populated medium and low-income residential areas and informal settlements. constructed through a variety of natural / developed land types.

Briefly, the Contractor's Additional Responsibilities will include:

- Setting out and verification survey of Sewer line routes.
- Preparation of "As-Built" drawings and O&M manuals for the whole Project.
- Compliance with the project specific Environmental and Social Management Plan, all according to NEMC Conditions. This shall include issues such as disposal of wastes, health and safety of workers, safety of public, access and avoid nuisance to the public and property owners, confirm to emissions requirements, drainage, and excessive erosion, among others.
- Maintaining the works for a pre-determined period (12 months) following hand-over, to ensure that the materials and workmanship are performing as intended.
- The Client has no land available for Contractor's Camp or Camps. The Contractor will procure / rent adequate land for his camps including offices, workshops, stores, labour camp and other facilities within the vicinity of the Project Site. The Contractor will submit probable camp site(s) location details to the Resident Engineer for approval prior to establishment.
- The Client has no land available for Storage of Materials including Sewer Pipes, Pumps, Fittings, etc. The Contractor will procure / rent adequate land for proper storage and protection of all pipes, valves, fittings, etc. The Contractor will submit probable storage site(s) location details to the Resident Engineer for approval prior to establishment.
- The Contractor shall be responsible for locating and protecting existing utilities and services, including existing bulk water supply trunk mains, electrical power cable routes (TANESCO), telephone (TTCL) and other service providers), water and sewerage pipes (MWAUWASA), roads and drains (TANROADS, RURA, TURA). In this respect, the Contractor shall be responsible for obtaining all Permits and Approvals, and in general complying with the requirements of the individual utilities and agencies.
- The new works will be connected to the existing, operational sewerage system. The Contractor will be required to liaise closely with the Water Company, Mwanza Urban Water and Sanitation Authority (MWAUWASA) when executing the works activities. Further, strict "rules" will apply to all such tie-in works since, in general, they may require for some time, a partial shut-down of the sewerage system and affected consumers to be informed well in advance.
- The sewer lines traverse along roads and densely populated commercial and residential areas. Working in these areas will require provision of safety barriers, warning signs and lighting, temporary accesses to properties, etc. The Contractor should indicate the cost of these works under Bill No. 1 (Preliminaries and General), ESHS Section or under Item 6 - Other Works / Obligations, Method Related

Charges. If this item is not priced or inadequately priced, the Contractor's rates for Other Works will be deemed to cover this requirement.

- The Contractor shall be responsible for identifying and paying all Government Levies and Statutory costs such as training levy, licencing fee, etc. The costs of these are deemed to be covered in the Contractor's rates for the Works.

#### **204. CONDITIONS OF CONTRACT**

The General and Particular Conditions of Contract are given in Volume I of the Bidding Document.

#### **205. CONSTRUCTION PERIODS**

The proposed construction period will be **18 months**. Potential Contractors will note that multiple installation teams will be required to comply with this requirement and will provide documentation to demonstrate adequacy of resources in this respect. Additionally, potential Contractors to note that some disruptions to scheduled work may be expected to occur during the rainy seasons. This to be allowed for in their programme of implementation.

#### **206. SITE AND OTHER DATA**

- Average temperature in the Project Area is around 21<sup>0</sup>C with minimum and maximum temperature varying from 11 to 28<sup>0</sup>C respectively.
- Average rainfall is 700 - 1200mm, with mainly two rainy seasons between March-May and October-Mid December but these periods can vary.
- Elevation of the Project Area varies between 1200m and 1400m above mean sea level.
- The works are to be executed along roads and densely populated commercial and residential areas. Working in these areas will require provision of safety barriers, warning signs and lighting, temporary accesses to properties, diversion management of traffic, etc.
- There are few major hospitals within Mwanza. The Contractor will be required to maintain basic medical facilities and transport on site for emergency use.
- Design, manufacture, and construction standards will conform to recognized international Codes and Standards. Local Tanzanian Codes and Regulations shall also apply.

#### **207. WAYLEAVE / EASEMENT FOR PIPELINE WORKS**

The proposed sewer lines traverse along existing roads / streets and are to be laid within the existing road reserve. Large sections of the road reserve also have other existing utilities such as electrical cables, water mains, sewer pipes, manholes and chambers. In some instances, the road reserve is paved with concrete / asphalt / stone pitched / concrete block paving. Sections of the road reserve may have encroachment by temporary structures. As-built details of the existing utilities are not available, and Contractor will be required to carry out pilot excavation to determine the location and extent of the existing utilities. Contractor will liaise with person(s) who have encroached within the road reserve and obtain clear right of way prior to commencement of work and to ensure no delay occurs in the construction work programme.

Any additional space required for purposes of construction including working space for plant, other access, storage, and movement of materials, excavated materials/filling, etc. will have to be appropriately arranged and paid for by the Contractor. In case of limited space in some sections, the Contractor may have to revert to manual excavation, double haulage of excavated material or any other means to execute the Works. The cost of all these exigencies will be deemed to be included in his rates for work.

The Employer will obtain and pay for the requisite permissions from Road Authorities - TANROADS, RURA, TURA, and Mwanza City Local Government to lay the sewer pipes within the road reserves. However, the Contractor will allow in his rates all costs for conditions prescribed by the authorities during the construction of the sewer lines and reinstatement of all reserve areas to the original condition.

## **208. RESTRICTIONS ON USE OF ROADS**

The Contractor shall not run tracked vehicles or tracked plant on any public or private road without the written approval of the Engineer and the responsible authority or owner and subject to such conditions as each may reasonably require.

The Contractor shall observe all weight and dimensions restrictions which apply to roads and tracks in Tanzania, and he shall comply with all reasonable restrictions which may from time to time be imposed by the Engineer. Where damage to roads and tracks is caused by the Contractor, this shall be repaired at the Contractor's expense. In particular, the Contractor shall fill potholes in roads with roadstone when these are deepened by his plant.

The Engineer shall have the power to restrict the Contractor's use of any roads, either in direction of traffic, speed of traffic or numbers of vehicles to preserve such roads or to make such roads safe for use by the general public.

## **209. PREVAILING CONDITIONS**

The Contractor is deemed to be fully familiar with local conditions and the potential effect (direct or indirect) on the planning and execution of the Works. The Contractor shall make his own studies / investigations in this respect. These conditions include, but are not limited to the following:

i) Climatic Conditions

There are generally two rainfall seasons, long rains between March and May and short rains between October and December.

ii) Access

The sewer lines traverse along roads and densely populated commercial and residential areas. The pipeline also crosses some rivers/ streams. Bidders to visit the Project Areas and familiarize themselves with the specific conditions in each area.

iii) Services

The Contractor shall make provision for the temporary supply of all services necessary for the execution of the works, including water, electricity, communications including Internet, fuels, and consumables etc. The Contractor

shall make all such applications and payments as necessary in order to obtain these services.

The Contractor is deemed to be familiar with the levels of service provided and shall make all necessary backup provisions (such as generator sets, water tankers, on-site storage for key materials, etc.) to ensure that delays are not experienced.

iv) Local Materials

The Contractor shall be familiar with the supply of local materials with respect to sources and location, delivery times, prices, quality and standards of products, sizes, quantities available, reliability and customer service, delivery capability, etc.

With respect to quarries and borrow pits, the Contractor shall be responsible for all fees, royalties, permits, and other obligations concerning such activities.

v) Laws and Regulations

The Contractor is deemed to be familiar with all laws and regulations pertaining to the implementation of the Contract, including relevant National Design and Construction Standards, Environmental Regulations, Transportation of Heavy Equipment by Road, Minimum Wage and Employment Standards, Health and Safety Regulations, Establishing / Operating / Decommissioning of Borrow Pits, Disposal of Wastes, Procedures and Regulations related to Procurement of Imported Goods, Local Customs, etc.

vi) Local Labour

The Contractor shall liaise with Local Authorities (Chiefs, Labour Office, etc.) to recruit casuals and semi-skilled / skilled labour from the Project Area site.

vii) Ground Conditions

The Contractor is deemed to be familiar with the site soil conditions, rock depths (whether hard or soft) including the presence of groundwater.

Approximate rock excavation quantities have been appropriately provided for in the Bills of Quantities. These quantities are re-measurable. Contractor to verify site conditions through site inspections prior to tendering.

In addition, the Contractor shall be aware of maximum flood levels in all Rivers along the sewer line route and schedule the construction works accordingly.

## **210. PROGRAM OF WORKS**

If the Work Program submitted with the Bid requires revision, then the Contractor will within 28 days of signing the Contract, submit a Revised Program of Works to the Engineer for his acceptance.

The Program of Works shall be in bar chart format and shall indicate the major work components (including mobilization, any designs, procurement, substantial completion, etc.) and the main sub-activities. The program shall have a unit of time of one month (with part months indicated) unless the Engineer indicates otherwise.

The program (or, if necessary, a secondary program similarly formulated) shall clearly indicate the various work teams by discipline, including specialist sub-contracts and suppliers, as well as the Contractor's major plant and staff requirements, in order to demonstrate sequencing and non-conflict of resources.

The Engineer may request summary versions of the program, or additional detail for critical sections. The Contractor will comply with all such requests.

Once a Work Program has been approved by the Engineer it shall remain as the current version until such time as the Engineer instructs the Contractor to update or revise the program. The Contractor shall not modify his program without such instruction from the Engineer. Specifically, the Contractor's progress reports shall relate to the current program, and any delays shall be duly indicated.

The exact format of the Work Program shall be to the approval of the Engineer but shall comprise the minimum of a detailed resource and cash flow schedule for the work, using Microsoft Project or a similar approved software system. This schedule, to be finalised and agreed between Employer and Contractor, will be used to measure Value of Work Done to enable the Contractor and Employer to monitor the progress of the project in terms of integrated cost, schedule, and technical performance measures. In order for Value of Work Done to be estimated, the Contractor will provide a system that can accurately and demonstrably measure the following three fundamental factors:

- i. The PLANNED VALUE COST also known as the Budgeted Cost of Work Scheduled (BCWS). This is the amount of expenditure the Employer anticipated he would have spent at time of reporting.
- ii. The ACTUAL COST of the progress made, known as the Actual Cost of Work Performed (ACWP). This is the actual amount of expenditure the Employer incurs at time of reporting.
- iii. The EARNED VALUE, known as the Budgeted Cost of Work Performed. This is the percentage complete

Payment within the Contract will be based on the achievement of earned value agreed between Employer and Contractor, independently assessed by the Engineer, in accordance with the value achieved based on measured quantities of work done.

## **211. METHOD STATEMENTS**

If the Method Statement submitted with the Bid requires revision, then the Contractor will within 28 days of signing the Contract, submit a Revised Method Statement to the Engineer for his Approval.

The Method Statement shall describe the Contractor's overall approach to the Contract, including issues such as type, number and layout of Contractor's buildings, stores and facilities; provision of temporary services: personnel issues including management structure, supervision and labour; Contractor's plant and equipment, and maintenance thereof; quality control management procedures; general methods for key work components such as structural works, electrical-mechanical installation, construction of sewer lines etc.; working adjacent to existing River Courses and any other special considerations, etc.

From time to time the Engineer may request detailed Method Statements for specific activities. The Contractor shall comply in full of the Engineer's requirements.

## **212. MISCELLANEOUS FORMS**

The Engineer and/or Contractor shall prepare other forms as necessary. These may include, but are not limited to:

- i. Site Instruction Form
- ii. Request for Information / Inspection / Approval Form
- iii. Materials Supply Form
- iv. Setting Out Works Form
- v. Pipeline Final Excavation Level Form
- vi. Pipeline Laying Form
- vii. Pipeline Backfilling Form
- viii. Pipeline Testing Form
- ix. Dayworks Form; and
- x. Concrete Pour Form; etc.

## **213. CERTIFICATES OF COMPLETION**

The Engineer shall prepare such forms in accordance with the Conditions of Contract. These include:

- i. Taking-Over Certificate, issued upon successful completion of the Tests on Completion
- ii. Performance Certificate, issued upon expiry of the Defects Notification Period and successful completion of defects and all other requirements under the Contract.

## **214. VERIFICATION BY CONTRACTOR**

### **Survey and Dimensional Checking**

The Contractor shall be responsible for checking the following prior to carrying out construction work:

- i. Confirm the alignment and elevations of the proposed sewer lines. All elevations shall be related to a single bench mark.
- ii. Confirm the location and elevation of existing sewer lines through excavation and backfilling of trial holes.
- iii. Verify the locations, depths, and other details of existing services along the proposed sewer alignment.
- iv. Confirm extent of existing road reserve and available wayleave.
- v. Confirm proposed distances and lengths.
- vi. Confirm location of proposed structures and sewer routes, including preliminary setting out. Confirm elevations of sewer lines at key locations such as crossings of rivers and roads. In particular this shall include sections where pipelines shall cross these locations. The Contractor shall excavate and backfill all necessary trial holes to confirm such elevations.
- vii. The Contractor shall provide the Engineer with drawings and other such documentation confirming all surveys and setting out.

### **3. CLEARING SITE**

#### **301. CLEARING SITE**

The Contractor shall demolish, break up and remove buildings, walls, gates, fences, advertisements and other structures and obstructions, grub up and remove trees, hedges, bushes and shrubs and clear the site of the works at such time and to the extent required by the Engineer but not otherwise. The materials so obtained shall so far as suitable be reserved and stacked for further use; all rubbish and materials for use shall be destroyed or removed from the site, as directed by the Engineer.

Where topsoil must be excavated this shall be removed and stacked on site. After completion of construction, it shall be spread over the disturbed ground, any surplus being disposed of as directed by the Engineer.

Underground structures and chambers where required to be demolished, shall be demolished to depths shown on drawings or as directed. They shall be properly cleaned out and backfilled and compacted with suitable material to the direction and approval of the Engineer.

#### **302. VEGETATION**

No allowance will be made for the cutting and removal of crops, grass, weeds, and similar vegetation. The cost of all such work will be included in the rates entered in the Bill of Quantities.

#### **303. BUSHES AND SMALL TREES**

All bushes and small trees, the main stem of which is less than 500mm girth at 1 metre above ground level shall be uprooted (unless otherwise directed by the Engineer) and burnt or otherwise disposed off as directed by the Engineer.

#### **304. HEDGES**

Where directed by the Engineer, hedges shall be uprooted and disposed off by burning.

#### **305. FELLING TREES**

Where shown on the drawings or directed by the Engineer, trees shall be uprooted or cut down as near to ground level as is possible. The rates entered in the Bill of Quantities shall include for cutting down, removing branches and foliage, cutting useful timber into suitable lengths, loading, transporting not more than 1 km. and stacking or disposing off all as directed by the Engineer.

For measurement trees cut down shall be classified according to their girth at 1 metre above ground level, the cost of grubbing up roots shall be deemed to be covered by the rate for cutting trees.

#### **306. GRUBBING-UP ROOTS**

Stumps and tree roots shall, unless otherwise directed, be grubbed up, blasted, burnt, or removed and disposed of in approved dumps to be provided by the Contractor. Where directed by the Engineer, the holes resulting from grubbing up shall be filled with approved materials, which shall be deposited and compacted in layers not exceeding 225mm loose depth, to the same dry density as that of the adjoining soil.

For the purpose of measurement, tree roots shall be classified according to the mean diameter of the stump measured across the cut.

### **307. WEED CONTROL**

The Contractor shall take all necessary precautions against the growth on the site of weeds and remove them as necessary throughout the period of construction.

The finished base of all footways and elsewhere as directed shall be sprayed with an approved persistent total herbicide at the rate recommended by the manufacturer. The application shall be by an even spray in a high volume of water at about 0.7 to 0.11 litres per square metre. After this application the footways shall receive at least two further waterings before the surface is sealed.

## 4. EXCAVATION

### 401. DEFINITION AND CLASSIFICATION OF EXCAVATED MATERIALS

Excavation in the Bills of Quantities shall be classified in two categories: -

1) Common Excavation

Any material which in the opinion of the Engineer can be excavated by use of pickaxes and hand levers shall be classified as common excavation. Waterlogged material shall be included in this class. Murram in any form shall be classified as common excavation.

2) Rock

The decision of the Engineer in classifying rock shall be final and binding.

Rock in the Bill of Quantities will be itemised in three classes: -

Class 'A'

Soft rock of the type known locally as 'tuff' which in the opinion of the Engineer cannot be considered as hard rock, but which considerably increases the amount of labour needed for its removal shall be known as Class 'A' rock.

Class 'B'

Very weathered phonolite lava containing many fissures and faults shall be known as hard rock. This type of rock contains stones and boulders of unweathered or incompletely formed blacktrap or lava. A boulder or outcrop of hard rock 1.5 cubic metres or less and grey or green building stone in a formation which is massive and geologically homogeneous, will be deemed to be Class 'B' rock.

Class 'C'

Phonolite in a formation which is massive and geologically homogeneous shall be known as Class 'C' rock.

### 402. STORAGE AND HANDLING OF EXPLOSIVES AND BLASTING

In the Bill of Quantities hard material is classified as rock where blasting will be permitted subject to this clause.

The removal of hard materials by use of explosives will normally be permitted subject to compliance by the Contractor in all respects with the Explosives Laws of Tanzania.

The Contractor shall provide proper buildings or magazines in suitable positions for the storage of explosives in manner and quantities to be approved; he shall also be responsible for the prevention of any unauthorized issue or improper use of any explosives brought on the works and shall employ only licensed and responsible men to handle explosives for the purpose of the works.

The shots shall be properly loaded and tamped and where necessary, the Contractor shall use heavy mesh blasting nets. Blasting shall be restricted to such periods and such parts of the works as the Engineer may prescribe. If, in the opinion of the Engineer, blasting would be dangerous to persons or property or to any finished work or is being carried out in a reckless manner, he may prohibit it, and order the rock to be excavated. Payment will be made at the rate for rock excavation where blasting is permitted.

The use of explosives by the Contractor in large blasts, as in seams, drifts, pits, or large holes, is prohibited unless authorized in writing by the Engineer. In the event of wasting of

rock through any such blasting, the Contractor shall if required by the Engineer, furnish an equivalent number of approved materials for fill, 1 cubic metre of rock in-situ being taken to equal 1.5 cubic metre of material in embankment.

#### **403. EXCAVATION FOR FILL**

Where excavation reveals a combination of suitable and unsuitable materials, the Contractor shall, wherever the Engineer considers it practicable, carry out the excavation in such a manner that the suitable materials are placed separately for use in the works without contamination by the unsuitable materials.

If any suitable material excavated from within the site is, with the agreement of the Engineer, taken by the Contractor for his use, sufficient suitable filling material to occupy after specified compaction, a volume corresponding to that which the excavated material occupied, shall, unless otherwise directed by the Engineer be provided by the Contractor from his own sources.

No excavated material shall be dumped or run to spoil except on the direction or with the permission of the Engineer who may require material which is unsuitable to be retained on site. Material used for haul roads shall not be re-used without the permission of the Engineer.

#### **404. COMPACTION OF FILL**

All materials used in fill shall be compacted to specification by plant approved by the Engineer for that purpose. Maximum compacted thickness of such layers shall not exceed 200mm.

Work on the compaction of plastic materials for fill 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 be run to spoil and an equal volume of material suitable for filling shall be replaced, unless the Contractor prefers, at his own expense, to wait until the material has dried sufficiently for acceptance again as suitable material.

Nevertheless, if with any material the Engineer doubts whether compaction 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 and 3 per cent below the optimum moisture content as determined by the laboratory compaction test method described in British Standard 1377: Methods 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 a way that the specified moisture content remains uniform throughout compaction.

Work shall be continued until a state of compaction is reached throughout the fill, which shall have relative compaction determined according to B.S. 1377 not less than 95% of maximum dry density at optimum moisture contents. For excavation under Roads, and Car Parks, backfilling shall be compacted in 150mm layers to 100% maximum dry density.

If with non-plastic materials the compacted material has become drier 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.

#### **405. EMBANKMENTS OVER SEWERS**

In carrying embankments over sewer pipes, care shall be taken by the Contractor to have the embankments brought up equally on both sides and over the top of any such structures. Earth embankments shall be formed and compacted in layers of 200mm as the Engineer may direct. The filling immediately adjacent to structures shall be deposited and compacted in accordance with the drawings and approved by the Engineer. The cost of these works shall be included in the prices entered in the Bill of Quantities for the excavations from which embankments are formed.

#### **406. STONE REVETMENTS (STONE PITCHING)**

Where shown on the drawings, the slopes of embankments, rivers, streams, watercourses, and other surfaces shall be protected against water or other action by hand-set stone facing set on end. The larger stones shall be roughly dressed on the bed and face, and roughly square to the full depth of the joints. No rounded boulder shall be used, or stones less than 225mm in depth of 0.05 cubic metre in volume. The stones shall be laid to break bond and shall be well bedded on to a 75mm layer of gravel or fine rubble rammed to a uniform surface and the whole work finished to the satisfaction of the Engineer. Where required, a trench shall be excavated at the bottom of the slope to such a depth as will ensure a safe foundation for the revetment.

#### **407. TIPPED REFUSE ON SITE**

Tipped refuse other than artificial deposits of industrial waste or shale found on the site shall be removed and disposed off in a spoil heap to be provided by the Contractor.

#### **408. REMOVAL OF INDUSTRIAL WASTE, ETC.**

Artificial deposits of industrial waste or shale found on the site shall be removed and disposed of as directed by the Engineer. Should any deposit consist of or contain material which in the opinion of the Engineer is suitable for incorporation in fills, all such material shall be used accordingly and deposited in layers and compacted as specified. The prices entered in the Bill of Quantities for the excavation of the material shall include loading, transportation, disposal, and compaction of same as and where directed.

#### **409. LAND SLIPS**

Remedial works and/or the removal of materials in slips, slides or subsidence and overbreaks of rock extending beyond the lines and slopes, or below the levels shown on the drawings or required by the Engineer, will not be paid for.

#### **410. CLASSIFICATION OF MATERIAL FROM SLIPS**

The classification of material from slips or slides will be in accordance with its condition at the time of removal, regardless of prior condition. Measurement of overbreak in rock excavation shall be that of the space originally occupied by the material before the slide occurred and regardless of its subsequent classification.

#### **411. BORROW PITS**

Where for any reason, it becomes necessary to form borrow pits, these shall be located, and the work executed in all respects to the instructions of the Engineer. They shall be regular in width and shape and admit of ready and accurate measurement and shall be properly graded and drained and finished with neatly trimmed slopes.

#### **412. STREAMS, WATERCOURSES AND DITCHES**

Excavations carried out in the permanent diversion, enlargement, deepening, or straightening of streams, watercourses, or ditches shall be performed as directed by the

Engineer. The rates for such excavations shall include for excavated materials and all pumping, timbering works, and materials necessary for dealing with the flow of water.

#### **413. FILLING OLD WATERCOURSES**

Where watercourses have to be diverted from the sites of embankments or other works, the original channels shall be cleared of all vegetable growths and soft deposits and carefully filled in with approved materials and compacted as directed by the Engineer.

#### **414. OPEN DITCHES**

Open ditches for drainage purposes shall be cut where and of such cross section as the Engineer shall direct and where so required by him, they shall be constructed before the cuttings are opened or the embankments begin. The sides shall be dressed fair throughout and the bottom accurately graded to carry off the water to the outlet to be provided. The material excavated from the ditches shall be disposed off as directed by the Engineer.

#### **415. CLEARING EXISTING DITCHES**

Where directed by the Engineer, existing ditches shall be cleared by removing vegetable growths and deposits. The sides shall be shaped fair throughout and the bottoms properly graded. Material removed from existing ditches shall be disposed of in tips provided by the Contractor. The rates included in the Bill of Quantities for clearing ditches shall include for maintaining and keeping clean until and up to maintenance period.

#### **416. EXCAVATION FOR FOUNDATIONS BELOW OPEN WATER**

The rates for excavation for foundations below the water level shall include for the cost of all temporary close timbering and shoring, sheet piling, coffer dams, caissons, pumps, and other special appliances required and for the draining of any water in the excavation.

#### **417. TRENCHES OF GREATER WIDTH AND DEPTH THAN NECESSARY**

The Contractor shall not be entitled to payment in respect of excavation to any greater extent, whether horizontally or vertically, than is necessary to receive any structure for which the excavation is intended, except where a separate item is provided for additional excavation for working space, timbering, or other temporary work. Excavation to a greater depth or width than directed shall be made good with suitable materials to the satisfaction of the Engineer and at the Contractor's cost.

#### **418. SUPPORTS FOR TRENCHES**

The sides of trenches shall where necessary be adequately supported to the satisfaction of the Engineer by timber or other approved means.

#### **419. PROVISION OF SPOIL HEAPS**

The Contractor shall provide spoil heaps at his own expense for the disposal of surplus material 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.

#### **420. USE OF VIBRATORY COMPACTION PLANT**

Where vibratory rollers or other vibratory compaction plant is used, the mechanism for vibration shall be kept working continuously during compaction operations, except during periods when the Engineer permits or directs discontinuance of vibration.

Unless otherwise permitted by the Engineer, the frequency for 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 vibrations.

#### **421. WATER IN EXCAVATIONS**

All excavations shall be kept free from water, from whatever source, at all times during construction of works until in the opinion of the Engineer, any concrete or other works therein are sufficiently set. The Contractor's rates are deemed to cover compliance with this requirement.

The Contractor shall construct any sumps or temporary drains that the Engineer may deem necessary and shall be responsible for the removal and disposal of all water entering the excavations from whatever source and shall deal with and dispose of such water in a manner approved by the Engineer to ensure that excavations are kept dry.

The Contractor shall provide all plant, labour and materials required for such work and all costs incurred shall be deemed to be included in his rates for excavation.

## **5. WORKMANSHIP**

### **501. HANDLING OF PIPES AND FITTINGS**

The Contractor shall exercise care in the handling of all pipes, fittings, valves etc., to prevent damage to the structure surfaces and to the ends of the pipes and fittings.

### **502. LOADING AND UNLOADING**

Normally loading and unloading of small diameter pipes and fittings can be undertaken by hand; where mechanical means are used care should be exercised to ensure that the handling methods do not damage the pipes and fittings.

### **503. STORAGE**

The Contractor shall comply with the manufacturer's specification regarding the storage of pipes, fittings, and valves. Where storage dumps are to be provided along the route of the pipeline, these will be subject to the Engineer's approval. The cost of so providing shall be borne by the Contractor and deemed to be covered by his rates in the Bill of Quantities.

### **504. TRANSPORT**

The Contractor shall provide such transport arrangements as will effectively cater for the lengths of pipes provided and the material of the piping. Adequate support shall be provided so as to ensure that the piping and fittings are not subject to excessive movement.

### **505. EXAMINATION OF PIPES AND FITTINGS**

The Contractor shall examine all pipes, valves, fittings, and other materials to ascertain that they are in perfectly sound condition before commencing to lay the pipes, valves etc.

### **506. INTERFERENCE WITH FENCES, DRAINS AND OTHER SERVICES**

The Contractor shall ensure the proper reinstatement of fences, drains, telephone lines, TANESCO cables etc. where affected by his work. All services shall be adequately protected and propped to the satisfaction of the Engineer. The Contractor shall be liable for any damage caused to the services due to his failure to provide adequate protection.

### **507. METHOD OF EXCAVATION**

The Contractor is deemed to have covered in his excavation rates all the work that is necessary in order to comply with the provisions of the Specifications in general and this Clause in particular.

- a) The Contractor shall excavate the pipe trenches in the line and to the depths indicated on drawings or as indicated by the Engineer. Except where otherwise indicated on the drawings or directed by the Engineer, it is intended that the trench shall be excavated to such a depth as will allow of a minimum cover of 600mm over the top of the barrel of the pipe when laid. All trenches shall be excavated in open cuttings and for trenching to uPVC piping, shall not be opened too far in advance of pipe laying.
- b) For the purpose of measurement, the width of trench shall be taken as the nominated width for the particular size of sewer, irrespective of the width of trench the Contractor may choose to excavate.

Nominated trench width for:

|            |      |
|------------|------|
| 75mm main  | 0.5m |
| 100mm main | 0.6m |
| 150mm main | 0.6m |
| 200mm main | 0.6m |
| 225mm main | 0.6m |
| 250mm main | 0.6m |
| 300mm main | 0.7m |
| 400mm main | 0.8m |
| 500mm main | 0.9m |
| 600mm main | 1.0m |
| 700mm main | 1.1m |
| 800mm main | 1.2m |

For two or more pipes in the same trench the nominated width shall be the distance between the centres of the outer pipes plus the internal radii of the outer pipes plus 400mm.

- c) Where the trench passes through grassland, arable land or gardens, whether enclosed or otherwise, the turf, if any, shall be carefully pared off and stacked, and the productive soil shall be carefully removed for a width of 600mm greater than the nominated trench width, or equal to the overall width of track of excavating machine, whichever is greater, and laid aside to be subsequently used in reinstating the surface of the ground after the trench has been refilled.
- d) The bottom of the trench shall be properly trimmed off, and all low places or irregularities shall be levelled up with fine material. Where rock or large stones are encountered, they shall be cut down to a depth of at least 100mm below the level at which the bottoms of the barrel of the pipes or flanges are to be laid, and covered to a like depth with fine material, to form a fine and even bed for the pipes. The bottom of trenches to accommodate uPVC piping shall be hardened by tamping in gravel or broken stone in all soft spots. The bedding shall consist of soil which can be properly compacted to provide support for the pipe and to comply with Clause 409 b).
- e) Joint holes shall be excavated to suit minimum dimensions as will allow the joints to be well and properly jointed.
- f) Pipe trench shall be kept clear of water at all times as per Clause 321 of this Specification.
- g) The Contractor shall, wherever necessary, by means of timbering or otherwise, support the sides of the trench so as to make them thoroughly secure, and afford adequate support to adjoining roads, land, buildings and property, during the whole time the trench remains open and shall remove such timbering when the trench has been backfilled. The cost of such timbering or other work shall be deemed to be included in the rates for excavation. In case the Contractor is instructed by the Engineer to leave any portion of such timber in position after backfilling the trench, he will be paid for it accordingly.
- h) The clear width inside the timbering shall be at least 150mm more than the external diameter of the pipe being laid, in order to allow it to be freely lowered into position, in the trench without damage to the external protection.

- i) Should the excavation be taken out to a greater depth than is specified the bottom shall be made good to the correct level with Class 15/20 concrete or other material approved by the Engineer. No payment shall be made for any over excavation carried out by the Contractor nor for the cost of filling up to required levels.
- j) If a mechanical excavator is used by the Contractor, he shall indemnify the Employer against all claims for damage which in the opinion of the Engineer, may be caused by the use of this plant.
- k) The Contractor shall fix Sight Rails for use with boning rods at intervals of not more than 30 metres and temporary Benchmarks related to the Mapping Division of Tanzania (SMD) Datum shall be provided at such intervals as directed by the Engineer.

### 508. PIPE LAYING

- a) Pipelines shall be laid in straight lines and/or smooth curves as indicated on the drawings. The vertical profile of the pipe shall be to even gradients. Any pipes not so laid shall be removed if so, directed by the Engineer, and re-laid in proper manner at the Contractor's expense.

In laying the pipes and specials care shall be taken not to damage the protective linings and the pipes shall be handled with tackle if so, directed by the Engineer.

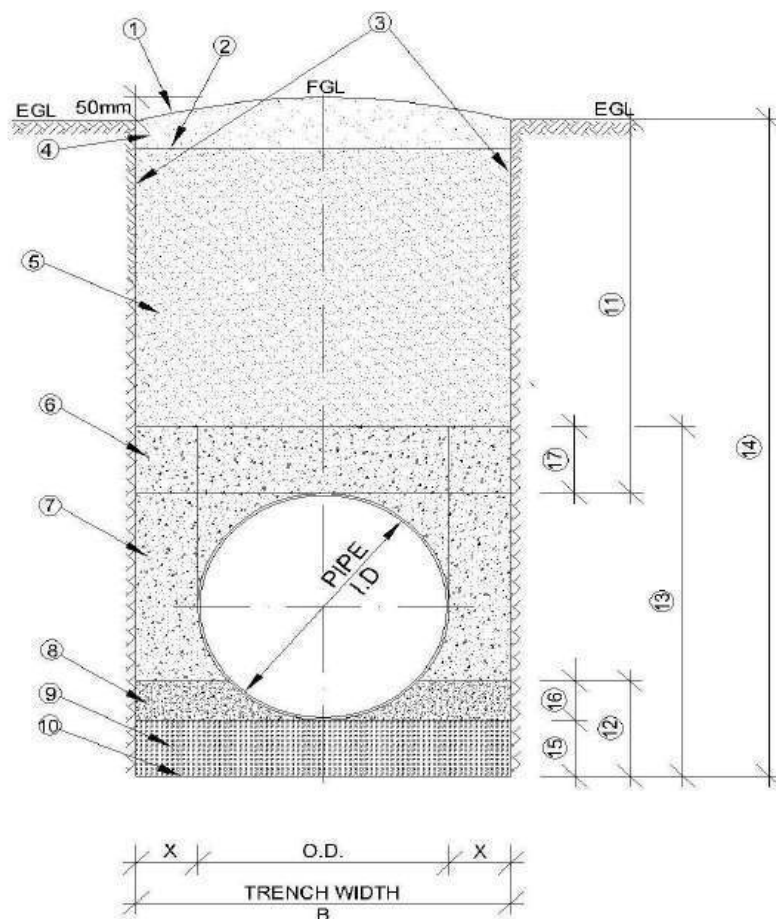
The pipes and specials shall be checked for flaws before they are lowered into the trench. After the pipes or specials have been checked they shall be cleaned and set to proper gradient and line.

When laying uPVC pipes, final connection at any fixed joints shall be deferred until most of the pipeline has been covered with backfill.

- b) large diameter curves to mains shall wherever possible be formed by allowing for deflection at flexible joints, not exceeding 3 degrees, or as specified by the manufacturers.
- c) In jointing of the pipes and specials the Contractor shall comply with the standards adopted for the various types of joints as specified.
- d) In laying pipes and specials with flanged joints, flanges shall be brought together and bolted with the faces absolutely parallel. A rubber jointing gasket ring 3mm thick shall be used in each flange joint and one washer with and not provided for each bolt.
- e) The bolts shall be tightened up gradually and equally in the customary manner to distribute the stress evenly over the flange. If it is found necessary to deviate slightly from the normal run of the flanged piping, the deflection shall be obtained by means of a bevelled gun metal ring washer between the flanges.
- f) The Contractor shall, subject to approval of the Engineer, cut pipes to such lengths as directed. Pipes should be cut off clean and square with the axis. Cuts should be made with an approved cutting device dependant on the type of pipe specified. Ends of pipes should be tapered by means approved by the Engineer if mechanical joints are to be used.
- g) Equipment for tapping off the mains under pressure may be employed in the making of service or branch connections. The Contractor is required to choose a suitable method for fixing of the ferrule to the type of pipe specified, to the Engineer's approval.

**509. BACKFILLING OF PIPE TRENCHES**

- i) Before commencing the placing of embedment in the trenches, the Contractor shall obtain approval from the Engineer 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 BS 1377 or ISO 22476 using the "sand replacement" method). The method of compaction and the testing thereof shall be always to the approval of the Engineer and in general at a frequency of once every 30 metres unless this is specifically relaxed based on continuously good in-situ test results.
- ii) Backfilling shall only take place with the prior approval of the Engineer.
- iii) Typical trench details are shown below.



- 1. Surface
- 2. Bottom of road construction (if any)
- 3. Trench walls
- 4. Topsoil
- 5. Main backfill.
- 6. Initial backfill.
- 7. Sidefill
- 8. Upper bedding
- 9. Lower bedding
- 10. Trench bottom
- 11. Depth of cover
- 12. Depth of bedding (refer to Note iii)
- 13. Depth of embedment
- 14. Trench depth
- 15. Depth of lower bedding
- 16. Depth of upper bedding
- 17. Depth of initial backfill

**Notes:**

- i) Compaction is the deliberate densification of soil during the construction process, whereas consolidation is the subsequent time-dependent densification after construction.
- ii) The embedment is the arrangement and type(s) of material(s) around the buried pipeline which contributes to its structural performance. Attaining cited minimum compaction requirements is mandatory for embedment.
- iii) Minimum cover is 1000 mm for all pipes. May be reduced at Engineer's discretion.

- iv) The embedment section comprises all materials below the pipe and surrounding the pipe, extending 300 mm above the crown of the pipe. All material above this point comprises the main backfill.
- v) The embedment section comprises the bedding (lower and upper), the side-fill, and the initial backfill (which extends from the crown of the pipe to 300 mm above the crown)
- vi) The embedment material shall be free from tree roots, lumps, stones, organic matter, fragments of rock larger than 20 mm, or similar objects, which through impact or by concentrating imposed loads might damage the pipes. Black cotton soil shall not be used as embedment material.
- vii) Where pipes are not to be surrounded in concrete or bedding materials (S1 to S4) described above, the pipe zone material placed around the pipes shall be selected and screened as necessary, free from and to the approval of the Engineer.
- viii) Classification of embedment materials for flexible (steel, uPVC, HDPE) and semi-rigid (DI) pipes is indicated in Table below.

| <b>Embedment Class</b> | <b>Embedment Material Allowed</b>   | <b>Notes</b>  |
|------------------------|---|---|
| S1 and S2              | Class S1: Gravel – single size<br>Class S2: Gravel – graded   | Normally processed granular materials where specified as bedding for ferrous pipes  |
| S3 and S4              | Class S3: Sand and coarse-grained soil with less than 12% fines<br><br>Class S4: Coarse grained soil with more than 12% fines OR Fine-grained soil, liquid limit less than 50%, medium to no plasticity and more than 25% coarse grained material | These can be “as dug” soils but require particularly close control when used with low stiffness pipes.<br><br>Class S3 shall be used for epoxy lined steel pipes.<br><br>Class S4 is suitable for cement mortar lined ferrous pipes |

- ix) Granular material for beddings shall consist of aggregate to BS 882 and shall conform to the grading shown in Table below.

| <b>Nominal Pipe</b> | <b>Grading (mm)</b>                           |                                  |
|---------------------|---|----------------------------------|
|                     | <b>S1 Lower Bedding</b>                       | <b>S2 Lower Bedding</b>          |
| 80-100              | 10 single sized gravel                        | 10 single-size gravel            |
| 150                 | 10 to 14 single-size gravel                   | 14 to 5 graded                   |
| 200-500             | 10, 14 or 20 single-size gravel               | 14 to 5 graded or 20 to 5 graded |
| >500<br>>1000       | 10, 14, 20 single-size crushed rock or gravel | 14 to 5 graded or 20 to 5 graded |

- x) The embedment material shall be in accordance with the above specifications, and not less than:

- a) Class S3 material for epoxy lined steel pipes.
  - b) Class S4 material for cement-mortar lined ferrous pipes (Ductile)
  - c) Class S2 material for thermoplastic pipes
- xi) Where the 'as-dug' trench material meets the bedding class requirements as specified or will meet the requirements through careful screening and processing, the Contractor may incorporate such material into the embedment, subject to the Engineer's approval. No additional payment shall be made for screening and processing.
  - xii) If the quantity of appropriate embedment material which can be obtained from the pipe trench excavation (with or without screening) is insufficient, the Contractor shall transport suitable material from other excavations on site, or from off-site. No additional payment shall be made for such imported material.
  - xiii) For all bedding classes, compaction shall be not less than 90% Modified Proctor Density (MPD) at optimum moisture content (+5% 1 -2%)
  - xiv) The placing and compaction of pipe embedment shall only be undertaken in the presence of the Engineer unless written authority from the Engineer has been granted.
  - xv) Sidefill shall be placed simultaneously on both sides of the pipe in layers not exceeding 150 mm thickness and compacted using hand rammers to achieve the required density, taking particular care to compact the material under the barrel of the pipe and around joints. Layer thickness is however subject to consistently achieving 90% MPD or better, failing which layers shall be reduced in depth as necessary to achieve the necessary compaction.  

The compaction shall be in accordance with Section 3.6 of BS 1377: 1990, Part 4 using a 4.5 kg rammer. In-situ density tests shall be carried out by the sand replacement method in accordance with BS 1377: 1990, Part 9 at every 30 metres or as directed by the Engineer.
  - xvi) Pipes 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 10 cm and then re-compacted to at least 90% MPD and then the surface loosened on the day of and prior to laying.
  - xvii) In rock excavation, the pipes shall be bedded on concrete or selected granular fill 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 approval.
  - xviii) The main backfill shall be filled with approved backfill material obtained from the trench excavations, free from clay lumps, boulders, and rock fragments larger than 100 mm. The material shall be placed in layers not exceeding 150 mm thickness and compacted using approved mechanical rammers.
  - xix) 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. Bedding material shall be compacted in layers not exceeding 50 mm thickness.
  - xx) In trenches where there is a continuous accumulation of ground water the trench shall, after obtaining the approval of the Engineer, be over-excavated by 150 mm and shall be backfilled using compacted free-draining granular material.
  - xxi) Where mechanical ramming of the backfill is employed, the machines shall be to the approval of the Engineer and soil shall be compacted by hand for a depth of

not less than 50 cm 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.

- xxii) 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.
- xxiii) Where minimum cover cannot be maintained, including roads 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 compacted as a cushion above the crown of the pipe before the slab is laid, and the slab must extend at least 300 mm out beyond either side of the trench.

#### **510. MAKING GOOD SUBSIDENCE AFTER REFILLING**

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

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

The affected section or sections will in any event be liable for a further twelve months maintenance period. All refilling necessary due to subsidence in pipe trench backfill shall be thoroughly compacted by ramming.

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 replaced.

#### **511. REINSTATEMENT OF SURFACES**

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.

The Contractor shall be responsible for the temporary reinstatement and permanent reinstatement of all surfaces whether the area requiring restoration is within the limits of his excavations if the necessity for the restoration arises from causes due to the operations of the Contractor. The Contractor's prices shall include for restoring all surfaces so damaged to their original condition, as no extra payment will be made for any such work. The Contractor shall take all necessary measures to ensure that no toxic materials that may cause damage to vegetation or livestock or pollute streams or 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.

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 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, the surface shall be necessary to consolidate the filling and keep the surface fit for traffic, suitable material being added to all places which have sunk or become rough.

For the purposes of temporary and permanent reinstatement in bitumen and murrum or gravel surfaced roads the surface width of trenches shall be increased by 300 mm on each side of the trench for a depth of 300 mm to provide a solid abutment for the surfacing material.

Reinstatement of murrum and gravel surfaced roads shall consist of approved "as dug" material placed in one layer 250 mm thick thoroughly compacted by an approved roller and surface blinded with fine material to leave a tight closed even surface, all to the satisfaction of the Engineer.

Temporary reinstatement of trenches in bitumen surfaced roads shall comprise a layer of compacted hardcore, of minimum thickness 150 mm, topped with a 75 mm layer of surface material taken from the original surface together with any additional material to form a satisfactory running surface. The surface shall be well rolled and sealed with a coat of approved cold applied bituminous emulsion, applied with an approved sprayer at the rate of approximately 2 litres/m<sup>2</sup>. The emulsion shall be blinded immediately with quarry dust or sand approved and then rolled with an 8-tonne roller.

The quality and grade of bitumen shall be suitable for the climatic conditions of the area and shall otherwise conform to BS 434.

Permanent reinstatement shall not be made until the ground has consolidated permanently and until approval to do so is received from the Engineer. It shall be carried out with materials similar to those that were used in the original Work to the entire satisfaction of the Engineer and/or responsible Authority. In the event of further settlement occurring after the completion of the permanent reinstatement the Contractor shall forthwith make good the reinstatement to the approval of the Engineer or responsible authority.

Trenches in open ground shall be reinstated to the condition in which the ground was found before excavation was commenced. The final surface of the trench shall be flush with the surrounding ground.

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.

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.

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.

If the work 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 within one week of being ordered to do so by the Engineer, any remedial work considered necessary may be undertaken by the Employer and/or the responsible authority at the Contractor's expense.

#### **512. ANCHOR BLOCKS AND SUPPORTS**

Concrete Class 15/20 shall be placed in anchor blocks at all changes of direction of the pipeline exceeding 6 degrees and wherever else required to withstand thrust resulting from internal water pressure e.g., at blank ends. Concrete in plinths shall be placed where specified.

#### **513. CHAMBERS AND SURFACE BOXES**

Gate valves, air valves and fire hydrants etc. shall be provided with suitable chambers or surface boxes in accordance with detailed drawings. In roads and footpaths, the boxes shall have metal covers laid flush with the surface. Indicator posts to suit shall also be provided.

#### **514. CLEARANCE OF SITE**

The Contractor shall remove all surplus pipes, specials and other fittings from the site as directed by the Engineer. The site of works shall be levelled and all surplus excavation, debris, cut trees or bushes shall be carted to approved tip sites.

## **6. DRAINS, SEWERS, AND MANHOLES**

### **601. EXCAVATION FOR DRAINS, SEWERS, AND MANHOLES**

The ground shall be excavated to the lines and depths shown on the drawings or to such other lines and depths as the Engineer may direct. Excavations taken out to a greater depth than is necessary shall be filled to the required level with approved material as specified for the pipe bed at the Contractor's own cost. Trenches shall be of sufficient width to enable the pipes to be properly laid and jointed. In case of pipes of greater diameter than 300mm, the width of trench shall be external diameter of pipe, plus 400mm. When any excavation has been taken out and trimmed to the levels and dimensions shown on the drawings or as directed by the Engineer, the Engineer shall be informed accordingly so that he may inspect the completed trench and no excavation shall be filled in or covered with concrete until it has been so inspected and the Contractor has been authorized to proceed with the work. All surplus materials from such excavations not required for refilling shall be carted away to tips, or otherwise disposed of, 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 and backfilling of trenches shall be taken to provide a solid and even bed for barrels of the pipes and, where a concrete bed is not specified, the floor of the trench shall be properly shaped to receive the sockets and the backfill must be thoroughly rammed along the sides of the pipe.

The rate of excavation in the Bill of Quantities shall include for keeping trenches dry and for all bailing, pumping, timbering, shoring and supporting of sides that may be required.

### **602. SUPPORTS FOR PITS, TRENCHES, AND OTHER EXCAVATIONS**

The sides of pits, trenches and other excavations shall, where necessary, be adequately supported to the satisfaction of the Engineer, and all such excavations shall be of sizes sufficient to enable the pipes and bedding to be laid accurately, and proper refilling and compacting to be carried out.

The Contractor shall take all precautions necessary for the safety of adjoining structures and building by shoring, opening in short lengths or otherwise, during the time the trenches are open.

### **603. ROCK CUTTING IN TRENCHES FOR PIPES**

Where solid rock is met within trenches, it shall be cut out to a depth of 100mm below the intended level of the bottom of the pipes and replaced with 100mm of approved material as specified. In measuring such rock excavation, the Contractor will be allowed a width of 400mm more than the external diameter of the pipes to a level of 100mm below the bottom of the pipes. The price inserted in the Bill of Quantities shall be held to cover all expenses in connection with excavating the rock, backfilling after laying of pipes and disposing of surplus material as directed by the Engineer.

### **604. WATER IN TRENCHES FOR PIPELINES**

Trenches shall always be kept free from water during construction of works until, in the opinion of the Engineer, any concrete or other works therein are sufficiently set, and the Contractor shall construct any sumps or temporary drains that the Engineer may deem necessary.

The Contractor shall be responsible for the removal and disposal of all water entering the excavations from whatever source and shall deal with and dispose of such water in a manner approved by the Engineer to ensure that excavations are kept dry while ensuring that the disposal of this water does not cause a nuisance to adjacent plot holders or works.

The Contractor shall provide all plant, labour and materials required for such work and all costs incurred shall be deemed to be included in his rates for excavation.

#### **605. LAYING AND JOINTING RIGID JOINTED CONCRETE PIPES**

Concrete pipes shall be laid true to line and level, each pipe being separately boned between sight rails.

For spigot and socket joints, the spigot of each pipe shall be placed home in the socket of the one previously laid, and the pipe then adjusted and fixed in its correct position with the spigot of the pipe accurately centred in the socket. A ring of tarred rope yarn shall next be inserted in the socket of each pipe previously laid and driven home with a wooden caulking tool and wooden mallet, such yarn when in position shall be 25mm in depth. The socket shall then be completely filled with cement mortar 1 to 2 as specified in Clause 1013 and a fillet of the same worked all round the side. The fillet shall be levelled off and extend for a length of not less than 50mm from the face of the socket.

For 'Ogee' jointed pipes, the joints shall be thoroughly cleaned before laying, and cement mortar, as specified in shall be applied evenly to the ends for jointing to completely fill the joint. The pipes shall then be neatly pointed with a band of cement mortar approximately 125mm wide and 20mm thick. The inside of each joint shall also be pointed up as the work proceeds.

Special care shall be taken to see that any excess of cement mortar etc. is neatly cleaned off while each joint is being made and any earth, cement or other material cleaned out of the pipes by drawing a tight-fitting wad through them as the work proceeds, or by other approved means. A properly fitting plug shall be well secured at the end of the last laid pipe and shall be removed only when pipe laying is proceeding. The trenches, pipes and joint holes shall be kept free from water until the joints are thoroughly set.

Where shown on the drawings or directed by the Engineer, concrete pipes shall be bedded and haunched or surrounded with concrete as specified in Clause 618.

The price inserted in the Bill of Quantities shall include for providing, laying, and jointing of pipes.

#### **606. PIPES LAID WITH OPEN JOINTS**

O.G. porous concrete pipes as specified in shall be laid unjointed with a space of 12mm between the spigot and the inner end of the socket.

All pipes shall be packed and surrounded as directed by the Engineer with approved broken stone, sand, or gravel aggregate, to the gradings as shown on the drawings or stated in the Bill of Quantities. The prices inserted in the Bill of Quantities shall include the trench excavation, providing and laying pipes, supplying, and placing graded packing material, refilling trench, and disposing of surplus all as specified.

#### **607. DRAINS TO BE LEFT CLEAN ON COMPLETION**

On completion, all drains, manholes, etc. shall be flushed from end to end with water from an approved source and left clean and free from obstructions.

### **608. REFILLING TRENCHES**

Trenches shall be refilled with suitable excavated material of 100mm surround but not before the work has been measured and approved by the Engineer. For pipes which are not surrounded with concrete, the first layer of filling material shall be free from stones and shall not be thrown directly on to the pipes but shall be placed and packed with care all round them. All filling shall be deposited and compacted in layers, not exceeding 225mm loose depth, to a dry density not less than that of the adjoining soil. The last 450mm of filling must be returned in the order in which it has been removed. Timber and framing shall be withdrawn ahead of the layer to be compacted, care being taken to keep the sides of the trenches solid and to fill all the spaces left by the withdrawn timber.

### **609. CONNECTIONS OF EXISTING SEWERS AND DRAINS**

Where shown on the drawings, existing sewers and drains shall be properly extended, connected, and jointed to new sewers, culverts, drains or channels. All such connections shall be made during the construction of the main sewer, drain or other work and a record of their positions kept for future use or reference. Where pipe connections are made to a sewer, stone pitched or lined channel, the pipes shall be well and tightly built into the concrete, or masonry work and be so placed as to discharge in the direction of the main sewer, drain or channel and with the end of the pipe carefully cut to the necessary angle. Where the connections are between pipe sewers or drains, special connecting pipes as shown on the drawings shall be supplied and be truly laid and properly jointed.

### **610. MANHOLES AND INSPECTION CHAMBERS**

Manholes and inspection chambers shall be constructed in accordance with the drawings and in the position shown on the drawings or directed by the Engineer. Foundation slabs shall consist of concrete of the appropriate classes as specified on drawings. The side walls shall consist of similar concrete or building stone as specified in Clause 1009 in accordance with the drawings.

The side walls shall be fair faced or rendered internally as specified on drawings. They shall be brought up vertically to receive a precast slab formed of concrete of the appropriate classes specified and reinforced all as shown on the drawings. Cast iron manhole covers and frames as specified in Clause 1045 shall be provided and frames shall be bedded in cement mortar 1 to 3 and so set that the tops of the covers shall be flush at all points with surrounding surface of the footway, verge, or carriageway, as the case may be. Any slight adjustment of the slab level which may be necessary to accomplish this shall be effected by topping the side walls with concrete integral with the slab.

If required, half channel pipes, bends and junctions shall be laid and bedded in cement mortar 1 to 3 to the required lines and levels, and both sides of the channel pipes shall be benched up with concrete of the appropriate class and finished smooth to the slopes and levels as shown on the drawings or directed by the Engineer. The ends of all pipes shall be neatly built in and finished flush with cement mortar 1 to 3. Where the depth of the invert exceeds 1 metre below the finished surface of the carriageway or the adjacent ground, iron steps as specified in Clause 1046 shall be built in with alternate steps in line vertically and with such additional hand irons as the Engineer may direct.

All manholes when completed shall be watertight and to the satisfaction of the Engineer. The prices inserted in the Bill of Quantities shall include for excavation, provision of all materials, construction, refilling and disposal of surplus.

**611. PRECAST CONCRETE MANHOLES**

Precast concrete manholes as specified in Clause 1054 shall be supplied and laid generally in accordance with Clause 510 and the drawings.

**612. GULLY CONNECTIONS**

Connections from gullies to sewers and surface water drains or ditches shall consist of concrete pipes and fittings as specified in Clause 1017 jointed with cement mortar 1 to 3 as specified in Clause 1013. All pipes, bends and junctions shall be laid to the lines and levels shown on the drawings or as directed by the Engineer.

**613. SURFACE BOXES, COVERS ETC.**

Surface boxes, manholes and other covers lying within the site of the works, shall be raised, lowered, altered, or removed as directed by the Engineer.

**614. GULLIES**

Gullies complete with gratings and with rodding eyes where necessary all as specified in Clause 1053 shall be supplied and laid in accordance with the drawings. Where directed by the Engineer, precast concrete gullies shall be laid on and surrounded with 100mm of concrete of the appropriate grade specified in Table 7.2. The concrete surround is to be brought up to the underside of the frame or flush with the top surface as the case may be. Masonry gullies shall be constructed from 225mm building stone and rendered internally. The rates included in the Bill of Quantities shall include for excavation, provision of all materials, construction, making junctions with connections to main drains, accurate setting of frames to line and level, refilling and disposal of surplus materials. Gullies shall be trapped where leading into foul sewers or into combined foul and surface water sewers.

**615. COMPLETION OF DRAINAGE WORKS**

All sub-soil and surface water drains shall be completed in advance of the construction.

**616. TEMPORARY STOPPERS**

Junction pipes which are laid but not immediately connected to gullies shall be fitted with temporary stoppers or seals, and the position of all such junctions shall be clearly defined by means of stakes or training wires properly marked and labelled.

**617. PROVISION FOR FUTURE CONNECTION TO MANHOLES**

Inlet pipes of the required diameters shall be built into the walls of manholes and elsewhere for future use and shall be of the diameters shown on the drawings. The external ends of all such connections shall be sealed off with temporary stoppers, approved by the Engineer. The pipes shall be laid and jointed as specified in Clause 505 and during the placing of the concrete they shall be adequately supported.

**618. SURROUNDING OR HAUNCHING OF PIPES WITH CONCRETE**

Surrounding or haunching of pipes shall be carried out using concrete of the appropriate grade specified in Table 7.2. In carrying out this work the Contractor shall take care to pack the concrete under and around the pipes to ensure even bedding and solidity in the concrete and the concrete shall not be thrown directly on to the pipes. The upper surface of the concrete shall be struck off with a wooden screed or template and neatly finished off. The rates shall include for any formwork that the Contractor requires to use under this item.

### **619. INVERT BLOCK AND STONE-PITCHED DRAINS**

Precast concrete invert blocks and side slabs shall be formed of concrete of the appropriate grade specified in Table 7.2 to the dimensions shown on the drawings. Each course of side slabs required in the Bill of Quantities shall be interpreted as one complete row of side slabs to one side of the channel concerned. Stone used for channels shall be 225mm x 100mm building stone. Drains should not normally be laid to a radius of curvature less than 10 times the actual width of the drain.

Invert block and stone-pitched drains shall be constructed in the positions and to the levels and dimensions shown on the drawings and laid to true line and even fall. Where under-filling is required, it shall be in 100mm maximum thickness layers of compacted murrum. The earth sides to such channels shall be neatly finished to a slope of 1 to 1 or such other slope as the Engineer may direct.

Invert blocks and side slabs shall be laid on a 100mm minimum thickness of compacted murrums and be neatly jointed with cement mortar 1 to 3 as the work proceeds. The excavation, murrum bedding, providing, laying, and jointing invert blocks or stone, backfilling and disposal of surplus shall all be as specified, and all in-situ connections shall be in concrete of the appropriate grade specified in Table 7.2.

### **620. TESTING OF JOINTED PIPES AND MANHOLES**

Sealed jointed drains, up to and including 600mm diameter shall be tested in sections (e.g., between manholes) by filling with water under a head of not less than 1 metre. Drains found to be water-tight after a period of 30 minutes will be passed as satisfactory, but the water must be retained in the pipes until a depth of at least 450mm of filling has been deposited and compacted on top thereof. Drains failing to stand the test shall be taken out and the pipes re-laid and re-jointed until completely watertight.

Drains exceeding 600mm in diameter shall be tested by means of a smoke test before they are covered up. Both ends of the lengths of drain to be tested shall be sealed to the satisfaction of the Engineer, and smoke shall then be pumped into the section from an approved machine. Should any joint in the section show an escape of smoke, the section shall be taken out and the pipes re-laid and re-jointed until there is no further escape of smoke.

Should the Engineer so direct, manholes shall be tested by completely filling with water, and there shall be no appreciable loss over a period of 2 hours.

On completion of the works, or at suitable intervals during construction, infiltration tests will be carried out. The permissible amount of infiltration shall be 1 litre per hour per linear metre of nominal internal diameter.

The Contractor shall provide all labour and apparatus for the above tests.

All testing will be done in accordance with the procedure of the British Standard Code.

### **621. PIPES WITH RUBBER RING JOINTS**

Rubber rings complying with SRN 308 will be provided by the Contractor. They will be laid in the socket and the pipes then jointed as specified. The jointing of pipes shall be carried out in accordance with manufacturer's instructions and in conformity with any modifications proposed by the Engineer.

## **622. LAYING, JOINTING AND BACKFILLING FOR FLEXIBLE JOINTED PIPES**

The Contractor shall ensure that any hard spots and loose stones are removed from the formation prior to laying of bedding materials. The Contractor shall lay a bed of thickness 100mm consisting of granular material i.e., sand, gravel, or approved soil of friable nature.

After laying of pipes the Contractor shall lay bedding material on the sides of the pipe compacted by tamping into soffit of sewer.

After completion of this operation the Contractor shall lay the bedding material on top of the pipe in 150mm layers to a thickness of 300mm. The material is to be compacted by tamping. However, precautions are to be taken to avoid excessive tamping on top of the pipe. The remaining trench excavation is to be backfilled to comply with Clause 508 of specification.

The pipes shall be laid with flexible ring seal joints provided that solvent cement joints could be used for fittings where necessary subject to the approval of the Engineer. Pipes and fittings shall be checked for deformities prior to laying. Deformed pipes and fittings shall not be accepted.

### **Flexible Rubber Ring Joints**

The Contractor shall ensure that the spigot end is free from grit, dust or dirt and sealing rings should be seated evenly in the socket groove. Pipe lengths and fittings are supplied with a chamfer on the spigot. Where pipes are to be cut or are supplied without a chamfer on the spigot end the Contractor shall ensure that the pipe is cut square and then form a chamfer on the spigot end with a medium file to an angle of 15 degrees. Remove saw flashing by scraping with a penknife.

### **Expansion Gap**

It is necessary to leave a gap between the edge of the spigot end and the base of the socket to allow for expansion. Moulded fittings are supplied with an embossed line indicating the correct depth of insertion. In other cases where the marking is not done, the Contractor shall ensure that an expansion gap of at least 3mm per metre length of pipe or at least 15mm per pipe length is provided. This can be done by marking spigot ends or by pushing spigot fully home, making a small mark on pipe and then withdrawing the pipe by 15mm.

After completing jointing the pipe shall be laid on the prepared bed making sure that a suitable depression is created in the bed for the socket.

### **Solvent Cement Joints**

For solvent cement joints make sure that mating surfaces are clean and free of grease and dirt. Roughen mating surface with sandpaper, clean both surfaces with cleansing fluid using a clean cloth. Apply solvent cement on both mating surfaces. Without delay bring mating surfaces together and hold in position firmly for a few seconds. A layer of cement should be visible at the edges. Joints should not be disturbed for at least 10 minutes after assembly.

## 7. CONCRETE

### 701. SCOPE OF SECTION

This section covers the materials, design of mixes, mixing, transport, placing, compaction and curing of concrete and mortar required in the Works. It also covers formwork and reinforcement for concrete.

### 702. DEFINITIONS

**Structural concrete** is any class of concrete which is used in reinforced, prestressed, or unreinforced concrete construction, which is subject to stress.

**Non-structural concrete** is composed of materials complying with the Specification but for which no strength requirements are specified, and which is used only for filling voids, blinding foundations, and similar purposes where it is not subjected to significant stress.

A **formed surface** is a face which has been cast against formwork.

An **unformed surface** is a horizontal or nearly horizontal surface produced by screeding or trowelling to the level and finish required.

A **pour** refers to the operation of placing concrete into any mould, bay, or formwork, etc. and to the volume which must be filled. Pours in vertical succession are referred to as lifts.

### 703. THE DESIGN OF CONCRETE MIXES

#### a) Cement

Cement shall be from an approved source and shall be low alkali (contain less than 0.6% alkali) cement and sulphate-resistant or ordinary Portland cement complying with EN197.

Cement shall be delivered in sealed manufacturer's branded bags or barrels, each consignment accompanied by the manufacturer's test certificates. Any cement that the Engineer considers unsatisfactory shall be rejected.

Cement stored on site shall be protected from the weather and raised from the ground.

Cement shall be used in the order in which it is delivered.

Each consignment of cement delivered to the site must be accompanied by a certificate showing the place and date of manufacture and the results of standard tests carried out on the bulk supply from which the cement was manufactured.

Notwithstanding the above requirements and tests, the Engineer may reject any cement which in his opinion is unsatisfactory for any reason whatsoever.

#### b) Classes of Concrete

The classes of structural concrete to be used in the works shall be those shown on the Drawings and designated in Table 6.1, in which the class designation includes two figures. The first figure is the nominal strength at 28 days expressed in N/mm<sup>2</sup> and the second figure is the maximum nominal size of aggregate in the mix expressed in millimetres.

**c) Design of Proposed Mixes**

All concrete mixes and tests shall be in conformity with EN 206 and EN 12350.

The Contractor shall design all the concrete mixes called for on the Drawings, making use of the ingredients which have been approved by the Engineer for use in the Works and in compliance with the following requirements: -

**Table 7.1 – CONCRETE CLASSES AND STRENGTHS**

| Class of Concrete | Nominal Strength<br>N/mm <sup>2</sup> | Maximum Nominal Size<br>of Aggregate<br>mm | Maximum Water / Cement Ratio |      | Trial Mixes Target Mean<br><br>Strength<br>(Clause 401 c)<br>N/mm <sup>2</sup> | Early Works Test Cubes (Clause 401 d) |   |
|-------------------|---------------------------------------|--|------------------------------|------|--|---------------------------------------|---|
|                   |                                       |  | A                            | B    |  | Any one Cube<br>N/mm <sup>2</sup>     | Average of any Group<br>of 4 Cubes<br>N/mm <sup>2</sup> |
| 10/75             | 10                                    | 75   | 0.60                         | 0.55 | 13.5   | 8.5                                   | 13.3  |
| 15/75             | 15                                    | 75   | 0.60                         | 0.50 | 21.5   | 12.8                                  | 20.0  |
| 15/40             | 15                                    | 40   | 0.60                         | 0.50 | 21.5   | 12.8                                  | 20.0  |
| 15/20             | 15                                    | 20   | 0.57                         | 0.50 | 21.5   | 12.8                                  | 20.0  |
| 20/40             | 20                                    | 40   | 0.55                         | 0.48 | 31.5   | 17.0                                  | 27.5  |
| 20/20             | 20                                    | 20   | 0.53                         | 0.48 | 31.5   | 17.0                                  | 27.5  |
| 20/10             | 20                                    | 10   | 0.50                         | 0.48 | 31.5   | 17.0                                  | 27.5  |
| 25/40             | 25                                    | 40   | 0.52                         | 0.46 | 36.5   | 21.3                                  | 32.5  |
| 25/20             | 25                                    | 20   | 0.50                         | 0.46 | 36.5   | 21.3                                  | 32.5  |
| 25/10             | 25                                    | 10   | 0.48                         | 0.46 | 36.5   | 21.3                                  | 32.5  |
| 30/40             | 30                                    | 40   | 0.50                         | 0.45 | 41.5   | 25.5                                  | 37.5  |
| 30/20             | 30                                    | 20   | 0.48                         | 0.45 | 41.5   | 25.5                                  | 37.5  |
| 30/10             | 30                                    | 10   | 0.47                         | 0.45 | 41.5   | 25.5                                  | 37.5  |
| 40/20             | 40                                    | 20   | 0.46                         | 0.43 | 51.5   | 34.0                                  | 47.5  |
| 40/10             | 40                                    | 10   | 0.45                         | 0.43 | 51.5   | 34.0                                  | 47.5  |

**NOTES:**

- Under water/cement ratio, column A applies to moderate and intermediate exposure, and column B applies to severe exposure. See NOTE after Table 6.2.
- In case of concrete having a maximum aggregate size of 40mm or less, 150mm cubes should be used.

In case of concrete having a 75mm or larger aggregate, 200mm cubes should be used.

- The aggregate portion shall be well graded from the nominal maximum size of stone down to the 150-micron size.

- ii) The cement content shall be such as to achieve the strengths called for in Table 6.1 but in any case, not less than the minimum necessary for impermeability and durability shown in Table 6.2.
- iii) The workability shall be consistent with ease of placing and proper compaction having regard to the presence of reinforcement and other obstructions.
- iv) The water/cement ratio shall be the minimum consistent with adequate workability but in any case, not greater than that shown in Table 7.1 taking due account of any water contained in the aggregates. The Contractor shall consider that this requirement may in certain cases require the inclusion of a workability agent in the mix.
- v) The drying shrinkage determined in accordance with BS 1881 shall not be greater than 0.05 percent.

**Table 7.2 - MINIMUM CEMENT CONTENT**

| Minimum Cement Content - kg/m <sup>3</sup> of Compacted Concrete |                   |                       |                 |
|--|-------------------|-----------------------|-----------------|
| Class of Concrete  | Moderate Exposure | Intermediate Exposure | Severe Exposure |
| 10/75,15/75  | 200               | 220                   | 270             |
| 15/40, 20/40, 25/40, 30/40                                       | 240               | 270                   | 290             |
| 15/20, 20/20, 25/20, 30/20                                       | 260               | 300                   | 330             |
| 40/20  | 300               | 320                   | 330             |
| 20/10, 25/10, 30/10  | 300               | 340                   | 390             |
| 40/10  | 310               | 340                   | 390             |

**Note:** The minimum cement contents shown in the above table are required to achieve impermeability and durability. In order to meet the strength requirements in the Specification higher contents may be required.

The categories applicable to the Works are based broadly on the factors listed hereunder:

Moderate exposure    Surface sheltered from severe rain.

   buried concrete, concrete continuously under water.

Intermediate

Exposure

Surface exposed to driving rain; alternate wetting and drying; traffic; corrosive fumes; heavy condensation.

Severe exposure

Surface exposed to sea water, moorland water having a pH of 4.5 or less, groundwater containing sulphates.

- c) Trial Mixes

At least six weeks before commencing placement of concrete in the Permanent Works trial mixes shall be prepared for each class of concrete specified.

For each mix of concrete for which the Contractor has proposed a design, he shall prepare three separate batches of concrete using the materials which have been approved for use in the works and the mixing plant which he proposes to

use for the Works. The volume of each batch shall be the capacity of the concrete mixer proposed for full production.

Samples shall be taken from each batch and the following action taken, all in accordance with BS 1881:

- i) The slump of the concrete shall be determined.
- ii) Six test cubes shall be cast from each batch. In the case of concrete having a maximum aggregate size of 40mm or less, 150mm cubes shall be used. In the case of concrete containing 75mm or larger aggregate, 200mm cubes shall be used and in addition any pieces of aggregate retained on a 53mm BS sieve shall be removed from the mixed concrete before casting the cubes.
- iii) Three cubes from each batch shall be tested for compressive strength at seven days and the remaining three at 28 days.
- iv) The density of all the cubes shall be determined before the strength tests are carried out.

Subject to the agreement of the Engineer, the compacting factor apparatus may be used in place of a slump cone. In this case the correlation between slump and compacting factor shall be established during preparation of the trial mixes.

The average strength of the nine cubes tested at 28 days shall be not less than the target mean strength shown in Table 7.1.

The Contractor shall also carry out tests to determine the drying shrinkage of the concrete unless otherwise directed by the Engineer.

Based on the results of the tests on the trial mixes, the Contractor shall submit full details of his proposals for mix design to the Engineer, including the type and source of each ingredient, the proposed proportions of each mix and the results of the tests on the trial mixes.

If the Engineer does not agree to a proposed concrete mix for any reason, the Contractor shall amend his proposals and carry out further trial mixes. No mix shall be used in the works without the written consent of the Engineer.

d) Quality Control of Concrete Production

i) Sampling

For each class of concrete in production at each plant for use in the works, samples of concrete shall be taken at the point of mixing and/or of deposition as instructed by the Engineer, all in accordance with the sampling procedures described in BS 1881 and with the additional requirements as set out below.

Six number 150mm or 200mm cubes as appropriate shall be made from each sample and shall be cured and tested all in accordance with BS 1881, two at seven days and the other four at 28 days.

Each sample shall be taken from one batch selected at random and at intervals such that each sample represents not more than 20m<sup>3</sup> of concrete unless the Engineer agrees to sampling at less frequent intervals.

Until compliance with the Specification has been established the frequency of sampling shall be three times that stated above or such lower frequency as may be instructed by the Engineer.

ii) Testing

- 1) The slump or compacting factor of the concrete shall be determined for each batch from which samples are taken and in addition for other batches at the frequency instructed by the Engineer.

The slump of the concrete in any batch shall not differ from the value established by the trial mixes by more than 25mm or one third of the value, whichever is the greater.

The variation in value of the compacting factor, if used in place of a slump value, shall be within the following limits:

For value of 0.9 or more +0.03

For value of between 0.8 and 0.9 +0.04

For values of 0.8 or less +0.05

- 2) The water/cement ratio as estimated from the results of (a) above, determined by samples from any batch shall not vary by more than five per cent from the value established during the trial mixes.
- 3) The air content of air entrained concrete in any batch shall be within 1.5 units of the required value and the average value of four consecutive measurements shall be within 1.0 unit of the required value, expressed as a percentage of the volume of freshly mixed concrete.
- 4) Until such time as sufficient test results are available to apply the method of control described in 5) below, the compressive strength of the concrete at 28 days shall be such that no single result is less than the value shown in Table 6.1 under the heading early works test cubes' and also that the average value of any four consecutive results is not less than the value shown in Table 6.1 under the same heading.

The 7-day cube result may be used as an early strength indicator, at the discretion of the Engineer.

- 5) When test cube results are available for at least 20 consecutive batches of any class of concrete mixed in any one plant, the average of any four consecutive results at 28 days shall exceed the nominal strength by not less than half the current margin (Table 6.3) and each individual result shall not be less than 85 per cent of the nominal strength.

The current margin shall be defined as 1.64 times the standard deviation of cube tests on at least 20 separate consecutive batches produced from one plant over a period exceeding five days but not exceeding six months or on at least 50 separate consecutive batches produced from one plant over a period not exceeding 12 months. If both figures are available, the smaller shall be taken.

The current margin shall in any case not be less than the figure given below: -

**Table 7.3 - MINIMUM CURRENT MARGIN FOR TEST CUBES**

|                  | Minimum Current Margin for |                             |                     |
|------------------|----------------------------|-----------------------------|---------------------|
|                  | 10N/mm <sup>2</sup>        | 15N/mm <sup>2</sup> & above | 20N/mm <sup>2</sup> |
| After 20 batches | 3.3                        | 5                           | 7.5                 |
| After 50 batches | 1.7                        | 2.5                         | 3.8                 |

Failure to comply with requirements:

If any one test cube result in a group of four consecutive results is less than 85% of the nominal strength but the average of the group of which it is part satisfies the strength requirement, then only the batch from which the failed cube was taken shall be deemed not to comply with the Specification.

If more than one cube result in a group of four consecutive results is less than 85% of the nominal strength or if the average strength of the group fails to satisfy the strength requirement then all the batches between those represented by the first and last cubes in the group shall be deemed not to comply with the Specification, and the Contractor shall immediately adjust the mix design subject to the agreement of the Engineer to restore compliance with the Specification. After adjustment of the mix design the Contractor will again be required to comply with sub-clauses 603(b) and 603(c) of this Section of the Specification.

The Contractor shall take necessary action to remedy concrete which does not comply with this Specification. Such action may include but is not necessarily confined to the following: -

- i) Increasing the frequency of sampling until control is again established.
- ii) Cutting test cores from the concrete and testing in accordance with SRN 117.
- iii) Carrying out strengthening or other remedial work to the concrete where possible or appropriate.
- iv) Carrying out non-destructive testing such as load tests on beams.
- v) Removing the concrete.

#### **704. MIXING CONCRETE**

Before any plant for batching, mixing, transporting, placing, compacting, and finishing concrete is ordered or delivered to site, the Contractor shall submit to the Engineer full details including drawings of all the plant which he proposes to use and the arrangements he proposes to make.

- a) the proposed mixes, the material to be used and the method of storage and mixing comply with the requirements of the Specification.
- b) adequate control is exercised during mixing.

Approval for the use of ready mixed concrete may be withdrawn if the Engineer is not satisfied with the control of the materials being used and control during mixing.

The mixing of concrete shall be carried out at central plant located at a site remote from place of discharge of mixed concrete. The mixed concrete shall be transported from the central plant using transit lorry mixers and/or agitator trucks.

Batching and mixing plants shall be modern efficient equipment complying with the requirements of SRN 118 and capable of producing a uniform distribution of the ingredients throughout the mass. Truck mixes shall comply with the requirements of SRN 121 and shall only be used with the prior agreement of the Engineer. If the plant proposed by the Contractor does not fall within the scope of SRN 118, it shall have been tested in accordance with SRN 119 and shall have a mixing performance within the limits specified in SRN 118.

All mixing operations shall be under the control of an experienced supervisor.

The aggregate storage bins shall be provided with drainage facilities arranged so that drainage water is not discharged to the weigh hoppers. Each bin shall be drawn down at least once per week and any accumulations of mud or silt removed.

Cement and aggregate shall be batched by weight. Water may be measured by weight or volume.

The weighing and water dispensing mechanisms shall be maintained in good order. Their accuracy shall be maintained within the tolerances described in SRN 118 and checked against accurate weighs and volumes when required by the Engineer.

The weighs of cement and of each size of aggregate as indicated by the mechanisms employed shall be within a tolerance of plus or minus two percent of the respective weights per batch agreed by the Engineer.

The Contractor shall provide standard test weights at least equivalent to the maximum working load used on the most heavily loaded scale and other auxiliary equipment required for checking the satisfactory operation of each scale or other measuring device. Tests shall be made by the Contractor at least once a week or at intervals to be determined by the Engineer and shall be carried out in his presence. For the purpose of carrying out these tests, there shall be easy access for personnel to the weigh hoppers. The Contractor shall furnish the Engineer with copies of the complete results of all check tests and shall make any adjustments, repairs, or replacements necessary to ensure satisfactory performance.

The nominal drum or pan capacity of the mixer shall not be exceeded. The turning speed and the mixing time shall be as recommended by the manufacturer, but in addition, when water is the last ingredient to be added, mixing shall continue for at least one minute after all the water has been added to the drum or pan.

The blades of pan mixers shall be maintained within the tolerances specified by the manufacturer of the mixer and the blades shall be replaced when it is no longer possible to maintain the tolerances by adjustment.

Mixers shall be fitted with an automatic recorder registering the number of batches discharged.

The water to be added to the mix shall be reduced by the amount of free water contained in the coarse and fine aggregates. This amount shall be determined by the Contractor by a method agreed by the Engineer immediately before mixing begins each day and thereafter at least once per hour during concreting and for each delivery of aggregates during concreting. When the correct quantity of water, determined as set out in the Specification, has been added to the mix, no further water shall be added, either during mixing or subsequently.

After mixing for the required time, each batch shall be discharged completely from the mixer before any materials for the succeeding batch are introduced.

Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before any fresh concrete is mixed and thereafter the first batch of concrete through the mixers shall contain only half the normal quantity of coarse aggregate. This batch shall be mixed for one minute longer than the time applicable to a normal batch.

Mixers shall be cleaned out before changing to another type of cement.

#### **705. HAND-MIXED CONCRETE**

Concrete for structural purposes shall not be mixed by hand. Where non-structural concrete is required, hand mixing may be carried out subject to the agreement of the Engineer.

The mixing shall be done on a hard impermeable surface. The materials shall be turned over not less than three times dry, water shall then be sprayed on, and the materials again turned over not less than three times in a wet condition and worked together until a mixture of uniform consistency is obtained.

For hand mixed concrete the specified quantities of cement shall be increased by 10% and not more than 0.5 cubic metre shall be mixed at one time. During windy weather efficient precautions shall be taken to prevent cement from being blown away during the process of gauging and mixing.

#### **706. TRANSPORTATION OF CONCRETE**

The concrete shall be discharged from the mixer and transported to the Works by means which shall prevent adulteration, segregation, or loss of ingredients, and which shall ensure that the concrete is of the required workability at the point and time of placing. The loss of slump between discharge from the mixer and placing shall not exceed 25mm. The mixed concrete shall be transported using agitator trucks or transit truck mixers. The agitating speed of the drum shall be between 2 and 4 rpm. The interval between feeding of water into the mixer drum and final discharging of the concrete shall not exceed one hour.

The time elapsed between mixing and placing a batch of concrete shall be as short as practicable and, in any case, not longer than will permit completion of placing and compaction before the onset of initial set. If the placing of any batch of concrete is delayed beyond this period, the concrete shall not be placed in the Works.

#### **707. PLACING OF CONCRETE**

##### **a) Consent for Placing**

Concrete shall not be placed in any part of the Works until the Engineer's consent has been given in writing, and the Contractor shall give the Engineer at least 1 full working days' notice of his intention to place concrete.

If concrete placing is not commenced within 24 hours of the Engineer's consent the Contractor shall again request consent as specified above.

##### **b) Preparation of Surface to Receive Concrete**

Excavated surfaces on which concrete is to be deposited shall be prepared as set out in Section 3 of this Specification.

Existing concrete surfaces shall be prepared as set out in Clause 616. Before deposition of further concrete, they shall be clean, hard, and sound and shall be wet but without any free-standing water.

Any flow of water into an excavation shall be diverted through proper side drains to a sump or be removed by other suitable methods which will prevent washing away the freshly deposited concrete or any of its constituents. Any underdrains constructed for this purpose shall be completely grouted up when they are no longer required by a method agreed by the Engineer.

Unless otherwise instructed by the Engineer surfaces against which concrete is to be placed shall receive a prior coating of mortar mixed in the proportions similar to those of the fines portion in the concrete to be placed. The mortar shall be kept ahead of the concrete. The mortar shall be well worked into all parts of the excavated surface and shall not be less than 5mm thick.

If any fissures have been cleaned out as described in Section 3 of this Specification, they shall be filled with mortar or with concrete as instructed by the Engineer.

The amount of mortar placed at any one time shall be limited so that it does not dry out or set before being covered with concrete.

c) Chutes

In general, transportation of concrete using chutes will not be permitted unless approved by the Engineer. The chute shall have a section with round corners and shall have a proper fixed slope to allow the concrete to flow satisfactorily and without segregation. The lower end of chute shall be provided with a drop chute not less than 0.6m in height to avoid segregation of falling concrete. The height of drop shall not exceed 1.5m. Chutes shall be protected from direct sunlight, wind, and rain.

d) Concrete Pump or Placer

The type and capacity of pump shall be determined to meet the specified requirements, considering the placing speed, construction schedule, quality of concrete, location to which concrete is poured, etc. Diameter of the delivery pipes shall be not smaller than 3 times of the maximum size of aggregates to be used in the concrete.

Delivery pipes shall be so installed as to permit easy removal. Before starting the pump or placer operation, about one cubic metre of mortar with the same proportion of water, admixture, cement, and fine aggregate as designated for the regular concrete mix shall be passed through the pipe. The pipe shall be set as straight and horizontally as possible to prevent clogging of the concrete mix in the pipe. The supports of the pipeline shall be stiff enough to fix the pipes firmly without adverse effect on forms and reinforcing steel already set in position. Care shall be taken to prevent leakage of the concrete mix from the pipeline or any other part.

Air boosters shall not be used except in conditions where the outlet of the pipe is completely embedded at least 2 metres in fresh concrete.

e) Placing Procedures

The concrete shall be deposited as nearly as possible in its final position. It shall be placed to avoid segregation of the concrete and displacement of the reinforcement, other embedded items, or formwork. It shall be brought up in layers approximately parallel to the construction joint planes and not exceeding 500mm in compacted thickness unless otherwise permitted or directed by the Engineer, but the layers shall not be thinner than four times the maximum nominal size of aggregate.

Layers shall be placed so that they do not form feather edges, nor shall they be placed on a previous layer which has taken its initial set. In order to comply with this requirement, a layer may be started before completion of the preceding layer.

All the concrete in a single bay or pour shall be placed in a continuous operation. It shall be carefully worked round all obstructions, irregularities in the foundations and the like so that all parts are completely full of compacted concrete with no segregation or honeycombing. It shall also be carefully worked round and between water stops, reinforcement, embedded steelwork and similar items which protrude above the surface of the completed pour.

All work shall be completed on each batch of concrete before its initial set commences and thereafter the concrete shall not be disturbed before it has set hard. No concrete that has partially hardened during transit shall be used in the Works and the transport of concrete from the mixer to the point of placing shall be such that this requirement can be complied with.

Concrete shall not be placed during rain which is sufficiently heavy or prolonged as to wash mortar from coarse aggregate on the exposed faces of fresh concrete. Means shall be provided to remove any water accumulating on the surface of the placed concrete. Concrete shall not be deposited into such accumulation of water.

In drying weather, covers shall be provided for all fresh concrete surfaces which are not being worked on. Water shall not be added to concrete for any reason.

When concrete is discharged above its place of final deposition, segregation shall be prevented using chutes, downpipes, trunking, baffles, or other appropriate devices, as approved by the Engineer.

Forms for walls, columns and other thin sections of significant height shall be provided with openings or other devices that will permit the concrete to be placed in a manner that will prevent segregation and accumulations of hardened concrete on the formwork or reinforcement above the level of the placed concrete.

When it is necessary to place concrete under water the Contractor shall submit to the Engineer his proposals for the method and equipment to be employed. The concrete shall be deposited either by bottom-discharging watertight containers or through funnel-shaped tremies which are kept continuously full with concrete up to level above the water and which shall have the discharging bottom fitted with a trapdoor and immersed in the concrete in order to reduce to a minimum the contact of the concrete with the water. Special care shall be taken to avoid segregation.

If the level of concrete in a tremie pipe is allowed to fall to such an extent that water enters the pipe, the latter shall be removed from the pour and filled with concrete before being again lowered into the placing position. During and after concreting under water, pumping, or dewatering in the immediate vicinity shall be suspended if there is any danger that such work will disturb the freshly placed concrete.

f) Interruptions to Placing

If concrete placing is interrupted for any reason and the duration of the interruption cannot be forecast or is likely to be prolonged, the Contractor shall immediately take the necessary action to form a construction joint so as to eliminate as far as possible feather edges and sloping top surfaces and shall

thoroughly compact the concrete already placed in accordance with Clause 608. All work on the concrete shall be completed while it is still plastic, and it shall not thereafter be disturbed until it is hard enough to resist damage. Plant and materials to comply with this requirement shall be always readily available during concrete placing.

Before concreting is resumed after such an interruption the Contractor shall cut out and remove all damaged or uncompacted concrete, feather edges or any other undesirable features and shall leave a clean sound surface against which the fresh concrete may be placed.

If it becomes possible to resume concrete placing without contravening the Specification and the Engineer consents to a resumption, the new concrete shall be thoroughly worked in and compacted against the existing concrete to eliminate any cold joints.

g) Dimensions of Pours

Unless otherwise agreed by the Engineer, pours shall not be more than two metres high and shall as far as possibly have a uniform thickness over the plan area of the pour. Concrete shall be placed to the full planned height of all pours except in the circumstances described in sub-clause 607 d).

The Contractor shall plan the dimensions and sequence of pours in such a way that cracking of the concrete does not take place due to thermal or shrinkage stresses.

h) Placing Sequence

The Contractor shall arrange that as far as possible the intervals between placing successive lifts of concrete in one section of the Works are of equal duration. This duration shall normally be not less than three or more than seven days under temperate weather conditions unless otherwise agreed by the Engineer.

Where required by the Engineer to limit the opening of construction joints due to shrinkage, concrete shall not be placed against adjacent concrete which is less than 21 days old.

When the drawings call for contraction gaps in concrete, these shall be of the widths and in the locations shown on the drawings and they shall not be filled until the full-time interval shown on the drawings has elapsed.

## 708. COMPACTION OF CONCRETE

The concrete shall be fully compacted throughout the full extent of the placed layer. It shall be thoroughly worked against the formwork and around any reinforcement and other embedded items, without displacing them. Great care shall be taken at rises and other confined spaces. Successive layers of the same pour shall be thoroughly worked together.

Concrete shall be compacted with the assistance of mechanical immersion vibrators unless the Engineer agrees to another method.

Immersion vibrators shall operate at a frequency of between 7,000 and 10,000 cycles per minute. The Contractor shall ensure that vibrators are operated at pressures and voltages not less than those recommended by the manufacturer in order that the compacting effort is not reduced.

Enough vibrators shall be operated to enable the entire quantity of concrete being placed to be vibrated for the necessary period. For each three vibrators in operation one standby vibrator shall be readily on hand

Where the concrete contains aggregate with a nominal size of 75mm or more, vibrators with a diameter of 100mm or more shall be used.

Vibration shall be continued at each point until the concrete ceases to contract, a thin layer of mortar has appeared on the surface and air bubbles have ceased to appear. Vibrators shall not be used to move concrete laterally and shall be withdrawn slowly to prevent the formation of voids.

Vibration shall not be applied by way of reinforcement, nor shall vibrators be allowed to touch reinforcement or other embedded items. The vibrators shall be inserted vertically into the concrete to penetrate the layer underneath at regular spacing. The spacing shall not exceed the distance from the vibrator over which vibration is visibly effective.

## **709. CURING OF CONCRETE**

### **a) General**

Concrete shall be protected during the first stage of hardening from loss of moisture and from the development of temperature differentials within the concrete sufficient to cause cracking. The methods used for curing shall not cause damage of any kind to the concrete.

Curing shall be continued for as long as may be necessary to achieve the objectives outlined in subclauses 609 b) and c), but in any case, for at least seven days or until the concrete is covered by later construction whichever is the shorter period.

Nothing shall prevent both objectives dealt with in subclauses 609 b) and c), being achieved by a single method where circumstances permit.

The curing process shall commence as soon as the concrete is hard enough to resist damage from the process, and in the case of large areas or continuous pours, shall commence on the completed section of the pour before the rest of the pour is finished.

Details of the Contractor's proposals for curing concrete shall be submitted to the Engineer before the placing of concrete commences in the Works.

Formed surfaces may be cured by retaining the formwork in place for the required curing period.

If the use of the foregoing methods is inappropriate, surfaces which will not have further concrete bonded to them and which are not to receive an application of a finish may be cured by the application of a curing compound having an efficiency index of at least 90 percent. Curing compounds shall contain a fugitive dye to enable the extent of the spread to be seen easily.

Curing compound is used on surfaces exposed to the atmosphere shall contain sufficient finely divided flake aluminium in suspension to produce a complete coverage of the surface with a metallic finish when applied at the rate recommended by the manufacturer.

Curing compounds shall become stable and impervious to the evaporation of water from the concrete surface within 60 minutes of application. The material shall not react chemically with the concrete surfaces for at least the first four days of the curing period.

If instructed by the Engineer, the Contractor shall, in addition to the curing provisions set out above provide a suitable form of shading to prevent the direct rays of the sun reaching the concrete surfaces for at least the first four days of the curing period.

**b) Loss of Moisture**

Exposed concrete surfaces shall be closely covered with impermeable sheeting, properly secured to prevent its removal by wind and the development of air spaces beneath it. Joints in the sheeting shall be lapped by at least 300mm.

If for some reason it is not possible to use impermeable sheeting, the Contractor shall keep the exposed surfaces continuously wet by means of a water spray or by covering with a water absorbent material which is kept wet, unless this method conflicts with sub-clause 609(c).

Water used for curing shall be of the same quality as that used for concrete mixing as stated in Clause 604.

**c) Limitation of Temperature Differential**

The Contractor shall limit the development of temperature differentials in concrete after placing by any means appropriate to the circumstances including the following:

- i) limiting concrete temperatures at placing as set out in subclause 611 b)
- ii) use of low heat cement, subject to the agreement of the Engineer;
- iii) insulation of exposed concrete surface by insulating blankets. Such blankets shall have an insulation value at least equivalent to 50mm of dry mineral wool;
- iv) leaving formwork in place during the curing period. Steel forms shall be suitably insulated on the outside;
- v) preventing rapid dissipation of heat from surfaces by shielding from wind;
- vi) avoiding the use of water sprays when such use would cause rapid cooling of the surface.

**710. PROTECTION OF FRESH CONCRETE**

Freshly placed concrete shall be protected from rainfall and from water running over the surface until it is sufficiently hard to resist damage from these causes.

No traffic shall be allowed on any concrete surface until such time as it is hard enough to resist damage by such traffic.

Concrete placed in the Works shall not be subjected to any loading until it has attained at least its nominal strength as defined in Table 7.1.

If the Contractor desires to impose loads on newly placed concrete, he shall make at least three test cubes and cure them in the same conditions as the concrete they represent. These cubes shall be tested singly at suitable intervals to estimate the time at which the nominal strength is reached.

**711. CONCRETING IN HOT WEATHER**

**a) General**

The Contractor shall prevent damage to concrete arising from exposure to extreme temperatures and shall maintain in good working order all plant and equipment required for this purpose.

In the event that conditions become such that even with the use of the equipment the requirements cannot be met, concrete placing shall immediately cease until such time as the requirements can again be met.

b) Concrete Placing in Hot Weather

During hot weather the Contractor shall take all measures necessary to ensure that the temperature of concrete at the time of placing in the Works does not exceed 30 degrees centigrade and that the concrete does not lose any moisture during transporting and placing.

Such measures may include but are not necessarily limited to the following: -

- i) Shielding aggregates from direct sunshine.
- ii) Use of a mist water spray on aggregates
- iii) Sun shields on mixing plants and transporting equipment.
- iv) Cooling the mixing water. If ice is used for this purpose, it should preferably be in flake form. Lump ice shall not be allowed to enter the tank supplying the mixer drum.
- v) Covering skips closely with polythene sheet so that the latter is in contact with the concrete.

Areas in which concrete is to be placed shall be shielded from direct sunshine and rock or concrete surfaces shall be thoroughly wetted to reduce absorption of water from the concrete placed on or against them.

After concrete in any part of an area has been placed, the selected curing process shall be commenced as soon as possible. If any interval occurs between completion of placing and start of curing, the concrete shall be closely covered during the interval with polythene sheet to prevent loss of moisture.

## 712. 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 7.4 - 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 7.4.

**713. MORTAR**

This clause covers mortar for use ahead of concrete placing, and other uses not covered elsewhere in the Specification.

Mortar shall be composed of fine aggregate complying with Clause 947 c) and ordinary Portland cement complying with EN 197. The mix proportions shall be as stated on the drawings or elsewhere in this Specification or if not stated shall be one part of cement to two parts of fine aggregate by weight.

Small quantities of mortar may be hand mixed but for amounts over 0.5 cubic metre a mechanical mixer shall be used.

The water content of the mortar shall be as low as possible consistent with the use for which it is required but, in any case, the water/cement ratio shall not be more than 0.5.

Mortar which is specified as 'dry pack' shall be mixed with sufficient water for the mix to become cohesive but not plastic when squeezed in the hand. Dry pack mortar shall be rammed into the cavity it is required to fill, using a hand rammer with sufficient force to ensure full compaction.

**714. CONCRETE FOR SECONDARY PURPOSES**

- a) Non-structural concrete (NS concrete) shall be used only for non-structural purposes where shown on the drawings.

NS concrete shall be composed of ordinary Portland cement complying with EN 197 and aggregates complying with SRN 108-111 including all-in aggregate within the grading limits of SRN 109 and SRN 111.

The weight of cement mixed with 0.3 cubic metres of combined or all-in aggregate shall not be less than 50 kg. The mix shall be proportioned by weight or by volume. The maximum aggregate size shall be 40mm nominal.

The concrete shall be mixed by machine or by hand to a uniform colour and consistency before placing. The quantity of water used shall not exceed that required to produce a concrete with sufficient workability to be placed and compacted where required.

The concrete shall be compacted by hand or by mechanical vibration.

- b) No Fines concrete (NF concrete) is intended for use where a porous concrete is required and shall only be used where shown on the drawings or instructed by the Engineer.

The mix shall consist of ordinary Portland cement complying with SRN 115. The aggregate size shall be 40mm to 10mm only. The weight of cement mixed with 0.3 cubic metre of aggregate shall not be less than 50 kg. The quantity of water shall not exceed that required to produce a smooth cement paste which will coat evenly the whole of the aggregate.

## 715. RECORDS OF CONCRETE PLACING

Records, in a form agreed by the Engineer, shall be kept by the Contractor of the details of every pour of concrete placed in the Works. These records shall include class of concrete, location of pour, date of pour, ambient temperature and weather conditions during mixing and placing and concrete temperature at time of placing, moisture contents of aggregates, details of mixes, batch numbers, cement batch number, results of all tests undertaken, location of test cube sample points and details of any cores taken.

The Contractor shall supply to the Engineer four copies of these records each week covering work carried out the preceding week. In addition, he shall supply to the Engineer monthly histograms of all 28-day cube strengths together with accumulative and monthly standard deviations and any other information which the Engineer may require concerning the concrete placed in the works.

## 716. CONSTRUCTION JOINTS

Whenever concrete is to be bonded to other concrete which has hardened, the surface of contact between the sections shall be deemed a construction joint.

Where construction joints are shown on the drawings, the Contractor shall form such joints in those positions. The location of joints which the Contractor requires to make for the purpose of construction shall be subject to the agreement of the Engineer. Construction joints shall be in vertical or horizontal planes except in sloping slabs where they shall be normal to the exposed surface or elsewhere where the drawings require a different arrangement.

Construction joints shall be so arranged as to reduce to a minimum the effects of shrinkage in the concrete after placing and shall be placed in the most advantageous positions regarding stresses in the structures and the desirability of staggering joints.

Feather edges of concrete at joint shall be avoided and any feather edges which may have formed where reinforcing bars project through a joint shall be cut back until sound concrete has been reached.

The intersection of horizontal or near horizontal joints and exposed faces of concrete shall appear as straight lines produced by use of a guide strip fixed to the formwork at the top of the concrete lift, or by other means acceptable to the Engineer.

Construction joints formed as free surfaces shall not exceed a slope of 20 per cent from the horizontal.

The surface of the fresh concrete in horizontal or near horizontal joints shall be thoroughly cleaned and roughened by means of high-pressure water and air jets when the concrete is hard enough to withstand the treatment without the leaching of cement. The surface of vertical or near vertical joints shall be similarly treated if circumstances permit the removal of formwork at a suitable time.

Where concrete has become too hard for the above treatment to be successful, the surface whether formed or free is to be thoroughly scabbled by mechanical means or wet sand blasted and then washed with clean water. The indentations produced by scabbling shall be not less than 10mm deep and shall not extend closer than 40mm to a finished face.

If instructed by the Engineer the surface of the concrete shall be thoroughly brushed with a thin layer of mortar composed of one part of cement to two parts of sand by weight and complying with Clause 613 all as set out in sub-clause 607 b) immediately prior to the deposition of fresh concrete. The mortar shall be kept just ahead of the fresh concrete being placed and the fresh layer of concrete shall be thoroughly and systematically vibrated to full depth to ensure complete bond with the adjacent layer.

No mortar or concrete may be placed in position on or against a construction joint until the joint has been inspected and passed by the Engineer.

#### **717. EXPANSION AND CONTRACTION JOINTS**

Expansion and contraction joints are discontinuities in concrete designed to allow thermal or other movements in the concrete.

Expansion joints are formed with a gap between the concrete faces to permit subsequent expansion of the concrete. Contraction joints are formed to permit initial contraction of the concrete and may include provision for subsequent filling.

Expansion and contraction joints shall be formed in the positions and in accordance with the details shown on the drawings or elsewhere in the Specifications.

#### **718. WATERSTOPS**

All references to waterstops include grout stops. Water stops shall be used in all construction joints. Web thickness shall not be less than 5 mm.

Waterstops shall be of the material and form shown on the drawings. No waterstop material shall be brought on the site until the Contractor has submitted full details of the materials he proposes to use, including samples, and these have been tested and approved by the Engineer. All samples shall be of adequate length for testing.

Waterstops shall be made of materials which are resistant to chlorides, sulphates, or other deleterious substances which may be present in the environment of the Works.

Rubber waterstops may be of natural rubber and shall have an elongation at breaking stress of at least 500 percent at 25 degrees centigrade and shall allow a joint movement of at least 50mm.

Polyvinyl chloride (PVC) waterstops shall be extruded from an unfilled plasticized PVC polymer or copolymer which does not contain any reclaimed or scrap PVC. PVC waterstops shall have an elongation at breaking stress of at least 225 percent at 25 degrees centigrade and shall allow a joint movement of at least 10mm.

Low modulus waterstops shall be of rubber or PVC as described above but shall have an elongation of at least 200 percent at 25 degrees centigrade under a tensile stress of 6 N/mm<sup>2</sup> and shall allow a joint movement of at least 50mm.

Waterstops shall be supplied in lengths as long as possible consistent with ease of handling and construction requirements.

In rubber or plastic materials, joints other than butt joints shall be supplied ready made by the manufacturer. Butt joints shall be made on site in accordance with the manufacturer's instructions and with equipment supplied for the purpose by the manufacturer.

Waterstop material shall be stored carefully on site to avoid damage and contamination with oil, grease, or other pollutants. Rubber and plastic waterstops shall be stored in cool well-ventilated places away from direct sunlight.

Rubber and plastic waterstops which are embedded in one side of a joint more than one month before the scheduled date of placing concrete on the other side, shall be protected from the sun.

Waterstops shall be firmly fixed in the formwork so that they cannot be displaced during concrete placing and shall be completely free of all dirt, grease, oil, etc., before placing concrete. Where eyelets are provided these shall be fully wired to the reinforcement and be the only means whereby the waterstop is fixed. In no circumstances shall a water stop be punctured with nails etc. as a means of fixing.

Concrete shall be placed carefully round waterstops so as to avoid distortion or displacement and shall be fully compacted. Where waterstops lie in a horizontal or nearly horizontal plane the Contractor shall ensure that no voids are left on the underside of the waterstop.

Formwork around waterstops shall be carefully removed to avoid damage. If waterstops suffer any damage which cannot be properly repaired in-situ the Engineer may require a section of concrete to be removed and the waterstop replaced.

#### **719. GROUTING OF POCKETS AND HOLES AND UNDERPINNING OF BASEPLATES**

Pockets and holding-down bolt holes shall be thoroughly cleaned out using compressed air and water jet. Holes drilled by a diamond bit shall be roughened. The pockets and holes shall be filled with grout consisting of cement and clean fresh water mixed in proportion of two parts by weight of cement to one part by weight of water. The pouring of liquid grout shall cease as soon as each hole is filled and any excess grout on the surface of the concrete foundation shall be completely removed and the surface dried off before the next operation proceeds.

The space between the top surface of foundation concrete and the underside of the baseplates shall be filled with a special mortar made up in the following proportions:

- Portland Cement ..... 50 kg.
- Fine aggregate ..... 50 kg.
- An additive acceptable to the Engineer to counteract shrinkage in proportions recommended by the manufacturer.

The special mortar shall be mixed with the lowest water-cement ratio which will result in a consistency of mix of sufficient workability to enable maximum compaction to be achieved.

The special mortar shall then be well rammed in horizontally below the baseplate and from one edge only until it is extruded from the other three sides. The mortar which has extruded shall then be rammed back to ensure complete support without voids.

## **720. REMEDIAL WORK TO DEFECTIVE SURFACES**

If on stripping any formwork the concrete surface is found to be defective in any way, the Contractor shall make no attempt to remedy such defects prior to the Engineer's inspection and the receipt of any instructions which the Engineer may give.

Defective surfaces shall not be made good by plastering.

Areas of honey combing (of a mild nature) which the Engineer agrees may be repaired shall be cut back to sound concrete or to 75mm whichever is the greater distance. In the case of reinforced concrete, the area shall be cut back to at least 25mm clear distance behind the reinforcement or to 75mm, whichever is the greater distance. The cavity shall have sides at right angles to the face of the concrete. After cleaning out with water and compressed air, a thin layer of cement grout shall be brushed on to the concrete surface in the cavity and it shall then be filled immediately with concrete of the same class as the main body but with aggregate larger than 20mm nominal size removed. A form shall be used against the cavity, provided with a lip to enable concrete to be placed. The form shall be filled to a point above the top edge of the cavity.

After seven days the lip of concrete shall be broken off and the surface ground smooth.

Surface irregularities which are outside the limits of tolerance set out in Clause 410 shall be ground down in the manner and to the extent instructed by the Engineer.

Severe honeycombing and defects other than those mentioned above shall be dealt with as instructed by the Engineer.

## **721. BENDING REINFORCEMENT**

Unless otherwise shown on the drawings, bending and cutting shall comply with SRN 129.

The Contractor shall satisfy himself as to the accuracy of any bar bending schedules supplied and shall be responsible for cutting, bending, and fixing the reinforcement in accordance with the drawings. Any discrepancies should be brought to the attention of the Engineer prior to ordering the reinforcement.

Bars shall be bent cold by the application of slow steady pressure. At temperatures below 5 degrees centigrade the rate of bending shall be reduced if necessary to prevent fracture of the steel.

After bending, bars shall be securely tied together in bundles or groups and legibly labelled as set out in SRN 129.

Reinforcement shall be thoroughly cleaned and all dirt, scale, loose rust, oil and other contaminants removed before it is placed in the Works.

## **722. FIXING REINFORCEMENT**

Reinforcement shall be securely fixed in position within a dimensional tolerance of 20mm in any direction parallel to a concrete face and within a tolerance of 5mm at right angles to a face, provided that the cover is not thereby decreased below the minimum shown on the drawings, or if not shown shall be not less than 25mm or the diameter of the bar, whichever is the greater. Cover on distribution steel shall not be less than 15mm or the diameter of the bar whichever is the greater.

Unless otherwise agreed by the Engineer, all intersecting bars shall either be tied together with 1.6mm diameter soft annealed iron wire and the ends of the wire turned into the body of the concrete or shall be secured with a wire clip of a type agreed by the Engineer.

Spacer blocks shall be used for ensuring that the correct cover is maintained on the reinforcement. Blocks shall be as small as practicable and of a shape agreed by the Engineer. They shall be made of mortar mixed in the proportions of one part of cement to two parts of sand. Wires cast into the block for tying into the reinforcement shall be 1.6mm diameter soft annealed iron.

Alternatively, another type of spacer block may be used subject to the Engineer's agreement.

Reinforcement shall be rigidly fixed so that no movement can occur during concrete placing. Any fixings made to the formwork shall not be within the space to be occupied by the concrete currently being placed.

No splices (laps) shall be made in the reinforcement except where shown on the drawings or agreed by the Engineer. Splice lengths shall be as shown on the drawings. Reinforcement shall not be welded except where required by the Contract or agreed by the Engineer. If welding is employed, the procedures shall be as set out in SRN 937 for gas welding or SRN 919 for metal arc welding. Full strength butt welds shall only be used for steel complying with SRN 126, and if used on high yield deformed bars complying with SRN 126 the permissible stresses in the vicinity of the weld shall be reduced to those applicable to plain bars complying with that Specification.

Mechanical splices shall not be used unless the Engineer agrees otherwise.

The Contractor shall ensure that reinforcement left exposed in the Works shall not suffer distortion, displacement, or other damage. When it is necessary to bend protruding reinforcement aside temporarily, the radius of the bend shall not be less than four times the bar diameter for mild steel bars or six times the bar diameter for high yield bars. Such bends shall be carefully straightened before concrete placing continues, without leaving residual links or damaging the concrete around them. In no circumstances will heating and bending of high yield bars be permitted.

Bars complying with SRN 127 or other high tensile bars shall not be bent after placing in the Works.

Before concrete is placed in any section of the Works which includes reinforcement, the reinforcement shall be completely clean and free from all contamination including concrete which may have been deposited on it from previous operations.

The Engineer's approval for concrete placing is to be sought in writing for each pour, leaving adequate time to inspect and rectify any defects noted in the formwork, falsework, reinforcement, scaffolding, concreting arrangements, etc.

## **723. MATERIALS FOR CONCRETE**

### **a) General**

The Contractor shall submit to the Engineer full details of all materials which he proposes to use for making concrete. No concrete shall be placed in the Works until the Engineer has approved the materials of which it is composed.

Approved materials shall not thereafter be altered or substituted by other materials without the consent of the Engineer.

b) **Cement**

Cement shall comply with the following Standards: -

- SRN 103 for Ordinary Portland cement.
- SRN 103 for Rapid Hardening Portland cement plus all special conditions to its use stipulated by the manufacturer.
- SRN 104 for Sulphate Resisting or High Alumina cement.

Cement shall be free flowing and free of lumps. It shall be supplied in the manufacturer's sealed unbroken bags or in bulk. Bagged cement shall be transported in vehicles with effective means of ensuring that it is protected from the weather.

Bulk cement shall be transported in vehicles or in containers specially built and equipped for the purpose.

Cement in bags shall be stored in a suitable weatherproof structure of which the interior shall be always dry and well-ventilated. The floor shall be raised above the surrounding ground level and shall be so constructed that no moisture rises through it.

Each delivery of cement in bags shall be stacked together in one place. The bags shall be closely stacked to reduce air circulation but shall not be stacked against an outside wall. If pallets are used, they shall be constructed so that bags are not damaged during handling and stacking. No stack of cement bags shall exceed 3 metres in height. Different types of cement in bags shall be clearly distinguished by visible markings and shall be stored in separate stacks.

Cement from broken bags shall not be used in the Works.

Cement in bags shall be used in the order in which it is delivered.

Bulk cement shall be stored in weatherproof silos which shall bear a clear indication of the type of cement contained in them. Different types of cement shall not be mixed in the same silo.

The Contractor shall provide sufficient storage capacity on site to ensure that his anticipated programme or work is not interrupted due to lack of cement.

Cement which has become hardened or lumpy or fails to comply with the Specification in any way shall be removed from the site.

All cement for any one structure shall be from the same source.

All cement used in the Works shall be tested by the manufacturer or the Contractor in a laboratory acceptable to the Engineer. The tests to be performed shall be those set out in SRN 103 and the Contractor shall supply two copies of each certificate to the Engineer.

Each set of tests carried out by the manufacturer or Contractor shall relate to not more than one day's output of each cement plant and shall be made on samples taken from cement which is subsequently delivered to the site. Alternatively, subject to the agreement of the Engineer, the frequency of testing shall be one set of tests for every 200 tonnes of cement delivered to site from each cement plant.

Cement which is stored on site for longer than one month shall be re-tested in the Building and Construction Laboratory at the Tanzania Bureau of Standards

or at any other approved laboratory at the rate of one set of tests as shown in SRN 103 for every 200 tonnes, and at monthly intervals thereafter.

Cement which does not comply with the Specification shall not be used in the Works and it shall be disposed of by the Contractor.

The Contractor shall keep full records of all data relevant to the manufacture, delivery, testing and use of all cement used in the Works and shall provide the Engineer with two copies thereof.

c) **Fine Aggregate**

Fine aggregate shall be clean, hard and durable and shall be natural sand, crushed gravel sand or crushed rock sand complying with SRN 108. All the material shall pass through a 5mm standard sieve and the grading shall be in accordance with Zones 1, 2 or 3 of SRN 109. To achieve an acceptable grading, it may be necessary to blend materials from more than one source. Fine aggregate for mortar only shall comply with SRN 135.

The fine aggregate shall not contain iron pyrites or iron oxides. It shall not contain mica, shale, coal or other laminar, soft or porous materials or organic matter unless the Contractor can show by comparative tests, on finished concrete as set out in SRN 117, that the presence of such materials does not adversely affect the properties of the concrete.

Other properties shall be as set out below:

Content passing a 75 micron standard sieve shall not exceed 3 per cent for natural or crushed gravel sand or 15 per cent for crushed rock sand.

Chlorides soluble in a 10 per cent solution by weight of nitric acid shall not exceed 0.05 per cent by weight expressed as chloride ion when tested as set out in SRN 107, subject also to the further restriction given in the note on total chloride content in sub-clause 623 (d).

Sulphates soluble in a 10 per cent solution by weight of hydrochloric acid shall not exceed 0.4 per cent by weight expressed as  $\text{SO}_3$ , when tested as set out in SRN 601, subject also to the further restriction given in the note on total sulphate content in sub-clause 623 (d).

Soundness: After five cycles of the test in AASHO T104 or an approved equivalent, the aggregate shall not show a weight loss of more than 10 per cent.

Organic impurities: If the test for presence of organic impurities in aggregates described below shows that more than a trace of organic impurities is present, the fine aggregate shall not be used in the Works unless the Contractor can show by tests on finished concrete as set out in SRN 117 that the presence of organic impurities does not adversely affect the properties of the concrete.

Test for presence of organic impurities in aggregates:

This test is designed to indicate the presence of organic impurities in aggregates used for making concrete.

A 350 cc graduated bottle shall be filled to the 120 cc mark with a sample of the aggregate to be tested and a 3% solution of sodium hydroxide in water added until the volume of aggregate and liquid after shaking gives a total volume of 200 cc. The bottle shall be stoppered, shaken thoroughly and allowed to stand for 24 hours. If, after 24 hours, the colour of the solution is not darker than a pale brown, the aggregate under test may be deemed satisfactory.

d) **Coarse Aggregate**

Coarse aggregate shall be clean, hard and durable crushed rock, crushed gravel or natural gravel complying with the requirements of SRN 110. The material shall not contain any iron pyrites, iron oxides, flaky or laminated material, hollow shells, coal or other soft or porous material, or organic matter unless the Contractor can show by comparative tests on finished concrete as set out in SRN 117 that the presence of such materials does not adversely affect the properties of the concrete. The pieces shall be angular, rounded or irregular as defined in SRN 107.

Coarse aggregate shall be supplied in the nominal sizes called for in the Contract and shall be graded in accordance with SRN 111 for each nominal size.

Other properties shall be as set out below:-

The proportion of clay, silt and other impurities passing a 75 micron standard sieve shall not be more than one per cent by weight.

The content of hollow and flat shells shall be such as will not adversely affect the concrete quality when tested as set out in SRN 117. The total content of aggregate shall not be more than the following:

- 40mm nominal size and above           2% of dry weight
- 20mm nominal size                       5% of dry weight
- 10mm nominal size                       15% of dry weight

Chlorides soluble in a 10 per cent solution by weight of nitric acid shall not exceed 0.03 per cent by weight, expressed as chloride ion when tested as set out in SRN 107 but subject also to the further restriction under the note on total chloride content hereunder. Sulphates soluble in a 10 per cent solution by weight of hydrochloric acid shall not exceed 0.4 per cent by weight expressed as SO<sub>3</sub> when tested as set out in SRN 601 subject also to the further restriction given in the note on total sulphate content hereunder.

Soundness: After 5 cycles of the test in AASHO T104, the aggregate shall not show a weight loss of more than 12 per cent.

When tested in accordance with test C289 of the American Society for Testing of Materials, the aggregate shall be non-reactive.

Flakiness Index when tested in accordance with SRN 113 shall be as set out hereunder:

- For 40mm stone and above, not more than 40
- For 20mm stone and below, not more than 35

If the Flakiness Index of the coarse aggregate varies by more than five units from the average value of the aggregate used in the approved trial mix, then a new set of trial mixes shall be carried out if the workability of the mixes has been adversely affected by such variation.

Impact value: Not more than 45 per cent when tested in accordance with SRN 107.

Ten per cent fines value: Not less than 50kN when tested in accordance with SRN 107.

Shrinkage: When mixed with other ingredients in the approved proportions for concrete and tested as set out in SRN 117, the shrinkage factor shall not exceed 0.05 per cent.

Organic impurities: If the test for presence of organic impurities in aggregates shows that more than a trace of organic impurities is present, the aggregate shall not be used in the Works unless the Contractor can show by tests on finished concrete as set out in SRN 117 that the presence of organic impurities does not adversely affect the properties of the concrete.

Water absorption: The aggregate shall not have a water absorption of more than 2.5 per cent when tested as set out in SRN 112.

Aggregate Crushing Value (ACV): Not more than 35 per cent.

Los Angeles Abrasion (LAA): Not more than 50 per cent.

**Note:** *Total chloride and sulphate content:-*

*The total chloride content, expressed as chloride ion, arising from all ingredients in a mix including cement, water and admixtures shall not exceed the following limits, expressed as a percentage of the weight of cement in the mix:*

*For prestressed concrete, steam cured concrete or concrete containing sulphate resisting or super sulphated cement: 0.05 per cent.*

*For any other reinforced concrete: 0.3 per cent in 95 per cent of all test results provided no result is more than 0.5 per cent.*

*The total sulphate content expressed as SO<sub>3</sub> of all the ingredients in a mix including cement, water and admixtures shall not exceed 0.4 per cent by weight of the aggregate or 4.0 per cent of the weight of cement in the mix, whichever is the lesser.*

e) **Testing Aggregates**

i) Acceptance Testing

The Contractor shall deliver to the Engineer samples containing not less than 50 kg of any aggregate which he proposes to use in the Works and shall supply such further samples as the Engineer may require. Each sample shall be clearly labelled to show its origin and shall be accompanied by all the information called for in SRN 107.

Tests to determine compliance of the aggregates with the requirements of sub-clause 623(c) and (d) shall be carried out by the Contractor in a laboratory acceptable to the Engineer. If the tested materials fail to comply with the Specification, further tests shall be made in the presence of the Contractor and the Engineer and acceptance of the material shall be based on such tests.

A material shall be accepted if not less than three consecutive sets of test results show compliance with the Specification.

ii) Compliance Testing

The Contractor shall carry out routine testing of aggregates for compliance with the Specification during the period that concrete is being produced for the Works. The tests set out below shall be performed on aggregates from each separate source based on one set of tests for each day on which aggregates are delivered to site provided that no set of tests shall represent more than 250 tonnes of fine aggregate nor more

than 500 tonnes of coarse aggregate, and provided also that the aggregates are of uniform quality. If the aggregate from any source is variable, the frequency of testing shall be increased as instructed by the Engineer.

- Grading SRN 107
- Silt and clay contents SRN 107
- Moisture content SRN 107
- Check on organic impurities

In addition to the above routine tests, the Contractor shall carry out the following tests at the frequencies stated:

Moisture content: As frequently as may be required in order to control the water content of the concrete as required by the Specification.

Chloride content: As frequently as may be required to ensure that the proportion of chlorides in the aggregates does not exceed the limit stated in the Specification.

The Contractor shall take account of the fact that when the chloride content is variable it may be necessary to test every load to prevent excessive amounts of chloride contaminating the concrete. For this purpose, the Contractor shall use the rapid field test (the Quantab test). In the event of disagreement regarding the results of the field test, the chloride content of the aggregate shall be determined in the laboratory as described in SRN 107 (the Volhard test).

f) **Delivery and Storage of Aggregates**

Aggregates shall be delivered to site in clean and suitable vehicles. Different types or sizes of aggregate shall not be delivered in one vehicle.

Each type or size of aggregate shall be stored in a separate bin or compartment having a base such that contamination of the aggregate is prevented. Dividing walls between bins shall be substantial and continuous so that no mixing of types or sizes occurs.

The storage of aggregates shall be arranged so that as far as possible rapid drying out in hot weather is prevented to avoid sudden fluctuations in water content. Storage of fine aggregates shall be arranged so that they can drain sufficiently before use to prevent fluctuations in water content of the concrete.

g) **Water for Concrete and Mortar**

Sea water or brackish water containing more than 1,000 ppm chloride ion or 2,000 ppm sulphate ion shall not be used for mixing or curing concrete.

Water shall be clean and free from harmful matter and shall comply with the requirements of SRN 114.

The Contractor shall carry out tests in accordance with SRN 114 to establish compliance with the Specification.

h) **Admixtures**

i) **General**

The use of the admixtures in concrete may be required under the Contract to promote special properties in the finished concrete or may be proposed by the Contractor to assist him to comply with the Specification.

In all cases the Contractor shall submit to the Engineer full details of the admixture he proposes to use and the way he proposes to add it to the mix. The information provided shall include but not be limited to: -

- a) The typical dosage, the method of dosing and the detrimental effects of an excess or deficiency in the dosage.
- b) The chemical names of the main active ingredients in the admixture.
- c) Whether or not the admixture contains chlorides, and if so the chloride ion content expressed as a percentage by weight of admixture.
- d) Whether the admixture leads to the entrainment of air when used at the manufacturer's recommended dosage, and if so, the extent to which it does so.
- e) Details of previous uses of the admixture in Tanzania

The chloride ion content of any admixture shall not exceed 2 per cent by weight of the admixture nor 0.03 per cent by weight of the cement in the mix.

Admixtures shall not be mixed without the consent of the Engineer.

Calcium chloride or admixtures containing calcium chloride shall not be used in prestressed concrete.

#### Workability Agents

Workability agents shall comply with SRN 149 and shall not have any adverse effect on the properties of the concrete.

### Reinforcement for Concrete

Reinforcement which shall comply with the following Standards, covers plain and deformed bar reinforcement and steel fabric to be cast into concrete in any part of the Works but does not include prestressing tendons or any other embedded steel.

- SRN 126 for hot rolled plain bar and high yield deformed bar
- SRN 127 for cold worked steel bar
- SRN 128 for steel mesh fabric

All reinforcement shall be from an approved manufacturer and, if required by the Engineer, the Contractor shall submit a test certificate from the manufacturer.

All reinforcement for use in the Works shall be tested for compliance with the appropriate British Standard in a laboratory acceptable to the Engineer and two copies of each test certificate shall be supplied to the Engineer. The frequency of testing shall be as set out in the relevant Standard.

In addition to the testing requirements described above, the Contractor shall carry out additional tests as instructed by the Engineer.

Any reinforcement which does not comply with the Specification shall be removed from site.

All reinforcement shall be delivered to site either in straight lengths or cut and bent. No reinforcement shall be accepted in long lengths which have been transported bent over double.

Any reinforcement which is likely to remain in storage for a long period shall be protected from the weather to avoid corrosion and pitting. All reinforcement which has become corroded or pitted to an extent which, in the opinion of the Engineer, will affect its properties shall either be removed from site or may be tested for compliance with the appropriate Standard at the Contractor's expense.

### **Dowel Bars**

Dowel bars and tie bars shall consist of mild steel, or deformed bars of high yield steel all complying with SRN 126 and they shall be free from oil, paint other than bond-breaking compound, dirt, loose rust and scale.

Dowel bars and tie bars shall be of sizes as shown on the drawings and directed by the Engineer, and shall be straight, free from burred edges, or other irregularities and shall have their sliding ends sawn or, if approved, sheared.

Bond breaking compound for dowel bars shall consist of 66 per cent of 200 pen bitumen blended hot with 14 per cent light creosote oil and, when cold, brought to the consistency of paint by the addition of 20 per cent solvent naphtha or other approved compound meeting the following requirements.

- i) It shall not retard or in any other way affect the setting of concrete.
- ii) The average bond stress on bars coated with the compound with half their length cast into concrete specimens and subject to pull out tests at 7 days shall not exceed 0.14 newtons per square millimetre and the total movement of the dowel bar relative to the concrete shall not be less than 0.25 millimetres at that stress. The concrete specimens shall be 150 millimetres by 150 millimetres in section and 0.45 metre long and made with the same mix proportions as used in the Works.

## 8. FORMWORK

### 801. FORMWORK FOR CONCRETE

#### Definitions

Formwork means the surface against which concrete is placed to form a face, together with all the immediate supports to retain it in position while concrete is placed.

Falsework means the structural elements supporting both the formwork and the concrete until the concrete becomes self-supporting.

A formed face is one which has been cast against formwork.

An exposed face is one which will remain visible when construction has been completed.

### 802. CONSTRUCTION OF FORMWORK AND FALSEWORK

Before construction begins, the Contractor shall submit to the Engineer, drawings showing details of the proposed formwork and falsework.

Formwork and falsework shall be so constructed that they will support the loads imposed on them by the fresh concrete together with additional stresses imposed by vibrating equipment and by construction traffic, so that after the concrete has hardened the formed faces shall be in the positions shown on the drawings within the tolerances set out in Clause 506.

Ground supports shall be properly founded on footings designed to prevent settlement. Joints in formwork for exposed faces shall, unless otherwise specified, be evenly spaced and horizontal or vertical and shall be continuous or form a regular pattern.

All joints in formwork including formwork for construction joints shall be tight against the escape of cement, water, and fines. Where reinforcement projects through formwork, the form shall fit closely round the bars.

Formwork shall be so designed that it may be easily removed from the work without damage to the faces of the concrete. It shall also incorporate provisions for making minor adjustments in position if required, to ensure the correct location of concrete faces. Due allowance shall be made in the position of all formwork for movement and settlement under the weight of fresh concrete.

Where overhangs in formwork occur, means shall be provided to permit the escape of air and to ensure that the space is filled completely with fully compacted concrete.

Formwork shall be provided for concrete surfaces at slopes of 30 degrees to the horizontal or steeper. Surfaces at slopes less than 20 degrees may be formed by screeding. Surfaces at slopes between 20 degrees and 30 degrees shall generally be formed unless the Contractor can demonstrate to the satisfaction of the Engineer that such slopes can be screeded with the use of special screed boards to hold the concrete in place during vibration.

Horizontal or inclined formwork to the upper surface of concrete shall be adequately secured against uplift due to the pressure of fresh concrete. Formwork to voids within the body of the concrete shall also be tied down or otherwise secured against floating.

The internal and external angles on concrete surfaces shall be formed with fillets and chamfers of the sizes shown on the drawings unless otherwise instructed by the Engineer.

Supports for formwork for non-water retaining structures may be bolted to previously placed concrete provided the type of bolt used is acceptable to the Engineer. If metal ties through the concrete are used in conjunction with bolts, the metal left in shall not be closer than 50mm to the face of the concrete.

Supports for formwork for water retaining structures may be bolted to previously placed concrete provided the type of bolts and positions of fixing are acceptable to the Engineer. After concreting the Contractor shall remove all support bolts and seal all holes with well rammed cement/sand mortar containing approved waterproofing cement additive. Metal ties which would be left in the concrete shall not be permitted.

Formwork shall not be re-used after it has suffered damage which in the opinion of the Engineer is sufficient to impair the finished surfaces of the concrete.

Where circumstances prevent easy access within the form for cleaning and inspection, temporary openings for this purpose shall be provided through the formwork.

Shear keys shall be provided in all construction joints of the size and shape indicated on the drawings.

Where precast concrete elements are specified for use as permanent formwork or proposed by the Contractor and agreed by the Engineer, they shall comply with the requirements of the Specification. Such elements shall be set true to line and level within the tolerances prescribed for the appropriate class of finish in Clause 506 and fixed so that they cannot move when concrete is placed against them.

### **803. PREPARATION OF FORMWORK**

Before any reinforcement is placed into position within formwork, the latter shall be thoroughly cleaned and then dressed with a release agent. The agent shall be either a suitable oil incorporating a wetting agent, an emulsion of water suspended in oil or a low viscosity oil containing chemical agents. The Contractor shall not use an emulsion of oil suspended in water nor any release agent which causes staining or discoloration of the concrete, air holes on the concrete surface, or retards the set of the concrete.

To avoid colour difference on adjacent concrete surfaces, only one type of release agent shall be used in any one section of the works.

In cases where it is necessary to fix reinforcement before placing formwork, all surface preparation of formwork shall be carried out before it is placed into position. The Contractor shall not allow reinforcement or prestressing tendons to be contaminated with formwork release agent.

Before placing concrete all dirt, construction debris and other foreign matter shall be removed completely from within the placing area.

Before concrete placing commences, all wedges and other adjusting devices shall be secured against movement during concrete placing and the Contractor shall maintain a watch on the formwork during placing to ensure that no movement occurs.

**804. REMOVAL OF FORMWORK**

Formwork shall be carefully removed without shock or disturbance to the concrete. No formwork shall be removed until the concrete has gained sufficient strength to withstand safely any stresses to which it may thereby be subjected.

The minimum periods which shall elapse between completion of placing concrete and removal of forms are given in Table 8.1 and apply to ambient temperatures higher than 10 degrees centigrade. At lower temperatures or if cement other than ordinary Portland are involved, the Engineer may instruct that longer periods be used.

Alternatively, formwork may be removed when the concrete has attained the strength set out in Table 8.1, provided that the attained strength is determined by making test cubes and curing them under the same conditions as the concrete to which they refer.

Compliance with these requirements shall not relieve the Contractor of his obligation to delay removal of formwork until the removal can be completed without damage to the concrete.

**Table 8.1 - MINIMUM PERIODS FOR FORMWORK REMOVAL**

| Position of Formwork  | Min. period for temp over 10 degrees Centigrade | Strength to be attained |
|---|---|-------------------------|
| Vertical or near vertical faces of mass concrete                        | 24 hours  | 0.2 C                   |
| Vertical or near vertical faces of reinforced walls, beams, and columns | 48 hours  | 0.3 C                   |
| Underside of arches, beams, and slabs (formwork only)                   | 4 days  | 0.5 C                   |
| Supports to underside of arches, beams, and slabs                       | 14 days   | 1 C                     |
| Arched linings in tunnels and underground works                         | 24 hours  | 4 N/mm <sup>2</sup>     |

**Note:** C is the nominal strength for the class of concrete used.

If the Contractor wishes to strip formwork from the underside of arches, beams and slabs before the expiry of the period for supports set out above, it shall be designed so that it can be removed without disturbing the supports. The Contractor shall not remove supports temporarily for the purpose of stripping formwork and subsequently replace them.

As soon as the formwork has been removed, bolt holes in concrete faces other than construction joints which are not required for subsequent operations shall be completely filled with mortar sufficiently dry to prevent any slumping at the face. The mortar shall be mixed in the same proportions as the fine aggregate and cement in the surrounding concrete and with the same materials and shall be finished flush with the face of the concrete.

**805. SURFACE FINISHES ON FORMED SURFACES**

Classes of Finish

The surface finish to be achieved on formed concrete surfaces shall be as shown on the drawings and defined hereunder: -

a) Class F1 Finish

This finish is for surfaces against which backfill, or further concrete will be placed. Formwork may be sawn boards, sheet metal or any other suitable material which will prevent the loss of fine material from the concrete being placed.

b) Class F2 Finish

This finish is for surfaces which are permanently exposed to view but where the highest standard of finish is not required. Forms to provide a Class F2 finish shall be faced with wrought thickened tongued and grooved boards with square edges arranged in a uniform pattern and close jointed or with suitable sheet material. The thickness of boards or sheets shall be such that there shall be no visible deflection under the pressure exerted by the concrete placed against them. Joints between boards or panels shall be horizontal and vertical unless otherwise directed. This finish shall be such as to require no general filling of surface pitting, but fins, surface discoloration and other minor defects shall be remedied by methods agreed by the Engineer.

c) Class F3 Finish

This finish is for surfaces which will be in contact with water flowing at high velocity, and for surfaces prominently exposed to view where good appearance is of special importance. To achieve this finish, which shall be free of board marks, the formwork shall be faced with plywood complying with B.S. 1088 or equivalent material in large sheets. The sheets shall be arranged in an approved pattern. Wherever possible, joints between sheets shall be arranged to coincide with architectural features or changes in direction of the surface.

All joints between panels shall be vertical and horizontal unless otherwise directed. Suitable joints shall be provided between sheets to maintain accurate alignment in the plane of the sheets. Unfaced wrought boarding or standard steel panels will not be permitted for Class F3 finish. The Contractor shall ensure that the surface is protected from rust marks, spillages, and stains of all kinds.

d) Curved Surfaces

For curved surfaces where F2 or F3 finishes are called for, the formwork face shall be built up of splines cut to make a tight surface which shall then be dressed to produce the required finish.

Alternatively, single curvature surfaces may be faced with plastic or plywood linings attached to the backing with adhesive or with escutcheon pins driven flush. Linings shall not bulge, wrinkle, or otherwise deform when subjected to temperature and moisture changes.

## 806. TOLERANCES

All parts of formed concrete surfaces shall be in the positions shown on the drawings within the tolerances set out in Table 8.2.

In cases where the drawings call for tolerances other than those given in Table 8.2 the tolerances shown on the drawings shall take precedence.

Where precast units have been set to a specified tolerance, further adjustments shall be made as necessary to produce a satisfactory straight or curved line. When the Engineer has approved the alignment, the Contractor shall fix the units so that there is no possibility of further movement.

**Table 8.2 - TOLERANCES**

| Class of Finish | Tolerances in mm (See Note) |    |              |
|-----------------|-----------------------------|----|--------------|
|                 | A                           | B  | C            |
| F1              | 10                          | 10 | + 25 to - 10 |
| F2              | 5                           | 10 | + or - 15    |
| F3              | 2                           | 5  | + or - 10    |

**Note:** The tolerances A, B and C given in the table are defined as follows:

1. Column A is an abrupt irregularity in the surface due to misaligned formwork or defects in the face of the formwork.
2. Column B is a gradual deviation from a plane surface as indicated by a straight edge 3m long. In the case of curved surfaces, the straight edge shall be replaced by a correctly shaped template.
3. Column C is the amount by which the whole or part of a concrete face is displaced from the correct position shown on the drawings.

## 9. MASONRY AND PLASTER WORK

### 901. SCOPE

This Specification covers the requirements for masonry work and plaster work.

### 902. MASONRY WORK

#### Materials

##### Bricks and blocks

Bricks shall be clay facing bricks manufactured locally. The quality shall correspond to DIN 105.

Blocks shall be dense concrete blocks to DIN 18153 with a compressive strength of > 7.5 N/mm<sup>2</sup>.

Bricks and blocks shall be hard, sound, square and clean with sharp well defined arises.

The Contractor shall submit samples of each type of brick and block and obtain approval before placing orders with suppliers.

Strength test certificates performed on the basis of appropriate DIN standards for all bricks and blocks shall also be submitted to the Engineer.

##### Reinforcement

Reinforcement for brickwork shall be in accordance with DIN 488, DIN 1045 and DIN 1053.

Reinforcement for brickwork shall be Type I G or Type III U standard. Reinforcement shall be detailed, stored and tested as specified under 'Reinforcement for concrete.'

##### Fixings

Stainless steel for sheet, strip, plate and bars shall be '1.4302 E 23 quality to DIN 17440.

##### Sand, Cement, Water

Sand shall be clean and sharp coarse grit, fresh water river or pit sand conforming in all respects to DIN 1053 and DIN 18550 and shall be re-washed in site if the silt loam or clay content exceeds the requirements described in DIN 4226. The sand shall be obtained from a source approved by the Engineer.

Cement shall be sulphate resisting Portland cement as specified in DIN 1164.

Water shall be clean and free from impurities and shall at regular intervals be tested to ensure compliance with DIN 4030 and DIN 38404.

##### Mortar Mix

Masonry mortar for setting blocks and bricks shall be of the quality of Group III according to DIN 18550.

The proportion shall be 1 part cement to 4 parts sand or as otherwise approved by the Engineer.

Mortar shall be mixed with water in an amount compatible with workability. Mortar constituents shall be measured by volume, using clean gauge boxes made to size to suit volumes required. Gauge boxes shall be overfilled and excess material struck off with a straight edge.

Mortar shall be mixed in a mechanically operated mortar mixer for at least three minutes after all ingredients are in the drum, and at least long enough to make a thorough, complete, intimate mix of the materials.

The mixing of mortar by hand will be permitted only when the quality of hand mixing is comparable to mechanical mixing. The Engineer reserves the right to reject hand mixing and require all mixing to be by mechanical means.

Mortar shall be used within two hours of discharge from the mixer at normal temperature and on no account shall mortar be used after the initial set has taken place. Reconstitution of mortar will not be permitted. Mortar boxes shall be cleaned out at the end of each day and all tools shall be kept clean.

Coloured mortar shall be mixed as specified using cement and sand in the above proportions with the addition of a coloured pigment in accordance with appropriate DIN standards.

### **903. WORKMANSHIP**

#### **General**

All masonry shall be laid plumb and true to lines and built to the thickness and bond required with courses level and joints and bond uniform. Masonry shall be carried up in a uniform manner. No one portion shall be raised more than a meter above adjacent portions, except with the approval of the Engineer.

Sample panels 1 m<sup>2</sup> shall be prepared for each type of facing brickwork/blockwork, including jointing or pointing, and the Contractor shall obtain approval before proceeding with the work.

#### **Hot weather:**

Bricks and blocks shall be stacked on a level hardstanding so as to prevent the absorption or ingress of water. Suitable shading shall be provided to prevent high temperatures existing within the brick and block stacks.

#### **Dry weather:**

Clay brickwork and blockwork shall be kept wet to the minimum extent necessary to prevent mortar drying out prematurely.

#### **Wet weather:**

Freshly laid brickwork/blockwork shall be protected during interruption through rain and at the completion of each day's work.

Facework shall be kept clean during construction and until practical completion. Scaffold boards shall be kept clear of the building at night and during heavy rain. Rubbing to remove stains will not be permitted.

All bricks shall be wetted before being laid.

Clay bricks shall not be used until completely cold from the kiln.

Facing bricks of varying colour shall be distributed evenly throughout the work so that no patches appear. Different deliveries which vary in colour shall be mixed to avoid horizontal stripes.

Brickwork shall be carried up, including both skins of cavity work where applicable, with no portion more than 1.5 m above another at any time, racking back between levels.

Brickwork shall be gauged for four courses to 300 mm including joints.

Bricks shall be laid on a full bed of mortar and all joints filled. Bed and vertical joint shall be of equal and consistent thickness.

Solid bricks shall be laid on a full bed of mortar with joints filled solid to a consistent thickness not more than 12 mm.

Should single frogged bricks be permitted, they shall be laid with the frog upwards and these shall be filled with mortar. Double frogged bricks shall not be used.

Courses shall be kept level and perpends vertical and in line. Quoins and other angles shall be plumbed as the work proceeds.

Templates shall be used for forming openings in face work where doors and windows are not built in at the time.

Brickwork and blockwork abutting concrete columns, walls and beams shall be tied with stainless steel ties in accordance with the relevant references and as directed by the design. Additional ties shall be supplied at openings. Walls which are to be fair face shall have selected bricks and blocks with perfect arises and flat surfaces and with faces in line.

#### **904. BONDING**

Where not otherwise required, bricks throughout the work shall be laid with the cross joints in any course not less than a quarter of a brick from those in the course below.

All brick and blockwork shall be laid in a regular pattern to the satisfaction of the Engineer.

#### **905. EXPOSED CONCRETE BLOCK**

Concrete block shall be laid in "stack" bond, unless otherwise indicated, with joints not exceeding 1.0 cm and uniform throughout and finished slightly concave and smooth, tool dense and neat (no finger pointing allowed). All blocks shall be laid in a full bed of mortar applied to shells only.

Mortar shall be applied to the vertical joint of blocks already set in the wall and all contact faces of the unit to be set.

Each unit shall be placed and shoved against the block previously laid so as to produce a well compacted vertical mortar joint for the full shell thickness. Moisture contents of blocks shall not exceed 35 % when laid. Intersection bearing walls shall be tied together with metal ties at one meter vertical spacing. Bends of tie bars and reinforcing shall be embedded in cells filled with mortar. Where indicated, concrete blocks shall be reinforced and concrete block lintel types shall be built in.

All necessary block cutting shall be neatly done by saws.

Control joints shall be installed at the intersection of block walls with structural concrete and elsewhere where such joints are useful. Joints not detailed otherwise shall be raked out to a depth of 2 cm for the full height of the wall and caulked.

maximum length between joints shall be 10 m.

Joints are to be examined to locate cracks, holes or other defects and all such defects shall be filled with mortar and pointed.

#### **906. CONCRETE BLOCKS TO BE PLASTERED**

Concrete block walls to be plastered may be laid with bonds described above. Joints are to be left rough to assist in bounding of plaster. Otherwise, concrete block masonry shall conform to previous paragraph "Exposed concrete block". Control joints in plastered block walls shall be carried through the plaster. The joint shall not be plastered.

#### **907. BRICKWORK**

Solid brick shall be laid in common bond with all joints filled solidly with mortar and backs fully purged to form solid masonry structures. Joints of walls to receive plaster shall be lightly raked to provide a bond for plaster. Solid brick shall be plastered only when so indicated on the approved drawings or required in the particular specifications.

Control joints in plastered brick walls shall be carried through the plaster. The joint shall not be plastered.

#### **908. LINTELS, TIES, MISCELLANEOUS**

The Contractor shall build in or provide all miscellaneous items to be set in masonry including frames, lintels, reinforcing steel, electrical boxes and fixtures, sleeves, grilles, anchors and other miscellaneous.

items. All anchorage, attachments and bonding devices shall be set so as to prevent stoppage and shall be completely covered with mortar.

Wired butterfly and double triangle type wall ties will not be permitted in any wall.

Wall ties shall be stainless steel strip, but of a twist type for the leaves of any cavity walls.

Padstones shall be bedded in mortar of the same strength as the adjacent wall, to give a level top surface.

### **909. GROUTING**

Grout and cement mortar for setting structural steel columns, railings, frames in walls and where otherwise required shall be done with mortar as hereinbefore specified. Before placing grout thoroughly clean all surfaces.

Grout shall be tamped into place with a blunt tool to fill the entire void. In the event space does not permit tamping, the Contractor shall build the necessary forms and place grout by pouring from one side only. When grout is placed by pouring a head of grout shall be maintained in the form. Grout shall be kept wet for three days and after the temporary supports adjusting wedges are removed the empty space shall be grouted and the surrounding grout pointed.

### **910. CLEANING**

Masonry work, to be exposed, shall be thoroughly cleaned. Mortar smears and droppings on concrete block walls shall be dry before removal with a trowel. Masonry work may be cleaned using a mild muriatic acid solution.

### **911. DAMP-PROOF COURSES**

As a minimum requirement, damp-proof courses shall be in accordance with DIN 4117 and DIN 4122.

Bituminous sheet damp-proof courses shall be laid on a level bed of cement mortar with a minimum lap of 75 mm at angles and joints and neatly pointed in matching mortar on exposed edges. Horizontal and sloping damp-proof coursing over door openings shall be in single pieces of material of a length to extend 225 mm at both sides beyond the width of the frame.

### **912. WATERPROOF BUILDING PAPER**

Waterproof building paper shall be laid beneath structural concrete. The paper shall be laid with 150 mm lapped joints which shall be treated and sealed with an approved bituminous solution. The weight of the paper shall not be less than 0.3 kg/m<sup>2</sup>.

### **913. RENDERING AND PLASTERING**

#### **General**

The work required under this Specification shall include all labour, materials, equipment, scaffolding etc., required to complete all internal and external plastering specified herein.

On completion, all surfaces shall be left in a neat and clean condition before handing over.

Materials, workmanship, and construction shall be in accordance with the requirements of DIN 18550.

Work shall not be started or continued when the air temperature exceeds 40°C.

### Materials

Sand shall be clean and sharp course grit, freshwater river or pit sand conforming in all respects to DIN 1053 and DIN 18550 and shall be re-washed on site if the silt loam or clay content exceeds the requirements described in DIN 4226. The sand shall be obtained from a source approved by the Engineer.

Cement shall be sulphate resisting Portland cement as specified in DIN 1164.

Water shall be clean and free from impurities and shall at regular intervals be tested to ensure compliance with DIN 4030 and DIN 38404.

### Mixing

Plaster shall be mixed with proportions according to DIN 18550.

Plaster shall be mixed with water in an amount compatible with workability.

Plaster constituents shall be measured by volume.

Plaster shall be mixed in a mechanically operated plaster mixer at least long enough to make a thorough, complete, intimate mix of the materials.

The mixing of plaster by hand shall not be permitted.

Bunkers, gauge boxes, gauging boards, etc. shall be thoroughly cleaned after each mix.

Mixer drums shall be thoroughly washed out at least four times a day if the mixer is in continuous use, and after each batch if not in continuous use. All tools shall be kept clean, and care taken to ensure that fresh plaster is not contaminated with set plaster.

### Preparation

Surfaces that are to receive plaster shall be carefully examined by the Contractor and any unsatisfactory surface shall be repaired as directed by the Engineer.

Where finished surfaces such as tile, lighting or other fixtures have been installed prior to plastering they shall be protected from damage during plastering. Protection shall consist of covering with a non-staining building paper or polyethylene sheet.

Protection shall be removed when plaster work is completed.

Concrete masonry and brick surfaces shall have sufficient roughness to provide proper bond and shall be dampened by brushing or spraying with water followed by plastering.

### Finish

Finishing coats shall be trowelled to a smooth and even finish.

### Tolerances

All surfaces shall be true to line, level, plumb and all junctions, angles and arises truly square. On two or three coat work, the plaster surface shall not show any deviation greater than specified in DIN 1 8202 for accuracy class B.

Connection of Work

Completion of work shall be as follows:

i. Curing:

Cement sand plasters shall be kept moist by sprinkling with water at regular intervals for a period of at least three days and until no powdery particles are present.

The Contractor shall plan his work such that rendering and plastering work is not carried out at extreme temperatures.

ii. Defects:

Work shall be free of all defects, and any work which shows signs of blistering, bond failure, hollow patches, flaking, peeling, cracking, crazing, grinning, tool marks, discolouration or any other defects will not be accepted, and shall be removed and replaced with acceptable work.

Upon completion of the work, all plaster surfaces shall be cleaned and all rubbish, debris and excess material and equipment shall be removed.

Thickness and Workmanship

All plaster shall be applied according to the following thicknesses. Additional thickness will be required for any unevenness in the masonry surface.

| Location      | Thickness of Coat (mm) |              |        | Total Thickness |
|---------------|------------------------|--------------|--------|-----------------|
|               | First                  | Intermediate | Finish |                 |
| Ceiling       | 15                     | —            | 10     | 25              |
| Interior Wall | 10                     | 6            | 4      | 20              |
| Exterior Wall | 10                     | 9            | 6      | 25              |

Plaster shall be of two or three coats: first, intermediate and finish coats. If plaster is to be applied to a smooth cement or other surface which does not offer bonding characteristics for plaster, a dash coat shall be required as a bonding surface.

Dash coats shall be of mush consistency, composed of 1 part Portland cement and 1.5 parts of sand.

The dash coat shall be applied with a whisk broom or fibre brush, in a whipping manner. The dash coat shall be kept moist for 48 hours before first coat is applied to the dash coat.

First coats shall cover the full length of the wall or to the border line formed by columns, doors and windows. Before the first coat hardens the surface shall be scratched to provide a mechanical key for the intermediate coat. This coat shall be kept moist for not less than 24 hours and allowed to set for not less than 14 days before application of the intermediate coat.

Before application of the intermediate coat, the surface of the first coat shall be dampened. The surface of the intermediate coat shall be brought to a true and even surface, then roughened with a wood float before setting to provide a bond for the finish coat.

The finishing coat shall be applied while the intermediate coat is moist and if the intermediate coat dries out it shall be wetted evenly. The finishing coat shall be first floated to a true and even surface, then trowelled in a manner that the sand particles are not exposed on the surface and with the final troweling, leaving the surface burnished smoothly and free from rough areas, trowel marks, checks, or other blemishes.

Before applying the plaster to ceilings, the surface of the ceiling shall be dampened and the cement paste applied with a whisk broom or fibre brush, to the entire ceiling.

The final plaster layer shall be applied to the ceiling slab tamping it with wood float until the cement paste is squeezed up through the surface of the plaster and finally trowelled to an even surface leaving the surface burnished smoothly and free from trowel marks, checks and other blemishes.

#### Waterproof

Waterproof plaster shall consist of plaster waterproofing compound, cement and sand mixed in strict accordance with the manufacturer's specification.

Waterproofing compound shall be paste, powder or liquid made by a manufacturer engaged in the mass production of such items and shall be approved by the Engineer.

## **10. MATERIALS**

### **1001. GENERAL**

The approval in writing or otherwise by the Engineer of any materials shall not in any way whatsoever relieve the Contractor from any liability or obligation under the Contract and no claim by the Contractor on account of the failure, insufficiency, or unsuitability of any such materials will be entertained.

- a) All items shall be suitable for Wastewater works purposes and for use with cold water installation and operation being in a tropical climate.
- b) All items hereinafter specified shall be to such other Standard or Specification which in the opinion of the Engineer provides for a quality of material and workmanship not inferior to the Standard Reference Number (SRN) quoted. The Standard or Specification must be submitted to the Engineer for approval before commencement of work.
- c) All ferrous pipes and fittings shall be coated with a protective paint suitable for use in and transport through a tropical climate.
- d) The Contractor shall supply to the Employer a certificate stating that each item supplied has been subjected to the tests hereinafter laid down and conforms in all respects to the said Specification.
- e) The Contractor shall provide adequate protection to all piping, flanged items, and valves to guard effectively against damage in transit and storage and ingress of foreign matter inside the valves.
- f) The Contractor should exercise diligence to provide the best material.
- g) Where applicable the manufacturer's Specification should accompany all offers. The name of the manufacturer must in every case be stated.
- h) Where necessary the Contractor shall provide rubber gaskets to comply with SRN 208 and all other bolts, nuts, washers, etc. to undertake jointing at fittings etc.
- i) Any articles required under this Contract which are found to be faulty due to a crack, flaw or any other reason or is not in accordance with the Specification stipulated will not be accepted nor will the Employer be liable for any charges in respect of such an article. Where any such rejected article can, in the opinion of the Engineer, be rendered usable, the Contractor may deal with it accordingly and include it in the Contract at a price to be mutually agreed. Straight pipes which have been cut will be accepted at the discretion of the Engineer, provided the length is not less than 4 metres or two thirds of the standard length whichever is the lesser and will be priced pro-rata.
- j) Wherever possible, samples of pipes and fittings shall be submitted for approval of the Engineer prior to the Contractor obtaining the total requirements.

### **1002. HIGH DENSITY POLYETHYLENE (HDPE) PIPES**

HDPE Pressure Pipes and Fittings shall be manufactured using a pre-compounded blue pigmented PE100 resin, having a Minimum Required Strength (MRS) value of  $\geq 10.0$  MPa, at a service temperature of 20°C for a minimum design service life of 50 years.

The pipes and fittings shall be manufactured in accordance with EN 12201:2011, ISO 4427 / ISO 4437 or another acceptable International Standard. The Pipes and Fittings shall comply with the following:

|                  |                 |   |
|------------------|-----------------|---|
| <b>Pipes:</b>    | Material        | Polyethylene PE100 (MRS100), density $\geq 0.95$ kg/dm <sup>3</sup>   |
|                  | Colour          | Black (Wastewater)  |
|                  | Supply Lengths: | All pipe sizes up to and including OD 75 mm shall be supplied in coils of 50 or 100 meters.<br>All pipes, OD 90mm and above shall be supplied in straight lengths not exceeding 12metres. |
|                  | Stiffness Class | SN 4  |
| <b>Fittings:</b> | Material:       | Polyethylene PE100 (MRS100), density $\geq 0.95$ kg/dm <sup>3</sup>   |
|                  | Colour:         | Black   |
|                  | Type of Joint:  | Electrofusion / Spigot type for Butt Fusion / Compression (for sizes 110mm and below)   |

**Performance Characteristics**

The pipes shall have the following basic minimum performance characteristics:

| <b>P</b>   | <b>Unit</b>        | <b>Val</b>           |
|--|--------------------|----------------------|
| Average Density as per ISO 1183                    | Gm/cm <sup>3</sup> | $\geq$               |
| Melt Flow Index MFI 190°C / 50N as per ISO 1133    | Gm/10 min.         | 0.4-0.55             |
| Minimum Tensile Strength                           | N/mm <sup>2</sup>  | 2                    |
| Elongation at Break                                | %                  | $\geq 600\%$         |
| E-Modulus (Modulus of Elasticity)                  | N/mm <sup>2</sup>  | 12                   |
| Minimum Radius of Curvature at 20°C                |                    | 25 x OD              |
| Linear Coefficient of Thermal Expansion (VDE 0304) | °K <sup>-1</sup>   | $1.3 \times 10^{-4}$ |

**Marking and Identification**

Pipes shall be clearly and indelibly marked to show the following:

- Name of Manufacturer / Brand
- Nominal Diameter x Minimum Wall Thickness
- Material Classification (i.e., PE100)
- Stiffness Class (i.e. SN4)
- Reference Standard of Manufacture (e.g., EN 12201)
- Date of Manufacture

**Transportation, Storage and Laying of Pipes and Fittings**

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.

Pipes, fittings, and coils 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 1m. 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.

Prior to laying in trench, the bed of the trench must provide support throughout the entire length of the pipe. The pipe shall not be laid directly on cohesive, rocky or stony soil. Such material shall be over excavated to a depth of not less than 0.1m and shall be removed and replaced by non-cohesive soil or a special pipe support. This shall initially be recompacted and then the surface loosened on the day of and prior to laying.

Pipes supplied in coils and of up to 63mm 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 x the diameter shall be observed.

### **Joining Methods**

- A. Butt Fusion:** The pipe shall be joined by the butt fusion procedure outlined in ASTM F 2620. All fusion joints shall be made in compliance with the pipe or fitting manufacturer's recommendations. Fusion joints shall be made by qualified fusion technicians.
- B. Saddle Fusion:** Saddle fusion shall be done in accordance with ASTM F 2620 or TR- 41 or the fitting manufacturer's recommendations. Saddle fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past year on the equipment to be utilized on this project. [Saddle fusion is used to fuse branch saddles, tapping tees, and other HDPE constructs onto the wall of the main pipe] (ASTM F905).
- C. Socket Fusion:** Molded socket fusion fittings are only to be used for joining of HDPE pipe from 1/2 inch to 2" in size. Socket fusion shall be done in accordance with ASTM F 2620 or the fitting manufacturer's recommendations. Socket fusion is the process of fusing pipe to pipe, or pipe to fitting by the use of a male and female end that are heated simultaneously, and pressed together so the outside wall of the male end is fused to the inside wall of the female end. Qualification of the fusion technician shall be demonstrated by evidence of socket fusion training within the past year on the equipment to be utilized on this project. [*Socket fusion is not widely used, and the specifier may decide to prohibit its use*].
- D. Electrofusion:** Electrofusion joining shall be done in accordance with the manufacturers recommended procedure. Other sources of electrofusion joining information are ASTM F 1290. The process of electrofusion requires an electric source, a transformer, commonly called an electrofusion box that has wire leads, a method to read electronically (by laser) or otherwise input the barcode of the fitting, and a fitting that is compatible with the type of electrofusion box used. The electrofusion box must be capable of reading and storing the input parameters and the fusion results for later download to a record file. Qualification of the fusion

technician shall be demonstrated by evidence of electrofusion training within the past year on the equipment to be utilized for this project.

**E. Mechanical:**

- Mechanical connection of HDPE to auxiliary equipment such as valves, pumps, and fittings shall use mechanical joint adapters and other devices in conformance with AWWA Manual of Practice M55, Chapter 6.
- Mechanical connections on small pipe under 3" are available to connect HDPE pipe to other HDPE pipe, or fittings, or to a transition to another material. The use of stab-fit style couplings is allowed, along with the use of metallic couplings of brass and other materials. All mechanical and compression fittings shall be recommended by the manufacturer for potable water use. When a compression type or mechanical type of coupling is used, the use of a rigid tubular insert stiffener inside the end of the pipe is recommended.
- Mechanical couplings that wrap around the pipe and act as saddles are made by several manufacturers specifically for HDPE pipe. All such saddles, tapping saddles, couplings, clamps etc. shall be recommended by the manufacturer as being designed for use with HDPE pipe at the pressure class listed in this section.
- Unless specified by the fitting manufacturer, a restraint harness or concrete anchor is recommended with mechanical couplings to prevent pullout.
- Mechanical coupling shall be made by qualified technicians. Qualification of the field technician shall be demonstrated by evidence of mechanical coupling training within the past year. This training shall be on the equipment and pipe components to be utilized for this project.

**F. Joint Recording:** The critical parameters of each fusion joint, as required by the manufacturer and these specifications, shall be recorded either manually or by an electronic data logging device. All fusion joint data shall be included in the Fusion Technician's joint report.

### 1003. DOUBLE WALL CORRUGATED (DWC) HDPE PIPES

#### **General Appearance**

Double Wall Corrugated (DWC) pipes must be manufactured using two layers of either Polypropylene (PP) or Polyethylene (PE) that are bonded in the extrusion process. The pipe will have a corrugated outer skin, forming ribs and bonded to the internal skin of the pipe leaving a smooth inner surface. This inner surface will be free of cracks, deformities and will ensure smooth flow properties throughout the pipeline. The pipe shall be socketed on one side and have a spigot on the other. The internal colour shall be a light reflective colour to reflect light to ease camera inspection. An elastomeric rubber water sealing ring will be placed on the spigot side to create a strong seal between the spigot and socket.

The pipe must have a coextruded line on the pipe of a different colour for easy identification of the fluid within the pipe. Pipes that do not have this coextruded stripe will not be accepted.

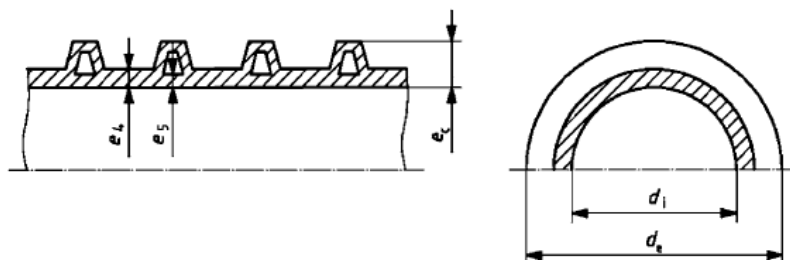
The pipe must also be produced with a reinforced air channel for added rigidity.

#### **Manufacturing Process**

The pipes shall use suitable PP or PE to acquire the required stiffness and deflection characteristics described below. The pipe will have inline socketing, with the required socket diameter to create a watertight seal with the help of an elastomeric ring.

### Corrugated Construction

The pipe will have a plain smooth inside surface, with an annular ribbed external surface as shown in the diagram below:



The profile of the corrugation may change to design requirement for desired ring stiffness of the pipe.

### Materials

PP (Polypropylene) material characteristics described in the table below:

| Characteristic   | Requirements                      | Test parameters        |                               | Test method   |
|--|-----------------------------------|------------------------|-------------------------------|---------------|
| Resistance to internal pressure, 140 h <sup>a, b</sup>   | No failure during the test period | End caps               | Type A or B                   | ISO 1167-1    |
|  |                                   | Test temperature       | 80 °C                         |               |
|  |                                   | Orientation            | Free                          | ISO 1167-2    |
|  |                                   | Number of test pieces  | 3                             |               |
|  |                                   | Circumferential stress | 4,2 MPa                       |               |
|  |                                   | Conditioning period    | In accordance with ISO 1167-1 |               |
|  |                                   | Type of test           | Water-in-water                |               |
| Test period  | 140 h                             |                        |                               |               |
| Resistance to internal pressure 1 000 h <sup>a, b</sup>  | No failure during the test period | End caps               | Type A or B                   | ISO 1167-1    |
|  |                                   | Test temperature       | 95 °C                         | ISO 1167-2    |
|  |                                   | Orientation            | Free                          |               |
|  |                                   | Number of test pieces  | 3                             |               |
|  |                                   | Circumferential stress | 2,5 MPa                       |               |
|  |                                   | Conditioning period    | In accordance with ISO 1167-1 |               |
|  |                                   | Type of test           | Water-in-water                |               |
| Test period  | 1 000 h                           |                        |                               |               |
| Melt mass-flow rate  | ≤ 1,5 g/10 min                    | Temperature            | 230 °C                        | ISO 1133:2005 |
|  |                                   | Loading mass           | 2,16 kg                       | Condition M   |
| Thermal stability, OIT <sup>c</sup>  | ≥ 8 min                           | Temperature            | 200 °C                        | ISO 11357-8   |
| <sup>a</sup> For extrusion compounds this test shall be carried out in the form of a solid-wall pipe made from the relevant extrusion material.<br><sup>b</sup> For injection-moulding compounds this test shall be carried out in the form of an injection-moulded, or extruded sample in solid-wall pipe form made from the relevant material.<br><sup>c</sup> This requirement is only valid for pipes and fittings intended to be jointed in the field by fusing or welding. |                                   |                        |                               |               |

PP material of MRS 1700Mpa is advisable and should have a minimum carbon content (for outer layer) of 2% to achieve UV resistant characteristics.

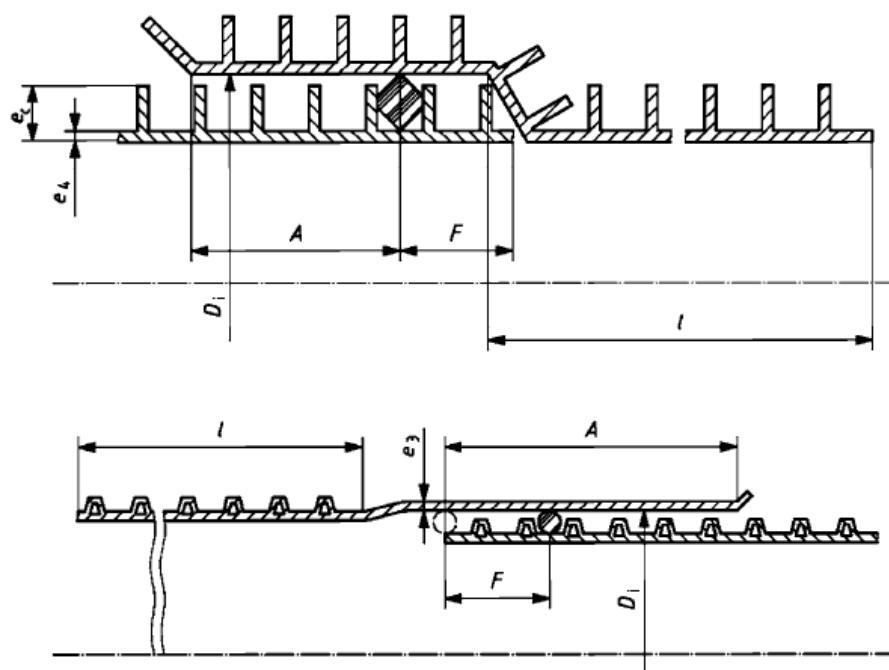
PE (Polyethylene) material characteristics described in the table below:

| Characteristic  | Requirements                      | Test parameters               |                               | Test method   |
|---|-----------------------------------|-------------------------------|-------------------------------|---------------|
| Resistance to internal pressure<br>165 h <sup>a, b</sup>  | No failure during the test period | End caps                      | Type A or B                   | ISO 1167-1    |
|   |                                   | Test temperature              | 80 °C                         | ISO 1167-2    |
|   |                                   | Orientation                   | Free                          |               |
|   |                                   | Number of test pieces         | 3                             |               |
|   |                                   | Circumferential stress        | 4,0 MPa                       |               |
|   |                                   | Conditioning period           | In accordance with ISO 1167-1 |               |
|   |                                   | Type of test                  | Water-in-water                |               |
|   |                                   | Test period                   | 165 h                         |               |
| Resistance to internal pressure<br>1 000 h <sup>a, b</sup>  | No failure during the test period | End caps                      | Type A or B                   | ISO 1167-1    |
|   |                                   | Test temperature              | 80 °C                         | ISO 1167-2    |
|   |                                   | Orientation                   | Free                          |               |
|   |                                   | Number of test pieces         | 3                             |               |
|   |                                   | Circumferential stress        | 2,8 MPa                       |               |
|   |                                   | Conditioning period           | In accordance with ISO 1167-1 |               |
|   |                                   | Type of test                  | Water-in-water                |               |
|   |                                   | Test period                   | 1 000 h                       |               |
| Melt mass-flow rate   | ≤ 1,6 g/10 min                    | Temperature                   | 190 °C                        | ISO 1133:2005 |
|   |                                   | Loading mass                  | 5 kg                          | Condition T   |
| Thermal stability, OIT <sup>c</sup>   | ≥ 20 min                          | Temperature                   | 200 °C                        | ISO 11357-6   |
| Reference density   | ≥ 930 kg/m <sup>3</sup>           | In accordance with ISO 1183-1 |                               | ISO 1183-1    |
| <sup>a</sup> This test shall be carried out in the form of a solid-wall pipe made from the relevant extrusion material.<br><sup>b</sup> For injection-moulding compounds this test shall be carried out in the form of an injection-moulded or extruded sample in solid-wall pipe form made from the relevant material.<br><sup>c</sup> This requirement is only valid for pipes and fittings intended to be jointed in field by fusing or welding. |                                   |                               |                               |               |

PE material of MRS 1000Mpa is advisable and should have a minimum carbon content (for outer layer) of 2% to achieve UV resistant characteristics.

### Typical Spigot & Socket Joint

Below are typical examples of elastomeric sealing ring joints, with the sealing ring located on the spigot.



Examples of Sealing Ring Joints

Below is a table showing the following: Nominal sizes, minimum internal diameters, thickness of inside layers and socket length. These must be strictly adhered to or exceeded under the ISO 21138 standard for structured wall pipes.

The indications for  $e_4$ ,  $e_5$  and  $A(\text{min})$  can be seen on the above figure as a reference diagram.

| Internal Diameter<br>(mm) | Minimum wall thickness |                     | A (min)<br>(mm) |
|---------------------------|------------------------|---------------------|-----------------|
|                           | $e_4$ (min)<br>(mm)    | $e_5$ (min)<br>(mm) |                 |
| 100                       | 1.00                   | 1.00                | 32.00           |
| 150                       | 1.30                   | 1.00                | 43.00           |
| 200                       | 1.50                   | 1.10                | 54.00           |
| 250                       | 1.80                   | 1.50                | 59.00           |
| 300                       | 2.00                   | 1.70                | 64.00           |
| 400                       | 2.50                   | 2.30                | 74.00           |
| 500                       | 3.00                   | 3.00                | 85.00           |
| 600                       | 3.50                   | 3.50                | 96.00           |
| 800                       | 4.50                   | 4.50                | 110.00          |
| 1000                      | 5.00                   | 5.00                | 140.00          |
| 1200                      | 5.00                   | 5.00                | 162.00          |

The minimum inner skin thickness ( $e_4$ ) is the minimum requirement for survivability for hard sewage mediums, and integrity for the lifespan of the pipe.

In addition to the minimum required wall thickness of sockets and spigots, their ring stiffness, when determined in accordance with ISO 9969, shall conform to the following equation:

$$S_{so} + S_{sp} \geq SN_{pipe}$$

For the test, it is permitted to use cut-off straight spigot and socket parts even if they do not conform to the length requirement specified in ISO 9969.

### **Mechanical Characteristics**

When tested in methods specified in the table below, using the indicated parameters, the pipe shall have the mechanical characteristics conforming to the requirements given in the table below.

The pipes shall be designated in one of the following nominal ring stiffness classes (SN):

DN ≤ 500: SN4, SN8 or SN16 DN > 500: SN2, SN4, SN8 or SN16

| Characteristic   | Requirements   | Test parameters                           |  | Test method |
|--|--|---|--|-------------|
| Ring stiffness   | ≥ relevant SN  | In accordance with ISO 9969               |  | ISO 9969    |
| Impact strength  | TIR ≤ 10 %   | Test temperature                          | (0 ± 1) °C   | ISO 3127    |
|  |  | Conditioning medium                       | Water or air   |             |
|  |  | Type of striker                           | d90  |             |
|  |  | Mass of striker for <sup>a</sup> :        |  |             |
|  |  | $d_{im,max} \leq 100$                     | 0,5 kg   |             |
|  |  | $100 < d_{im,max} \leq 125$               | 0,8 kg   |             |
|  |  | $125 < d_{im,max} \leq 160$               | 1,0 kg   |             |
|  |  | $160 < d_{im,max} \leq 200$               | 1,6 kg   |             |
|  |  | $200 < d_{im,max} \leq 250$               | 2,0 kg   |             |
|  |  | $250 < d_{im,max} \leq 315$               | 2,5 kg   |             |
|  |  | $315 < d_{im,max}$                        | 3,2 kg   |             |
|  |  | Fall height of striker for <sup>a</sup> : |  |             |
|  |  | $d_{em,min} \leq 110$                     | 1 600 mm   |             |
|  |  | $d_{em,min} > 110$                        | 2 000 mm   |             |
| Ring flexibility   | In accordance with 9.1.2 at 30 % of $d_{em}$   | Deflection                                | 30 %   | EN 1446     |
|  |  | Length of test piece                      | Shall incorporate at least 5 ribs/spirals <sup>b</sup>                     |             |
|  |  | Position of test piece                    | Mould split line, when applicable, at 0°, 45° and 90° from the upper plate |             |
| Creep ratio  | PVC-U:<br>≤ 2,5 at 2 year extrapolation<br><br>PP and PE:<br>≤ 4 at 2 year extrapolation | In accordance with ISO 9967               |  | ISO 9967    |
| Tensile strength of seam <sup>b</sup>  | In accordance with 9.1.3   | Rate of movement                          | 15 mm/min  | EN 1979     |
| <sup>a</sup> Refer to the specified $d_{em,min}$<br><sup>b</sup> Only applicable to spirally formed pipes. |  |   |  |             |

### **Ring Flexibility**

When tested in accordance with the test methods described in the previous table, and visually inspected without magnification;

- a. There shall be no decrease of the measured force
- b. There shall be no cracking in any part of the wall structure
- c. There shall be no wall delamination except possible delamination between the outside and inside wall of double layer pipes
- d. There shall be no other types of rupture in the test piece
- e. Permanent buckling in any part of the structure of the pipe wall including depressions and craters shall not occur in any direction

### **Tensile Strength**

When tested in accordance with the test methods highlighted above, the minimum require tensile strength of the seam shall conform to the table below:

| Nominal size<br>DN/ID or DN/OD | Minimum tensile<br>force<br>N |
|--------------------------------|-------------------------------|
| $DN \leq 375$                  | 380                           |
| $400 \leq DN \leq 560$         | 510                           |
| $600 \leq DN \leq 710$         | 760                           |
| $DN \geq 800$                  | 1 020                         |

The pipe should have an allowable deflection of up to 30% without any signs of cracks, or ovality during the process.

### **Performance Requirements**

When tested in accordance with the test methods below, the joints and system shall have the characteristics conforming to the requirements given in the table below:

| Characteristic  | Requirements  | Test parameters   |                             | Test method                               |
|---|---|---|-----------------------------|---|
| Tightness of elastomeric ring seal joint  |   | Temperature   | (23 ± 2) °C                 | EN 1277:2003, Condition B                 |
|   |   | Spigot deflection   | 10 %                        |   |
|   | No leakage  | Water pressure  | 5 kPa (0,05 bar)            |   |
|   | No leakage  | Water pressure  | 50 kPa (0,5 bar)            |   |
|   | ≤ -27 kPa (-0,27 bar)   | Air pressure  | -30 kPa (-0,3 bar)          |   |
| Tightness of elastomeric ring seal joint  |   | Temperature   | (23 ± 2) °C                 | EN 1277:2003, Condition C                 |
|   |   | Joint deflection for:<br>$d_e \leq 315$ mm                          | 2°                          |   |
|   |   | 315 mm < $d_e \leq 630$ mm  | 1,5°                        |   |
|   |   | 630 mm < $d_e$  | 1°                          |   |
|   | No leakage  | Water pressure  | 5 kPa (0,05 bar)            |   |
|   | No leakage  | Water pressure  | 50 kPa (0,5 bar)            |   |
|   | ≤ -27 kPa (-0,27 bar)   | Air pressure  | -30 kPa (-0,3 bar)          |   |
| Resistance to combined temperature cycling and external loading <sup>b</sup>  | <sup>a</sup>  | For $d_{im} \leq 160$ mm: In accordance with EN 1437:2002, Method A |                             | EN 1437:2002 Method A, hot and cold water |
|   |   | For $d_{im} > 160$ mm: In accordance with EN 1437:2002, Method B    |                             | EN 1437:2002 Method B, hot water          |
| Long-term performance of TPE seals  | Tube pressure:<br>-100 years extrapolated:<br>≥ 150 kPa (1,5 bar) | Test temperature  | (23 ± 2) °C                 | EN 14741                                  |
| Watertightness <sup>c</sup>   | No leakage  | Water pressure<br>Duration  | 50 kPa (0,5 bar)<br>1 min   | EN 1053                                   |
| Tensile test of welded or fused joints  | No break in the joint   | Minimum tensile force   | In accordance with Table 15 | EN 1979 <sup>d</sup>                      |
| <sup>a</sup> The following requirements apply:<br>— vertical deformation: ≤ 9 %<br>— deviation from surface evenness in bottom: ≤ 3 mm<br>— radius of bottom: ≥ 80 % of original<br>— opening of weld line: ≤ 20 % of wall thickness<br>— tightness at 35 kPa (0,35 bar)/15 min: no leakage allowed.<br><sup>b</sup> Only for components in accordance with this part of ISO 21138 with DN/OD ≤ 335 and DN/ID ≤ 300.<br><sup>c</sup> Only for fabricated fittings made from more than one piece. A sealing ring retaining component is not considered as a piece.<br><sup>d</sup> This test is applicable for all pipe and fitting constructions when jointed by fusion or welding. The test pieces shall be cut longitudinally in the fusion area. The length of the test piece shall include the joint plus a length at each end sufficient to ensure a proper grip in the tensile testing machine. |   |   |                             |   |

### Marking

The following information shall be marked on the Pipe:

- Quality Standard e.g., ISO 21138
- Manufacturer's identification
- Dimensions DN/ID series e.g., ID 200mm
- Stiffness class e.g., SN4
- Material – PE or PP
- Production date
- Country of Production

#### **1004. AGRICULTURAL TILES AND PIPES**

Agricultural tiles and pipes shall be best well-burnt earthenware, true and circular in bore and with an external flat bottom and plain ends suitable for laying with open or butt joints.

#### **1005. ARCHITRAVES AND STOPS**

Architraves and stops shall be Class 1 Mvuli matching to the frames and linings.

#### **1006. BLOCKWORK**

Building blocks shall be dense concrete blocks complying with the requirements of B.S. 2028, 1364, with faces for plastering and having a compressive strength of 14 N/sq.mm. (Table 2, Type A14).

Blocks shall be obtained from an approved manufacturer and shall be equal to sample blocks previously approved by the Engineer's Representative.

Blocks shall be carefully handled and stored on site and always protected from the weather.

Surfaces on which blockwork is to be built shall be kept clean. Blocks shall be well wetted before being laid and the tops of walls where blockwork has been left shall be well wetted before re-commencing. Blockwork shall be built plumb, true to line and level, with all perpend vertical and in line. Blocks shall be built in half bond and alternate courses shall be block bonded at all junctions, no cut block shall be less than half a block. Joints in concrete blockwork shall be well filled with gauged mortar and shall not exceed 10mm in width.

#### **1007. BOLTS AND NUTS**

Bolts and nuts shall comply with the relevant requirements of the British Standards as set out below: -

|  |                      |
|--|----------------------|
| Black Hexagon Bolts, Screws and Nuts                       | B.S. 4190, Grade 4.6 |
| Metal Washers for General Purpose                          | B.S. 4320            |
| Black Cup and Countersunk Head Bolts and Screws, with Nuts | B.S. 4993            |

The items shall preferably have coarse metric threads but items with B.S.W. threads may be used. Bolt lengths shall be sufficient to ensure that nuts are full threaded when tightened in their final position.

#### **1008. BONDING TIES**

Bonding ties shall be 75mm wide x 250mm long galvanized bitumen-coated expanded metal strip, cast 100mm into concrete surfaces in contact with block work. The bonding tie used shall be approved by the Engineer's Representative.

#### **1009. BUILDING STONE**

All building stone shall be capable of withstanding when wet a crushing stress of 3.5 N/sq.mm. The source of stone shall be approved by the Engineer and stone supplied therefrom shall be free from Magadi, overburden, mudstone, cracks, sand holes, veins, laminations, or other imperfections.

The stone shall be chisel dressed into true rectangular blocks, with each surface even and at right angles to all adjoining surfaces, to the size specified. For exposed stonework the maximum permissible variation of any of the specified dimensions shall be 6mm provided that cut stone, supplied as 'rock face' stone may be hammer dressed on one face only, or on one face and one end, if in other respects it conforms with this specification. Stones shorter than 375mm will not be accepted.

Unless the Engineer allows otherwise the Contractor shall at his own expense provide and dress four 100mm cubes of stone for testing.

The stone shall be sound when tested in accordance with SRN 870 except that:

- i) The treatment shall be repeated for 10 cycles only;
- ii) The second criterion of failure shall be amended to allow for a loss of weight of not more than 20% of its original weight.

#### **1010. CALCIUM CHLORIDE**

Calcium chloride shall be of good industrial grade and shall be obtained from an approved source.

#### **1011. CAST STONE**

Cast stone shall be manufactured by an approved manufacturer to the shapes and dimensions shown on the drawings and shall conform to the requirements of SRN 871: Cast Stone. It shall have a dense and even surface of the texture and colour detailed on the drawings or required by the Engineer. Where indicated exposed faces of the stone shall be formed of a specially graded mix. Metal bond ties of approved manufacture shall be cast in with the stone as shown on the drawings. Samples of the completed stone shall be submitted for the Engineer's prior approval.

All stones shall be protected from damage during transport and erection by means of cement slurry coatings or by other approved methods.

#### **1012. CEMENT GROUT**

Cement grout shall consist of Portland Cement and water mixed in the proportion of one part by volume of cement and one and a half parts by volume of water. The grout shall be used within one hour of mixing.

#### **1013. CEMENT MORTAR**

Cement mortar shall consist of proportions by volume as specified of Portland Cement and natural sand or crushed natural stone or a combination of both as specified in SRN 135 and SRN 136: Building Sands from Natural Sources. The constituent materials shall be accurately gauged and mixed in an approved manner.

Cement mortar shall be made in small quantities only as and when required, and any mortar which has begun to set or which has been mixed for a period of more than one hour shall be rejected.

#### **1014. CEMENT-LIME MORTAR**

Cement-lime mortar shall consist of Portland Cement, hydrated lime and natural sand or crushed natural stone or a combination of both, as specified for cement mortar in Clause 613. The constituent materials shall be accurately gauged and mixed by volume in an approved manner in the proportions specified.

Cement-lime mortar shall be made only in small quantities as and when required. Any mortar which has begun to set or which has been mixed for a period of more than two hours shall be rejected.

#### **1015. CONCRETE BLOCKS**

Solid and hollow concrete blocks for walling shall comply with SRN 804 in every respect.

All solid and hollow concrete blocks used in the walling must be capable of withstanding a crushing pressure of not less than 0.35 kg per square millimetre after 28 days. The blocks shall be cast in Metric sizes.

#### **1016. CONCRETE DRAIN INVERT BLOCKS**

Precast concrete invert blocks shall be manufactured to the detail drawings supplied from concrete Class 20/10 as specified in Table 6.2 using maximum 12mm size aggregates. If required, cube test certificates shall be supplied by the manufacturer.

#### **1017. CONCRETE PIPES AND SPECIALS**

Concrete pipes and specials shall comply with the requirements of SRN 840. They shall carry the relevant Standards Institution registration certification trade mark, or test certificates shall be furnished by the manufacturers.

#### **1018. CONCRETE POROUS PIPES**

Concrete porous pipes shall comply with the requirements of SRN 410: Concrete Porous Pipes for Under-drainage.

#### **1019. CONCRETE SLABS FOR OPEN DRAINS**

Precast concrete slabs for lining open drains shall be manufactured to the detail drawings supplied from concrete Class 20/10 as specified in Table 6.2 using maximum 12mm size aggregates. If required, cube test certificates shall be supplied by the manufacturer.

#### **1020. DAMP-PROOF COURSE (D.P.C.)**

Hessian based metal cored bitumen for damp-proof courses shall be lead cored, complying with B.S. 743 paragraph 4, type D, weighing not less than 4.4 kg. per square metre. Damp-proof course shall be bedded horizontally in mortar as for blockwork with 115mm laps in length and full laps at angles.

#### **1021. DOORS**

Internal doors shall be hardwood framed solid cored flush doors constructed in accordance with B.S. 459 Part 3, faced both sides with 3mm thick Mvuli veneered plywood and lipped all round with matching hardwood lipping. Moisture content at delivery shall be 12% (+ or - 2%).

#### **1022. DUCTILE IRON AND CAST IRON PIPES AND SPECIALS**

All cast iron piping and fittings shall conform to the requirements of SRN 200.

Ductile iron pipes and fittings shall comply with SRN 202. Where required the pipes shall be protected as specified by the manufacturer of the pipes and shall be used as recommended by the manufacturer of the pipe.

Where the requirements include for the supply of flexible couplings the Contractor shall submit for approval by the Engineer full details of the type of joint offered and a full description of the method of jointing prior to arranging for the delivery of goods on site.

All flexible couplings shall be protected from corrosion by wrapping with Denso paste and tape or by some similar approved material.

The quality of metal used for the manufacture of the pipes shall be of good quality grey cast iron and subject to the various quality control tests as specified in the relevant Standards.

All piping and fittings shall be coated internally with cement mortar lining to SRN 211. Cement mortar lining shall not contain any constituents soluble in water nor any ingredient which could impart any taste or odour whatsoever to the water after sterilization and washing out of the mains. External protection to be as specified in SRN 258.

The flanges of straight pipes shall be at right angles to axis of the pipe and the faces of the flanges shall be parallel and machine finished.

The faces of the flanges of fittings shall be at right angles to the directional axis. The bolt holes shall be concentric with the bore and located symmetrically off the centre line.

In flanged pipework the holes in one flange shall be located in line with those in the other.

All flanges shall be drilled to SRN 207, unless otherwise detailed.

The weights of the pipe and fittings shall comply with the Specification in the relevant Standard.

### **1023. ELECTRICAL INSTALLATION**

The electrical installations will be carried out by Licensed Electrician and complying with the following: -

- a) Regulations for Electrical Equipment of Buildings issued by the Institution of Electrical Engineers.
- b) Tanzania Electric Supply Company Limited (TANESCO) regulations.
- c) The Electricity Act of the United republic of Tanzania
- d) Relevant current British Standards and Codes of Practice.
- e) All the relevant clauses in this Specification.

### **1024. FIRE HYDRANTS**

Fire hydrants shall be in accordance with SRN 509. They shall be for installation underground and shall be in accordance with SRN 509.

The spindle shall be provided with a universal cast iron cap conforming to SRN 501.

The spindle of the fire hydrant shall be of the non-rising type and screwed so as to close the hydrant when rotated in a clockwise direction viewed from above. The direction of closing shall be clearly cast on the valve cap.

The flanged outlet of the outlet bend shall have a Bayonet Joint Outlet for a 63mm standpipe. The outlet of the hydrant shall be of the hooked type with hooks 112mm apart.

The outlet shall have a gun metal standpipe seating and be covered by a loose cast iron cap which shall be attached to the hydrant by means of a chain.

Both flanges shall be 63mm drilled to requirements of SRN 207.

The outlet bends shall be subject to a hydrostatic test in accordance with procedure set out in SRN 509 and shall be water-tight against a test pressure of 1.85 Pa. head of water.

#### **1025. FIXING IRONMONGERY**

The rates for supplying and fixing ironmongery shall include for all sinking, cutting, boring, mortising etc., making good, replacing damaged screws, oiling, adjusting and leaving in good working order and for mastering all keys.

#### **1026. FIXING JOINERY**

Doors shall be hung on one or one and a half pairs of butt hinges to give a maximum even tolerance of 2mm all round.

Sub-frames shall be fixed to blockwork with three fixing clamps per side and one dowel let 50mm into the floor and 50mm into the foot of each leg. Linings shall be fixed after completion of other finishings by means of screwing and pelleting to sub-frames with matching hardwood pellets. Architraves and stops shall be pinned on, heads punched and filled with tinted filler.

#### **1027. FLANGED JOINTS**

All flanges on fittings and pipework where flanged connections are required must comply with the requirements of SRN 207 and drilled to NP 16, unless otherwise specified.

Inspection gaskets for flanged joints shall be rubber reinforced with cotton, 3mm thick and shall be in accordance with SRN 208. Bolts, washers and nuts for flanged joints shall be of mild steel complying with SRN 914.

#### **1028. FLEXIBLE JOINTS**

All flexible couplings shall be supplied complete with rubber gaskets, bolts, nuts and washers. All couplings shall be coated with red oxide primer and bituminous composition suitable for use with potable water.

#### **1029. FRAMES AND LININGS**

Door frames and linings shall be Class 1 Mvuli mortice and tenon jointed at angles. Sub-frames for internal doors shall be Class 1 Mvuli tongued at angles.

#### **1030. GABIONS**

Gabions shall be of the hexagonal wire mesh type, with mesh dimensions of 80 mm x 100 mm. The minimum dimension shall not exceed 83 mm. Wire shall be galvanised prior to weaving the mesh to resist corrosion from water.

All wire used in the fabrication of the gabion and in the wiring operation during construction shall be in accordance with BS 1052/1980 Mild Steel wire appended having a tensile strength of 38-50 kg/mm<sup>2</sup>

All wire shall be galvanised to BS 443: 1982 'Zinc coatings on steel wire' with the minimum weight of Zinc coating in accordance with Table below.

|                             | Diameter (mm) | Minimum Weight of Coating (g/m <sup>2</sup> ) |
|-----------------------------|---------------|---|
| Mesh wire                   | 2.7           | 260   |
| Binding and connecting wire | 2.2           | 240   |
| Selvedge wire               | 3.4           | 275   |

All wire used in the fabrication of gabions and in the wiring operations during construction shall, after galvanising, have extruded onto it a coating of polyvinyl chloride compound referred to as PVC. The coating shall be black in colour, not less than 0.4 mm thickness and shall be capable of resisting deleterious effects of exposure.

Gabions shall be of the following standard sizes:

- 2m x 1m x 0.5m
- 2m x 1m x 1m
- 6m x 2m x 0.3m

Gabions shall be provided with diaphragms to divide the boxes in compartments with a maximum dimension in any direction of 1m.

Joints shall be flexible and shall consist of not less than one and a half full turns of wire, at each mesh point of the joint line.

Gabions or Alternative materials shall be subject to the approval of the Engineer.

Rockfill for gabions shall consist of hardcore i.e., sound hard stone or broken rock. The maximum size shall be 220mm, and the minimum size shall be 120mm; however, up to 10% of some smaller blinding material (min. 75mm) to fill the internal voids between the bigger rocks will be allowed.

Gabions shall be placed in their final positions prior to filling with rock and shall then be tied together and filled with rock. After filling with rock, the tops shall be closed and securely tied with connecting wire. The larger rocks shall be placed on the upper face of the gabion to present a reasonably closed surface. All assembly, erection, stretching, filling with rock and final filling shall be in accordance with the instructions as issued by the manufacturer.

### 1031. G.R.P. PIPES AND SPECIALS

Glass Reinforced Plastic piping shall be in accordance with SRN 317.

### 1032. GALVANISED PIPES AND SPECIALS

All piping shall conform to SRN 823 and SRN 903 for "Medium" Piping. The pipes shall be screwed and socketed, coupled or flanged.

All specials shall be of such dimensions as will mate with the piping supplied. Screw down stop valves shall conform to SRN 826. Barrel nipples shall conform to SRN 823 and all other specials shall conform to SRN 824.

All pipes supplied shall be certified by the manufacturer to have been tested in accordance with the relevant Standard Specification.

### 1033. GALVANISED WORK

Iron and steel, where galvanized, shall comply with B.S. 729, entirely coated with zinc after fabrication by complete immersion in a zinc bath in one operation and all excess carefully removed. The finished surface shall be clean and uniform.

### 1034. CHECK VALVES (DIRECTIONAL VALVES)

Check valves shall comply with the requirements of SRN 505 with cast iron body and cover, gun metal doors with bronze facing rings and flanged connections in accordance with SRN 207, NP 16.

### 1035. AIR VALVES

The Contractor shall provide air valves to suit the site on which the main is located and the maximum water pressure specified. The body and cover of air valves shall comply with SRN 906 and SRN 916.

The body, cover, splash cowl and joint support ring of the air valve shall be of mechanite cast iron with flanges drilled to SRN 207.

The internal screwed isolating valve shall have the valve and seating of gun metal, operating screws of bronze, nuts of gun metal, and glands and cap of mechanite.

The large orifice valve shall have a vulcanite covered ball closing on a moulded dextrine seat ring. The bush may be in gun metal.

The double orifice type of air valve shall comprise a small and large orifice unit with common connection to the main and screw down isolating valve to permit inspection of the valve. The spindle of the isolating valve shall be screwed so as to close the valve when rotated in a clockwise direction and be provided with a Spindle Cap to dimensions as specified in SRN 501.

Design of the air valves shall be such that the balls do not blow shut under any working or test conditions when large volumes of air are being released.

### 1036. GATE VALVES

Gate valves shall comply with the requirements of SRN 501.

The gate valves shall be suitable for use in pipelines and for the operating pressure to a head of 160 metres of water (NP 16).

The gate valves shall be double flanged. The dimensions and drilling of flanges shall be in accordance with SRN 207. Flanges shall be machined flat. Flanges shall be NP 16 complying with SRN 207.

Spindles of the gate valves shall be provided with cast iron caps conforming to the requirements as specified under "Valve Caps" in SRN 501 or handwheels if so specified.

The spindles of the gate valves shall be of the non-rising type and screwed so as to close the valves when rotated in a clockwise direction. The direction of closing shall be clearly cast on the valve cap or handwheel.

The gate valves shall be subject to "Closed End Tests" in accordance with the procedure set out in SRN 501.

The gate valves shall be suitable for opening and closing against an unbalanced head by manual operation.

### **1037. GULLY GRATINGS AND FRAMES**

Gully gratings and frames shall be basically in accordance with the requirements of SRN 846, nominal size 500mm x 350mm except that the gully gratings shall be constructed of mild steel concrete filled in accordance with the standard detail drawings.

Where indicated as being kerb inlet type, the gullies shall conform to the shape and dimensions given on the detail drawings supplied, but in respect of materials and workmanship conform to SRN 846.

### **1038. HARDWOOD**

Hardwood for joinery shall be sound, well-conditioned and seasoned Mvuli complying with the requirements of B.S. 1186 Part 1, Class 1. A sample of each representative section for use in the work shall be previously submitted by the Contractor for approval by the Engineer's Representative. Moisture content shall be 12% (+ or - 2%).

### **1039. HYDRATED LIME**

Hydrated lime shall comply with SRN 801: Building Limes and shall be of the semi-hydrated type.

### **1040. IRONMONGERY**

All ironmongery shall be obtained from a source approved by the Engineer's Representative. Samples shall be submitted before ordering and the articles ordered shall match up with the approved samples. Screws of a like metal shall be used for all fittings.

### **1041. JOINERY**

All exposed joiner's work shall have wrought faces. The prices of all joiner's work shall include for slightly rounded arises.

Where the term 'framing' or 'framed' is made use of, it shall be understood to mean all halvings, dovetails, tenons and hardwood pins and the best-known means of putting the work together.

All framed work shall be put together loosely and stacked under cover where a free current of air can circulate and is not to be wedged and glued until it is required for fixing.

All joinery, when brought on the works, shall be stacked under cover.

The Engineer or his representative, shall have full right of access to the joinery works and power to condemn any work not approved and any approval expressed or implied is not to relieve the Contractor from his responsibility and liability to make good any shrinkage or other defects that may appear after the work is fixed.

All joinery to be painted shall be knotted and primed.

The Contractor shall provide all materials, labour, framing, fixing, etc., nails, screws and everything necessary for the proper execution and completion of the work.

### **1042. JOINT PRIMER**

Joint priming compound shall be entirely in accordance with the manufacturer's recommendations for the joint sealant to be used.

**1043. JOINT SEALING COMPOUND**

Poured joint sealing material shall consist of an approved rubber-bitumen compound, complying with the requirements of SRN 879, or a two component, cold applied compound complying with SRN 879 as stated in the Bill of Quantities. Test Certificates, prepared by an approved testing laboratory, shall be supplied by the Contractor to show that the material does in fact comply in respect of cone penetration, flow and bond with the under-mentioned requirements:

| <u>Test Cone Penetration</u>  | <u>Hot-poured Materials</u>                | <u>Cold-poured Materials</u>                             |
|---|--|--|
| 0.15 kg. for 5 secs. at 25° centigrade using standard grease cone   | Penetration not to exceed 9mm              | Penetration to be not less than 5mm not more than 27.5mm |
| <u>Flow</u>   |  |  |
| On a plane inclined at 75° to the horizontal, 5 hours at 60° centigrade   | Flow not to exceed 5mm                     | Flow not to exceed 20mm                                  |
| <u>Bond</u>   |  |  |
| 25mm wide joint extended 12mm at rate of 4mm per hour at 18° centigrade. No more than one specimen in three to develop a crack separation or other opening more than 4mm deep | Five cycles of extension and recompression | Three cycles of extension and recompression              |

Approved hot-poured materials shall also comply with a requirement whereby when heated for a period of 6 hours at a temperature of 80 degrees centigrade above recommended pouring temperature or 30 degrees centigrade below the safe heating temperature whichever is the greater shall still comply with the flow requirements of this clause.

In addition to materials complying with SRN 879, the Engineer may approve the use of alternative materials provided they meet the requirements of this clause relating to cold-poured joint sealing compounds.

**1044. LIME MORTAR**

Lime mortar shall consist of proportions by volume as specified of hydrated lime and naturals and/or crushed natural stone or a combination of both as specified for cement mortar in Clause 613. The constituent materials shall be accurately gauged and mixed in an approved manner.

**1045. MANHOLE COVERS AND FRAMES**

Manhole covers and frames shall be basically in accordance with the requirements of SRN 846: Cast Manhole Covers, Road Gully Gratings and Frames for Drainage Purposes except that the manhole covers shall be constructed of heavy duty circular polyresin composite, in accordance with the standard detail drawings.

Foul water sewer manholes shall have triangular Grade “A” heavy duty covers and frames. Circular manhole covers and frames shall be used on surface water sewer manholes.

#### **1046. MANHOLE STEP IRONS**

Step irons of general-purpose type shall comply in all respects with SRN 845: Malleable Step Irons.

#### **1047. MARKER AND INDICATOR POSTS**

Marker posts shall be erected at changes in direction of water mains as directed by the Engineer. Indicator posts shall be erected at valves and other fittings as directed.

Marker and indicator posts shall be embedded in concrete as shown on drawings and shall be vibrated precast reinforced concrete as per dimensions shown on drawings. They should be painted in colours as indicated on the drawings.

#### **1048. MURRAM**

Murram shall be from an approved source quarried so as to exclude vegetable matter, loam, topsoil or clay. The California Bearing Ratio (CBR) of the murram, as determined for a sample compacted to maximum density (as defined under SRN 601) and allowed to soak in water for four days, shall not be less than 30%. The C.B.R. is a guide to quality only and the compaction in the work will be judged by density.

#### **1049. PAINTS**

All priming, undercoating and finishing paints shall be in accordance with SRN 877 or SRN 878 as appropriate.

The painting of all building works shall comprise a special paint recommended for external work while all other paints, plastic emulsion coating etc. are to be of an approved manufacturer. All paints, distempers etc. shall be delivered on site intact in the original drums or tins and shall be mixed and applied in accordance with the manufacturer's printed directions. The only addition which will be allowed to be made will be liquid thinners, driers etc. supplied by the makers for the purpose.

All surfaces must be thoroughly cleaned down prior to painting and decorating work and no external painting shall be carried out in rainy weather. All paint must be thoroughly well worked on and excess of paint in any coat must be avoided.

All colours will be selected by the Engineer from the standard range of colours.

#### **1050. PENSTOCKS**

Cast iron penstocks shall be all in accordance with SRN 906 and SRN 916. Seating faces shall be gun metal or bronze.

Spindles shall be threaded as necessary and non-rising unless otherwise specified. Spindles shall be of aluminium bronze, manganese bronze and extension spindles may be of mild steel.

Handwheels shall be of cast iron and words "OPEN" and "SHUT" marked on upper side with appropriate direction arrows.

#### **1051. PLYWOOD**

Plywood generally shall comply with B.S. 1455. That from sources not included in B.S. 1455 shall be of corresponding grades of veneers and types of bonding. Plywood for flush doors shall be Grade I Mvuli veneered.

### **1052. POLYETHYLENE (PALOTHENE, PEH) PIPES**

Polyethylene High Density pipes shall comply with SRN 307 for testing, storage, handling, laying and backfilling. Contractor shall conform to requirements indicated for PVC pipes. Joints shall be required to sustain test pressures similar to which the pipe shall be subjected.

Contractor shall comply with all instructions issued by the manufacturers and shall submit full details of the type, class, dimensions and test pressures of the brass fittings to the Engineer for approval.

### **1053. PRECAST CONCRETE GULLIES**

Precast concrete gullies shall be unreinforced and shall comply with the requirements of SRN 854: Concrete Cylindrical Pipes and Fittings including Manholes, Inspection Chambers and Street Gullies.

### **1054. PRECAST CONCRETE MANHOLES AND INSPECTION CHAMBERS**

Precast concrete manholes and inspection chambers shall comply with the requirements of SRN 854: Concrete Cylindrical Pipes and Fittings including Manholes, Inspection Chambers and Street Gullies and they shall carry the relevant Standard Institution registered certification trademark, or test certificates shall be furnished by the manufacturer.

### **1055. PRECAST CONCRETE UNITS**

Precast concrete covers to be precast units for use in the works, whether instructed under the Contract or proposed by the Contractor.

#### **a) Formwork for Precast Units**

Moulds shall be so constructed that they do not suffer distortion or dimensional changes during use and are tight against loss of cement grout or fines from the concrete.

Moulds shall be set up on firm foundations so that no settlement occurs under the weight of the fresh concrete.

Moulds shall be constructed so that units may be removed from them without sustaining any damage.

Release agents used for demoulding shall not stain the concrete or affect its properties in any way.

#### **b) Reinforcement for Precast Units**

Reinforcement in precast units shall comply with the requirement of Clauses 623 i), 621 and 622. When preformed cages are used the cages shall be made up on jigs to ensure dimensional accuracy and shall be carefully supported within the mould in such a way that they cannot move when concrete is placed. Reinforcement complying with SRN 126 may be tack welded where bars cross to provide rigidity in the cage but reinforcement complying with SRN 127 shall not be welded.

Cover to main reinforcement shall be as shown on the drawings, or if not shown shall be not less than 25mm or the diameter of the bar, whichever is the greater. Cover on distribution steel shall not be less than 15mm or the diameter of the bar whichever is the greater.

Bars shall be spaced so that the minimum clear distance between them is the maximum nominal aggregate size plus five millimetres but in any case, not less than the diameter of the bars.

Bars may be placed in pairs provided there are no laps in the paired lengths.

**c) Casting of Units**

Concrete for precast units shall comply with Clauses 951/952 and 601-609 using the class of concrete specified on the drawings.

If lightweight aggregates are specified, they shall comply with SRN 147.

The area in which units are cast shall be adequately protected from the weather so that the process is not affected by rain, sun or drying winds.

**d) Curing Precast Units**

Requirements for curing shall be generally as set out in Clause 709.

The Contractor shall ensure that units do not suffer any loss of moisture or sudden changes of temperature for at least four days after casting. If a water spray is used for curing, the water shall be at a temperature within 5 degrees centigrade of the temperature of the unit being cured.

If Contractor proposes curing at elevated temperatures, the method shall be subject to the agreement of the Engineer and shall include means whereby units are heated and subsequently cooled evenly without sudden changes of temperature.

**e) Dimensional Tolerances of Precast Units**

Units shall be accurately formed to the dimensions shown on the drawings unless closer tolerances are called for by the Engineer.

**f) Surface Finish of Precast Units**

The formed faces of precast units shall be finished to Class F3 as set out in Clause 705c) unless another class of finish is specified on the drawings.

Free faces shall be finished to Class UF2 unless another class of finish is specified on the drawings.

In cases where a special finish is required a trial panel shall be constructed by the Contractor which after approval by the Engineer shall be kept available for inspection at the place of casting and production units shall thereafter match the approved pattern.

Those parts of the unit which are to be joined to other units or to in-situ concrete shall be brushed with a stiff brush before the concrete has fully hardened. Alternatively, if the concrete has been allowed to harden, the surfaces shall be roughened by sand blasting or using a needle gun.

**g) Handling and Storage of Precast Units**

Precast units shall be handled in a manner which will not cause damage of any kind and shall be stored on a hard impermeable base.

Prestressed units and large precast normally reinforced units shall be handled and stored so that no stresses shall be induced more than those which they will incur in their final positions in the Works unless they have been designed to resist such stresses.

Units shall be provided with adequate lifting holes or loops, placed in the locations shown on the drawings or agreed by the Engineer and they shall be lifted only by such holes or loops. Where it is not possible to provide holes or loops, suitable sling positions shall be indicated in paint on the units.

Units shall be marked indelibly with the reference number and date of casting and shall be stacked on suitable packers which will not damage the concrete or stain the surfaces. Not more than two packers shall be placed under each unit and these shall be located either at the positions of the permanent support points or in positions such that the induced stresses in the unit will be a minimum.

#### **h) Testing Precast Units**

Precast units shall be capable of safely sustaining the loads which they have been designed to carry. The Contractor shall subject units selected by the Engineer to load tests simulating the working conditions. Details of such tests shall be agreed between the Engineer and the Contractor.

In the case of units subject to bending loads the test piece shall be supported at full span and a loading equivalent to 1.25 times the sum of the live and dead loads which were assumed in the design shall be maintained for one hour without the appearance of any signs of distress. The recovery one hour after the removal of load shall be not less than 75 per cent of the full load deflection.

If the unit fails to meet the above requirements, further tests shall be carried out on two more units. If either of these fail, the whole batch of units will be rejected.

If the Engineer so requires, a test to destruction shall also be carried out which on units subject to bending shall be as follows:-

- The units shall be supported at full span and a load applied in increments instructed by the Engineer up to 95 per cent of the designed ultimate load. This load shall be held for 15 minutes without failure of the unit. The deflection at the end of this period shall be not more than 1/40th of the span. The load shall then be further increased until failure occurs.
- If the unit fails to sustain the required load for the prescribed period or if the deflection exceeds the specified amount, the Engineer may order two further tests, and if either of these fail, the batch of units which they represent may be rejected.

### **1056. PRECAST LINTELS**

All precast items shall be marked with the date of casting and shall not be built into the works until they have matured for 28 days. Ends of bar reinforcement shall be hooked or bent as required. The cover for reinforcement shall be 25mm from internal faces and 38mm from external exposed faces. The 'top' of lintels shall be numbered for identification.

Lintels shall have timber or pre-formed inserts cast in for fixing metal windows where required and shall have fair face finish on all surfaces exposed to view and hacked surfaces where plastered.

### **1057. PREFORMED JOINT FILLER**

Prefomed joint filler shall be of the thickness shown on the drawings or as stated in the Bill of Quantities.

The material comprising joint filler shall be as stated on the drawings or approved by the Engineer.

### 1058. PRESSED STEEL TANKS AND TOWERS

The pressed steel tanks (or similar approved), towers and associated materials and fittings shall comply with SRN 909 and SRN 863.

The following requirements shall apply:

- a) The Contractor shall submit to the Engineer for review and approval Detailed Structural Design Calculations and Shop Drawings of the steel tank and tower from an approved Fabricator.
- b) The capacity quoted in the Bidding Documents is the minimum Net capacity of water stored in the Tank. The size of the Tank supplied by the Contractor shall have adequate gross capacity to provide the required net capacity plus free board, allowance for inlet fittings, etc.
- c) The pressed steel tank to SRN 909 (B.S. 1564 Type A (2) or similar approved) shall be supplied complete with:-
  - i. All stays, cleats, bolts, nuts, washers, jointing compound and associated materials and fittings.
  - ii. Connections for inlet, outlet, washout and overflow.
  - iii. Galvanized access ladder 450mm wide.
  - iv. Steel roof cover to fit the tank complete with access manhole and mosquito-proof cowl ventilators.
  - v. Water level indicator.
- d) Jointing material to the tank to be a non-toxic plastic compound which does not impart taste, colour, or odour to the water.
- e) Connections to the tank shall be welded to the outside of the tank plate and drilled and tapped to suit flanges to SRN 207, NP 16 unless otherwise stated.
- f) The cover to the tank shall be of mild steel cambered for external use and adequately supported by rolled steel or pressed steel bearers or trusses.
- g) The tank tower shall be supplied complete with:-
  - i. Anchor bolts.
  - ii. Bolts, nuts, washers and associated materials and fittings.
  - iii. Access ladder 450mm wide extending from ground level to the top of the tank. Safety rings shall be at 1.2m centres.
- h) The supports to the tank shall consist of steel joints designed to carry imposed load under each transverse joint and the two ends of the tank.
- i) The columns of the tank shall consist of rolled steel joist sections or similar. At least Four such columns shall be provided with adequate bracing.
- j) The tank and tower shall be galvanized. In addition, the tank and tower shall be painted as follows:
  - i. Internal surfaces of the tank shall be painted with 1 coat of approved non-toxic primer and 2 coats of non-toxic bituminous paint.
  - ii. External surfaces of the tank and tower shall be painted with 1 coat of approved primer and 2 coats of approved aluminium paint.

### **1059. STEEL PIPES AND SPECIALS**

All piping shall be plain ended unless otherwise specified and suitable for use with flexible mechanical couplings. The grade of steel used shall comply with the requirements of SRN 213.

The pipes shall be welded or seamless and shall conform to SRN 213.

All the pipes shall be internally protected with cement mortar lining in accordance with SRN 212. External protection to be as specified in SRN 241.

All joints shall be of the flexible mechanical type and shall be supplied complete with all bolts, nuts, washers and joint rings as may be required. All metal parts of joints shall be adequately protected with rust-proof paint. The joints shall be protected from corrosion by wrapping with Denso paste and tape or by some similar approved material.

All fittings and specials shall be of such dimensions as will mate up with the piping supplied.

Flanged adaptors shall be pieces suitable for connecting a flanged gate valve etc. to the type of piping supplied and shall be supplied complete with all bolts, nuts, washers and joint rings.

The spigot ends of all Tees shall be suitable for connection to the pipework supplied using the aforementioned flexible mechanical joints. Branches shall be flanged with flanges drilled to NP 16 in accordance with SRN 207, unless otherwise detailed.

All flanges on specials shall conform to NP 16 in accordance with SRN 207, unless otherwise detailed.

All flanged joints shall be protected from corrosion by wrapping with Denso paste and tape or some similar approved material.

### **1060. STONE DUST**

Stone dust for blinding shall be blacktrap screened to the following grading:-

|                       |            |
|-----------------------|------------|
| Passing 10mm sieve    | 100%       |
| Passing No. 4 sieve   | 85% - 100% |
| Passing No. 100 sieve | 5% - 25%   |

### **1061. STOP VALVES**

All stop valves shall be in accordance with SRN 826. Samples of valves shall be submitted for test and approval to the Engineer.

### **1062. STRUCTURAL STEEL FOR WELDED WORK**

Structural steel for riveted and welded work shall comply with the requirements of SRN 125 : Structural Steel, SRN 126 : The Use of Structural Steel in Building and for Welded Work, SRN 125 : High Yield Stress and High Tensile Structural Steel, High Tensile (Fusion Welding Quality) Structural Steel for Bridges, etc. and General Building Construction.

### **1063. STRUCTURAL STEELWORK**

The whole of the structural steelwork and testing shall comply with the relevant clauses of B.S. 449. The Contractor shall include for the preparation of all shop details from the drawings supplied by the Engineer. All such details shall be approved in writing by the Engineer before the work is put in hand. Every drawing shall show the number and sizes of all rivets and bolts, complete details of welds, type of electrodes, welding procedure, whether the welds are to be made in the shop or elsewhere and any other relevant information. The Contractor shall be responsible for the accuracy of his shop details and for shop fittings and site connections.

The Contractor shall take the dimensions from the structure and he shall verify all dimensions given on the drawings before the work is put in hand.

Any damage to materials on the site due to inadequate precautions being taken during the erection of the steelwork shall be made good to the satisfaction of the Engineer's Representative at the Contractor's expense.

The fabrication and erection of the steelwork shall be carried out in accordance with Part 5 of B.S. 449.

### **1064. SUBMISSION OF SAMPLES**

As soon as possible after the contract has been awarded, the Contractor shall submit to the Engineer a list of the suppliers from whom he proposes to purchase the materials necessary for the execution of the Works. Each supplier must be willing to admit the Engineer or his representatives, to his premises during ordinary working hours for the purpose of obtaining samples of the materials in question. Alternatively, if desired by the Engineer, the Contractor shall deliver the samples of the materials to the Engineer's office without charge.

The information regarding the names of the suppliers may be submitted at different times, as may be convenient, but no source of supply shall be changed without the Engineer's prior approval once a supplier, source or material has been approved.

Samples of materials approved will be retained at the Engineer's office until the completion of the contract. Samples may be tested to destruction.

All materials delivered to site must be at least equal in all respects to approved samples, otherwise they shall be rejected. No special payment will be made for compliance with clauses specifying tests etc. to ensure quality control etc. unless specifically itemised in Bills of Quantities.

### **1065. TIMBER**

Timber shall be sound, well-seasoned and entirely free from worm, beetle, warps, shakes, splits, and all forms of rot and deadwood. Where required, all timber shall be treated with creosote, as specified in SRN 872: Coal Tar Creosote for the Preservation of Timber or an alternative approved timber preservative.

### **1066. UNPLASTICISED PVC (uPVC) PIPES**

Unplasticised PVC piping shall be in accordance with SRN 300

The maximum sustained working pressures to which the pipes and fittings will be subjected is based on water at a temperature of 20 degrees centigrade.

The Supplier shall submit full details of the pipes he intends to supply.

The pipes upto and including 40mm diameter can be of a solvent weld type. The pipe

shall be supplied with interchangeable sockets preformed at the factory and of such internal diameter that it takes the plain end of the pipe with the same nominal diameter.

The joint shall sustain the end thrust to which the pipe shall be subjected. The Supplier shall supply enough of the cleaner and adhesive which shall be required to make the joints with the pipes.

The pipes of 50mm diameter and over shall consist of a grooved socket at one end of the pipe. The socket shall be designed to give a clearance fit on the outside diameter of the parent pipe. The sealing medium which shall seat in the groove shall be a rubber ring.

If the formation of the socket and groove results in the thinning of the original wall thickness of the pipe, it shall be compensated for by shrinking on to the outside of the socket area a reinforcing sleeve of the same material as the pipe. The socket and groove shall incorporate no sharp angles where the stress points are created.

The joint shall take 10% deformation of the spigot at the point where it enters the socket without leakage from the pipe when subjected to the test pressure specified for the pipe. Thermal expansion of the pipe shall be accommodated in the joint. The joint shall be capable of linear deflection up to 3 degrees.

The sealing ring shall be of first grade natural rubber and the physical properties of the mix shall meet the requirements of SRN 308.

The Supplier shall supply sufficient quantity of any lubricant or other material which shall be needed to make the joint which shall be assembled by hand.

The Supplier shall submit full details of the type of joint offered and a full description of the method of jointing.

The fittings shall have the same type of joint as for the pipes to be used. The Supplier shall submit full details of the materials dimensions and test pressures of the fittings offered.

Precautions shall be taken to avoid damage to the pipes and fittings.

In handling and storing the pipes and fittings, every care shall be taken to avoid distortion, flattening, scoring or other damage. The pipes and fittings shall not be allowed to drop or strike objects. Pipe lifting and lowering shall be carried out by approved equipment only.

Special care shall be taken in transit, handling, and storage to avoid any damage to the ends.

Pipes and fittings shall be marked at not greater than one metre intervals showing their class and diameter.

## **1067. WATER BARS**

Water bars shall be "Dumbell" type and be of natural or synthetic rubber or extruded PVC. They shall be flexible, tough, elastic and durable and of dimensions detailed. They should be unaffected on contact with dilute acids or alkalis. Joints and junctions shall, when possible, be prefabricated by the manufacturer, but if made at site the manufacturer's instructions including recommended adhesives shall be followed and used. Samples shall be submitted for approval of the Engineer before use of any material.

**1068. WATER FOR CEMENT TREATED MATERIALS**

If water for the works is not available from the Employer's supply the Engineer's approval must be obtained regarding the source of supply and manner of its use. Water to be used with cement or lime shall be free from salt, oil, alkali, organic matter, and other deleterious substances. If the water is required to be tested, this shall be done in accordance with SRN 114: Tests for Water for Making Concrete, all to the cost of the Contractor.

**1069. WATERPROOF UNDERLAY**

Waterproof underlay shall consist of either waterproof paper complying with SRN 856: Waterproof Building Paper, containing approved fibrous reinforcement, or 500 gauge polythene sheeting as stated in the Bill of Quantities.

## **11. TESTING OF MATERIALS AND WORKMANSHIP**

### **1101. APPARATUS REQUIRED FOR TESTING ON SITE**

Apparatus for testing shall be, if directed by the Engineer, made available on site of the works, for as long a period as required by the Engineer, and regarded as constructional plant. The Contractor to allow for this provision in his rates. The following may be required: -

- a) A set of sieves complying with British Standard 410: Test Sieves, or the following nominal sizes: -  
Fine mesh wire cloth 200, 100, 72, 52, 36, 25, 18, 14, 10 and 7.  
Medium mesh wire cloth 3mm.  
Perforated plate 5mm, 6mm, 9mm, 12mm, 20mm, 38mm, 50mm, 65mm and 75mm.
- b) A suitable balance, a pycnometer and a stove or other approved apparatus for determining the moisture content of the aggregate. The methods of test shall be as described in Part Four of British Standard 812: Sampling and Testing of Mineral Aggregates, Sands and Fillers.
- c) A 200 ml. graduated cylinder in accordance with British Standard 604: Graduate Measuring Cylinders, for the use in the field settling test for clay and fine silt in aggregates.
- d) Two 0.34 kg. graduated clear glass medicine bottles for use in the test of organic impurities in sand.
- e) Apparatus required for testing soils in accordance with British Standard 1377: Methods of Test for Soil Classification and Compaction, and British Standard 1924: Methods of Test for Stabilized Soils.
- f) Apparatus for testing concrete in accordance with British Standard 1881: Methods of Testing Concrete, Parts 1 to 7.
- g) A straight edge 3 metres long and measuring wedge or other approved apparatus for testing the accuracy of surfaces.
- h) Additional testing equipment as stated in the Bill of Quantities or as required by the Engineer.

### **1102. LOAD TESTING OF PIPES**

The Engineer may instruct the Contractor to make a Loading Test (Three-Edge Bearing or Sand Bearing) on pipes to be used to construct the sewer. Payment for Load Tests will be entirely in accordance with the General Conditions of Contract.

## **12. CESSPIT EMPTIER TRUCKS (EXHAUSTER TRUCKS)**

These specifications describe the basic requirements of goods. All the dimensions and capacities of the equipment to be supplied shall not be less than those required in these specifications. Deviations from the basic requirements, if any, shall be explained in detail in writing with the offer, with supporting data such as calculation sheets, catalogues, drawings, etc. The Engineer reserves the right to reject the products if such deviations shall be found critical to the use and operation of the products.

### **1201. TECHNICAL SPECIFICATIONS FOR 10,000 LITRES CESSPIT EMPTIER TRUCK (EXHAUSTER TRUCK)**

| <b>ITEM DESCRIPTION</b>       | <b>TECHNICAL SPECIFICATION</b>  |
|-------------------------------|---|
| <b>THE TANK</b>               | (a) Reinforced vacuum- and pressure-resistant cylindrical steel tank with front and rear cones, designed for an operating pressure of 0,5 bar, <ul style="list-style-type: none"> <li>• Tank volume: 10,000 Litres</li> <li>• Tank is to be divided by a fix separation wall for 4000ltrs fresh water in front part and 6000 litre sludge in the rear part of tank or in another proportion according to customer's requirement.</li> </ul> (b) Tank must be torsion-free bedded on the superstructure rear in two bearings and a solid seat in front.                     (c) Reinforced rear hatch with re-adjustable hinges and hydraulic overhead opening.                     (d) SUCKING/DRAINAGE CONNECTION DN 100 with wear-resistant shut-off valve and replaceable rubber sealing in lower part of hatch including a male part Perrot-coupling with handle outside.                     (e) Fitted with inspection glass lateral at superstructure to check the filling level in the tank.                     (f) Sludge to be removed.                     (g) A tank supported with mechanical notch lateral at superstructure.                     (h) Suction line guided over the pivot for pressure emptying while tank is tipped.                     (i) On top of water chamber should be fixed with a manhole with cover for filling and ventilation of tank acc. to regulations for protection of potable water.                     (j) Fitted with a water pipe DN 50 with Storz-fitting size C incl. blind cap and locking valve.                     (k) Equipped with Inspection glass near the water pipe to check the water level in the water chamber during filling. |
| <b>SUCKING/BLOWING SYSTEM</b> | The system will have the following features: <ul style="list-style-type: none"> <li>• Water-cooled rotary-vacuum-pump</li> <li>• Air supply at free passage 900 m3/h</li> <li>• Volume at 400 mbar (60%) 820 m3/h</li> <li>• Max. vacuum 90%</li> <li>• e) Required drive power 30 kW at 1500 rpm.</li> </ul>   |

| ITEM DESCRIPTION                                     | TECHNICAL SPECIFICATION  |
|--|--|
| <b>SUCTION MATERIAL SEPARATOR (Over sucking pot)</b> | <p>Must be maintenance-free with double float ball and screwed cover for easy installation. Separator fitted with outlet-valve 2" and STORZ-C fitting.</p> <p>Equipped with Drain for removing lube-oil deposits from inlet filter.</p> <p>Equipped with Sucking/blowing line with fittings for the vacuum pump incl. silencer, non-return valve and pneumatically operated multi-way valve for change-over from "SUCKING", NEUTRAL "BLOWING".</p> <p>Fitted with technical inspected valve for pressure limitation of 0.5 bar operating pressure.</p>   |
| <b>HIGH-PRESSURE JETTING SYSTEM</b>                  | <p>The system will have the following features:</p> <ul style="list-style-type: none"> <li>a) <i>High-pressure piston pump</i></li> <li>b) <i>Jetting power max. 170 bar at 3251/min.</i></li> <li>c) <i>Required drive power 106.0 kW</i></li> <li>d) <i>Pressure line with fittings DN 25 (1")</i></li> <li>e) <i>GEAR OIL COOLING DEVICE for continuous operation of high-pressure pump.</i></li> <li>f) <i>Equipped with an automatic, pneumatically operated valve with four functions, as safety over-stream valve</i></li> <li>g) <i>Fitted with check valve, continuously adjustable pressure limitation valve at operating panel and to act as switch valve</i></li> <li>h) <i>Equipped with suction line of high-pressure pump with large water filter and shut-off valve.</i></li> <li>i) <i>Equipped with aluminium filter housing with lateral opening, seal ring with fast locking device, and replaceable filter of stainless steel. The pressure line with fittings</i></li> <li>j) <i>Corresponds to the water supply of high-pressure pump.</i></li> </ul> |
| <b>HYDRAULIC SYSTEM</b>                              | <p>With hydro gear pump, operating pressure 150 bar, required drive power 9 kW, driven by countershaft, with oil-tank, pipelines and flexible connections, filters and valves.</p>   |
| <b>PNEUMATIC SYSTEM</b>                              | <p>Connected to the air brake installation of chassis incl. overflow valve, pipelines and control valves.</p>  |
| <b>OPERATING BOARD</b>                               | <p>Rear at the superstructure the lockable, illuminated central operating board including the operating/ control equipment like:</p> <ul style="list-style-type: none"> <li>• pressure gauge</li> <li>• vacuum manometer</li> <li>• hydraulic manometer</li> <li>• electric rev. counter</li> <li>• speed adjustment handle</li> <li>• control valves for hose reel</li> </ul> <p>a) Equipped with Electric safety module for switching on the high-pressure- resp. the vacuum-pump with automatic speed lowering to avoid damage of drive elements and pumps.</p> <p>b) Fixed with large HOSE REEL for 120m, jetting hose DN25 (1"),</p>  |

| ITEM DESCRIPTION                    | TECHNICAL SPECIFICATION   |
|-------------------------------------|---|
|                                     | <p>Hose reel hydraulically driven to both directions of rotation with continuous speed adjustment, free-wheeling, and Valve to shut-off the pressure line.</p> <p>c) Equipped with an automatic HOSE GUIDE below reel for proper winding of jetting hose; synchronically driven from hose reel.</p> <p>d) Equipped with hand operated SMALL HOSE REEL for max. 60 m jetting hose 1/2" for connecting a spray gun or a nozzle.</p> <p>e) Equipped with HAND OPERATED BYPASS as protection of the safety valve when, using the spray gun.</p> <p>f) Equipped with INSPECTION GLASS with float ball left side of water chamber to check filling level in water chamber during jetting procedure.</p> |
| <b>VARNISHING OF SUPERSTRUCTURE</b> | <p>a) Sand-blasting and multi-layer varnishing of all individual parts at superstructure acc. to the regulations of- the paint-manufacturer. (superstructure in standard colour RAL 2011 = orange)</p> <p>b) Thickness of varnishing acc. to international. Standards</p> <p>c) Sandblasting of all individual parts after dismounting of superstructure</p> <p>d) Reflecting red/white warning acc. to DIN 30710 stripes rear.</p>   |

**1202. TECHNICAL SPECIFICATIONS FOR 7,000 LITRES CESSPIT EMPTIER TRUCK (EXHAUSTER TRUCK)**

| ITEM DESCRIPTION | TECHNICAL SPECIFICATION  |
|------------------|--|
| <b>THE TANK</b>  | <p>(a) Reinforced vacuum- and pressure-resistant cylindrical steel tank designed for an operating pressure of 0,5 bar,</p> <ul style="list-style-type: none"> <li>• Tank volume: 7,000 Litres</li> </ul> <p>(b) Tank must be torsion-free bedded on the superstructure rear in two bearings and a solid seat in front.</p> <p>(c) Reinforced rear hatch with re-adjustable hinges and hydraulic overhead opening.</p> <p>(d) Sucking connection DN 100 with wear-resistant shut-off valve and replaceable rubber sealing in lower part of hatch including a male part Perrot-coupling with handle outside.</p> <p>(e) Fitted with inspection glass lateral at superstructure to check the filling level in the tank.</p> <p>(f) A tank supported with mechanical notch lateral at superstructure.</p> <p>(g) Rear Drain flap to be provided for draining water and light sludge by gravity. Low viscosity materials to be drained by means of a pressure cushion of 0.2 to 0.3 bar of pressure.</p> <p>(h) Suction line guided over the pivot for pressure emptying while tank is tipped.</p> <p>(i) The painting on the inside will include sand blasting crossed coats of primer, coatings of bitumen resins for protection against corrosion and rust, outside sand blasting crossed coats of primer, epoxy synthetic enamel final paint.</p> |

| ITEM DESCRIPTION                                     | TECHNICAL SPECIFICATION  |
|--|--|
|  | <p>(j) 2 Nr. Beacon lights to be fixed at the rear end of the tank and the other one on the front cabin.</p> <p>(k) Tank door should be hydraulically operated and suspended on the hinges so that it opens upwards.</p> <p>(l) Special profile seal in connection with mushroom head anchor screws to give sealed tightness to the door</p>   |
| <b>SUCKING SYSTEM</b>                                | <p>The system will have the following features:</p> <ul style="list-style-type: none"> <li>• Water-cooled rotary-vacuum-pump</li> <li>• Air supply at free passage 900 m<sup>3</sup>/h</li> <li>• Max. vacuum 90%</li> <li>• Required drive power 30 kW at 1500 rpm.</li> </ul>  |
| <b>SUCTION MATERIAL SEPARATOR (Over sucking pot)</b> | <ul style="list-style-type: none"> <li>• Must be maintenance-free with double float ball to protect vacuum pump from soiling and screwed cover for easy installation. Separator fitted with outlet-valve 2" and STORZ-C fitting.</li> <li>• Equipped with Sucking line with fittings for the vacuum pump incl. silencer, non-return valve and pneumatically operated multi-way valve for change-over from "SUCKING", NEUTRAL "BLOWING".</li> <li>• Fitted with technical inspected valve for pressure limitation of 0.5 bar operating pressure.</li> <li>• Preliminary suction filter to be installed in a position prior to entry of the line into the vacuum pump as a third safety device.</li> </ul> |
| <b>HYDRAULIC SYSTEM</b>                              | <p>With hydro gear pump, operating pressure 150 bar, required drive power 9 kW, driven by countershaft, with oil-tank, pipelines and flexible connections, filters and valves.</p>   |
| <b>PNEUMATIC SYSTEM</b>                              | <p>Connected to the air brake installation of chassis incl. overflow valve, pipeline and control valves.</p>   |
| <b>OPERATING BOARD</b>                               | <p>Rear at the superstructure the lockable, illuminated central operating board including the operating/ control equipment like:</p> <ul style="list-style-type: none"> <li>• pressure gauge</li> <li>• vacuum manometer</li> <li>• hydraulic manometer</li> <li>• electric rev. counter</li> <li>• speed adjustment handle</li> <li>• control valves for hose reel</li> </ul>   |
| <b>VARNISHING OF SUPERSTRUCTURE</b>                  | <p>a) Sand-blasting and multi-layer varnishing of all individual parts at superstructure acc. to the regulations of- the paint-manufacturer. (superstructure in standard colour RAL 2011 = orange)</p> <p>b) Thickness of varnishing acc. to international. Standards</p> <p>c) Sandblasting of all individual parts after dismantling of superstructure</p> <p>d) Reflecting red/white warning acc. to DIN 30710 stripes rear.</p>  |

### **1203. INSPECTION OF EQUIPMENT AT POINT OF MANUFACTURE BEFORE SHIPMENT/FREIGHT TO THE PURCHASER**

The equipment will be subjected to inspection and testing at point of manufacture to confirm adherence to specifications before shipment or freight to the purchaser at the cost of The Contractor.

### **1204. ESSENTIAL SPARE PARTS**

The necessary spares required for the proper functioning of the cesspit emptyer trucks shall be provided with each truck as listed below and in the BoQ.

Spares to be supplied with each truck include:

- 3Nr. extra Spare Wheels
- 10 Nr Suction Non-Collapsible Hoses
- Set of mechanical contamination prevention filters
- Mounting Bracket
- Additional pump accessories.

A list of any other spares the bidder may deem essential according to design of product offered in bid should be submitted with quantity and price.

### **1205. MANUALS AND INSTRUCTION HANDBOOKS**

The Cesspit Emptyer Trucks are to be supplied with Manuals, written in English as follows:

- Operator's Handbook
- Repair Manuals
- Parts Catalogue/Microfiche/CD
- Service Schedule
- Driver's Handbook
- Service Schedule
- etc.

## **13. MISCELLANEOUS**

### **1301. GENERAL**

The Contractor is referred to the drawings as to the general character of the works and he shall allow in his rates for any extra costs he may consider incurred by reason of the work being in detached positions, in small quantities, difficulty of access or for any other cause. He should also make do allowance for specialist installations taking place during the currency of this contract.

This section of the Specification refers to miscellaneous items. Clauses elsewhere in the Specification shall also be followed where relevant.

### **1302. PLUMBING INSTALLATION**

#### **1302.(a) WATER AUTHORITIES REGULATIONS**

The internal plumbing work shall be carried out to the satisfaction of and in accordance with the regulations of the local water authority.

#### **1302.(b) RAINWATER INSTALLATIONS**

Rainwater installation shall be in grey PVC pipework with 'O' ring joints.

#### **1302.(c) TESTING PLUMBER'S WORK**

The plumbing work and sanitary fittings shall be tested at such times as the Engineer's Representative shall direct and to his entire satisfaction. Gutters and rainwater pipes shall be tested with water to satisfy the Engineer's Representative that gutters are to correct falls, pipes are unobstructed and joints are sound.

#### **1302.(d) SETTING OUT**

The positions of all pipe runs, including joints and connections, shall be agreed with the Engineer's Representative before work is commenced.

#### **1302.(e) COPPER TUBES AND FITTINGS**

Light gauge copper tubes shall comply with B.S. 2871 Part 1, Table X.

Fittings: Fittings and couplings for jointing pipes shall comply with B.S. 864, Part 2 for capillary and compression type A fittings.

Fixing: Tubes shall be fixed clear of walls or soffits with two-piece copper spacing clips complying with B.S. 1494 Table 8d, but in metric sizes to suit tubes spaced at not more than 1.2m horizontally and 1.5m vertically for 15mm diameter pipes 2.0m horizontally and 2.5m vertically for 22mm and 28mm diameter pipes.

#### **1302.(f) PLASTIC PIPES, FITTINGS AND ACCESSORIES**

uPVC soil and ventilating pipes and fittings shall comply with B.S. 4514. Waste pipes and fittings shall be modified unplasticized polyvinyl chloride (MuPVC). Waste traps shall comply with B.S. 3943. Balloon gratings shall be plastic coated steel wire.

### **1302.(g) SLEEVES**

Where sleeves are required for pipes passing through concrete or blockwork, they shall be of galvanized steel heavy gauge tube of sufficient diameter to give a space of 3mm all-round the pipe.

### **1302.(h) PIPEWORK GENERALLY**

Pipes shall be in the maximum lengths possible to avoid unnecessary jointing and fixed to sufficient falls to prevent air locks and to enable the system to be drained down.

### **1302.(i) BRASSWORK**

Ball Valves: Piston type ball valves shall comply with BS. 1212, Part 1 for high or low pressure as described. Floats to break feed cisterns shall be copper type complying with B.S. 1968, Class C.

Bib-taps shall comply with B.S. 1010 and shall be of brass with fixed jumpers, chromium plated and colour coded for hot and cold.

Pillar valves shall comply with B.S. 1010 and shall be of brass with fixed jumpers, chromium plated and colour coded for hot and cold.

Stop valves shall comply with B.S. 1010 and shall be of brass with crutch handles.

### **1302.(j) CISTERNS**

Storage cisterns and break feed cisterns shall be galvanized steel cisterns complying with BS. 417, Grade A.

### **1302.(k) SANITARY FITTINGS**

Sanitary fittings shall be manufactured from glazed vitreous china complying with the requirements of B.S. 3402. They shall be supplied by an approved firm and shall pass the requirements of the local Water Authority.

## **1303. PLASTERWORK AND OTHER FLOOR, WALL AND CEILING FINISHINGS**

### **1303.(a) GENERAL**

All branded materials shall be delivered in the manufacturer's packages bearing the manufacturer's name and the name of the material concerned. Cement, lime, plaster etc., shall be stored separately off the ground in dry conditions. All surfaces shall be properly prepared for plastering, rendering and screeding and brushed or cleaned free from dust and all traces of efflorescence and contamination removed. Concrete surfaces shall be thoroughly cleaned free from all traces of mould oil or other formwork coatings and hacked to provide a key.

Surface to receive plastering, rendering, screeding etc. shall be wetted sufficiently in advance to ensure the correct conditions for adhesion. Undercoats shall be thoroughly scratched to allow for keying and allowed to dry sufficiently before application of further coats. Dubbing out shall be in the same mix as the subsequent coat and shall not exceed 20mm in thickness in one application.

### **1303.(b) METAL LATHING**

Metal lathing shall be light galvanized expanded metal weighing not less than 1.2 kg. per square metre and complying in all other respects with BS. 1369.

**1303.(c) CEMENT**

Cement shall be Ordinary Portland Cement and shall comply with EN197. White and coloured cements shall comply with EN197 and shall be obtained from an approved manufacturer.

**1303.(d) SANDS**

Sand for cement and lime shall comply with BS. 1199, Table 1 for undercoats and Table 2 for finishing coats. Sand for floor screeds shall comply with BS. 1199, Table 1.

**1303.(e) LIME PUTTY**

Lime putty shall be prepared from hydrated lime complying with B.S. 890, Table 2. Hydrated lime shall be added to water, stirred to a creamy consistency and left to mature for at least sixteen hours before use. Alternatively, ready slaked lime may be obtained from an approved manufacturer. The lime putty shall be protected from drying out.

**1303.(f) PLASTICISERS**

Plasticisers shall be of the resin type and shall be used only with the approval of the Engineer's Representative in accordance with the manufacturer's instructions.

**1303.(g) WATER PROOFERS**

Water proofers shall be approved integral water proofers and shall be used in accordance with the manufacturer's instructions.

**1304. TILE WORK**

**1304.(a) GLAZED CERAMIC WALL TILES**

Glazed and eggshell ceramic wall tiles shall comply with B.S. 1218 and shall be of the colours described. Samples of tiles shall be submitted to the Engineer's Representative for approval.

**1304.(b) ADHESIVE**

Adhesive for fixing wall tiles shall be approved adhesive.

**1304.(c) FIXING WALL TILES**

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.

**1304.(d) CERAMIC FLOOR TILES**

Ceramic floor tiles shall be fully vitrified clay tiles complying with B.S. 1286 and having a water absorption not exceeding 0.3%.

**1304.(e) LAYING FLOOR TILES**

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.

#### **1304.(f) FIXING METAL LATHING**

At junctions of blockwork and concrete where rendering continues over both surfaces a 100mm wide strip of expanded metal lath shall be fixed, centred on the joint.

#### **1304.(g) FINISH**

Cement-lime-sand undercoats shall be allowed to dry out thoroughly before a further coat is applied and scratched to provide an adequate key for the next coat. The finishing coat shall be finished with a steel float. A neat cut shall be made with the edge of the trowel through all coats of the wall plaster at junctions with concrete columns and soffits.

#### **1304.(h) INTERNAL RENDERING**

The internal rendering on concrete block panels shall be two coat work, total 20mm finished thickness. The undercoat to be 1:1:5 cement, lime putty, sand by volume, 9mm to 12mm thick and scratched for key. The finishing coat to be 1:1:6 cement, lime putty, sand by volume, 6mm to 9mm thick, trowelled smooth. At junctions of panels to concrete columns and beam soffit, finish the rendering with a clean trowel cutting through both coats of rendering.

#### **1304.(i) EXTERNAL RENDERING (TYROLEAN)**

The external rendering on concrete blockwork and outer face of in-situ concrete frame shall be two coat work, total 15mm finished thickness. Clean and prepare block and concrete surfaces, shot pin metal lath strip 100mm wide at concrete/blockwork junctions and apply undercoat 10mm finished thickness of 1:1:6 cement, lime putty, sand by volume, floated smooth. The finishing coat shall be approximately 6mm thick off white Culamix Tyrolean open honeycombed texture machine applied to the required thickness by skilled operatives strictly in accordance with the manufacturer's recommendations. The undercoat surface shall be sound and clean and free from any loose material. All window and door frames shall be protected by suitable masking.

#### **1304.(j) EXPANSION JOINTS**

Expansion joints in clay ceramic tile flooring shall be 6mm wide x 50mm deep, unless otherwise described, formed with 6mm wide x 38mm deep butyl rubber or other equal and approved compressible strip pointed with 6mm wide x 12mm deep polysulphide compound to match colour of tiling. All surfaces of concrete or screed in contact with the butyl rubber shall be primed.

Expansion joints shall be formed at perimeters and at not less than 4.5 metre centres both ways in the tiled areas.

#### **1304.(k) PREPARATION**

Concrete floors to receive screeds shall be raked where necessary to remove concrete, plaster or mortar droppings and well brushed to remove all loose particles and dirt. Concrete floors shall be well wetted before the screeds are laid.

## 1305. PAINTING AND DECORATING

### 1305.(a) PAINT AND PAINTING

All paint, including primers, undercoats and finishings, polish, emulsion etc., to be used shall be obtained ready for use from the manufacturer approved by the Engineer.

The Contractor shall order direct from the manufacturer and only fresh paint will be allowed to be used.

All paints shall be of the qualities, i.e. exterior, interior etc., types and colours scheduled. All coats of paint system shall be obtained from the same manufacturer, shall be ordered for use together and as far as practicable, shall be ordered on one order in sufficient quantity for the whole of the work, particularly in the case of the finishing colour. Where more than one of the three systems (gloss, semi-gloss or flat) is in use, these paints shall be used in strict accordance with their accompanying printed instructions.

The Contractor shall use only paints delivered to the site in original sealed containers, not exceeding five litre capacity, stamped and bearing the manufacturer's name or mark, the specification number, method of application (e.g. brushing) colour, quantity, batch number and date of manufacture, and expiry.

Contractor's stocks shall not be accepted unless expressly approved by the Engineer's Representative.

The paint, which will be subject to sampling and testing, shall be used exactly as received, after adequate stirring, without the addition of thinners, driers, or adulterating materials of any kind.

All tints and shades (including colours of undercoats) shall be selected and approved by the Engineer's Representative and the Contractor shall allow in his prices for executing the painting work in colour schemes, to be prepared from a wide range of colours.

All paints described as oil paint shall be alkyd paint.

No painting on exterior work shall be carried out in wet weather or upon surfaces which are not thoroughly dry. Painting shall not proceed in dusty conditions. Each coat of paint shall be thoroughly dry and shall be rubbed down with glass paper before a subsequent coat is applied. Adequate care must be taken to protect surfaces of paintwork, still wet.

Lead based priming paints for steelwork shall conform to B.S. 2521 and 2523.

### 1305.(b) PREPARATION

Copper pipes shall be washed with soap and water, roughened with abrasive paper and washed with white spirit.

Metalwork - remove all scale from unprimed iron and steelwork, degrease using proprietary solution compatible with paint finish, remove all dirt and rust by brushing with a steel wire brush. Clean all steel delivered primed, of dirt and dust and touch up any damage to primed surfaces in transit or erection.

Hardwood - rub down and brush off all dirt and dust, stop any holes or other imperfections with stopping tinted to match pigment finish.

### **1305.(c) PROTECTIVE DECORATIVE FINISH**

The protective decorative finish on hardwood joinery shall be PX65 (Pinotex) and Holdex as manufactured and supplied by Sadolins Paints (E.A.), or other equal and approved finish.

External frames and doors shall be treated with two coats PX65 (Pinotex) Pigmented before fixing and one coat PX65 (Pinotex) Top Coat after fixing.

Internal frames and doors shall be treated with two coats PX65 (Pinotex) Pigmented before fixing and one coat after fixing and finished with two coats of Holdex, Silk Matt Interior Lacquer.

Application shall be strictly in accordance with the manufacturer's recommendations.

Not more than three months should separate the initial (before fixing) and final (after fixing) coats.

### **1305.(d) RENDERED PANELS**

The internal rendered blockwork panels shall be painted with two coats Sandtex Matt resin- based surface coating or other equal and approved coating.

Rendered wall surface shall be cleaned down and Sandtex coats laid on by brush or roller in accordance with the manufacturer's recommendations. Spraying wall surfaces will not be allowed.

### **1305.(e) IRONMONGERY FURNITURE**

The rates for painting shall include for taking down and refixing ironmongery furniture, kicking plates etc., as necessary.

## **1306. ROADS AND FOOTPATHS**

### **1306.(a) PREPARATION OF ROAD FORMATION**

After excavation or filling has been completed the road formation shall be shaped to the required contour and compacted with an 8 - 10 tonne roller.

If any soft places develop in the formation during compaction they shall be excavated to such depths as the Engineer may direct, refilled with hardcore or other approved granular material, levelled and re-compacted before the sub-base is laid.

### **1306.(b) MURRAM SUB-BASE**

The murrum sub-base will be constructed only in poor soil conditions where directed by the Engineer. The murrum shall be from an approved source quarried so as to exclude vegetable matter, loam, topsoil or clay. The California Bearing Ratio (C.B.R.) of the murrum, as determined for a sample compacted to maximum density as defined under B.S. 1377 and allowed to soak in water for four days, shall not be less than 30. This C.B.R. is a guide to quality only and the compaction in the work will be judged by density.

The murrum sub-base shall be of the thickness as shown on drawings or stated in the Bill of Quantities.

The sub-base shall be evenly spread and compacted using an 8-10 tonne roller for road construction and a 2-4 tonne roller for footpath construction. The Contractor will be required to maintain the selected material at its optimum moisture content to achieve

maximum compaction. The roads and footpaths shall be finished to the grades and levels shown on the drawings.

### **1306.(c) WATER-BOUND MACADAM BASE**

The base shall consist of crushed building stone mechanically laid in one or more separate layers, so as to give a total compacted thickness as shown on the drawings, or stated in the Bill of Quantities. The first layer shall be placed to produce a thickness of 75mm to 150mm after compaction as specified. Where a greater thickness than 150mm of base is specified the material shall be laid in separate layers each not less than 75mm or more than 150mm in thickness after compaction.

The stone shall have the following gradings:-

| <u>B.S. Sieve Size</u> | <u>% by Weight Passing</u> |
|------------------------|----------------------------|
| • 5 in. (125mm) ring   | 100                        |
| • 3 in. (75mm)         | 25 - 80                    |
| • 1.5 in. (38mm)       | 0 - 20                     |
| • 3/4 in. (20mm)       | 0 - 5                      |

Alternatively, a stone base may be placed by hand. In this case the first stones in each layer, which shall be of a cubical nature, shall be placed to the approximate height of the layer. When an area has been covered in this way a second placing of stones of smaller size shall be positioned by eye in the spaces between these first placed, and wedged home by hammering. A third placing of stones shall follow the second and so on until in the opinion of the Engineer the voids are sufficiently filled to permit compaction.

Thorough watering shall be carried out at all stages of compaction. Initial compaction shall be with a light roller. The surface shall then be blinded with quarry dust so as to fill the interstices completely and again rolled, this time using a heavy roller. The base shall then be well watered and brushed and permitted to dry. Further rolling with a heavy roller, blinding with quarry dust, watering and brushing shall be carried on until the whole presents a homogeneous surface and no movement is visible under the action of the heavy roller. On completion of the base, and before any surfacing is laid, the finishing surface shall be maintained free from potholes, ruts and undulations, irregularities, depressions, loose material or other defects, and shall remain true to cross-section, line and level.

### **1306.(d) ROLLED ASPHALT HOT PROCESS WEARING COURSE**

Rolled asphalt wearing course shall be made and laid in accordance with British Standard 594: Rolled Asphalt (Hot Process) and the thickness after compaction shall be as shown on the drawings or stated in the Bill of Quantities. Except where impracticable, the rolled asphalt shall be laid using an approved paver.

Where a base course has been used as part of the surfacing, the wearing course shall be laid thereon as soon as practicable, care being taken that the latter is thoroughly clean. In any case the wearing course should be laid within 3 days of the laying of the base course, unless the Engineer allows otherwise, and no construction or other traffic shall be allowed on the base course.

#### **1306.(e) BITUMEN MACADAM WEARING COURSE**

Bitumen macadam wearing course shall be made and laid in accordance with British Standard 1621: Bitumen Macadam with Crushed Rock or Slag Aggregate, using the appropriate Table and Section(s) thereof, other than those for Dense Bitumen Macadam, and nominal size of aggregate all as shown on the drawings or stated in the Bill of Quantities. Except where impracticable the bitumen macadam shall be laid using an approved paver. The maximum mixing temperature for straight run bitumen of penetration 85-100 is 155 degrees centigrade. For other penetration bitumen the mixing temperature shall be as determined by the Engineer.

#### **1306.(f) COMPACTION AND SURFACE FINISH**

As soon as rolling can be effected without causing undue displacement of the material, and while the material is above the minimum temperature stated in Table 3.9, it shall be uniformly compacted by an 8-10 tonne roller having a width of roll not less than 18 inches.

#### **1306.(g) PREPARATION OF THE BASE FOR SURFACING OR SURFACE DRESSING**

Before any binder or coating material is applied to a base the latter shall have been freed from all extraneous material by brushing with mechanical sweepers or stiff brooms.

Macadam or murram bases shall normally receive a priming coat in accordance with the following clause.

Concrete, bitumen bound or rolled asphalt bases shall normally receive a tack coat in accordance with the following clause.

#### **1306.(h) PRIME COAT AND TACK COAT**

When a base is to be sealed before surfacing by means of a prime coat, the surface shall first be prepared in accordance with the preceding clause.

Unless otherwise stated in the Bill of Quantities or ordered by the Engineer, the prime coat material shall be bitumen grade M.C.O. at a rate of application of 1.2-1.5 lit./sq.m. It shall be applied with a mechanical bitumen distributor complying with the requirements of British Standard 1707: Binder Distributors for Road Surface Dressing.

The prime coat shall be cured for 48 hours. This period may be relaxed at the discretion of the Engineer who shall be informed and shall give his consent before any surfacing works are commenced.

The Contractor shall not permit traffic to run on a prime coat. Where this is unavoidable the Engineer shall order an application of medium sand at a rate of 6 kg./sq.m. which item shall be measured and paid for separately.

Where adhesion on an existing surface is to be improved before surfacing by means of a tack coat, the surface shall first be prepared in accordance with the preceding clause.

Unless otherwise stated in the Bill of Quantities or ordered by the Engineer, the tack coat material shall be approved bitumen emulsion in accordance with British Standard 434: Bitumen Road Emulsion containing not less than 55% of bitumen. It shall be mechanically applied at a rate of 0.38 - 0.43 lit./sq.m.

The tack coat shall be allowed to cure to a tacky condition and the Engineer's consent obtained before any surfacing works are commenced. Any ponding which has occurred must be brushed out to bring the coverage within the limits specified.

The Contractor shall not permit traffic under any circumstances to run on a tack coat.

### **1306.(i) ROLLING OF SURFACE MATERIALS**

The type and weight of roller to be employed on each course of surfacing shall be approved before hand by the Engineer. Notwithstanding this, the Engineer may call for a certified weighbridge ticket in respect of any roller at any time.

Roller wheels shall always be clean and even. An adequate water tank shall be provided together with a fully operating roller sprinkler system. The roller shall be operated by a person fully trained and experienced in rolling technique.

Rolling shall be generally carried out in a longitudinal direction, working from the edge of the carriageway to the crown or, in the case of a super elevated carriageway, from the low to the high side. The second pass should be precisely on the path of the first, before the roller shifts transversely. Heavy drive wheels should approach the freshly laid material. Reversing should be carried out slowly and smoothly and the reversing points staggered across the carriageway to avoid any wave effect. Rolling should be continued until all rollmarks are eliminated and there is no perceptible movement under the roller wheels.

Idle standing on freshly laid material is not permitted.

If the total surfacing to be compacted exceeds 3,300 sq.m. per day, the Contractor shall provide a second roller.

In confined areas where normal rolling is not possible, mechanical tamping will be permitted. The tampers must be employed systematically to give a smooth "as-rolled" finish.

No traffic will be permitted on a surfacing course until it has been compacted and in the opinion of the Engineer has acquired a sufficient set.

### **1306.(j) TRAFFIC ON NEWLY CONSTRUCTED ROADS**

The Contractor will not be permitted to use a new carriageway at any stage of construction without the written permission of the Engineer's Representative.

Notwithstanding any conditions which the Engineer's Representative may stipulate at the time of giving his permission, the Contractor will be solely responsible for maintaining the new carriageway, keeping the surface clean and for making good at his own expense any damage or wear so caused.

### **1306.(k) LAYING KERBS, CHANNELS AND EDGING BLOCKS**

Kerbs, channels and edging blocks shall be bedded true to line and level in cement mortar on a concrete foundation Grade 15. They shall be haunched with concrete Grade 15. The foundation and haunch shall be laid before the approved sub-base is laid to the dimensions shown on the drawings.

### **1306.(l) CONCRETE BLOCK PAVINGS**

The precast concrete blocks have to be manufactured to the following requirements:-

- i) Depth of block to be 60mm and 80mm.
- ii) The concrete used shall have a maximum aggregate size of 20mm, high workability, and shall be designed to have a 20 day characteristic cube strength of 45 N/sq.mm.
- iii) To ensure that the surface does not polish but retains a micro texture to give good low speed skidding resistance, sands containing more than 25% acid soluble material must not be used.

- iv) To ensure interlock between blocks, they must be manufactured to accurate dimensions, which allows them to be laid with only small spaces between the joints. When laid, the spaces between blocks should not exceed 2 to 3mm.

#### **1306.(m) LAYING OF BLOCKS**

The blocks should be laid in such a way so as to develop interlock. The surface course comprises closely fitting paving blocks, the spaces between them being filled with dust and sand particles.

The finished surface level shall be within 5mm of the design level. The maximum deformation within the completed surface measured by a 3m straight edge placed parallel to the centre line of the road in parts of the carriageway where vertical curves necessitate a greater deviation.

The level of any two adjacent blocks should not deviate by more than 2mm.

#### **1306.(n) LAYING COURSE**

The laying course shall consist of 40mm sand as specified containing not more than 3% of silt and clay by weight, and, with no more than 10% retained on a 5mm sieve. It is spread to give a thickness when compacted of 40mm. The profile of the uncompacted sand should be similar to that of the final surface. The required thickness of uncompacted sand forming the laying course will depend upon its moisture content grading, and degree of pre-compaction. The laying course sand needs to be spread to a greater depth than the target compacted depth of 40mm. The amount of surcharge will be of the order of 10 to 15mm but the exact value is best determined by trial. To avoid any need to adjust the surcharge during construction, it is helpful to keep the sand grading and moisture content sensibly constant.

Once spread the sand should be screed smooth to level. For roads less than 4.5m wide, the kerbs may be used as screeding guides, but on wide pavements, it is necessary to set temporary screed rails for striking off the laying course. During spreading and screeding, operatives must not stand in the sand, otherwise uneven pre-compaction will occur causing irregularities in the final road surface. To minimize the risk of disturbance, it is advisable to avoid screeding sand long distances in front of the block laying face.

#### **1306.(o) CUTTING BLOCKS**

Awkward shapes at edges or obstructions, like gulleys manholes are filled by cutting blocks with a block splitter or by using a bolster chisel and hammer.

#### **1306.(p) VIBRATION**

When the laying of concrete blocks has been completed, then blocks should be vibrated with a plate vibrator. The vibrator should have a centrifugal force of 0.35 to 0.50 sq.m. A frequency of 75 to 100 Hz is recommended.

The required number of passes of the plate depends upon a variety of factors and is best determined by site trial. It should be sufficient to provide an even riding surface and prevent vehicles from causing further compaction. Normally two or three passes will suffice. Vibration should not be carried out within about 1m of unrestricted blocks; on the other hand, as little surface course as possible should be left unvibrated overnight.

Finally, sand should be brushed over the surface and two or three further passes of the vibrator made, to complete interlock and fill the joints.

As soon as vibration has been completed, the road can be used.

#### **1306.(q) PREPARATION OF FOOTPATH FORMATION**

After the excavation of filling has been completed as specified the footpath formation shall be regulated to an even and uniform surface, and compacted with a roller weighing not less than 2.5 tonnes.

If any soft places develop in the formation during compaction they shall be excavated and backfilled with approved granular material, levelled and re-compacted.

#### **1306.(r) PRECAST CONCRETE PAVING**

Precast concrete paving slabs shall be to BS. 368:1971 and shall be laid with 1:3 lime mortar using five pats not less than 150mm diameter for each slab. They shall be laid at a level not exceeding 4mm above the top of the kerb or concrete edging. The joints shall be thoroughly cleaned out and grouted with cement mortar well brushed in and flushed off. No cracked or broken slabs shall be used.

#### **1306.(s) CHASING**

Chasing in load-bearing walling for pipes, etc., is to be kept to a minimum size of cut and the positions and runs of chases are to be approved by the Engineer before any cutting is commenced.

#### **1306.(t) DAMP-PROOF COURSES (D.P.C.)**

Damp-proof courses shall be 1000 gauge polythene free from tears and holes and be laid with 150mm minimum laps on and including a levelling screed of cement mortar.

#### **1306.(u) BITUMINOUS FELT ROOFING**

Bituminous felt roofing shall be carried out complete by an approved Specialist Sub-Contractor.

Felt roofing shall be executed in accordance with British Standard Code of Practice C.P. 114/101 and strictly in accordance with the manufacturer's instructions, laps shall be 100mm minimum and falls 100mm minimum in 3 metres for flat roofs, and the minimum specification shall be as follows (Felt to B.S. 747):-

- a) One layer of asphalt saturated felt (weighing 6.8 kg. per 10 square metres) laid loose to screed or random and lap nailed to the boarding.
- b) One layer of asphalt saturated felt but weighing 9 kg. per 10 square metres and bedded to underlayer with hot bituminous compound.
- c) One layer of white mineral surfaced roofing felt (weighing not less than 23 kg. per 10 square metres) bedded to underlayer with hot bituminous compound.

#### **1306.(v) HACKING, ETC.**

The prices for all paving and plastering, etc., shall include for hacking concrete surfaces and for raking out joints of walls 12mm deep and for cross scoring undercoats to form a proper key.

Plastering on walls generally shall be taken to include flush faces of lintels, beams, etc., in the walls.

### **1306.(w) SURFACES**

All surfaces to be paved or plastered must be brushed clean and well wetted before each coat is applied. All cement paving and plaster shall be kept continually damp in the interval between application of coats and for seven days after the application of the final coat.

### **1306.(x) PRICES FOR PAVING**

Prices for paving are to include for adequate covering and protection during the progress of the Works to ensure that the floors are handed over in perfect condition on completion.

### **1306.(y) 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 12mm thick for paving trowelled to a smooth and even finish and well rubbed and polished with carborundum.

## **1307. GROUND IMPROVEMENT METHODS**

### **1307.(a) GENERAL**

Should the preliminary geological site surveys show that for heavy structures, bearing capacity and settlements are critical for the structures intended in an area, the Contractor is required to improve foundation soil for these structures and /or show that the settlements and bearing capacities are within the allowable range.

Any ground treatment proposed by the Contractor to improve the bearing capacity and/or settlement characteristic of the soil must be supported by a full method statement and design calculations with a statement of the minimum performance to be achieved. Where directed by the Engineer, the Contractor shall carry out a field trial of the proposed treatment to demonstrate that it meets the stated performance criteria.

The ground improvement methods indicated below may be proposed by the Contractor.

### **1307.(b) SOIL REPLACEMENT**

Soil replacement involves excavating the soil that needs to be improved and replacing it. The excavated soil shall be replaced with compacted granular soil (Sand & gravel) with more suitable properties for the proposed application.

Method and material or soil replacement shall be approved by the Engineer.

### **1307.(c) ADMIXTURE STABILIZATION**

Admixture stabilization consists of mixing or injecting admixtures such as cement, lime, fly-ash or bentonite into a soil to improve its properties. Admixtures shall be used to increase the strength, decrease the permeability, or improve the workability of the soil where need be. Admixtures shall also be used to fill voids, bind particles, or break down soil particles and form cement. The process of admixture stabilization shall be as follows:

- (1) Excavating and breaking up the soil
- (2) Adding the stabilizer and water, if necessary
- (3) Mixing thoroughly
- (4) Compacting the soil and allowing it to cure.

The most important observations are the amount of admixture and water mixed into the soil, the amount of mixing performed, and the amount of compacting effort used on the fill. The moisture content and density of the fill can be determined in the field. The curing time and conditions should also be recorded. Samples should be taken for laboratory testing.

Method of admixture stabilization shall be approved by the Engineer.

### **1308. ATTENDANCE UPON ENGINEER'S STAFF**

The Contractor is to provide the necessary support staff, as and when requested by the Engineer, to assist in some of the duties on site. These staff may include but not be limited to chainmen and other short-term staff required for quality control monitoring. An allowance for these is made in the Bill of Quantities.

### **1309. RADIO COMMUNICATION SYSTEM**

The existing Communication System to be checked and rectified where necessary to make it efficient.

### **1310. TRAINING OF EMPLOYER'S PERSONNEL**

On commissioning of all the Works, the Contractor will be responsible for the operation and maintenance of the Works for 4 weeks, during which period training of MWAUWASA Staff will be done.

During the above training period, the Contractor will deploy specialized persons capable of giving theoretical and practical training to the MWAUWASA Staff in the following fields:

- operation and maintenance
- treatment process and laboratory tests
- mechanical / electrical units

After the training period, the Plant Manager(s) will take over the operation of the Works.

In the Bid, the Contractor shall outline his proposal for training. An item for such training is allowed for in the Bills of Quantities. Prior to Commissioning of the Works, a detailed training programme shall be submitted to the Engineer for approval. The training shall be divided into four different levels:

1. Training of Management Staff and Department Heads:  
Theoretical and Practical Seminar(s)
2. Training of Skilled Personnel:  
Short theoretical introduction and practical seminar(s)  
The laboratory personnel shall be trained in analysing various parameters and handling of laboratory equipment. Include for training of Plant Operators especially in operation and maintenance of electro/mechanical equipment.
3. Training of Unskilled Personnel:  
Familiarization with various appurtenances of the Works and daily and routine works associated with maintenance works
4. General Operation and Maintenance of all the Works i.e. daily, weekly, monthly and yearly procedures to be followed, recording of observations, and reporting action plan for any remedial works, etc.

## **14. ELECTROMECHANICAL WORKS - PUMPING STATIONS REHABILITATION**

### **1401. DESCRIPTION OF THE WORKS**

#### **1401.(a) GENERAL DESCRIPTION**

This section covers the supply, delivery, installation/replacement, testing, commissioning, and upholding during the operational acceptance and maintenance periods of the mechanical and electrical installations at existing Mwanza City Pumping Stations.

#### **1401.(b) EXTENT OF THE WORKS**

There are 3 Nr. Existing Pumping Stations in Mwanza City with different number of Pump Sets, namely:

- i) Mwanza South Pumping Station – 3Nr. Pumps
- ii) Kirumba Pumping Station – 3Nr. Pumps
- iii) Central Pumping Station – 2Nr. Pumps

Mwanza South and Kirumba Pump Sets each have a capacity of approximately 3,024m<sup>3</sup>/day while Central Pump Sets have a capacity of approximately 7,344m<sup>3</sup>/day. Under this Contract, the Pumping System in the Pumping Stations will be rehabilitated by installation of new Pump Sets, and Control Panels / Motor Control Centres and upgrading the Electrical Power Supply and associated Civil Works.

The work under this Contract consists of the following items of work as shown on the Drawings and Bills of Quantities or as directed by the Engineer:

- a) Supply, installation, and commissioning of eight (8) Nr. Pump sets complete with all motors, suction and discharge pipework, valves, specials, and fittings at the three Pumping Stations.
- b) Supply, installation, and commissioning of all Electrical Panels / Motor Control Centers / Equipment including Pump Control Systems and metering devices.
- c) New Flow Measuring Instrumentation at Mwanza South and Kirumba Pumping Station

#### **1401.(c) LOCATION OF THE WORKS AND ACCESS**

The principal site of the works is located at Mwanza City within the three Pumping Stations.

### **1402. PROCUREMENT**

#### **1402.(a) PROCUREMENT SCHEDULE**

The Contractor shall submit from the time of the first submission of Monthly Reports, a Procurement Schedule, indicating deliveries of all bought out items purchased by the Contractor for inclusion into the Works.

The Procurement Schedule shall be submitted and updated monthly. Explanations of slippage and measures to be taken to rectify the slippage should accompany the Report where necessary.

## **1403. CONSTRUCTION**

### **1403.(a) GENERAL**

The mechanical and electrical equipment are to be installed in existing and operating Pumping Stations. The Contractor shall be responsible for protecting all existing plant, building works and services.

Any damage caused by the Contractor to existing structures or services shall be repaired to the satisfaction of the Engineer. The Contractor shall immediately carry out essential repairs to any buildings, structures or services damaged by him during the execution of the Works and shall maintain them until such time as final reinstatement and repairs are completed.

The existing Pumping Stations are fully operational, and the Contractor shall ensure that they always remain in operation during the works except at times of agreed shutdowns. Prior to commencing work on connecting into the existing Pipework and Electrical Systems the Contractor shall submit to the Engineer his proposals for executing this operation and in particular his proposed method for ensuring that shut-down time is minimized. The Contractor shall liaise closely with the Employer regarding the planning of shutdowns. No work shall commence until the Engineer has provided his approval in writing of the Contractor's proposals in this regard.

### **1403.(b) THE OPERATOR**

The Pumping Station is operated by Mwanza Urban Water and Sanitation Authority (MWAUWASA) on behalf of the Employer. MWAUWASA shall be consulted on all decisions affecting the operation of the Facilities and shall be kept informed of all actions likely to impact on their water supply operations. MWAUWASA have no authority to issue instructions under the Contract and all formal Contract Correspondence shall be with the Engineer.

## **1404. MANAGEMENT**

### **1404.(a) CONTRACTOR'S SUPERINTENDENCE OF SITE WORK**

The Contractor shall always have an approved Representative for the purpose of attending, site meetings and other meetings deemed necessary by the Engineer for the proper programming and execution of the Works during the duration of the Contract.

It is a specific requirement of this Contract that the Contractor shall nominate a Project Manager, who has proven experience in managing projects involving equipment like the Works specified and the Controls thereof. This Project Manager shall co-ordinate all suppliers and sub-contractors and shall be fully responsible for the complete Contract.

### **1404.(b) WORKMANSHIP, QUALITY CONTROL AND TESTING**

The Contractor shall at his own expense institute a Quality Control System and shall employ experienced engineers, foremen and other staff to always ensure proper supervision and control of the work and shall at his own cost carry out all necessary testing to ensure that materials and workmanship comply with specified requirements.

The Contractor shall be deemed to have allowed in his tender for the costs of all testing of materials and completed work as are required to be rendered by him in terms of the contract. It is the Contractor's sole responsibility at his own cost and by means of any

necessary tests to demonstrate to the Engineer that all materials and completed work comply with all specified requirements.

#### **1405. SPARE PARTS AND TOOLS**

The Contractor shall supply sufficient spare parts and tools for five years operation in accordance with the requirements stipulated by the manufacturers of all key equipment including Pumps, Motors and Switchgear.

#### **1406. INSTALLED / CONNECTED POWER**

The current systems at the Mwanza South, Kurumba and Central Pumping Stations have an electrical load of 40.5 kW, 40.5 kW and 264kW respectively.

The proposed replacements for pumps are of similar makes to the existing pumps hence the loading in each Pumping station should remain the same.

#### **1407. ELECTRICAL UPGRADE**

The Electrical Upgrade Works include:

1. Supply and installation of submersible sewage pumps, complete with duck foot, discharge bend, guide rails and guide brackets as per specifications.
2. Supply and installation of vertical sewage pumps as per specifications.
3. Supply and installation of motor control centre as per specifications.
4. Supply and installation of cables from generator to new panel 4core X 16mm<sup>2</sup>
5. Supply and installation of cables for 4core X 10mm submersible from motor control centre to pump sets.
6. Supply and installation of 1.5mm X 3core submersible control cables
7. Supply and installation of cables 4 x 300mm complete with glands / lug set
8. Supply and installation of 1000A main incomer.

#### **1408. MECHANICAL WORKS**

The scope of Mechanical Works involved are as follows:

1. Supply and installation of heavy-duty sewage application float switch
2. Supply and installation of manometers & Isolator Valves (Pairs)
3. Supply and installation of 2-tonne chain pulley blocks, height 10m
4. Supply and installation of flow meter DN 250, PN 16, including digital display showing instantaneous and cumulative flow rate and supply of necessary fittings & cabling for flow meter.
5. Supply and installation of manometer with isolation.

**1409. FIELD ASSESSMENT OF THE PRESENT SITUATION**



**Central Pumping Station Pumps (To be Replaced)**



**Kirumba Pumping Station Submersible Pumps (To be Replaced)**



**Central Pumping Station Motor Control Center (To be Retained)**



**Mwanza South Pumping Station Motor Control Center (To be Replaced)**

## **1410. SCOPE OF WORKS**

### **1410.(a) MOTOR CONTROL CENTRE**

New Motor Control Centers to be supplied and installed in 2 pumping stations (Mwanza South Pumping Station and Kirumba Pumping Station) according to the specifications. The existing dysfunctional Motor Control Centres will be dismantled and decommissioned and replaced with the new units.

### **1410.(b) PUMPS**

The existing Pump Sets will be dismantled and decommissioned. This will also include the dismantling of the existing Cables, Cable Channels and Trays.

New Pump Sets, Cables and Cable Trays will be supplied and installed according to the fulling specifications.

1. Supply and Install Submersible Sewage Pumps (3Nr) for **Mwanza South**, complete with duck foot, discharge bend, guide rails and guide brackets of the following characteristics;- Capacity: 35l/s – (126m<sup>3</sup>/hr)  
Dynamic Head: 20m  
(One pump with a suitable power rating and voltage requirements for solar operation)
2. Supply, and Install Submersible Sewage Pumps (3Nr) for **Kirumba**, complete with duck foot, discharge bend, guide rails and guide brackets of the following characteristics; Capacity: 45l/s – (162m<sup>3</sup>/hr)  
Dynamic Head: 20m  
(One pump with a suitable power rating and voltage requirements for solar operation)
3. Supply, and Install Vertical Sewage Pumps of the following characteristics; Capacity: 85l/s – (306m<sup>3</sup>/hr) • Dynamic Head: 80m  
Motor Rating: 132kW, 1450rpm, 50Hz  
(One pump with a suitable power rating and voltage requirements for solar operation)

Further details can be found under point 1411.(q).

All control and protection circuits to be wired as per IEC specs to ensure safe operation of both operator and equipment.

## **1411. TECHNICAL SPECIFICATION**

### **1411.(a) GENERAL PROVISIONS**

#### ***i Preamble***

The bidding documents are designed to provide information on the nature and consistency of the works to be carried out to replace, refurbish, upgrade or service existing equipment and materials, as specified.

The relevance of these general specifications, in whole or in part, to the works identified for a particular pump station, shall be as determined by the cross-references to these Specifications and the Scope of Work section.

The Contractor shall have visited the site before submitting its offer to assess on-site consistency and extent of work required, as well as the local operational and environmental constraints. The Contractor shall provide all labour, materials, equipment, tools and supervision necessary to undertake the works.

**The Contractor will not have only a means obligation but also a results obligation. He will analyse and verify the different data and provide a corresponding Inception Report to the Client prior to any rehabilitation and ordering of material of works, etc.**

#### ***ii Standards and Norms***

All workmanship and materials shall be of the best quality appropriate to each category of work. The Contractor should provide certificates for the proposed materials and equipment. The list of all the main standards and norms used in this design is given below. The design decisions are worked out based on international norms and standards (ISO, CEI, etc.).

Contractor's proposals concerning usage of any other norms and standards should be handed to the Engineer. The proposal should contain full description of the proposed standard and its difference from the other. Any proposal which cannot guarantee design quality will be declined unconditionally.

#### **1411.(b) GENERAL REQUIREMENTS**

The Contractor shall design, manufacture, deliver to Site, install and test the pumps and its associated accessories and shall ensure that the pumps meet the performance requirements and objectives as specified in the Particular Specification.

Any items necessary for the completion and operation of the Works as particularly specified in the Scope of Works shall be provided under the Contract. Any clause in the General Specification which relates to the work or materials not required by the Scope of Works shall be deemed not to apply.

The Contractor shall provide competent engineers and installation personnel to carry out the installation of the pumps and the tests on completion, and to give instruction on the operation and maintenance of the pumps to the Employer's staff.

Where existing equipment is to be removed, the Contractor shall transport the equipment to a regional storage compound, or to an approved disposal area as directed by the Engineer.

#### **1411.(c) LEVELS, DIMENSIONS AND EQUIPMENT DUTIES**

Levels and dimensions shown on the Tender Drawings or stated within the Particular Specifications are preliminary, for the tender purposes, and shall be subject to confirmation by the Contractor who shall verify the levels and dimensions and obtain the Engineer's approval before any item for that installation is ordered.

Drawings of existing pumping stations and other existing installations indicate the present arrangement of the plant and equipment. The Contractor shall design and detail the arrangement of the items to be installed and shall collect all information, data, dimensions and details of existing work and equipment as necessary for the detailed design, and for the supply and installation of the Plant and equipment. Where existing installations are equipped with plant and/or equipment of Imperial or non-standard

dimensions the Contractor shall supply any special fittings required to interface between the non-standard or imperial items being retained and the new plant and equipment.

#### **1411.(d) INFORMATION TO BE SUPPLIED BY THE CONTRACTOR**

Within the times stated in Clause 8 of the Conditions of Contract the Contractor shall submit to the Engineer for his approval a detailed manufacturing and delivery programme.

In accordance with the requirements of the Conditions of Contract the Contractor shall submit to the Engineer for approval, a list those items of the existing plant which are to be retained. The Contractor shall furnish additional information and calculations if requested by the Engineer. The Contractor shall allow 21 days for the Engineer to check the details, from the receipt by the Engineer of complete information. No item or equipment shall be manufactured or ordered from suppliers for a particular installation until the Engineer has given approval of the information.

All Drawings and Documents shall be submitted for approval in triplicate and after approval being given, the Contractor shall supply a further five copies to the Engineer. Drawings and Documents which have been approved by the Engineer shall not be departed from without the approval of the Engineer.

#### **1411.(e) INSPECTION AND TESTING DURING MANUFACTURE**

The Pump Sets, Motors, Transformers, etc. shall be subject to inspection, examination and testing during manufacture and before shipping in accordance with the Conditions of Contract, to demonstrate that it complies with the Specification and that the performance is suitable for the intended purpose. The cost for attendance by the Client and Engineer's Representative for witness testing is covered under a provisional sum item in the Bills of Quantity. The Engineer's costs for attendance of retesting due to failure of the plant, or inappropriate preparation by the Contractor with respect to initial tests, shall be borne by the Contractor.

The Contractor shall submit for approval a Test Plan covering all stages of inspection and testing for all items of plant. The Plan shall include full details of inspection/test methods and procedures together with appropriate schedules to record all results. No inspection or testing shall take place until all equipment is approved. The inspection/test schedules shall be completed at each stage showing full results of all inspections/tests and shall be signed off by all parties.

The Contractor shall provide all necessary equipment and instruments required for testing. He shall ensure that all equipment and instruments, used for the purpose of testing or demonstrating the worthiness and functionality of that being inspected/tested, holds a current certificate verifying calibration, range, accuracy and date of latest official examination/calibration. Such certificates shall be presented to the Engineer prior to any inspection/test taking place.

Each pump shall be tested with its motor as an integral pump set, and with similar starting equipment and electricity supply conditions to those pertaining in the permanent installation, unless otherwise directed by the Engineer. Pump sets shall be tested with suction conditions and water temperatures corresponding to those under which the pump sets will operate on site.

The Contractor shall also carry out tests on existing equipment, which is to be associated with the pumps supplied under this Contract, to ensure that the equipment and connections operate correctly in conjunction with the pumps.

The evaluated combined motor and pump efficiency shall be at least 0.975 of the guaranteed value stated Technical Proposals.

All parts of a pump subject to pressure shall be submitted to a hydraulic test pressure not less than 1.5 times the maximum pressure which can occur within the pump under any site operating condition.

Pipework, valves and fittings shall be submitted to a hydraulic pressure test in accordance with the applicable Standard.

Valves shall be tested for operation against the maximum operational unbalanced pressure.

Tests shall include the following:

- a) Visual inspection;
- b) Inspection of provision for cable entries;
- c) Checking access, type of cable gland etc.;
- d) High voltage pressure test (2000V) for 1 minute followed by insulation test;
- e) Test relays with varied controlled supply to ensure relays close at 85% of nominal voltage and hold close down to 65% nominal voltage;
- f) Test tripping of relays occurs at 60% nominal voltage;
- g) Any special tests applicable to the installation;
- h) Injection testing of current transformer for correct polarity and ratio, and protection relays for correct operation;
- i) Functional testing including simulation of operation of sequence controls (e.g. level controls, etc);
- j) Checking of time delay settings and protection relay settings;
- k) Checking of fuses for correct type and rating;
- l) Any other tests required by the Engineer.

Test certificates including log sheets, performance curves, etc. in triplicate shall be submitted by the Contractor to the Engineer within two weeks of the date of the tests. Type tests are not acceptable. Test certificates shall be supplied for test carried out on the actual equipment being supplied.

Packing shall be subject to inspection by the Engineer's representative.

#### **1411.(f) PERFORMANCE TESTS ON COMPLETION**

The Contractor shall submit to the Engineer a detailed description and schedule of the performance tests to be carried out on completion. These descriptions shall be submitted not less than 21 days prior to the Contractor giving notice, in compliance with the Conditions of Contract, of the date for carrying out the Tests on Completion.

As part of the Tests on Completion, each pump shall be operated to demonstrate its correct functioning, and instruments shall be checked and zeroed. Copies of all test certificates shall be submitted to the Engineer.

The new pumps and equipment shall be operated and maintained by the Contractor for a continuous period of 6 weeks after commissioning and issuance of the test certificates.

The equipment shall also be subject to testing after completion throughout the defects notification period to an approved Test Plan with the Bid. The Contractor shall provide guidance to the Engineer for the sampling regime and tests to be undertaken. The Contractor shall attend the tests undertaken and his representative(s) shall have

relevant experience with conducting such tests and the interpretation of the results obtained.

#### ***i Pumping Set Tests***

Test on completion shall include the following:

- a) The performance of all pumps shall be tested and compared with the specified duties and characteristic curves prepared from tests at the manufacturer's works. The rotation of all pumps shall be checked;
- b) The pump protective devices shall be demonstrated to operate satisfactorily;
- c) All rotating machinery shall be tested for vibration in accordance with the principles of ISO 10826-1; 1995. Vibration shall not exceed the limits set out in ISO 10826-1; 1995 for the particular class of equipment.
- d) The sequence of operation and control systems shall be tested;
- e) All pipe work, valves and fittings shall be pressure tested;
- f) Load tests shall be carried out on all lifting equipment. The lifting equipment shall be tested over the full range of travel in all directions;
- g) Calibration tests shall be carried out in all instrumentation;
- h) Greasing and lubricating systems shall be tested on all plant;
- i) Test of all alarm systems, overloads and safety equipment;
- j) Any other test requested by the Engineer.

#### ***ii Tests – Cable Insulation and Earthing***

On completion of the separate parts of the electrical installations the Contractor shall carry out, as and when required by the Engineer tests for the insulation of cables and continuity of conduits and earth connections, together with the ability to withdraw conductors from any and re-draw in conductors and shall submit signed copies of the results of the tests in triplicate to the Engineer.

The following tests results shall be submitted:

- a) Insulation resistance tests to earth and between phases on sections of the installation as completed and also on the whole of the installations when completed;
- b) Earth continuity tests on each main, sub-main circuit and sub-circuit installed;
- c) Polarity of switches and socket outlets and continuity of ring main circuits;
- d) Resistance of earth main.

In addition to these tests the Contractor shall provide readings of potential drop at various points in the installation and current balance over the phases on all mains.

The Contractor shall provide all instruments necessary for carrying out such tests and shall provide attendance on the Engineer when tests are being carried out. The Contractor will receive notice in advance of the timing of such tests.

#### **1411.(g) SPARE PARTS AND STORES**

The quality of spare parts shall not be inferior to the original parts. Spare parts shall be adequately protected and packed in suitable containers to withstand storage under site conditions and shall be handed over with four copies of a detailed and itemized list of the spare parts prior to issue of the Taking Over Certificate. Any spare parts needed within the Defects Liability Period shall be provided by the Contractor.

Where the Contractor includes the provision of a Spare Parts Store the Contractor shall instruct the Engineer storemen in the placing of the parts and tools into store and shall familiarise the staff with the proposed inventory system. He shall also instruct the Employer's staff in the operation of the stores including the correct identification of parts and tools by reference to drawings and maintenance manuals, analysing rate of parts usage and identification of ordering intervals.

#### **1411.(h) TOOLS**

Complete sets of maintenance tools including spanners and special tools necessary for the servicing, maintenance and dismantling of the pumps shall be supplied by the Contractor and shall be contained in suitably fitted painted steel boxes marked with the contents and fitted with good quality locks and keys.

Tools shall be handed over to the Employer upon satisfactory passing the Tests on Completion. Instruments such as ammeters, voltmeters and vibration meters shall remain the property of the Contractor unless specified otherwise.

#### **1411.(i) OPERATING AND MAINTENANCE MANUALS**

At least two weeks before commencement of the Tests on Completion the Contractor shall submit to the Engineer four draft copies of the Operation and Maintenance (O&M) Manuals for approval and shall take account of any amendments or additions required by the Engineer in the production of the final manuals. A separate set of manuals shall be provided for each installation.

Two copies of the draft O & M Manuals for each installation shall be always available on site during the testing of the installed equipment for the instructions to be verified. Any modifications found necessary shall be incorporated in the final version.

Upon completion of commissioning of the works or section of the works the Contractor shall supply six sets of final operating and maintenance manuals for the respective section pump sets and equipment. Each volume shall be bound in a stout plastic or other approved cover and shall be suitably labelled.

The manuals shall be compiled in accordance with BS4884-1 and -2 and shall include the following:

- a) Full detailed instructions, diagrams, etc. for maintaining the installed equipment, including dismantling and stripping down for repairs, and maintenance schedules for daily, weekly, monthly and annual servicing;
- b) Manufacturer's instruction leaflets for component parts
- c) General arrangement, schematics and PI/Ds as appropriate including all pipework, equipment etc.;
- d) Comprehensive parts list for all equipment;
- e) Records of factory and site test figures and all settings for timers, relays etc.;
- f) Operation and maintenance manuals written in English language. All parts and equipment listing shall be in English.

#### **1411.(j) GUARDING OF MOVING MACHINERY**

All moving machinery shall be adequately guarded to prevent injury through accidental contact. In particular, exposed shafting and couplings shall be protected with suitable guards except where they are in normally inaccessible positions.

#### **1411.(k) RATING PLATES, NAME PLATES AND LABELS**

Each item shall have permanently attached to it, in a conspicuous position, a rating plate of durable material engraved with the manufacturer's name, type and serial number, together with relevant details such as the duty or output, speed, pressure or loading.

Each item shall be provided with a name plate or label designating the service of the particular item. The inscription shall be to the approval of the Engineer.

Each cable shall be fitted with identification labels. The type of labels and the inscription shall be to the approval of the Engineer.

All rating plates, name plates and labels shall be in English.

Labels shall be engraved onto durable material, metal or plastic and shall be securely fixed by screws on or alongside the item to which it applies. Sticking is not acceptable.

#### **1411.(l) PACKING**

The Contractor shall be responsible for the proper packing, storage and crating and clear identification of all equipment prior to dispatch and shipment from its place of manufacture.

All items shall be packed and marked in accordance with international standards for exports from the country of manufacture. The equipment shall be packed and protected against deterioration during shipment and for at least 12 months storage on site. Straw or similar organic materials shall not be used for packing.

Materials liable to deteriorate from water or moisture shall be packed in cases with waterproofing lining. Items liable to deterioration from moisture shall be specially packed to prevent ingress of moisture. Unless otherwise agreed by the Engineer the protection shall include placing in a sealed 0.13 mm thick polythene bag and silica gel or other approved air dryer shall be placed within the unit and sufficient air drawn out to cause the polythene bag to adhere to the outline of the unit.

All packages shall be clearly and conspicuously marked with the Contractor's identification mark and the Employer's reference mark.

All separate component parts shall be identified by metal tags tied by wire and reference to drawings, installation instructions, packing list etc. Details of the referencing system shall be submitted to the Engineer for approval.

#### **1411.(m) CORROSION PROTECTION**

Where dissimilar materials are in contact or close proximity and corrosion may occur through electrolytic action or differences in electrical potential, protection shall be afforded by electroplating, suitable gaskets, cathodic, protection or other means approved by the Engineer.

Chromium plated parts shall not be used on sewage works or in any other damp or corrosive atmosphere.

After cleaning and inspection but before the plant leaves the manufacturer's works, the machined surfaces of steel and ironwork shall be covered with a preserving fluid of an approved type, or otherwise protected to the Engineer's satisfaction.

All surfaces shall be adequately protected in transit, and any damage shall be renovated immediately on off-loading and on completion of erection.

All external screw fixings shall be supplied in the galvanised condition, stainless steel, or sherardised to comply with BS 4921, Class 1 or Class 2 passivation treatment.

#### **1411.(n) STANDARDS**

All plant and equipment shall comply with the latest additions of appropriate international standards quoted in this specification or near equivalent. Any deviation from quoted standards shall be subject to the written approval of the Engineer.

#### **1411.(o) INSTALLATION**

The Contractor shall be responsible for the transportation of all equipment and materials from the place of manufacture to the site, together with the supply and setting up of off-loading and handling equipment necessary for installation. The Contractor shall be responsible for covered storage on site of all equipment prior to installation. Security of the equipment prior to installing and handing over is the responsibility of the Contractor. Adequate land is available on site for erecting temporary storage facilities.

The Contractor shall be deemed to have undertaken a site survey to assess the exact requirements for plant erection prior to have submitted his Tender for the Contract.

The installation of the pump sets and all specified ancillary works shall be undertaken in accordance with the Contract program and shall be fully integrated and interfaced with other works carried out under this Contract.

The Engineer reserves the right to make additional un-scheduled inspections at any time and may attend, observe and take note of any activity of the Contractor or his employees, including his sub-contractors. In the event of any item failing to meet the requirements of the Specification, or the workmanship being defective, the Contractor shall take immediate steps to remedy the deficiency to the satisfaction of the Engineer.

#### **1411.(p) SITE TESTS**

After completion, there will be tests of individual functioning for installed equipment. It will include the checks and tests to ensure that the facility meets all the requirements of the Contract. They will be reported by the establishment of minutes signed by the Engineer and the Contractor and specifying the eventually repairs and adjustment necessary to achieve the compliance.

The Engineer will be entitled to ask the Contractor to perform all actions it deems necessary to operate the devices, control and protection, as often as it may deem necessary. In case of faulty construction or adjustment or defective equipment, the Contractor will be required to remedy the defects or replace the equipment for which repair would be impossible or couldn't offer any sufficient guarantee of normal operation. Repaired or new equipment will be further tested.

Tests and successive changes or replacements will in no circumstances involve additional expenses of any nature whatsoever for the client. Moreover, it reserves the right to ask for any compensation and damages for the harm caused by the fact that the facility did not comply. The reception will take effect as soon as the installation will meet the requirements stated in the Contract and provided that the tests themselves are satisfactory.

When the approval procedure is completed, the taking over of the installation will be effective. If applicable to refuse certain materials, the reception can be made for equipment satisfactory to the extent that this equipment will be used regardless of the material refused.

### **1411.(q) PUMPS**

#### **General**

The pumps shall be designed and constructed so as to be suitable for the particular liquid to be pumped. All pumps shall comply with the requirements of ISO 9905, Technical Specification for Centrifugal Pumps - Class I.

The pumps that have been specified for replacement of the old pumps have the same characteristics and features as the existing ones as outlined below.

6 No. Submersible Sewage Pumps will have the following features:

- Capacity: 35l/s – (126m<sup>3</sup>/hr)
- Dynamic Head: 14m
- Motor Rating: 13.5kW, 1450rpm; 2p, 50Hz
- Construction: Open Screw type, Cutting impeller 2 vanes

Installation will include duck foot, discharge bend, guide rails and guide brackets.

2 No. Vertical Sewage Pumps will have the following characteristics:

- Capacity: 85l/s – (306m<sup>3</sup>/hr)
- Dynamic Head: 80m
- Motor Rating: 132kW, 1450rpm, 50Hz

Each set must be capable of running satisfactorily in parallel with other sets in the system without throttling and by itself, without cavitation or overload under all operating conditions within the system characteristics given.

A label made of non-deteriorating material shall be attached to each pump and motor in a place where it can be easily read and shall show the following information:

- a) Manufacturers, serial numbers and types of both pump and motor
- b) Nominal flow in m<sup>3</sup>/h ( $Q_{opt}$ )
- c) Manometric head in m ( $H_{man\ opt}$ )
- d) Efficiency  $\eta_{opt}$  in %
- e) Net positive suction head (NPSH req opt) in m.
- f) Power consumption, voltage, start-up mode in kW, V
- g) Speed of rotation 1/min

Pumps shall withstand continuous operation at full load (8000 hours/year).

### **1411.(r) MOTORS CONTROL SETS**

#### **Characteristics**

Each motor set to be installed will have the following features:

- 1 x 100A Main MCCB
- 3 x 63A TP MCB
- 3 x 15kW Soft Starter
- 3 Sets of run / trip indicator lamps
- 3 Sets of starter / stop push buttons.
- 3 Nr. Ammeters

- 1Nr. Voltmeter + Selector Switch + MCB
- 1Nr. Under/over voltage/ phase failure relay
- 1 No. Surge Arrestor

#### **1411.(s) ESSENTIAL SPARES**

The following electromechanical spares have to be supplied under the Contract as indicated under the Bills of Quantity:

##### **Electrical**

Items required for complete wiring of one starter of 400kW comprise of:

- 1nr. soft starter
- 1nr. MCCB
- 1nr. Main Contractor
- 1 set of motor protection relay
- 1 set of relays used in the panel.
- 1 set of protection devices including temperature monitoring and control devices
- 1 set of surge arrestor
- 1 set of terminals
- Set of lugs / glands etc.
- 10 sets of indicating lamps with holder

##### **Mechanical**

- 1nr. rotating assembly
- 2 sets of bearing housing
- 4 sets of bearings for pumps and motors
- 2nr. spare impellers
- 4nr. motor fans.

#### **1411.(t) WORKMANSHIP**

Upgrade Works shall include but not limited to the following: replacement, modification and/or repair of electrical components as indicated in the specifications for the particular pump station; and inspection, servicing, testing and putting the affected electrical systems back into service.

The Contractor shall be required to obtain all assembly drawings; operation and maintenance manuals; and recommendations from the Manufacturer of the original equipment and perform the required Works in full conformance with these documents and recommendations.

The Contractor shall submit the methodology for all tests to be performed including references and standards, in sufficient detail, for the Engineer's approval prior to conducting such tests. The electrical installation must be certified by an independent official organization. Tests to be certified by the Electrical Inspectorate shall meet with their requirement.

## **15. STANDARD REFERENCE NUMBERS**

### **1. Introduction**

The Engineer has agreed to use a method of modifying the text of Engineering specifications by referring to a Standard Specification Reference Number (SRN) instead of a National Standard and then providing a tabulated comparison between British and German Standards, cross-referenced further where appropriate to an International Standard (ISO), an International Electro-technical Standard (IEC), to an American Waterworks Standard (AWWA) or other appropriate National Standards.

### **2. General Clause on Standard Specification**

A general introductory clause to be inserted into general specification documents has been prepared. It is quoted below to assist in the preparation of Future Specification Volumes.

#### **Standards**

The Contractor shall observe these Specifications and shall carry out all work in a skilled and workmanlike manner in keeping with modern methods of mechanical and construction Engineering.

In addition, the Contractor shall conform with all conditions currently in force regarding the execution of construction work and shall follow all instructions issued by the competent Authorities, the Employer and the Engineer.

Where Standard Specifications are referred to in the Text of the Specifications this is done by reference to a Standard Specification Reference Number (SRN). A table of comparison is annexed to this Specification where the SRN is cross-referenced to Standard Specifications issued by the International Standards Organization (ISO) and to National Standard Specification that will be accepted in their English version by the Engineer as providing for the quality of workmanship etc. required.

The Bidder shall at his discretion base his Bid on one or other of the National Standard Specifications indicated in that table save that where a relevant Standard Specification issued by the ISO exists at the date of Bid, such an International Standard should as a minimum be compiled with. As the National Standards referred to in the table of comparison may expand on or strengthen further the requirements of ISO, Bidders choosing not to comply with one of the National Standards indicated may either indicate an alternative National Standard with which they shall comply or provide with their Bid a full and detailed description of the Standards they propose to attain.

Where a Bidder offers a particular item to a National Standard not specified in the table of comparison he shall comply with the requirements of the Instructions to Bidders in this respect and shall enclose a copy in English of the alternative National Standard offered with his Bid. Alternative National Standards or Bidder's own detailed description of the Standards they propose shall be subject to the approval of the Engineer.

### **3. List of National Specification Cross Referenced**

The list has been sub-divided into sections as follows: -

| <u>SRN No.</u> | <u>Specification</u>                        |
|----------------|---|
| 001-099        | Electrical and Mechanical                   |
| 100-199        | Concrete                                    |
| 200-299        | Metallic Pipes and Fittings                 |
| 300-399        | Plastic Pipes and Fittings                  |
| 400-499        | Other Pipes and Fittings                    |
| 500-599        | Valve, Meters, Hydrants and Other Specials  |
| 600-649        | Testing Methods and Equipment               |
| 650-699        | Site Work Codes of Practice                 |
| 700-749        | Drawing Practice, Standard Symbols, etc.    |
| 750-799        | Glossary                                    |
| 800-899        | Building Materials (excl. In-situ Concrete) |
| 900-999        | Miscellaneous                               |

**3.1 ELECTRICAL / MECHANICAL**

| SRN | SUBJECT  | DIN   | PART            | BSS  | PART        | OTHER                             | REMARKS  |
|-----|--|-------|-----------------|------|-------------|-----------------------------------|--|
| 001 | FRACTIONAL HORSE-POWER MOTORS (DIMENSIONS)     | 42021 |                 | 2048 | 1           |                                   |  |
| 002 | CURRENT TRANSFORMERS                           |       |                 | 7626 |             | IEC 60185                         |  |
| 003 | VOLTAGE TRANSFORMERS                           |       |                 | 7625 |             | IEC 60186/186A                    |  |
| 004 | CIRCUIT BREAKERS 1 kV A.C.                     |       |                 | 5311 |             | IEC 60056/267                     |  |
| 005 | CIRCUIT BREAKERS A.C. VOLT. OPERATED           |       |                 | 842  |             | BS EN 61008-1                     |  |
| 006 | CIRCUIT A.C. CURRENT OPERATED                  |       |                 | 4293 |             | BS IEC 1008-2-2                   | BS 4293 Partially Replaced by BS EN 61008-1 and BS IEC 1008-2-2  |
| 007 | FUSE SWITCHES (AIR BREAK)                      |       |                 | 5419 |             | IEC 408                           | BS 5419 Withdrawn<br>Replaced by BS EN 60947-3   |
| 008 | MOTOR STARTERS AND CONTROLLERS                 | 46062 |                 | 587  |             |                                   | BS 587 Withdrawn<br>Replaced by BS EN 60947-4-1 and BS 5856-1  |
| 009 | MOTOR STARTERS ABOVE 1000 V.A.C.               |       |                 | 5856 | 1           | IEC 60632-1                       |  |
| 010 | ELECTRIC MOTOR DIMENSIONS                      | 42673 | BL. 1-4         | 4999 | 10          | IEC 60072, 72A                    |  |
| 011 | INDUCTION MOTORS FOR GENERAL PURPOSE           | 42673 | BL. 1-4         | 5000 | 10          | IEC 60072                         |  |
| 012 | ENCLOSURE PROTECTION SWITCH / CONTROL GEAR     | 40050 | BL. 2, 6, 9, 10 | 5420 |             | IEC 60144 (IP32)                  | BS 5420 Withdrawn<br>Replaced by BS EN 60947-1   |
| 013 | MOTOR STARTERS NOT EXC. 1000 V.A.C.            | 46062 |                 | 4941 | 1, 3, 4     | IEC 292, 1, 2, 3, 4               | BS 4941 Withdrawn<br>Replaced by BS EN 60947-4-1   |
| 014 | ELECTRICITY METERS                             |       |                 | 37   | 1, 5, 8     |                                   | BS 37 Withdrawn<br>Replaced by Parts 1-4 of BS 5685  |
| 015 | WATT-HOUR METERS                               |       |                 | 5685 |             | IEC 521                           | BS 5685 Part 1 (1979) and Parts 2, 3 & 4 (1986) all Obsolete   |
| 016 | ACCEPTANCE TESTS FOR PUMPS (CLASS C)           | 4325  |                 | 5316 | 1           | ISO 2548<br>IEC 198               |  |
| 017 | ACCEPTANCE TESTS FOR PUMPS (CLASS B)           | 4325  |                 | 5316 | 2           | ISO 3555<br>IEC 198               |  |
| 018 | CODE OF PRACTICE, ELECTRICAL WIRING            |       |                 |      |             | IEE W. REGS (15 <sup>TH</sup> ED) |  |
| 019 | ELECTRICAL PROTECTIVE RELAYS                   |       |                 | 142  |             |                                   | BS 142 Part 1 Section 1.5 Sub-Section 1.5.1 - 1.5.3 all renumbered as BS 60255-21-1, 2, 3 respectively |
| 020 | FACTORY BUILT SWITCHGEAR ASSEMBLIES            | 57670 | TL. 6           | 5486 | 1, 2, 3, 13 | IEC 439-2                         | BS 5486 Part 1 Withdrawn<br>Replaced by BS EN 60439-1  |
| 021 | RECIPROCATING INT/COMB. ENGINES                |       |                 | 5514 | 1, 2        | ISO 3046, PT. 1, 2                | BS 5514 Part 2 (1988) 'Test Methods' Withdrawn - Replaced by BS 5514 Part 1 (1996)                     |
| 022 | MACHINES FOR MISCELLANEOUS APPLICATIONS        |       |                 | 5000 | 99          |                                   |  |
| 023 | INSULATING MATERIALS FOR ELECTRICAL MACHINES   |       |                 | 2757 |             | IEC 85                            |  |
| 024 | PCV INSULATED CABLES NOT EXCEEDING 1900 V.A.C. | 57207 | 4, 5            | 6346 |             |                                   |  |

| SRN | SUBJECT   | DIN         | PART | BSS                  | PART    | OTHER                      | REMARKS   |
|-----|---|-------------|------|----------------------|---------|----------------------------|---|
| 025 | ROTATING ELECTRICAL MACHINES - GENERAL                    |             |      | 4999                 | 1, 2, 3 | IEC 34-1, 34-8, 72, 72A    | Renumbered as EN 60034-4  |
| 026 | CONCRETE CABLE COVERS                                     |             |      | 2484                 |         |                            | BS 2484 Obsolescent   |
| 027 | ELECTRIC POWER SWITCHGEAR (LOW VOL. N.E. 1kV)             | 57660       |      | 5486<br>5727<br>7354 |         |                            |   |
| 028 | SAFETY ISOLATING TRANSFORMERS                             |             |      | 3535                 |         |                            |   |
| 029 | ROTATING ELECTRICAL MACHINES - RATING PLATES              | 42961       |      | 4999                 | 4       | IEC 60034-1                |   |
| 030 | ROTATING ELECTRICAL MACHINES - ENCLOSURES                 | 40050       |      | 4999                 | 20      | IEC 60035-5                |   |
| 031 | ROTATING ELECTRICAL MACHINES - CONDITIONS                 |             |      | 4999                 | 31      | IEC 60034-1                |   |
| 032 | ROTATING ELECTRICAL MACHINES - TEMPERATURE LIMITS         | See E DIN   |      | 4999                 | 32      | IEC 60034-1<br>E DIN       |   |
| 033 | ROTATING ELECTRICAL MACHINES - VIBRATION                  | See DIN ISO |      | 4999                 | 50      | ISO 2373                   |   |
| 034 | ROTATING ELECTRICAL MACHINES - TESTS                      |             |      | 4999                 | 60      | IEC 60034-1                |   |
| 035 | GENERATORS DRIVEN BY I/C ENGINES                          | See VDMA    |      | 5000                 | 3       | VDMA 6280                  |   |
| 036 | MACHINES WITH FLAMEPROOF ENCLOSURES                       | 22418       |      | 5000                 | 17      |                            |   |
| 037 | MAINTENANCE OF ELECTRICAL SWITCHGEAR (V.N.E. 14 kV)       |             |      | 6626                 |         |                            |   |
| 038 | PROTECTION PROVIDED BY ENCLOSURES (CLASS N OF DEG.)       |             |      | 5490                 |         | IEC 600529,<br>BS EN 60529 | BS 5490 Withdrawn<br>Replaced by BS EN 60529  |
| 039 | ELECTRICAL EQUIPMENT OF INDUSTRIAL MACHINES               |             |      | 2771                 |         | EN 60204,<br>Part 1        | BS 2771 Part 1 Replaced by EN 60204-1 (1993) but remains current for use as a reference standard for<br>BS EN 60204-3-1: 1992 |
| 040 | SWITCHGEAR AND CONTROL GEAR UPTO 1000V                    |             |      | 4752                 |         | IEC 600157-1,<br>600157-1A | BS 4752 Withdrawn<br>Replaced by BS EN 60947-2  |
| 041 | PVC INSULATED CABLES FOR SWITCHES AND CONTROL GEAR        |             |      | 6231                 |         |                            |   |
| 042 | BASIC ENVIRONMENTAL TESTING PROCEDURES                    |             |      | 2011                 | 1.1     | IEC 60068-1                | BS 2011 Parts Withdrawn and Replaced by Parts of BS EN 60068  |
| 043 | DEFINITIONS AND GENERAL REQUIREMENTS                      |             |      |                      |         | IEC 60051-1                |   |
| 044 | PANEL MOUNTED INSTRUMENTS - DIMENSIONS                    |             |      |                      |         | IEC 600473                 |   |
| 045 | CELLULOSIC PAPERS FOR ELECTRICAL PURPOSES                 |             |      | 5626                 | 1, 2, 3 | IEC 600554                 |   |
| 046 | COMMISSIONING, OPERATION AND MAINTENANCE OF STORAGE PUMPS |             |      |                      |         | IEC 600805                 |   |
| 047 | RUBBER INSULATED CABLES                                   |             |      |                      |         | IEC 600245                 |   |
| 048 | VOLTAGE FLUCTUATION LIMITS – GUIDE                        |             |      |                      |         | IEC 600827                 |   |
| 049 | ELECTRIC CABLES - ARMOURING - WIRE FOR                    |             |      |                      |         | KS 04-290                  |   |

| SRN | SUBJECT   | DIN | PART | BSS         | PART | OTHER         | REMARKS  |
|-----|---|-----|------|-------------|------|---------------|--|
| 050 | ROTATING ELECTRICAL MACHINES FOR HARZARDOUS AREAS ("N") |     |      | 5000        | 16   |               |  |
| 051 | POWER TRANSFORMERS – GENERAL                            |     |      |             |      | BS EN 60076-1 |  |
| 052 | ELECTRIC CONDUIT - STEEL                                |     |      | 4568        | 2    |               |  |
| 053 | BUS BARS  |     |      | 159         |      |               |  |
| 054 | NON-METALLIC CONDUITS                                   |     |      | 4607 (6099) | 2    |               | Partially Replaced by BS 6099 Part 1 and BS 6099 Section 2.2       |
| 055 | PVC CABLES IN CONDUITS                                  |     |      | 6004        |      |               |  |
| 056 | INSULATED FLEXIBLE CORD                                 |     |      | 6500        |      |               |  |
| 057 | M.I.C.C. CABLES   |     |      | 4782        | 1    |               |  |
| 058 | FLUSH SWITCHES  |     |      | 3676        |      |               |  |
| 059 | ELECTRIC SOCKETS  |     |      | 1363        |      |               | Part 3: 1989 Replaced by BS 1363 Part 3 (1995) but remains current |
| 060 | FUSED SPUR BOXES  |     |      | 1362        |      |               |  |
| 061 | CONTACTORS  |     |      | 775         |      |               | Part 1 (1969) Withdrawn<br>Replaced by BS 5424: Part 1 1977        |
| 062 | SECURITY LIGHTING INSTALLATION                          |     |      |             |      | CP 1004       | Renumbered as BS 5498  |
| 063 | ALUMINIUM SOLID CONDUCTORS                              |     |      | 3988        |      |               |  |

### 3.2 CONCRETE

| SRN | SUBJECT   | DIN  | PART      | BSS  | PART               | OTHER                       | REMARKS   |
|-----|---|------|-----------|------|--------------------|-----------------------------|---|
| 100 | METHOD FOR SPECIFYING CONCRETE                                  | 1045 | TBL. 1    | 5328 | TBL. 3             | KS 02-594                   |   |
| 101 | STANDARD OF MATERIAL & WORK - GENERAL                           | See  | VOB       | 8110 |                    | VOB 2                       |   |
| 102 | STANDARDS OF MATERIAL, WATER RETAINING STRUCTURES               |      | SUB. NO.  | 8007 |                    |                             |   |
| 103 | ORDINARY PORTLAND CEMENT  | 1164 | 1         | 12   |                    | KS 02-1262 &<br>KS 02-1263  |   |
| 104 | SULPHATE RESISTANT CEMENT                                       | 1164 | 1;CL. 4   | 4027 |                    |                             |   |
| 105 | MORTAR CUBES - COMPRESSIVE STRENGTH                             | 1164 | 1;CL. 4-4 | 12   | METHOD 2<br>CL.7.3 | ISO 3893                    |   |
| 106 | CEMENT - TEST FOR SOUNDNESS                                     |      | 6, EN.112 | 12   | CL.9               |                             |   |
| 107 | SAMPLING AND TESTING OF AGGREGATES                              | 4226 | 1-4       | 812  | 1, 2, 3            | BS EN 1097-3<br>BS EN 932-1 | BS 812 Part 1 Replaced by BS 882<br>Part 2 Replaced by BS EN 1097-3<br>Part 102 Replaced by BS EN 932-1 but remains current |
| 107 | SAMPLING AND TESTING OF AGGREGATES (CONT.)                      | 1045 |           | 812  | 101-119            |                             |   |
| 108 | FINE AGGREGATE FOR CONCRETE - GENERAL                           | 4226 | 1-4       | 882  | CL.4.1             |                             |   |
| 108 | FINE AGGREGATE FOR CONCRETE - GENERAL (CONT.)                   | 1045 |           |      |                    |                             |   |
| 109 | FINE AGGREGATE FOR CONCRETE - GRADING                           | 4226 | 1-4       | 882  | TBL.2              |                             |   |
| 110 | COARSE AGGREGATES FOR CONCRETE - GENERAL                        | 4226 |           | 882  | CL.4.1             |                             |   |
| 110 | COARSE AGGREGATES FOR CONCRETE - GENERAL (CONT.)                | 1045 |           |      |                    |                             |   |
| 111 | COARSE AGGREGATES FOR CONCRETE - GRADING                        | 4226 |           | 882  | TBL.2              |                             |   |
| 111 | COARSE AGGREGATES FOR CONCRETE - GRADING (CONT.)                | 1045 |           |      |                    |                             |   |
| 112 | COARSE AGGREGATES FOR CONCRETE - SHRINKAGE & ABSORPTION         | 4226 |           | 812  | 2                  | ISO 6783<br>BS EN 1367      | BS 812 Part 120 Replaced by BS EN 1367 but remains current  |
| 112 | COARSE AGGREGATES FOR CONCRETE - SHRINKAGE & ABSORPTION (CONT.) | 1045 |           |      |                    |                             |   |
| 113 | COARSE AGGREGATES FOR CONCRETE - FLAKINESS                      | 4226 |           | 812  | 105.1              |                             |   |
| 113 | COARSE AGGREGATES FOR CONCRETE - FLAKINESS (CONT.)              | 1045 |           |      |                    |                             |   |
| 114 | WATER FOR MAKING CONCRETE                                       | 4226 |           | 3148 |                    |                             |   |
| 114 | WATER FOR MAKING CONCRETE (CONT. 1)                             | 4030 |           |      |                    |                             |   |
| 114 | WATER FOR MAKING CONCRETE (CONT. 2)                             |      |           |      |                    |                             |   |
| 115 | CONCRETE MIX DESIGN – GENERAL                                   |      |           | 5328 |                    |                             |   |
| 115 | CONCRETE MIX DESIGN - GENERAL (CONT.)                           | 1084 | 1         |      |                    |                             |   |

| SRN | SUBJECT   | DIN   | PART | BSS          | PART             | OTHER                      | REMARKS  |
|-----|---|-------|------|--------------|------------------|----------------------------|--|
| 116 | TRIAL MIXES - CUBES                                     | 1048  |      | 1881         | 108              |                            |  |
| 117 | SAMPLING & TESTING OF CONCRETE                          | 1048  |      | 1881         | 5, 114, 121, 122 | ISO 1920, 4012, 4108, 4013 |  |
| 118 | CONCRETE BATCH MIXER                                    |       |      | 1305         |                  |                            | BS 1305 Obsolescent  |
| 119 | CONCRETE BATCH TYPE MIXERS                              | 459   |      | 3963         |                  |                            | BS 3963 Obsolescent  |
| 120 | STRUCTURAL USE OF R/C IN BUILDING                       | 1045  |      | 8110         | 1                |                            |  |
| 121 | CONCRETE TRUCK-MOUNTED MIXERS                           | 1084  | 3    | 4251         | Withdrawn        |                            | BS 4251 Withdrawn  |
| 122 | BITUMEN RUBBER JOINT SEALING COMPOUND                   |       |      | 2499         | TYPE A1          |                            |  |
| 123 | POLYSULPHIDE JOINT SEALING COMPOUND                     |       |      | 4254         |                  |                            | BS 4254 Obsolescent  |
| 124 | WATERPROOF BUILDING PAPERS                              |       |      | 1521         | (CLASS B)        |                            |  |
| 125 | IMPACT TESTING OF MILD STEEL                            | 488   | 3    | 7613<br>7668 | Grade NDI, CL.B  |                            | BS 4360 Withdrawn.<br>Replaced by BS 7613, BS 7668,<br>BS EN 10029<br>Parts 1 to 3 of BS EN 10113,<br>BS EN 10155, BS EN 10210-1 |
| 126 | STEEL R/F HOT-ROLLED STEEL BARS                         | 488   | 1-3  | 4449         |                  |                            |  |
| 127 | STEEL R/F COLD TWISTED                                  | 488   | 1-3  | 4449         |                  |                            |  |
| 128 | STEEL R/F STEEL FABRIC                                  | 488   | 4-5  | 4483         |                  |                            |  |
| 129 | BAR REINFORCEMENT AND BENDING                           |       |      | 4466         |                  |                            |  |
| 130 | SAND FOR INTERNAL PLASTERING                            | 4226  |      | 1199         |                  |                            |  |
| 131 | PLYWOOD SHUTTERING                                      | 68791 |      | 6566         | 1-8              |                            | BS 6566 Withdrawn.<br>Replaced by various BS EN standards on the same subject  |
| 131 | PLYWOOD SHUTTERING (CONT.)                              | 68792 |      |              |                  |                            |  |
| 132 | CONCRETE COMPACTION                                     | 4235  | 1,2  |              |                  |                            |  |
| 133 | CONCRETE - SITE QUALITY CONTROL                         | 1084  | 1    |              |                  |                            |  |
| 134 | DESIGN OF CONCRETE MIXES                                | 52171 |      | See HMSO     |                  | HMSO RD NOTE 4             |  |
| 135 | SAND FOR MORTAR   | 4226  |      | 1200         |                  |                            |  |
| 136 | SAND FOR RENDERING                                      | 4226  |      | 1199         |                  |                            |  |
| 137 | HOT APPLIED JOINT SEALER                                |       |      | 2499         |                  |                            |  |
| 138 | WATER STOPS AND WATER BARS                              | 7865  | 1, 2 | 8007         |                  |                            |  |
| 139 | TESTING CONCRETE STATIC MODULES (COMPARISON ELASTICITY) |       |      | 1881         | 121              |                            |  |
| 140 | TESTING CONCRETE - WATER ABSORPTION                     |       |      | 1881         | 122              |                            |  |
| 141 | TESTING CON-SAMPLING, TESTING FRESH CONCRETE, ETC.      | 1048  |      | 1881         | 101-110 & 113    | KS 02-595 : 1-8            |  |
| 142 | PRECAST CONCRETE COMPONENTS (COPING UNITS)              |       |      | 5642/2       | 2                |                            |  |

| SRN | SUBJECT  | DIN  | PART | BSS         | PART  | OTHER    | REMARKS   |
|-----|--|------|------|-------------|-------|----------|---|
| 143 | STRUCTURAL USE OF CONCRETE DESIGN & CONSTRUCTION                               |      |      | 8110        | 1     |          |   |
| 144 | STRUCTURAL USE OF CONCRETE - SPECIAL CIRC.                                     |      |      |             |       |          |   |
| 145 | IN-SITU CONCRETE DIAPHRAGM WALLS   | 4126 |      |             |       |          |   |
| 146 | TEST SIEVES FOR AGGREGATES   |      |      | 410         |       |          |   |
| 147 | LIGHT WEIGHT AGGREGATES FOR CONCRETE   | 4226 | 2, 3 | 3797        | 2     |          | BS 3797 Partly Replaced by BS EN 1744-1: 1998           |
| 148 | SUPERSULPHATED CEMENT  |      |      | 4248 (4550) |       |          | BS 4248 Partly Replaced by Parts and Section of BS 4550 |
| 149 | CONCRETE ADMIXTURES  |      |      | 5075        |       |          |   |
| 150 | GRADUATE MEASURING CYLINDER  |      |      | 604         |       | ISO 4788 |   |
| 151 | COLD REDUCED STEEL WIRE FOR THE REINFORCEMENT OF CONCRETE                      |      |      | 4482        |       |          |   |
| 152 | FUSION BONDED EPOXY COATED CARBON STEEL BARS FOR THE REINFORCEMENT OF CONCRETE |      |      | 7295        | 1 & 2 |          | Part 1: Coated bars<br>Part 2: Coatings                 |

**3.3 METALLIC PIPES AND FITTINGS**

| SRN | SUBJECT   | DIN  | PART | BSS  | PART  | OTHER                         | REMARKS   |
|-----|---|------|------|------|-------|-------------------------------|---|
| 200 | GREYCAST IRON PRESSURE PIPES AND FITTINGS       |      |      | 1211 |       | ISO 13; ISO 49                | BS 1211 Obsolescent<br>Partially replaced by BS 4772                              |
| 200 | GREY IRON PIPES AND FITTINGS (CONT)             |      |      | 4622 |       | ISO 13                        | BS 4622 Obsolescent   |
| 201 | CAST IRON FLANGED PIPES & FITTINGS              |      |      | 2035 |       | ASME/ANSI B16.1 - 1998        | BS 2035 Obsolescent<br>Partially replaced by BS 4772                              |
| 202 | DUCTILE IRON PIPES & FITTINGS (WATER)           |      |      |      |       | ISO 2531, EN 545              |   |
| 202 | DUCTILE IRON PIPES & FITTINGS (SEWERAGE)        |      |      |      |       | EN 598                        |   |
| 202 | DUCTILE IRON PIPES & FITTINGS (GAS)             |      |      |      |       | EN 969                        |   |
| 203 | STEEL TUBES WITH PLAIN OR THREADED ENDS         |      |      | 1387 |       | ISO 65                        |   |
| 203 | STEEL TUBES WITH THREADED ENDS (CONT)           | 2440 |      |      |       |                               |   |
| 203 | STEEL TUBES WITH THREADED ENDS )CONT)           | 2441 |      |      |       |                               |   |
| 203 | STEEL TUBES WITH THREADED ENDS (CONT)           | 2442 |      |      |       |                               |   |
| 203 | STEEL TUBES WITH THREADED ENDS-THREADS          | 76   | 2    | 21   |       | ISO 7/1:1982;<br>ISO 7/2:1982 |   |
| 204 | WROUGHT STEEL PIPE FITTINGS TO SSRN 203         |      |      | 1740 | 1     | ISO 4145                      |   |
| 204 | TH. STEEL PIPE FITTINGS TO SSRN 203             | 2980 |      |      |       |                               |   |
| 204 | TH. STEEL PIPE FITTINGS TO SSRN 203-LONG THREAD | 2981 |      |      |       |                               |   |
| 204 | TH. STEEL PIPE FITTINGS TO SSRN 203-NIPPLES     | 2982 |      |      |       |                               |   |
| 204 | TH. STEEL PIPE FITTINGS TO SSRN 203-BENDS       | 2983 |      |      |       |                               |   |
| 204 | TH. STEEL PIPE FITTINGS TO SSRN 203-TEES ETC.   | 2987 | 1, 2 |      |       |                               |   |
| 204 | W. STEEL PIPE FITT. TO SSRN 203-BUSHINGS        | 2990 |      |      |       |                               |   |
| 204 | W. STEEL PIPE FITT. TO SSRN 203-PLUGS & CAPS    | 2991 |      |      |       |                               |   |
| 204 | TH. STEEL PIPE FITTINGS TO SSRN 203-SOCKETS     | 2986 |      |      |       | ISO 7-2:1982                  |   |
| 204 | W. STEEL PIPE FITT. TO SSRN 203-RED'NG SOCKETS  | 2988 |      |      |       |                               |   |
| 205 | COPPER TUBES FOR WATER                          |      |      |      |       | EN 1057, ISO 8493 (TESTS)     |   |
| 205 | COPPER TUBES FOR WATER (CONT)                   | 1754 | 3    |      |       |                               |   |
| 205 | COPPER TUBES FOR WATER (CONT)                   | 1755 | 3    |      |       |                               |   |
| 206 | COPPER TUBES - GENERAL PURPOSE                  |      |      | 2871 | 2     | ISO 196:1978                  |   |
| 206 | COPPER TUBES - GENERAL PURPOSE (CONT)           | 1754 | 1,2  |      |       |                               |   |
| 206 | COPPER TUBES - GENERAL PURPOSE (CONT)           | 1755 | 1,2  |      |       |                               |   |
| 207 | FLANGES FOR FERROUS PIPES - STEEL BY PN         | 2500 |      | 4504 | 3-3.1 | ISO 7005-1:1992               | BS 4504 Part 3: Sections 3.2 (1989) Withdrawn.<br>Replaced by BS EN 1092-2 (1997) |

| SRN | SUBJECT  | DIN     | PART    | BSS      | PART  | OTHER   | REMARKS |
|-----|--|---------|---------|----------|-------|---|---------|
| 207 | FLANGES FOR FERROUS PIPES - STEEL BY CLASS     | 2501    | 1       | 1560     | 3-3.1 | ISO 7005:1988; ANSI B 16.5                          |         |
| 207 | FLANGES FOR FERROUS PIPES - C.I. BY CLASS      | 2519    | 1       | 1560     | 3-3.2 | ISO 7005-2  |         |
| 207 | FLANGES FOR FERROUS PIPES - C.I. BY PN         |         |         |          | 2     | EN 1092, ISO 2531:1991; ISO 7005-2:1988             |         |
| 207 | FLANGES FOR FERROUS PIPES-SLIP ON FOR WELDING  | 2576    |         |          |       |   |         |
| 207 | FLANGES FOR FERROUS PIPES-WELDING NECK         | 2627-38 |         |          |       |   |         |
| 207 | FLANGES FOR FERROUS PIPES-SCREWED              | 2566    |         |          |       |   |         |
| 207 | FLANGES FOR FERROUS PIPES-LAPPED-PLAIN COLLAR  | 2655-56 |         |          |       |   |         |
| 207 | FLANGES FOR FERROUS PIPES-LOOSE-WELDING NECK   | 2673    |         |          |       |   |         |
| 207 | FLANGES FOR FERROUS PIPES-CONTACT SURFACE      | 2526    |         |          |       |   |         |
| 207 | FLANGES FOR FERROUS PIPES-BLANK                | 2527    |         |          |       |   |         |
| 208 | GASKET DIMENSIONS TO SSRN 207 (a) & (d)        |         |         |          | 1     | EN 1514   |         |
| 208 | GASKET DIMENSIONS TO SSRN 207 (a) & (d) (CONT) |         |         |          | 2     | EN 1514   |         |
| 208 | GASKET DIMENSIONS TO SSRN 207 (a) & (d) (CONT) |         |         |          | 3     | EN 1514   |         |
| 208 | GASKET DIMENSIONS TO SSRN 207 (a) & (d) (CONT) |         |         |          | 4     | EN 1514   |         |
| 208 | GASKETS-FOR GROOVED FLANGES                    | 2693    |         |          |       |   |         |
| 208 | GASKETS-GROOVED O-RINGS                        | 2697    |         |          |       |   |         |
| 209 | C.I. PIPE FITTINGS, MALLEABLE, SCREWED         |         |         |          |       | ISO 49:1994   |         |
| 210 | STEEL PIPES & FITTINGS – GENERAL               |         |         | 534      |       |   |         |
| 210 | STEEL PIPES - WATER-GENERAL                    | 2460    |         | 534      |       | EN 10224, AWWA C200-97, NFA 49-150<br>JIS G 3460-88 |         |
| 210 | STEEL PIPES & FITTINGS – DESIGN                | 2413    | 1, 2    | 8010 2.1 |       | AWWA M11  |         |
| 210 | STEEL PIPES & FITTINGS - WELDING JOINTS        | 2559    | 1, 2, 3 | 8010 2.1 |       | AWWA M11<br>ASTM A333/A333M-99                      |         |
| 211 | CEMENT MORTAR LINING - D.I. PIPES              |         |         | EN 545   |       | EN 545, AWWA C.104A, C602-95                        |         |
| 211 | CEMENT MORTAR LINING - D.I. PIPES              | 2614    |         |          |       |   |         |
| 211 | CEMENT MORTAR LINING - D.I. PIPES (CONT)       |         |         |          |       | DVGW W343<br>ISO 4179:1985,<br>ISO 6600:1980,       |         |

| SRN | SUBJECT   | DIN         | PART    | BSS  | PART  | OTHER                                | REMARKS                                    |
|-----|---|-------------|---------|------|-------|--------------------------------------|--|
| 212 | CEMENT MORTAR LINING - STEEL PIPES  | 2614        |         | 534  |       | AWWA C 205, NFA 49-701DVGW-W343/W346 |  |
| 212 | CEMENT MORTAR LINING - STEEL PIPES (CONT)                                       | 2614        |         |      |       | AWWA C 602-95<br>ISO / DIS 8324      |  |
| 213 | S. PIPES & TUBES-MATERIAL, PROP., TESTS   | 1629        |         | 3600 |       | AWWA C200-97                         |  |
| 213 | CARBON STEEL PIPES AND TUBES  |             |         | 3601 |       | ISO 2604/2 /3 /6                     |  |
| 213 | STEEL PIPES AND TUBES-SPECIAL REQUIREMENTS                                      | 1626        |         |      |       |                                      |  |
| 213 | STEEL PIPES AND TUBES-SEAMLESS  | 2448        |         |      |       |                                      |  |
| 213 | STEEL PIPES AND TUBES-WELDED  | 2458        |         |      |       |                                      |  |
| 214 | BITUMEN PROTECTION TO IRON AND STEEL - HOT                                      |             |         | 4147 |       | (BS 4147 type I, grade 'd')          |  |
| 214 | BITUMEN PROTECTION TO IRON AND STEEL- COLD                                      |             |         | 3416 |       | (BS 3416 type II)                    |  |
| 214 | BITUMEN PROTECTION TO STEEL PIPES ETC.  | 30673       | Type E4 |      |       |                                      |  |
| 214 | BITUMEN PROTECTION TO DUCTILE IRON PIPES  | 30674       | 4       |      |       |                                      |  |
| 215 | EXT. PROTECTION - IRON & STEEL-EPOXY C.   |             |         | none |       | AWWA C210-97                         |  |
| 216 | STEEL FITTINGS - REINFORCING  |             |         | none |       | AWWA C208-59 AWWA M11                |  |
| 216 | STEEL FITTINGS - DIMENSIONS   |             |         | 534  |       | AWWA C208-59 AWWA M11                |  |
| 217 | D.I. PIPES & FITT.-SCREWED GLAND JOINTS   |             |         |      |       | See SSRN 219                         |  |
| 218 | D.I. PIPES & FITT.-BOLTED GLAND JOINTS  |             |         |      |       | See SSRN 219                         |  |
| 219 | D.I. PIPES & FITT.-S & S JOINTS   |             |         | 8010 | 2-2.1 |                                      |  |
| 219 | D.I. PIPES & FITT.-S & S JOINTS (CONT)  |             |         |      |       | EN 545                               |  |
| 219 | D.I. PIPES & FITT.-S & S JOINTS (CONT)  | 28603       |         |      |       |                                      |  |
| 219 | PIPELINES ON LAND; DESIGN, CONSTRUCTION AND INSTALLATION: STEEL FOR OIL AND GAS |             |         | 8010 | 2.8   |                                      |  |
| 220 | D.I. PIPES-ZINC COATING & PROT. SHEATHS   | 30674       | 3       | none |       |                                      |  |
| 221 | IRON AND STEEL PIPES-ENAMEL-HOT APPLIED   |             |         | 7873 |       | AWWA C203-97                         |  |
| 221 | STEEL FLANGED PIPES & FITTINGS-ENAMELLED  | 2873        |         |      |       |                                      |  |
| 222 | ELASTOMERIC JOINTS RINGS-REQUIREMENTS   |             |         | 2494 |       |                                      | Partly replaced by BS 7874 and BS EN 681-1 |
| 222 | ELASTOMERIC JOINTS RINGS-VULCANISED RUBBER                                      |             |         |      | 1     | EN 681                               |  |
| 222 | ELASTOMERIC JOINTS RINGS-DRAINS & SEWERS  | 4060        |         |      |       |                                      |  |
| 223 | PIPE THREADS-TUBES & FITT. (WATERTIGH)  | See ISO DIN |         | 21   |       | ISO 7/1:1982; ISO 7/2:1982           |  |

| SRN | SUBJECT   | DIN   | PART | BSS      | PART | OTHER                        | REMARKS   |
|-----|---|-------|------|----------|------|------------------------------|---|
| 224 | CAST IRON S & S PIPES AND FITTINGS                    |       |      | 78       | 2    |                              | BS 78 Withdrawn, Replaced by BS 4622<br>Part 2 Obsolescent, Partially replaced by BS 4772 |
| 225 | STEEL PIPES-HOT DIP GALVANISING                       |       |      |          |      | EN 10240                     |   |
| 226 | CARBON STEEL FITTINGS - BUTT-WELDING-GENERAL          | 2609  |      | 1965     | 1    |                              | BS 1965 Part 2 Withdrawn  |
| 226 | STEEL FITTINGS - BUTT-WELDING-TEES                    | 2615  | 1, 2 |          |      |                              |   |
| 226 | STEEL FITTINGS - BUTT-WELDING-REDUCERS                | 2616  | 1, 2 |          |      |                              |   |
| 226 | STEEL FITTINGS - BUTT-WELDING-CAPS                    | 2617  |      |          |      |                              |   |
| 227 | POLYTHENE SLEEVING FOR STEEL PIPES & FITTINGS         | none  |      | none     |      | ISO 8180:1985                |   |
| 227 | POLYTHENE SLEEVING FOR D. I. PIPES                    | 30674 | 5    |          |      |                              |   |
| 228 | ST. PIPES-DIMENSION & MASSES-PRESS. PURPOSE           | 2413  | 1, 2 | 3600     |      |                              |   |
| 228 | S. PIPES-DIMENSION & MASSES-PRESS. (CONT)             | 2460  |      |          |      |                              |   |
| 229 | STAINLESS STEEL TUBES AND WIRES                       |       |      | 1554     |      |                              |   |
| 229 | STAINLESS STEEL TUBES AND WIRES (CONT)                |       |      | 4825     | 1    | ISO 2037:1980                |   |
| 229 | STAINLESS STEEL TUBES AND WIRES (CONT)                |       |      | 6362     |      | ISO 7598                     |   |
| 229 | STAINLESS STEEL TUBES AND WIRES (CONT)                | 17457 |      |          |      |                              |   |
| 229 | STAINLESS STEEL TUBES AND WIRES (CONT)                | 17440 |      |          |      |                              |   |
| 230 | STEEL PIPES FOR WATER FLEXIBLE SOCKET & SPIGOT JOINTS | 2460  |      | CP2010-2 |      | EN 10224, ISO 559            |   |
| 230 | STEEL PIPES FOR WATER FLEXIBLE SOCKET & SPIGOT JOINTS | 2460  |      | CP2010-2 |      | EN 10224, AWWA C200-97       |   |
| 231 | FERROUS P. DEFINITION OF NOMINAL PRESSURE             |       |      | none     |      | ISO 7268:1983                |   |
| 232 | STEEL PIPELINES - TAPE COATING SYSTEMS                | 30672 | 1    | none     |      | AWWA C214-95                 |   |
| 233 | BURSTING DISCS & DEVICES                              |       |      | 2915     |      | ISO 6718:1991                |   |
| 234 | STEEL PIPES FOR PETROLUEM AND GAS INDUSTRY            | 17172 |      |          |      | EN 10208-2, API 5L           |   |
| 235 | FITTINGS TO STAINLESS STEEL TUBES                     |       |      | 4825     | 2    | ISO 2851:1973                |   |
| 235 | FITTINGS TO STAINLESS STEEL TUBES (CONT)              |       |      | 4825     | 3    | ISO 2852:1974                |   |
| 235 | FITTINGS TO STAINLESS STEEL TUBES (CONT)              |       |      | 4825     | 4    | ISO 2853:1976                |   |
| 235 | FITTINGS TO STAINLESS STEEL TUBES (CONT)              |       |      | 4825     | 5    |                              |   |
| 236 | FITTINGS TO BRASS TUBES                               |       |      | 2051     | 1    |                              |   |
| 237 | RUBBER GASKET MATERIAL JOINTS FOR PIPELINES           |       |      | 2494     |      | ISO 4633; ISO 6447; ISO 6448 |   |
| 238 | STORAGE OF VULCANISED RUBBER                          |       |      | none     |      | ISO 2230:1973                |   |

| SRN | SUBJECT  | DIN   | PART | BSS      | PART | OTHER                             | REMARKS |
|-----|--|-------|------|----------|------|-----------------------------------|---------|
| 239 | BITUMINOUS VARNISH TO DUCTILE IRON PIPES                 |       |      | none     |      | ISO 8179-2:1995                   |         |
| 240 | FOUNDING - SPHEROIDAL GRAPHITE CAST IRON                 |       |      |          |      | EN 1563                           |         |
| 240 | FOUNDING - AUSTEMPERED DUCTILE IRON CASTINGS             |       |      |          |      | EN 1564                           |         |
| 241 | FUSION BONDED EPOXY COATINGS FOR STEEL PIPES             | 30671 |      | none     |      | EN 10309, AWWA C213, NFA 49-706   |         |
| 241 | FUSION BONDED EPOXY LININGS FOR STEEL PIPES              |       |      |          |      | AWWA C213                         |         |
| 242 | FLEXIBLE BOLTED SLEEVE COUPLINGS                         |       |      | 534      |      | AWWA C219                         |         |
| 243 | FLEXIBLE GROOVED AND SHOULDERED COUPLINGS                |       |      |          |      | AWWA C606                         |         |
| 244 | SPHERICAL JOINTS FOR WELDING, STEEL PIPES                |       |      | 534      |      | UNI 6363                          |         |
| 245 | BIT. SEAL COAT'GS ON D.I. PIPE CEM. MOR. LINING          |       |      | 7892     |      |                                   |         |
| 246 | POLYMERIC FILM PROT. SLEEV'G FOR IRON PIPES              | 30674 | 5    | 6076     |      | EN 534                            |         |
| 247 | HOT ENAMEL COATING TO IRON & STEEL PIPES                 |       |      | 7873     |      |                                   |         |
| 248 | EXTERNAL ZINC COATINGS ON DI PIPES                       | 2444  |      | none     |      | ISO 8179-1:1995                   |         |
| 249 | BOLTS & NUTS FOR PIPELINES                               | 2507  |      | none     |      |                                   |         |
| 250 | STEEL PIPELINES - THERMOSET PLASTIC COATINGS             | 30671 |      | BGC/CW 6 |      | AWWA C213, NFA 49-706             |         |
| 251 | STEEL PIPES - POLYPROPYLENE COATING                      | 30678 |      | none     |      | EN 10286, NFA 49-711              |         |
| 252 | STEEL TUBES - ELECTROMAGNETIC TESTING - LEAKS            |       |      |          | 1    | EN 10246                          |         |
| 253 | TWO & THREE LAYER POLYTHENE COATINGS FOR STEEL PIPES     | 30670 |      | 534      |      | AWWA C215, NFA 49-704, NFA 49-710 |         |
| 254 | LIQUID EPOXY COATINGS FOR STEEL PIPES                    |       |      |          |      | AWWA C210                         |         |
| 255 | LIQUID EPOXY LININGS FOR STEEL PIPES                     |       |      |          |      | AWWA C210, NFA 49-709             |         |
| 256 | LIQUID POLYURETHANE COATINGS FOR STEEL PIPES             | 30671 |      |          |      | AWWA C222                         |         |
| 257 | LIQUID POLYURETHANE LININGS FOR STEEL PIPES              |       |      |          |      | AWWA C222, NFA 49-709             |         |
| 258 | EXTRUDED POLYTHENE COATINGS FOR D.I. PIPES               | 30674 | 1    | EN 545   |      | EN 545                            |         |
| 259 | CEMENT MORTAR COATINGS FOR D.I. PIPES                    | 30674 | 2    |          |      |                                   |         |
| 260 | LIQUID EPOXY COATINGS FOR D.I. PIPES                     |       |      | EN 545   |      | EN 545                            |         |
| 261 | FUSION BONDED EPOXY COATINGS & LININGS FOR D.I. FITTINGS |       |      |          |      | AWWA C116                         |         |
| 262 | LIQUID POLYURETHANE COATINGS FOR D.I. PIPES              |       |      | EN 545   |      | EN 545                            |         |
| 263 | LIQUID POLYURETHANE LININGS FOR D.I. PIPES               |       |      | EN 545   |      | EN 545                            |         |
| 264 | TWO LAYER EPOXY-NYLON COATINGS & LININGS FOR STEEL PIPES |       |      |          |      | EN 10310, AWWA C224               |         |

**3.4 PLASTIC PIPES AND FITTINGS**

| SRN | SUBJECT   | DIN   | PART  | BSS                     | PART | OTHER                            | REMARKS  |
|-----|---|-------|-------|-------------------------|------|----------------------------------|--|
| 300 | uPVC PIPES FOR COLD WATER   | 19532 |       | 3505                    |      | ISO 2505, 3114, 3606             |  |
| 300 | uPVC PIPES FOR COLD WATER (CONT. 1)   | 8062  |       |                         |      | ISO 3472, 3472, 3473, 3474       |  |
| 300 | uPVC PIPES FOR COLD WATER (CONT. 2)   |       |       |                         |      | ISO 161/1                        |  |
| 300 | uPVC PIPES FOR COLD WATER (CONT. 3)   |       |       |                         |      | KEBS 06-149:2                    |  |
| 301 | JOINTS AND FITTINGS FOR uPVC PRESSURE PIPES   | 8063  | 1, 12 | 4346                    | 1-3  | ISO 2035, 2044                   |  |
| 301 | JOINTS AND FITTINGS FOR uPVC PRESSURE PIPES (CONT. 1)                               | 16450 |       |                         |      | ISO 2045, 2048, 2536             |  |
| 301 | JOINTS AND FITTINGS FOR uPVC PRESSURE PIPES (CONT. 2)                               | 16451 |       |                         |      |                                  |  |
| 302 | uPVC PIPELINES - LAYING AND JOINTING  | 16928 |       | See CP                  |      | CP 312                           |  |
| 303 | uPVC PIPELINES - PRESSURE TESTING   | 4279  | 1, 7  |                         |      |                                  |  |
| 304 | uPVC PIPELINES - ADHESIVES FOR JOINTING   | 16970 |       |                         |      |                                  |  |
| 305 | uPVC PIPES - GENERAL  | 8061  |       | 3505                    |      |                                  |  |
| 305 | uPVC PIPES - GENERAL (CONT. 1)  | 8062  |       | 3506                    |      |                                  |  |
| 305 | uPVC PIPES - GENERAL (CONT. 2)  | 19532 |       |                         |      |                                  |  |
| 306 | uPVC PIPES - PRESSURE TESTS TO DESTRUCTION  |       |       | 4728                    |      | ISO 1167                         | Obsolescent (but still remains current) Replaced by BS EN 921 and partially replaced by BS EN 2782 Part II method 1127P - 1997 but remains current |
| 307 | HDPE PIPES, JOINTS, FITTINGS  | 16963 | 1-3   | 3284 (6572) (6730) 2494 |      |                                  | Obsolescent - Partially replaced by BS 6572, BS 6730   |
| 308 | RUBBER RINGS FOR MECHANICAL JOINTS  |       |       |                         |      |                                  |  |
| 309 | uPVC UNDERGROUND DRAIN PIPES & FITTINGS   |       |       | 4660                    |      |                                  | Partially replaced by BS EN 1401-1   |
| 310 | uPVC PIPES IMPACT TEST 20 DEGREES CENTIGRADE  |       |       | 3505                    |      | ISO 3127                         |  |
| 311 | uPVC PIPES SHORT TERM HYDROSTATIC TEST  |       |       | 3505                    |      |                                  |  |
| 312 | uPVC PIPES LONG TERM HYDROSTATIC TEST   |       |       | 3505                    |      |                                  |  |
| 313 | uPVC PIPES INTERNAL PRESSURE ENDURANCE TEST   | 8061  |       |                         |      |                                  |  |
| 314 | uPVC WATER ABSORPTION TEST  | 8061  |       |                         |      | ISO 2508                         |  |
| 315 | uPVC PIPES - VARIOUS OTHER TESTS  |       |       |                         |      | ISO 2505, 3114, 3472, 3473, 3474 |  |
| 316 | PIPES - RATE OF LEAKAGE   |       |       | 8010:2                  |      |                                  |  |
| 317 | G.R.P. PIPES  |       |       | 6464                    |      |                                  |  |
| 318 | PLASTICS PIPES AND FITTINGS FOR USE AS SUB SOIL FIELD DRAINS                        |       |       | 4962                    |      |                                  |  |
| 318 | POLYPROPYLENE WASTE PIPE AND FITTINGS (EXTERNAL DIAMETER 34.6MM, 41.0MM AND 54.1MM) |       |       | 5254                    |      |                                  |  |

| SRN | SUBJECT   | DIN | PART | BSS  | PART | OTHER | REMARKS  |
|-----|---|-----|------|------|------|-------|--|
| 319 | THERMOPLASTICS WASTE PIPE AND FITTINGS  |     |      | 5255 |      |       |  |
| 320 | GLASS REINFORCED PLASTICS (GRP) PIPES, JOINTS AND FITTINGS FOR USE FOR WATER SUPPLY OR SEWERAGE |     |      | 5480 |      |       |  |
| 321 | UNPLASTICIZED PVC PIPE AND FITTINGS FOR GRAVITY SEWERS  |     |      | 5481 |      |       |  |
| 322 | PLASTICS PIPEWORK (THERMOPLASTICS MATERIALS)  |     |      | 5955 | 6    |       | Part 6: Installation of unplasticized PVC pipework for gravity drains and sewers |
| 323 | BLUE POLYETHYLENE PIPES UP TO NOMINAL SIZE 63 FOR BELOW GROUND USE FOR POTABLE WATER            |     |      | 6572 |      |       |  |
| 324 | BLACK POLYETHYLENE PIPES UP TO NOMINAL SIZE 63 FOR ABOVE GROUND USE FOR COLD POTABLE WATER      |     |      | 6730 |      |       |  |

### 3.5 OTHER PIPES AND FITTINGS

| SRN | SUBJECT   | DIN      | PART        | BSS  | PART | OTHER                  | REMARKS  |
|-----|---|----------|-------------|------|------|------------------------|--|
| 401 | ASBESTOS CEMENT (A/C) PRESSURE PIPES                  | 19800    | 1-3         | 486  |      | ISO 160<br>BS EN 512   | BS 486 Withdrawn<br>Replaced by BS EN 512  |
| 401 | ASBESTOS CEMENT (A/C) PRESSURE PIPES (CONT.)          |          |             | 4624 |      |                        |  |
| 402 | A/C SEWER PIPES, JOINTS, FITTINGS                     |          |             | 3656 |      | ISO 881<br>BS EN 588-1 | BS 3656 Withdrawn<br>Replaced by BS EN 588-1   |
| 402 | A/C SEWER PIPES, JOINTS, FITTINGS (CONT. 1)           |          |             |      |      |                        |  |
| 402 | A/C SEWER PIPES, JOINTS, FITTINGS (CONT. 2)           | 19850    | 1, 2        |      |      |                        |  |
| 403 | A/C PIPES FOR THRUST BORING                           |          |             |      |      | ISO 4488               |  |
| 404 | A/C PIPES - GUIDE FOR LAYING                          |          |             | 5927 |      | ISO 4482               |  |
| 405 | A/C PIPES - FIELD PRESSURE TESTING                    | 4279     | 1, 6, 9, 10 | 5886 |      | ISO 4483               |  |
| 406 | PIPE SUPPORTS   | See DVGW |             | 3974 | 1    | DVGW 310 PT. 2         |  |
| 407 | UNREINFORCED CONCRETE PIPES (OGEE)                    | 4032     |             | 5911 | 3    |                        |  |
| 408 | PRESTRESSED CONCRETE PRESSURE PIPES                   | 4035     |             | 4625 |      |                        |  |
| 409 | PRECAST CONCRETE PIPES - DRAINS & SEWERS              | 4032     |             | 5911 | 1, 3 |                        |  |
| 409 | PRECAST CONCRETE PIPES - DRAINS & SEWERS (CONT.)      | 4035     |             |      |      |                        |  |
| 410 | CONCRETE POROUS PIPES - UNDER DRAINS                  |          |             | 5911 | 114  |                        |  |
| 411 | NON-PRESSURE DUCTILE IRON PIPES ETC.                  |          |             |      |      | ISO 7186               |  |
| 412 | RUBBER AND PLASTIC HOSES AND ASSEMBLIES               |          |             |      |      | ISO 7751               |  |
| 413 | CONCRETE CYLINDRICAL PIPES & FITTINGS METRIC          |          |             | 5911 | 1-3  | AWWA C602-83           | BS 5911 Part I: 1981 Withdrawn<br>Replaced by BS 5911 Part 100: 1988<br>BS 5911 Part 200: 1989<br>BS 5911 Part 200: 1994 |
| 414 | CLAY PIPES (SEWERAGE)                                 |          |             | 65   |      |                        |  |
| 415 | TESTING OF JOINTED PIPES AND MANHOLES                 |          |             | 2005 |      |                        | BS 2005 - Obsolescent  |
| 416 | CONCRETE PRESSURE PIPES INCLUDING JOINTS AND FITTINGS |          |             |      |      | BS EN 639              |  |

**3.6 VALVES, METERS, HYDRANTS**

| SRN | SUBJECT   | DIN      | PART | BSS  | PART    | OTHER           | REMARKS   |
|-----|---|----------|------|------|---------|-----------------|---|
| 501 | DOUBLE FLANGED C.I. GATE VALVES (WATER)           |          |      | 5163 |         | AWWA C203-78    |   |
| 501 | DOUBLE FLANGED C.I. GATE VALVES (WATER) (CONT. 1) | 3230     | 1-3  |      |         |                 |   |
| 501 | DOUBLE FLANGED C.I. GATE VALVES (WATER) (CONT. 2) |          |      |      |         |                 |   |
| 501 | DOUBLE FLANGED C.I. GATE VALVES (WATER) (CONT. 3) | 3352     | 1, 4 |      |         |                 |   |
| 502 | C.I. GATE VALVES - GENERAL                        |          |      | 5150 |         |                 |   |
| 502 | C.I. GATE VALVES - GENERAL (CONT.)                | 3352     | 1, 4 |      |         |                 |   |
| 503 | C.I. (PARALLEL SLIDE) GATE VALVES - GENERAL       |          |      | 5151 |         |                 |   |
| 504 | C.I. GLOBE VALVES - GENERAL                       | 3356     | 1-5  | 5152 |         |                 |   |
| 505 | C.I. CHECK VALVES - GENERAL                       | 3202     |      | 5153 |         | AWWA C508-82    |   |
| 505 | C.I. CHECK VALVES - GENERAL (CONT.)               | See DVGW |      | 6282 | 1, 4    | DVGW-W376       |   |
| 506 | C.I. AND STEEL BUTTERFLY VALVES - GENERAL         | 3354     | 1-4  | 5155 |         | BS EN 593: 1998 | BS 5155 Withdrawn<br>Replaced by BS EN 593: 1998        |
| 507 | BOURDON TYPE PRESSURE GAUGES                      |          |      | 1780 |         | BS EN 837: 1998 | BS 1780 Withdrawn<br>Replaced by BS EN 837-1: 1998      |
| 508 | FLOAT OPERATED VALVES N.D. 500MM                  |          |      | 1212 | 1, 2, 3 |                 |   |
| 509 | FIRE HYDRANTS                                     | 3221     | 1, 2 | 750  |         |                 |   |
| 510 | WATER METERS                                      | 19648    | 1-3  | 5728 | 1, 2    | ISO 4064-1      | BS 5728 Part 1 Withdrawn<br>Replaced by BS 5728: Part 7 |
| 510 | WATER METERS (CONT.)                              |          |      |      |         | KS 06-248 1, 2  |   |
| 511 | COPPER ALLOY GATE, CHECK, ETC. VALVES             | 3352     | 11   |      |         |                 |   |
| 511 | COPPER ALLOY GATE, CHECK, ETC. VALVES (CONT.)     |          |      | 5154 |         |                 |   |
| 512 | FIRE HOSE COUPLINGS & EQUIPMENT                   | 14244    |      | 336  |         |                 |   |
| 513 | SURFACE BOXES                                     |          |      | 5834 | 2, 3    |                 |   |
| 513 | SURFACE BOXES (CONT. 1)                           |          |      |      |         |                 |   |
| 513 | SURFACE BOXES (CONT. 2)                           |          |      |      |         |                 |   |
| 513 | SURFACE BOXES (CONT. 3)                           |          |      |      |         |                 |   |
| 513 | SURFACE BOXES (CONT. 4)                           |          |      |      |         |                 |   |
| 514 | METALLIC BALL VALVES                              | 3357     | 1-7  |      |         |                 | DIN 3357 Part 6, 7 Withdrawn                            |
| 515 | uPVC VALVES                                       | 3441     | 2    |      |         |                 |   |
| 517 | FIRE HYDRANT SYSTEMS FOR BUILDINGS                |          |      | 5041 | 1-5     |                 |   |
| 518 | BUTTERFLY VALVES                                  |          |      | 5155 |         |                 |   |
| 519 | DIAPHRAGM VALVES                                  |          |      | 5156 |         |                 |   |
| 520 | CAST IRON PLUG VALVES                             |          |      | 5158 |         |                 |   |
| 521 | UNDERGROUND STOPVALVES FOR WATER SERVICES         |          |      | 5433 |         |                 |   |

**3.7 TESTING METHODS AND EQUIPMENT**

| SRN | SUBJECT  | DIN      | PART       | BSS         | PART    | OTHER                                  | REMARKS  |
|-----|--|----------|------------|-------------|---------|--|--|
| 600 | NON-DESTRUCTIVE TESTING OF WELDS (TUBES)           | 8564     | 1          | 3889 (6072) | 1, 2A   | AP15LS                                 | BS 3889 Partially Replaced by 6072   |
| 600 | NON-DESTRUCTIVE TESTING OF WELDS (TUBES) (CONT.)   | 50120    | 1, 2       | 6072        |         |  |  |
| 601 | SOILS FOR CIVIL ENGINEERING PURPOSE - TEST METHODS | 18196    |            | 1377        |         |  |  |
| 602 | TESTING OF PIPELINE FOR WATER (INTERNAL PRESSURE)  | 4279     | 1-7, 9, 10 |             |         |  |  |
| 603 | TESTING OF CEMENT                                  | See EDIN |            | 4550        | 1, 2, 3 | BS EN 196-7<br>EDIN EN75, 112, 114, 15 | BS 4550 Part 1 & Part 2 Withdrawn<br><br>Replaced by BS EN 196-7: 1992   |
| 604 | MATERIAL TESTING - DOCUMENTATION                   |          |            |             |         | ISO 404,<br>EURONORM 21                |  |
| 605 | MEASUREMENT OF WATER FLOW (WATER METERS)           |          |            |             |         | ISO 4064/3                             |  |
| 606 | DRINKING WATER QUALITY – TESTING                   |          |            |             |         | KS 05-459:5                            |  |
| 607 | RECOMMENDATIONS AND CLASSIFICATION FOR TOPSOIL     |          |            | 3882        |         |  |  |
| 608 | METHODS OF TESTING MORTARS, SCREEDS AND PLASTERS   |          |            | 4551        |         |  |  |
| 609 | STRUCTURAL FIXINGS IN CONCRETE AND MASONRY         |          |            | 5080        | 1 & 2   |  | Part 1: Method of test for tensile loading<br><br>Part 2: Method for determination of resistance to loading in shear |
| 610 | SIZE OF HARDWOODS AND METHODS OF MEASUREMENT       |          |            | 5450        |         |  |  |
| 611 | RECOMMENDATIONS FOR TESTING OF AGGREGATES          |          |            | 5835        | 1       |  | Part 1: Compactibility test for graded aggregates  |

**3.8 SITE WORK CODES OF PRACTICE**

| SRN | SUBJECT  | DIN   | PART   | BSS            | PART | OTHER                                      | REMARKS   |
|-----|--|-------|--------|----------------|------|--|---|
| 650 | SITE INVESTIGATIONS  | 18196 |        | 5930           |      |  |   |
| 650 | SITE INVESTIGATIONS (CONT.)  | 18307 |        |                |      |  |   |
| 651 | WATER SUPPLY   | 2000  | See BS | BS 6007        |      | CP 310                                     | CP 310 Withdrawn<br>Replaced by BS 6007   |
| 651 | WATER SUPPLY (CONT. 1)   | 2425  | 3, 5   | BS 8301        |      | CP 301                                     | CP 301 Withdrawn<br>Replaced by BS 8301   |
| 651 | WATER SUPPLY (CONT. 2)   | 4046  |        |                |      |  |   |
| 651 | WATER SUPPLY (CONT. 3)   | 19630 |        |                |      |  |   |
| 652 | BUILDING DRAINAGE  | 1986  | 2-4    | BS 8301        |      | CP 301                                     | CP 301 Withdrawn<br>Replaced by BS 8301   |
| 653 | WATER PIPELINE CONSTRUCTION  | 19630 |        |                |      |  |   |
| 654 | TRENCHING FOR PIPELINES  | 4124  |        |                |      |  |   |
| 655 | SEWAGE PIPELINE CONSTRUCTION   |       |        |                |      |  |   |
| 656 | WALLING (BRICK & BLOCK MASONRY)  | 18330 | See BS | 5390<br>5628   |      | CP 121                                     | CP 121 Withdrawn<br>Replaced by BS 5390 and BS 5628<br>Part 3   |
| 657 | USE OF STRUCTURAL STEEL IN BUILDING  | 18203 | 1, 2   | 449<br>BS 5950 | 2    | GB 7101-91<br>SABS 1431                    | BS 449 Parts 1 and 2 Withdrawn<br>Part 2: Addendum No. 1 (1975)<br>Replaced by BS 5950 Part 5 (1987)  |
| 658 | SEWERAGE   |       |        | 8005           |      | BS EN 1610                                 |   |
| 659 | SMALL SEWAGE TREATMENT WORKS AND CESSPOOLS                                       |       |        | 6297           |      |  |   |
| 660 | TEST PUMPING OF WATER WELLS  |       |        | 6316           |      |  |   |
| 661 | METHODS OF MEASUREMENT OF LIQUID FLOW IN OPEN CHANNEL                            |       |        | 3680           | 1-10 | BS ISO 748<br>BS ISO 1100-2<br>ISO TR 8363 | BS 3680 Part 3A Withdrawn<br>Replaced by BS ISO 748: 1997<br>BS 3680 Part 3C Withdrawn<br>Replaced by BS ISO 1100-2<br>BS 3680 Part 3G Withdrawn<br>Replaced by ISO TR 8363<br>BS 3680 Parts 3J, 8F, 8G Withdrawn |
| 662 | MEASUREMENT OF FLOW IN CLOSED CONDUITS (BY CURRENT METERS OR PITOT STATIC TUBES) |       |        |                |      | ISO 7194                                   |   |
| 663 | CONSTRUCTION AND DEMOLITION OF CONCRETE AND MASONRY                              |       |        |                |      | ANSI A10, 9-1983                           |   |
| 664 | DRAINAGE OF ROOFS AND PAVED AREAS  |       |        | 6367           |      |  |   |
| 665 | FOUNDATIONS  |       |        | 8004           |      | CP 2004                                    | CP 2004 Withdrawn<br>Replaced by BS 8004  |

| SRN | SUBJECT  | DIN   | PART | BSS  | PART     | OTHER  | REMARKS   |
|-----|--|-------|------|------|----------|--|---|
| 666 | STRUCTURAL USE OF TIMBER   |       |      | 5268 |          | CP 112, 2  | CP 112, 2 Withdrawn<br>Replaced by BS 5268 Part 2<br>BS 5268 Part 3   |
| 667 | RETAINING WALLS  | 4085  |      |      |          |  |   |
| 668 | WATERPROOFING OF BUILDINGS & STRUCTURES  | 18195 | 1-4  |      |          |  |   |
| 669 | WATER QUALITY - SAMPLING   |       |      |      |          | ISO 5667/2/3   |   |
| 670 | WELDING PROCEDURES - APPROVAL TESTING  |       |      | 4870 | 1        | BS EN 288-3<br>BS EN 288-4   | BS 4870 Part 1 Withdrawn<br>Replaced by BS EN 288-3<br>BS 4870 Part 2 Withdrawn<br>Replaced by BS EN 288-4  |
| 671 | WELDING - APPROVAL TESTING   |       |      | 4871 | 1        | BS EN 287-1<br>BS EN 287-2   | BS 4871 Part 1 Withdrawn<br>Replaced by BS EN 287-1<br>BS 4871 Part 2 Withdrawn<br>Replaced by BS EN 287-2  |
| 672 | LOGGING OF ROCK CORES  |       |      |      |          | LOGGING OF ROCK CORES FOR ENGINEERING PURPOSES, GEOL. SOC. OF LONDON |   |
| 673 | TEST FOR STABILISED SOILS  |       |      | 1924 |          |  |   |
| 674 | DRAIN AND SEWER SYSTEMS OUTSIDE BUILDINGS  |       |      |      | 1, 2 & 3 | BS EN 752  | Part 1: Generalities and definitions<br>Part 2: Performance requirements<br>Part 3: Planning  |
| 675 | CONSTRUCTION AND TESTING OF DRAINS AND SEWERS  |       |      |      |          | BS EN 1610   |   |
| 676 | IDENTIFICATION OF PIPELINES AND SERVICES   |       |      | 1710 |          |  |   |
| 677 | WELDING OF STEEL PIPELINES ON LAND AND OFFSHORE  |       |      | 4515 |          |  |   |
| 678 | PERFORMANCE REQUIREMENTS FOR JOINTS AND COMPRESSION FITTINGS FOR USE WITH POLYETHYLENE PIPES |       |      | 5114 |          |  |   |
| 679 | STRUCTURAL USE OF TIMBER   |       |      | 5268 | 2, 3 & 5 |  | Part 2: Permissible stress design, materials and workmanship<br>Part 3: Trussed rafter roof<br>Part 5: Preservative treatment of structural timber          |
| 680 | STAIRS, LADDERS AND WALKWAYS   |       |      | 5395 | 1, 2 & 3 |  | Part 1: Design of straight stairs<br>Part 2: Design of helical and spiral stairs<br>Part 3: Design of industrial type stairs, permanent ladder and walkways |
| 681 | INTERNAL PLASTERING  |       |      | 5492 |          |  |   |
| 682 | GUIDE TO ACCURACY IN BUILDING  |       |      | 5606 |          |  |   |

| SRN | SUBJECT  | DIN | PART | BSS  | PART | OTHER | REMARKS  |
|-----|--|-----|------|------|------|-------|--|
| 683 | SAFE USE OF EXPLOSIVES IN THE CONSTRUCTION INDUSTRY  |     |      | 5607 |      |       |  |
| 683 | USE OF MASONRY   |     |      | 5628 | 3    |       | Part 3: Materials and components, design and workmanship |
| 684 | EARTHWORKS   |     |      | 6031 |      |       |  |
| 685 | PAINTING OF BUILDINGS  |     |      | 6150 |      |       |  |
| 686 | LOADING FOR BUILDINGS  |     |      | 6399 | 1    |       | Part 1: Dead and imposed loads                           |
| 687 | GUIDE TO INSTALLATION AND USE OF VALVES  |     |      | 6683 |      |       |  |
| 688 | DESIGN, INSTALLATION, TESTING AND MAINTENANCE OF SERVICES SUPPLYING WATER FOR DOMESTIC USE WITHIN BUILDINGS AND THEIR CURTILAGES |     |      | 6700 |      |       |  |
| 689 | GUIDE FOR STRUCTURAL DESIGN OF PAVEMENTS CONSTRUCTED WITH CLAY OR CONCRETE BLOCK PAVER   |     |      | 7533 |      |       |  |
| 690 | SEWERAGE   |     |      | 8005 | 1    |       | Part 1: Guide to new sewerage construction               |
| 691 | PROTECTION OF STRUCTURES AGAINST WATER FROM THE GROUND   |     |      | 8102 |      |       |  |
| 692 | DESIGN AND INSTALLATION OF DAMP-PROOF COURSES IN THE MASONRY CONSTRUCTION  |     |      | 8215 |      |       |  |
| 693 | CODE OF PRACTICE FOR BUILT-UP FELT ROOFING   |     |      | 8217 |      |       |  |

**3.9 DRAWING PRACTICE, STANDARD SYMBOLS ETC.**

| SRN | SUBJECT  | DIN   | PART | BSS  | PART     | OTHER               | REMARKS  |
|-----|--|-------|------|------|----------|---------------------|--|
| 700 | IDENTIFICATION OF PIPELINE ACCORDING TO FLUID CONVEYED             | 2403  |      |      |          |                     |  |
| 701 | GRAPHICAL SYMBOLS FOR GENERAL ENGINEERING - PIPING SYSTEMS         | 2406  |      | 1553 | 1        |                     |  |
| 701 | GRAPHICAL SYMBOLS FOR GENERAL ENGINEERING - PIPING SYSTEMS (CONT.) | 2429  | 1    |      |          |                     |  |
| 702 | PROJECT NETWORK TECHNIQUES   |       |      | 4335 |          |                     |  |
| 703 | DRAWING OFFICE PRACTICE - ARCHITECTS AND BUILDERS                  |       |      | 1192 | 1-4      |                     | BS 1192 Part 2 Obsolescent   |
| 704 | CONSTRUCTION DRAWING PRACTICE                                      |       |      | 1192 | 1-4      |                     | BS 1192 Part 2 Obsolescent   |
| 705 | ENGINEERING DRAWING PRACTICE                                       |       |      | 308  | 1        | ISO 128, 2162, 2203 |  |
| 706 | DRAWING PRACTICE FOR ENGINEERING DRAWINGS                          |       |      | 5070 | 1-3      | BS EN 61082         | BS 5070 Part 1 Partially Replaced by BS EN 61082-1<br>BS 5070 Part 2 Withdrawn Replaced by BS EN 61082-2 |
| 707 | BUILDING AND CIVIL ENGINEERING TERMS                               |       |      | 6100 | 1-6      |                     |  |
| 708 | WATER SUPPLY - MAPS AND PLANS                                      | 2425  | 3, 5 |      |          |                     |  |
| 709 | CARTOGRAPHIC REPRESENTATION OF CLIMATE                             | 50019 | 1    |      |          |                     |  |
| 750 | CONCRETE (INC. R/F) – GLOSSARY                                     |       |      | 6100 | 6.2, 6.3 |                     |  |
| 751 | VALVES - GLOSSARY  |       |      |      |          |                     |  |
| 752 | IRON AND STEEL - GLOSSARY FOR PIPES                                |       |      | 6562 | 1-2      |                     |  |

**3.10 BUILDING MATERIALS**

| SRN | SUBJECT                                 | DIN   | PART        | BSS                                      | PART    | OTHER                                       | REMARKS  |
|-----|---|-------|-------------|--|---------|---|--|
| 801 | LIME FOR MORTAR                         | 1060  | 1, 2, 3     | 890                                      | CL.B    |   | DIN 1060 Part 2 & 3 Withdrawn  |
| 802 | QUARRY TILES FOR SILLS                  |       |             | 6431                                     |         | BS EN ISO 10545-2, 3, 4, & 6                | BS 6431 Parts 10, 11, 12 & 14 Replaced by BS EN ISO 10545-2, 3, 4, 6 Respectively but remain current   |
| 803 | DAMP-PROOF COURSE (BITUMINOUS FELT)     |       |             | 743 (6398: BS 6398, BS 6515 and BS 8215) |         |   | BS 743 Partially Replaced by   |
| 804 | CONCRETE BLOCKS                         |       |             | 6398                                     |         | DIN 18153.                                  |  |
| 804 | CONCRETE BLOCKS (CONT.)                 |       |             | 6073                                     | 1, 2    |   | BS 6073 Partially Replaced by BS EN 772-2  |
| 805 | HOLLOW CLAY PARTITION BLOCKS            | 278   |             | 3921                                     |         |   | BS 3921 Partially Replaced by BS EN 772-3 & 7  |
| 806 | BRICK WALLING                           | 105   | 1-5         | 3921                                     |         |   | BS Partially Replaced by BS EN 772-3 & 7   |
| 806 | BRICK WALLING (CONT.)                   | 106   | 1, 2        |  |         |   |  |
| 807 | ASBESTOS ROOF SLATES AND SHEETING       |       |             | 690                                      | 3, 4    |   | BS 690 Part 3 & 4 Withdrawn Replaced by BS EN 494 and 492 respectively   |
| 808 | FIXING BOLTS & SCREENS FOR ROOFING      |       |             |  |         |   |  |
| 809 | INSULATION BOARD AND HARD BOARD         |       |             | 1142                                     | 1, 2, 3 | ISO 766/7/9, 818/19, 2695, 3340, 3546, 3729 | BS 1142 Partially Replaced by BS EN 120, 310, 316-323, 324: 1 & 2, 325, 382-1 and BS EN 622: 1-5   |
| 809 | INSULATION BOARD AND HARD BOARD (CONT.) |       |             |  |         |   |  |
| 810 | BLOCKBOARD                              | 68705 | 1, 3        | 3444                                     |         | ISO 1096, 97, 98, 2074, 2426-30             | DIN 68705 Part 1 Withdrawn   |
| 811 | PLYWOOD (TROPICAL HARDWOOD)             | 4078  |             | 6566                                     | 1-8     | ISO 1096, 1097                              | BS 6566 Replaced by various BS EN Standards on the same subject  |
| 811 | PLYWOOD (TROPICAL HARDWOOD) (CONT.)     | 68705 | 1, 5        |  |         | ISO 1098                                    | DIN 68705 Part 1 Withdrawn   |
| 812 | SEALING OF EXT. WALL JOINTS             | 18540 | SH. 1, 2, 3 |  |         |   |  |
| 813 | CHIPBOARD                               | 68761 | 4           | 5669                                     |         |   | BS 5669 Part 1 Partially Replaced by BS EN 120, 309, 310, 311, 312, Parts 1-6 and 317 BS 5669 Part 4 Partially Replaced by BS EN 634-2 & BS EN 1328 BS 5669 Part 5 Withdrawn Replaced by BS 7916 |
| 813 | CHIPBOARD (CONT.1 )                     | 68763 |             |  |         |   |  |

| SRN | SUBJECT                                       | DIN   | PART | BSS                  | PART    | OTHER  | REMARKS   |
|-----|---|-------|------|----------------------|---------|--|---|
| 813 | CHIPBOARD (CONT. 2)                           | 68764 |      |                      |         |  |   |
| 814 | LAMINATED PLASTIC SHEETING                    | 16922 |      | 3794                 |         | BS EN 438  | BS 3794 Withdrawn<br>Replaced by BS EN 438 Parts 1 & 2  |
| 814 | LAMINATED PLASTIC SHEETING (CONT. 1)          |       |      |                      |         |  |   |
| 814 | LAMINATED PLASTIC SHEETING (CONT. 2)          |       |      |                      |         |  |   |
| 815 | WOOD WOOL SLABS                               | 1101  |      | 1105                 |         |  | BS 1105 Obsolescent   |
| 815 | WOOD WOOL SLABS (CONT. 1)                     | 1102  |      |                      |         |  |   |
| 816 | QUALITY OF TIMBER – WORKMANSHIP               | 68141 |      | 1186                 | 2       |  |   |
| 817 | MATERIAL FOR FLUSH DOORS                      | 68706 |      | 459                  |         |  | BS 459 Part 3 Withdrawn   |
| 817 | MATERIAL FOR FLUSH DOORS (CONT. 1)            | 18101 |      |                      |         |  |   |
| 817 | MATERIAL FOR FLUSH DOORS (CONT. 2)            |       |      |                      |         |  |   |
| 818 | WATERPROOF ADHESIVE                           | 53255 |      | 1203                 | TYPE MR |  |   |
| 819 | STRUCTURAL STEEL & METALWORK                  |       |      | 4360<br>7316<br>7668 |         | ISO 630, 6891<br>BS EN 10029: 1-3<br>BS EN 10113<br>BS EN 10155<br>BS EN 10210-1 | BS 4360 Withdrawn - Replaced by<br>BS 7316, BS 7668,<br>BS EN 10029 Parts 1 to 3<br>BS EN 10113, BS EN 10155 and<br>BS EN 10210-1 |
| 819 | STRUCTURAL STEEL & METALWORK (CONT. 1)        |       |      |                      |         | JIS G30101-87  |   |
| 820 | SPLIT RING TIMBER CONNECTORS                  |       |      | 1579                 |         |  |   |
| 821 | METAL WINDOWS                                 |       |      | 6510                 |         |  |   |
| 822 | GLASS FOR GLAZING                             | 1249  | 1    | 952                  | 1       |  |   |
| 822 | GLASS FOR GLAZING (CONT.)                     | 18301 |      |                      |         |  |   |
| 823 | GALVANISED M.S. TUBING (MILD STEEL)           | 2440  |      | 1387                 |         | ISO 65, 7/1, 7/2   |   |
| 823 | GALVANISED M.S. TUBING (MILD STEEL) (CONT. 1) | 2441  |      | 21                   |         |  |   |
| 823 | GALVANISED M.S. TUBING (MILD STEEL) (CONT. 2) | 2442  |      |                      |         |  |   |
| 823 | GALVANISED M.S. TUBING (MILD STEEL) (CONT. 3) | 2999  | 1    |                      |         |  |   |
| 824 | FITTINGS TO M.S. TUBING MILD STEEL            | 2460  |      | 1256, 143            |         |  |   |
| 824 | FITTINGS TO M.S. TUBING MILD STEEL (CONT. 1)  |       |      | 143                  |         | BS EN 10242  |   |
| 824 | FITTINGS TO M.S. TUBING MILD STEEL (CONT. 2)  |       |      | 1740                 | 1       |  |   |
| 825 | POLYTHENE TUBING FOR COLD WATER SERVICES      | 19533 |      | 2782                 |         | ISO 161-1<br>BS ISO 4065<br>BS ISO 11922-1                                       |   |

| SRN | SUBJECT  | DIN     | PART | BSS          | PART   | OTHER       | REMARKS                                      |
|-----|--|---------|------|--------------|--------|-------------|--|
| 825 | POLYTHENE TUBING FOR COLD WATER SERVICES (CONT. 1) | 8072    |      | 6572<br>6730 |        |             |  |
| 825 | POLYTHENE TUBING FOR COLD WATER SERVICES (CONT. 2) | 8073    |      |              |        |             |  |
| 825 | POLYTHENE TUBING FOR COLD WATER SERVICES (CONT. 3) | 8075    |      |              |        |             |  |
| 825 | POLYTHENE TUBING FOR COLD WATER SERVICES (CONT. 4) | 8074    |      |              |        |             |  |
| 826 | BRASSWORK & FITTINGS FOR TAPS & STOP VALVES        |         |      | 1010         | 2      |             |  |
| 827 | BALL VALVES FOR CISTERNS                           |         |      | 1212         | 3      |             |  |
| 828 | PLASTIC FLOATS FOR BALL VALVES                     |         |      | 2456         |        |             |  |
| 829 | CAST IRON SOIL, WASTE & VENT PIPES                 |         |      | 416          |        |             |  |
| 829 | CAST IRON SOIL, WASTE & VENT PIPES<br>(CONT. 1)    |         |      |              |        |             |  |
| 829 | CAST IRON SOIL, WASTE & VENT PIPES (CONT. 2)       |         |      |              |        |             |  |
| 829 | CAST IRON SOIL, WASTE & VENT PIPES (CONT. 3)       | 19522   | 1, 2 |              |        |             |  |
| 830 | GALVANISED MILD STEEL COLD WATER TANKS             |         |      | 417          | 2 CL.A |             |  |
| 831 | ENAMELLED CAST IRON BATH                           |         |      | 1189         |        |             |  |
| 831 | ENAMELLED CAST IRON BATH (CONT. 1)                 |         |      |              |        |             |  |
| 831 | ENAMELLED CAST IRON BATH (CONT. 2)                 | 4774    |      |              |        |             |  |
| 832 | PILLAR TAPS  | 7572    |      | 1010         | 2      |             |  |
| 833 | GLAZED VITREOUS CHINA W.C. PAN                     | 1387    |      | 5503         |        |             |  |
| 833 | GLAZED VITREOUS CHINA W.C. PAN (CONT.)             | 1381    |      |              |        |             |  |
| 834 | HINGED PLASTIC SEAT TO W.C. PAN                    |         |      | 1254         |        |             |  |
| 835 | GLAZED VITREOUS CHINA LAVATORY BASIN               | 4462    |      | 1188         |        |             |  |
| 835 | GLAZED VITREOUS CHINA LAVATORY BASIN (CONT.)       |         |      | 5506         | 2      |             |  |
| 836 | STAINLESS STEEL SINK                               | 4465    |      | 1244         | 2      |             |  |
| 837 | BRASS "S" AND "P" TRAPS                            |         |      | 1184         |        |             | BS 1184 Obsolescent                          |
| 839 | A/C DRAIN PIPES AND FITTINGS                       | 19831   |      | 3656         |        | BS EN 588-1 | BS 3656 Withdrawn<br>Replaced by BS EN 588-1 |
| 839 | A/C DRAIN PIPES AND FITTINGS (CONT. 1)             | 19841   |      |              |        |             |  |
| 839 | A/C DRAIN PIPES AND FITTINGS (CONT. 2)             | 19850   | 1, 2 |              |        |             |  |
| 840 | CONCRETE DRAIN PIPES                               | See 409 |      | 2870         |        |             |  |
| 841 | PITCH FIBRE DRAIN PIPES                            |         |      | 2760         |        |             | BS 2760 Withdrawn                            |
| 842 | CAST IRON DRAIN PIPES                              | 19500   |      | 437          |        | ISO 6594    |  |
| 842 | CAST IRON DRAIN PIPES (CONT.)                      | 19501   |      |              |        |             |  |

| SRN | SUBJECT   | DIN    | PART    | BSS     | PART       | OTHER     | REMARKS                                   |
|-----|---|--------|---------|---------|------------|-----------|---|
|     | 1)  |        |         |         |            |           |   |
| 842 | CAST IRON DRAIN PIPES (CONT. 2)                 | 19502  |         |         |            |           |   |
| 842 | CAST IRON DRAIN PIPES (CONT. 3)                 | 19503  |         |         |            |           |   |
| 842 | CAST IRON DRAIN PIPES (CONT. 4)                 | 19504  |         |         |            |           |   |
| 842 | CAST IRON DRAIN PIPES (CONT. 5)                 | 19505  |         |         |            |           |   |
| 842 | CAST IRON DRAIN PIPES (CONT. 6)                 | 19506  |         |         |            |           |   |
| 842 | CAST IRON DRAIN PIPES (CONT. 7)                 | 19507  |         |         |            |           |   |
| 842 | CAST IRON DRAIN PIPES (CONT. 8)                 | 19508  |         |         |            |           |   |
| 842 | CAST IRON DRAIN PIPES (CONT. 9)                 | 19509  |         |         |            |           |   |
| 842 | CAST IRON DRAIN PIPES (CONT. 10)                | 195010 |         |         |            |           |   |
| 842 | CAST IRON DRAIN PIPES (CONT. 11)                | 195011 |         |         |            |           |   |
| 842 | CAST IRON DRAIN PIPES (CONT. 12)                | 195014 |         |         |            |           |   |
| 842 | CAST IRON DRAIN PIPES (CONT. 13)                | 195019 |         |         |            |           |   |
| 842 | CAST IRON DRAIN PIPES (CONT. 14)                | 19521  |         |         |            |           |   |
| 843 | JOINTING COMPOUND FOR C.I. DRAIN PIPES          |        |         | BS 6956 | 1, 5, 6, 7 |           |   |
| 844 | C.I. S & S FITTINGS FOR DRAINS                  | 19519  |         | 437     |            |           |   |
| 845 | STEP-IRONS TO MANHOLES & SEPTIC TANKS           | 1211   | 1       | 1247    |            |           |   |
| 845 | STEP-IRONS TO MANHOLES & SEPTIC TANKS (CONT. 1) | 1212   | 1       |         |            |           |   |
| 845 | STEP-IRONS TO MANHOLES & SEPTIC TANKS (CONT. 2) | 1213   |         |         |            |           |   |
| 845 | STEP-IRONS TO MANHOLES & SEPTIC TANKS (CONT. 3) | 4281   |         |         |            |           |   |
| 846 | C.I. MANHOLE COVERS AND FRAMES                  | 1229   |         | 497     | 1          | BS EN 124 | BS 497 Withdrawn<br>Replaced by BS EN 124 |
| 846 | C.I. MANHOLE COVERS AND FRAMES (CONT. 1)        | 4271   | 1, 3    |         |            |           |   |
| 846 | C.I. MANHOLE COVERS AND FRAMES (CONT. 2)        | 19593  | 1, 2, 3 |         |            |           |   |
| 846 | C.I. MANHOLE COVERS AND FRAMES (CONT. 3)        | 19594  | 1, 2    |         |            |           |   |
| 846 | C.I. MANHOLE COVERS AND FRAMES (CONT. 4)        | 19596  |         |         |            |           |   |
| 846 | C.I. MANHOLE COVERS AND FRAMES (CONT. 5)        | 19597  |         |         |            |           |   |
| 847 | STEEL LADDERS FOR PERMANENT ACCESS              | 3620   |         | 4211    |            |           |   |
| 848 | HANDRAILING                                     | 24533  |         | 6180    |            |           |   |
| 849 | GALVANISED CHAIN LINK FENCING                   | 11991  |         | 1722    | 1          |           |   |
| 850 | OPEN MESH STEEL FLOORING                        |        |         | 4592    | 1          |           |   |

| SRN | SUBJECT                                     | DIN   | PART | BSS           | PART | OTHER                               | REMARKS  |
|-----|---|-------|------|---------------|------|-------------------------------------|--|
| 851 | MASTIC ASPHALT FOR ROOFING                  |       |      | 6925          |      |                                     |  |
| 852 | ALUMINIUM FOR LOUVRE WINDOWS                |       |      | 1470          |      | BS EN 485<br>BS EN 515<br>BS EN 573 | BS 1470 Withdrawn<br>Replaced by BS EN 485 Parts 1-4,<br>BS EN 515, BS EN 573 Parts 1-4                                      |
| 853 | FIXING ACCESSORIES FOR BUILDING PURPOSES    |       |      | 1494          | 1    |                                     | BS 1494 Part 2 Withdrawn   |
| 854 | PRECAST CONCRETE MANHOLES                   | 4034  |      | 5911          | 2, 3 |                                     | BS 5911 Part 1 Withdrawn<br>Replaced by<br>BS 5911 Part 100 (1988)<br>BS 5911 Part 200 (1989) and<br>BS 5911 Part 200 (1994) |
| 855 | PRECAST CONCRETE KERBS & CHANNELS           | 483   |      | 7263          | 1    |                                     |  |
| 856 | WATERPROOF BUILDING PAPERS                  | 4122  |      | 1521          |      |                                     |  |
| 856 | WATERPROOF BUILDING PAPERS<br>(CONT. 1)     | 52126 |      |               |      |                                     |  |
| 856 | WATERPROOF BUILDING PAPERS<br>(CONT. 2)     | 52127 |      |               |      |                                     |  |
| 856 | WATERPROOF BUILDING PAPERS<br>(CONT. 3)     | 52128 |      |               |      |                                     |  |
| 856 | WATERPROOF BUILDING PAPERS<br>(CONT. 4)     | 52129 |      |               |      |                                     |  |
| 856 | WATERPROOF BUILDING PAPERS<br>(CONT. 5)     | 52130 |      |               |      |                                     |  |
| 857 | METAL TIES FOR CAVITY WALL                  |       |      | 1243          |      |                                     |  |
| 858 | A/C BUILDING PRODUCTS<br>(TESTS FOR SHEETS) | 274   | 1-4  | 4624          |      |                                     |  |
| 859 | PRECAST CONCRETE FLAGSTONES                 | 485   |      | 7263          | 1    |                                     |  |
| 860 | ASBESTOS CEMENT RAIN WATER GOODS            | 19831 | 1-9  | 569           |      |                                     |  |
| 860 | ASBESTOS CEMENT RAIN WATER GOODS (CONT. 1)  | 19841 | 1-6  |               |      |                                     |  |
| 860 | ASBESTOS CEMENT RAIN WATER GOODS (CONT. 2)  | 19850 | 1    |               |      |                                     |  |
| 861 | LINTELS - PREFABRICATED                     |       |      | 5977          | 2    |                                     |  |
| 862 | uPVC SOIL AND VENT PIPES, FITTINGS, ETC.    | 1187  |      | 4514          |      |                                     |  |
| 863 | STRUCTURAL STEEL IN BUILDINGS               |       |      | 449<br>(5950) | 2    |                                     | BS 449 Part 2 Withdrawn<br>Replaced by BS 5950 Part 5  |
| 864 | PROTECTIVE BARRIERS IN AND ABOUT BUILDINGS  |       |      | 6180          |      |                                     |  |
| 866 | BITUMENS FOR BUILDING & CIVIL ENGINEERING   |       |      | 3690          | 1, 3 |                                     |  |
| 867 | SOLAR WATER HEATERS                         |       |      |               |      | AS 2813-85                          |  |
| 868 | FLOORING - INITIAL TREATMENT MAINTENANCE    |       |      | 6263          | 2    |                                     |  |
| 869 | RIGID FLAT SHEET BUILDING MATERIALS         |       |      |               |      |                                     |  |

| SRN | SUBJECT  | DIN | PART | BSS                     | PART     | OTHER     | REMARKS  |
|-----|--|-----|------|-------------------------|----------|-----------|--|
| 870 | BUILDING STONE   |     |      | 1438                    |          |           |  |
| 871 | CAST STONE   |     |      | 1217                    |          |           |  |
| 872 | WOOD PRESERVATIVES – CREOSOTE  |     |      | 144                     |          |           |  |
| 873 | WASTE TRAPS - PLASTIC  |     |      | 3943                    |          |           |  |
| 874 | COPPER FLOATS FOR FLOAT OPERATED VALVES  |     |      | 1968                    |          |           |  |
| 875 | VITREOUS CHINA SANITARY FITTINGS   |     |      | 3402                    |          |           |  |
| 876 | PAINTS - LEAD BASED  |     |      | 2523<br>(5082,<br>5358) |          |           | BS 2523 Obsolescent, Partially Replaced by BS 5082 and BS 5358         |
| 877 | READY MIXED OIL-BASED PRIMING PAINTS   |     |      | 2521/4<br>(See<br>2523) |          |           |  |
| 878 | READY MIXED OIL-BASED UNDERCOATING AND FINISHING PAINTS  |     |      |                         |          |           |  |
| 879 | COLD POURED SEALING MATERIALS FOR CONCRETE PAVEMENTS   |     |      | 5212                    |          |           |  |
| 880 | GULLY TOPS AND MANHOLE TOPS FOR VEHICULAR PEDESTRIAN AREAS, DESIGN REQUIREMENTS, TYPE TESTING, MARKING QUALITY CONTROL |     |      |                         |          | BS EN 124 |  |
| 881 | STRUCTURAL TIMBER. STRENGTH CLASSES  |     |      | 338                     |          |           |  |
| 882 | CLAY ROOFING TILES AND FITTINGS  |     |      | 402                     | 1        |           | Part 1: Specification for plain tiles and fittings                     |
| 883 | BITUMEN ROAD EMULSIONS (ANIONIC AND CATIONIC)  |     |      | 434                     | 1        |           | Part 1: Bitumen road emulsions   |
| 884 | DRESSED NATURAL STONE KERBS, CHANNELS, QUADRANTS AND SETTS   |     |      | 435                     |          |           |  |
| 885 | CONCRETE ROOFING TILES AND FITTINGS. PRODUCT SPECIFICATION   |     |      |                         |          | BS EN 490 |  |
| 886 | AIR BRICKS AND GRATINGS FOR WALL VENTILATION   |     |      | 493                     |          |           |  |
| 887 | EAVES GUTTERS AND FITTINGS MADE OF PVC-C   |     |      |                         |          | BS EN 607 |  |
| 888 | EAVES GUTTERS AND RAINWATER DOWN-PIPES OF METAL SHEET  |     |      |                         |          | BS EN 612 |  |
| 889 | PLYWOOD  |     |      |                         |          | BS EN 635 |  |
| 890 | TIMBER IN JOINERY  |     |      |                         |          | BS EN 942 |  |
| 891 | PRESSED STEEL GUTTERS, RAINWATER PIPES, FITTINGS AND ACCESSORIES   |     |      | 1091                    |          |           |  |
| 892 | WC FLUSHING CISTERNS (INCLUDING DUAL FLUSH CISTERNS AND FLUSH PIPES)   |     |      | 1125                    |          |           |  |
| 893 | NAILS  |     |      | 1202                    | 1, 2 & 3 |           | Part 1: Steel nails<br>Part 2: Copper nails<br>Part 3: Aluminium nails |
| 893 | FIXING ACCESSORIES FOR BUILDING PURPOSES   |     |      | 1494                    | 1        |           | Part 1 Fixings for sheet, roof and wall coverings                      |

| SRN    | SUBJECT   | DIN | PART | BSS  | PART           | OTHER | REMARKS  |
|--------|---|-----|------|------|----------------|-------|--|
| 894    | AUTOMATIC FLUSHING CISTERNS FOR URINALS                                 |     |      | 1876 |                |       |  |
| 895    | WASTES (EXCLUDING SKELETON SINK WASTES) AND BATH OVERFLOWS              |     |      | 3380 |                |       |  |
| 896    | LIGHTWEIGHT AGGREGATES FOR MASONRY UNITS AND STRUCTURAL CONCRETE        |     |      | 3797 |                |       |  |
| 897    | TERRAZO TILES   |     |      | 4131 |                |       |  |
| 898    | WELDABLE STRUCTURAL STEELS  |     |      | 4360 |                |       |  |
| 899.1  | UNPLASTICIZED POLYVINYL CHLRIDE (PVC-U) RAINWATER GOODS AND ACCESSORIES |     |      | 4576 |                |       |  |
| 899.2  | INDUSTRIAL TYPE METAL FLOORING, WALKWAYS AND STAIRS TREADS              |     |      | 4592 | 1, 2, 3 & 4    |       | Part 1: Open bar gratings<br>Part 2: Expanded metal grating panels<br>Part 3: Cold formed planks<br>Part 4: Glass reinforced plastics open bar gratings  |
| 899.3  | READY-MIX BUILDING MORTARS  |     |      | 4721 |                |       |  |
| 899.4  | INTERNAL AND EXTERNAL WOOD DOORSETS, DOOR LEAVES AND FRAMES             |     |      | 4787 | 1              |       | Part 1: Dimensional requirements   |
| 899.5  | HOT-ROLLED STRUCTURAL STEEL SECTIONS                                    |     |      | 4848 | 2 & 4          |       | Part 2: Hot-finished hollow sections<br>Part 4: Equal and unequal angles   |
| 899.6  | URINALS   |     |      | 4880 | 1              |       | Part 1: Stainless steel slab urinals   |
| 899.7  | MORTAR ADMIXTURES   |     |      | 4887 | 1 & 2          |       | Part 1: Air-entraining (plasticizing) admixtures<br>Part 2: Set retarding admixtures   |
| 899.8  | SOFTWOOD GRADES FOR STRUCTURAL USE                                      |     |      | 4978 |                |       |  |
| 899.9  | COATED MACADAM FOR ROADS AND OTHER PAVED AREAS                          |     |      | 4987 | 1 & 2          |       | Part 1: Constituent materials and mixtures<br>Part 2: Transport, laying and compaction   |
| 899.10 | WATER-BORNE PRIMING PAINTS FOR WOODWORK                                 |     |      | 5082 |                |       |  |
| 899.11 | MASONRY CEMENT  |     |      | 5224 |                |       |  |
| 899.12 | EXTERNAL RENDERINGS   |     |      | 5262 |                |       |  |
| 899.13 | SOLVENT-BORNE PRIMING PAINTS FOR WOODWORK                               |     |      | 5358 |                |       |  |
| 899.14 | WALL AND FLOOR TILING   |     |      | 5385 | 1, 2, 3, 4 & 5 |       | Part 1: Design and installation of internal ceramic wall tiling and mosaics in normal conditions<br>Part 2: Design and installation of external ceramic wall tiling and mosaics (including terra cotta and faience tiles)<br>Part 3: Design and installation of ceramic floor tiles and mosaics<br>Part 4: Tiling and mosaics in specific conditions<br>Part 5: Design and installation of terrazzo tile and slab, natural stone and composition block floorings |

| SRN    | SUBJECT   | DIN | PART | BSS  | PART  | OTHER | REMARKS  |
|--------|---|-----|------|------|-------|-------|--|
| 899.15 | STONE MASONRY   |     |      | 5390 |       |       |  |
| 899.16 | SPECIFICATION FOR LOW-RESISTANCE SINGLE TAPS AND COMBINATION TAP ASSEMBLIES (NOMINAL SIZE ½ AND ¾) SUITABLE FOR OPERATION AT PN 10 MAX. AND A MINIMUM FLOW PRESSURE OF 0.01 MPa (0.1 BAR) |     |      | 5412 |       |       |  |
| 899.17 | VITREOUS CHINA WASHDOWN WC PANS WITH HORIZONTAL OUTLET  |     |      | 5503 | 1 & 2 |       | Part 1: Connecting dimensions<br>Part 2: Materials, quality, performance and dimensions other than connecting dimensions |
| 899.18 | VITREOUS CHINA BOWL URINALS (RIMLESS TYPE)  |     |      | 5520 |       |       |  |
| 899.19 | PRESERVATION OF TIMBER  |     |      | 5589 |       |       |  |
| 899.20 | PLASTIC CONNECTORS FOR USE WITH HORIZONTAL OUTLET VITREOUS CHINA WC PANS  |     |      | 5627 |       |       |  |
| 899.21 | STILES, BRIDLE GATES AND KISSING GATES  |     |      | 5709 |       |       |  |
| 899.22 | GLAZING FOR BUILDINGS   |     |      | 6262 |       |       |  |
| 899.23 | MANUFACTURE OF GLUED STRUCTURAL COMPONENTS FOR TIMBER AND WOOD BASED PANEL PRODUCTS   |     |      | 6446 |       |       |  |
| 899.24 | POLYETHYLENE DAMP-PROOF COURSES FOR MASONRY   |     |      | 6515 |       |       |  |
| 899.25 | INSTALLATION OF CHMICAL DAMP-PROOF COURSES  |     |      | 6576 |       |       |  |
| 899.26 | PORTLAND PULVERIZED-FUEL ASH CEMENTS  |     |      | 6588 |       |       |  |
| 899.27 | PRECAST CONCRETE PAVING BLOCKS  |     |      | 6717 | 1     |       | Part 1: Paving blocks  |
| 899.28 | EXTERIOR WOOD COATING SYSTEMS   |     |      | 6952 | 1     |       | Part 1: Guide to classification and selection  |
| 899.29 | PRECAST CONCRETE FLAGS, KERBS, CHANNELS, EDGINGS AND QUADRANTS  |     |      | 7263 | 1 & 2 |       | Part 1: Specification<br>Part 2: Code of practice for laying   |
| 899.30 | IN-SITU FLOORINGS   |     |      | 8204 | 2     |       | Part 2: Concrete wearing surfaces  |

**3.11 MISCELLANEOUS**

| SRN | SUBJECT   | DIN        | PART     | BSS  | PART     | OTHER                          | REMARKS  |
|-----|---|------------|----------|------|----------|--------------------------------|--|
| 900 | ZINC SPRAY PROTECTION   | 55928      | 1-9      | 2569 | 1        | ISO 2063<br>BS EN 22063        | BS 2569 Withdrawn<br>Replaced by BS EN 22063   |
| 900 | ZINC SPRAY PROTECTION<br>(CONT.)                                  |            |          | 5493 |          | BS EN ISO<br>12944             | BS 5493 Proposed for<br>Obsolescence<br><br>Partially Replaced by Parts 1-8<br>of<br>BS EN ISO 12944         |
| 901 | METALLIC ZINC RICH PRIMER   |            |          | 4652 |          |                                |  |
| 902 | COLOUR OF FINISH (BUILDING<br>MATERIALS)                          | See<br>VOB |          | 4800 |          | VOB pt. C                      |  |
| 903 | HOT DIP GALVANIZING ON IRON<br>& STEEL                            |            |          | 729  |          | ISO 1459                       |  |
| 903 | HOT DIP GALVANIZING ON IRON<br>& STEEL (CONT.)                    |            |          | 5493 |          | ISO 1461<br>BS EN ISO<br>12944 | BS 5493 Proposed for<br>Obsolescence<br><br>Partially Replaced by Parts 1-8<br>of<br>BS EN ISO 12944         |
| 904 | BLACK BITUMEN SOLUTION<br>(COLD APP.) FOR WATER TANKS             |            | See DVGW | 3416 | TYPE II  | DVGW-GWS                       |  |
| 905 | WELDABLE STRUCTURAL<br>STEELS                                     | 1025       | 1-5      | 4360 |          | ISO 630                        | BS 4360 Withdrawn -<br><br>Replaced by BS 7613, BS<br>7668,<br><br>BS EN 10113, BS EN 10155 &<br>BS EN 10210 |
| 906 | CLASSIFICATION OF GREY CAST<br>IRON                               |            |          | 1452 |          | ISO 185                        | BS 1452 Withdrawn<br>Replaced by BS EN 1561  |
| 907 | BEARING DESIGN LIFE   |            |          |      |          |                                |  |
| 908 | BITUMEN - HOT APPLIED -<br>COATINGS FOR IRON AND STEEL            | 30673      |          | 4147 |          |                                |  |
| 908 | BITUMEN - HOT APPLIED -<br>COATINGS FOR IRON AND STEEL<br>(CONT.) |            |          | 5493 |          |                                |  |
| 909 | PRESSED STEEL RECTANGULAR<br>TANKS                                |            |          | 1564 |          |                                |  |
| 910 | GREY IRON CASTINGS FOR<br>MANHOLE COVERS                          |            |          | 1452 | GRADE 10 |                                |  |
| 911 | MALLEABLE CAST IRON   |            |          | 6681 |          | ISO 5922                       | BS 6681 Withdrawn -<br>Replaced by BS EN 1562  |
| 911 | MALLEABLE CAST IRON (CONT.)                                       |            |          |      |          | ASTM A 47-77                   |  |
| 912 | ROLLED STEEL  |            |          | 4360 |          | ISO 630                        | BS 4360 Withdrawn -<br><br>Replaced by BS 7613, BS<br>7668,<br><br>BS EN 10113, BS EN 10155 &<br>BS EN 10210 |
| 912 | ROLLED STEEL (CONT.)  |            |          |      |          |                                |  |
| 913 | STRUCTURAL STEEL SECTIONS   | 1025       | 1-5      | 4    | 1        |                                | BS 4 Part 2 (1969) Withdrawn<br>Replaced by BS 4848 Part 2   |
| 914 | ISO METRIC BLACK HEXAGONAL<br>BOLTS, SCREWS AND NUTS              | 267        | 1, 2     | 4190 |          | ISO 272, 4759-<br>1, 3         | BS 4160 Obsolescent  |
| 914 | ISO METRIC BLACK HEXAGONAL<br>BOLTS, SCREWS AND NUTS<br>(CONT 1)  |            |          |      |          | ISO 885, 888                   |  |

| SRN | SUBJECT  | DIN   | PART | BSS  | PART          | OTHER                               | REMARKS   |
|-----|--|-------|------|------|---------------|-------------------------------------|---|
| 914 | ISO METRIC BLACK HEXAGONAL BOLTS, SCREWS AND NUTS (CONT 2) |       |      |      |               | ISO 898/2, 898/1                    |   |
| 915 | SIZES FOR FERROUS & NON-FERROUS BARS                       |       |      | 6722 |               |                                     |   |
| 916 | MECHANITE IRON, GRADE E                                    |       |      |      |               | ASTM A48, No. 308                   |   |
| 917 | CORROSION PROTECTION OF STEEL STRUCTURES - GENERAL         | 55928 | 1-9  | 5493 |               | BS EN ISO 12944                     | BS 5493 Proposed for Obsolescence<br>Partially Replaced by Parts 1-8 of<br>BS EN ISO 12944  |
| 918 | INGOT ZINC   |       |      | 3436 |               | ISO 752<br>BS EN 1179 (1996)        | BS 3436 Withdrawn<br>Replaced by BS EN 1179 (1996)  |
| 919 | WELDING OF STEELS (METAL ARC)                              | 8528  | 1-2  | 5135 | 1             |                                     | BS 5135 Partially Replaced by BS EN 1011-1 (1998)   |
| 919 | WELDING OF STEELS (METAL ARC) (CONT 1)                     | 8553  |      | 499  | 1             |                                     | BS 499 Part Obsolescent / Withdrawn   |
| 919 | WELDING OF STEELS (METAL ARC) (CONT 2)                     | 8558  | 1    |      |               |                                     |   |
| 919 | WELDING OF STEELS (METAL ARC) (CONT 3)                     | 50120 | 1    |      |               |                                     |   |
| 920 | STEEL PLATE, SHEET AND STRIP                               |       |      | 1449 | 1 (Withdrawn) | ISO 3573                            | BS 1499 Parts Withdrawn<br>Replaced by BS EN 10111, 10209,<br>BS EN 10149-2 & 3, 10051, 10131, 10139, 10149-2 & 3, 10048, 10140, 10029, 10258 & 10259 |
| 920 | STEEL PLATE, SHEET AND STRIP (CONT 1)                      |       |      |      |               | ISO 3574                            |   |
| 920 | STEEL PLATE, SHEET AND STRIP (CONT 2)                      |       |      |      |               |                                     |   |
| 920 | STEEL PLATE, SHEET AND STRIP (CONT 3)                      |       |      |      |               |                                     |   |
| 920 | STEEL PLATE, SHEET AND STRIP (CONT 4)                      |       |      |      |               |                                     |   |
| 920 | STEEL PLATE, SHEET AND STRIP (CONT 5)                      |       |      |      |               |                                     |   |
| 920 | STEEL PLATE, SHEET AND STRIP (CONT 6)                      | 1614  |      |      |               |                                     |   |
| 920 | STEEL PLATE, SHEET AND STRIP (CONT 7)                      | 1632  | 2    |      |               |                                     |   |
| 920 | STEEL PLATE, SHEET AND STRIP (CONT 8)                      | 1624  |      |      |               |                                     |   |
| 921 | ELECTROPLATED COATINGS ON THREADS - STANDARD               |       |      | 3382 | 1-6           |                                     |   |
| 922 | ELECTROPLATED COATINGS ON THREADS - THICKENED              |       |      | 3382 | 7             | ISO-DIS 4042                        |   |
| 923 | ISO METRIC SCREW THREADS                                   |       |      | 3643 | 1-2           | ISO 68, 261, 724, 965/1, 965/3, 262 |   |
| 923 | ISO METRIC SCREW THREADS (CONT)                            |       |      |      |               | ISO 1106-3, 7438                    |   |

| SRN | SUBJECT   | DIN   | PART | BSS   | PART | OTHER                                    | REMARKS   |
|-----|---|-------|------|-------|------|--|---|
| 924 | ISO METRIC PRECISION HEXAGON BOLTS, SCREWS AND NUTS   |       |      | 3692  |      | ISO 887                                  | BS 3692 Obsolescent   |
| 925 | METAL WASHERS FOR GENERAL ENGINEERING   |       |      | 4320  |      | ASS 2602: 83<br>2603: 83 -<br>ISO/12 887 |   |
| 926 | STEEL STRUCTURES - PAINTS FOR POLYURETHANE  |       |      |       |      |  |   |
| 927 | SHEAR TEST FOR METALS   | 50141 |      |       |      |  |   |
| 928 | WELDED STEEL TANKS FOR OIL STORAGE  |       |      |       |      | APS 650                                  |   |
| 929 | LIFTING APPLIANCES - OVERHEAD TRAVELLING CRANES   |       |      |       |      | ISO 7752/5                               |   |
| 930 | HIGH STRENGTH FRICTION GRIP BOLTS   |       |      | 4325  |      |  |   |
| 931 | ELECTRODES FOR MANUAL ARC WELDING   |       |      | 639   |      | BS EN 499                                | BS 639 Withdrawn<br>Replaced by BS EN 499   |
| 932 | BLACK CUP COUNTERSUNK BOLTS, SCREWS WITH NUTS   |       |      | 4933  |      |  | BS 4933 Obsolescent   |
| 933 | METAL LATHING   |       |      | 1369  |      |  |   |
| 934 | ROLLED ASPHALT HOT PROCESS FOR ROADS  |       |      | 594   |      |  |   |
| 935 | BINDER DIST. FOR ROAD SURFACE DRESSING  |       |      | 1707  |      |  |   |
| 936 | BITUMINOUS ROOFING FELT   |       |      | 747   |      | CP 114: 3                                | CP 114:3 Withdrawn  |
| 937 | GAS WELDING   |       |      | 2640  |      |  |   |
| 938 | METALLIC COATINGS. HOT DIP GALVANISED COATINGS ON FERROUS MATERIALS   |       |      |       |      | BS EN 1460                               |   |
| 939 | METHOD FOR SPECIFYING ELECTROPLATED COATINGS OF ZINC AND CADMIUM ON IRON AND STEEL  |       |      | 1706  |      |  |   |
| 940 | DIMENSIONS OF GASKETS FOR PIPE FLANGES TO BS 4504   |       |      | 4865  | 1    |  | Part 1: Non-metallic flat gaskets (including gaskets for flanges to BS 4722)                          |
| 941 | BONDING AGENTS FOR USE WITH GYPSUM PLASTERS AND CEMENT  |       |      | 5270  | 1    |  | Part 1: Polyvinyl acetate (PVAC) emulsion bonding agents for indoor use with gypsum building plasters |
| 942 | FALSEWORK   |       |      | 5975  |      |  |   |
| 943 | TUBULAR POLYETHYLENE FILM FOR USE AS A PROTECTIVE SLEEVING FOR BURIED IRON PIPES AND FITTINGS   |       |      | 6076  |      |  |   |
| 944 | FLEXIBLE JOINTS FOR GREY OR DUCTILE CAST IRON DRAINPIPES AND FITTINGS (BS 437) AND FOR DISCHARGE AND VIENTILATING PIPES AND FITTINGS (BS 416) |       |      | 6087  |      |  |   |
| 945 | HOT ROLLED PRODUCTS OF NON-ALLOY STRUCTURAL STEELS  |       |      | 10025 |      |  |   |
| 946 | STAINLESS STEELS  |       |      | 10088 | 2    |  | Part 2: Technical delivery conditions for sheet/plate and strip for general purposes                  |

4.1 **DIN**

| DIN  | SRN | DIN  | SRN | DIN  | SRN | DIN   | SRN | DIN   | SRN |
|------|-----|------|-----|------|-----|-------|-----|-------|-----|
| 105  | 806 | 2000 | 651 | 2988 | 204 | 4279  | 405 | 19630 | 651 |
| 106  | 806 | 2403 | 700 | 2990 | 204 | 4279  | 602 | 19648 | 510 |
| 267  | 914 | 2406 | 701 | 2991 | 204 | 4281  | 845 | 19800 | 401 |
| 278  | 805 | 2410 | 213 | 2993 | 204 | 4325  | 017 | 19850 | 402 |
| 459  | 119 | 2413 | 210 | 2999 | 203 | 4325  | 016 | 19850 | 839 |
| 483  | 855 | 2413 | 228 | 2999 | 823 | 7572  | 832 | 19850 | 860 |
| 488  | 128 | 2425 | 708 | 3202 | 502 | 7865  | 138 | 22418 | 036 |
| 488  | 127 | 2425 | 651 | 3202 | 505 | 8061  | 305 | 28500 | 201 |
| 488  | 126 | 2429 | 701 | 3202 | 501 | 8061  | 314 | 28500 | 200 |
| 488  | 125 | 2440 | 203 | 3221 | 509 | 8061  | 313 | 28601 | 217 |
| 1025 | 905 | 2440 | 823 | 3230 | 501 | 8062  | 300 | 28602 | 218 |
| 1025 | 913 | 2441 | 203 | 3352 | 501 | 8062  | 305 | 28603 | 219 |
| 1045 | 108 | 2441 | 823 | 3352 | 502 | 8063  | 301 | 30670 | 227 |
| 1045 | 107 | 2442 | 203 | 3352 | 511 | 8072  | 825 | 30671 | 215 |
| 1045 | 110 | 2442 | 823 | 3354 | 506 | 8073  | 825 | 30672 | 221 |
| 1045 | 120 | 2444 | 225 | 3356 | 504 | 8074  | 825 | 30673 | 214 |
| 1045 | 111 | 2448 | 213 | 3357 | 514 | 8075  | 825 | 30673 | 908 |
| 1045 | 113 | 2458 | 213 | 3441 | 515 | 8528  | 919 | 30674 | 220 |
| 1045 | 112 | 2460 | 210 | 3620 | 847 | 8553  | 919 | 40050 | 012 |
| 1048 | 116 | 2460 | 213 | 4030 | 114 | 855   | 919 | 40050 | 030 |
| 1048 | 117 | 2460 | 824 | 4032 | 407 | 8564  | 600 | 42021 | 001 |
| 1060 | 801 | 2500 | 207 | 4032 | 409 | 8565  | 220 | 42673 | 010 |
| 1084 | 115 | 2501 | 207 | 4033 | 655 | 1045  | 100 | 42673 | 011 |
| 1084 | 121 | 2505 | 216 | 4034 | 854 | 16450 | 301 | 42961 | 029 |
| 1084 | 133 | 2519 | 207 | 4035 | 409 | 16451 | 301 | 46062 | 008 |
| 1101 | 815 | 2526 | 207 | 4035 | 408 | 16922 | 814 | 46062 | 013 |
| 1102 | 815 | 2559 | 210 | 4046 | 651 | 16928 | 302 | 50019 | 709 |
| 1164 | 103 | 2566 | 207 | 4060 | 222 | 16963 | 307 | 50120 | 600 |
| 1164 | 106 | 2605 | 226 | 4078 | 811 | 16970 | 304 | 50120 | 919 |
| 1164 | 105 | 2615 | 226 | 4085 | 667 | 18101 | 817 | 50141 | 927 |
| 1164 | 104 | 2615 | 216 | 4124 | 654 | 18195 | 668 | 50976 | 903 |
| 1187 | 862 | 2616 | 226 | 4126 | 145 | 18196 | 601 | 52128 | 856 |
| 1199 | 849 | 2616 | 216 | 4226 | 109 | 18196 | 650 | 52129 | 856 |
| 1211 | 845 | 2617 | 216 | 4226 | 110 | 18203 | 657 | 52130 | 856 |
| 1212 | 845 | 2617 | 226 | 4226 | 108 | 18301 | 822 | 53255 | 818 |
| 1229 | 846 | 2632 | 207 | 4226 | 107 | 18307 | 650 | 55928 | 900 |
| 1230 | 414 | 2633 | 207 | 4226 | 130 | 18330 | 656 | 55928 | 917 |
| 1249 | 822 | 2673 | 207 | 4226 | 111 | 18540 | 812 | 57207 | 024 |
| 1381 | 833 | 2693 | 208 | 4226 | 136 | 19522 | 829 | 57660 | 027 |
| 1387 | 833 | 2695 | 208 | 4226 | 114 | 19532 | 300 | 57670 | 020 |
| 1614 | 920 | 2696 | 208 | 4226 | 113 | 19532 | 305 | 68705 | 811 |
| 1623 | 920 | 2697 | 208 | 4226 | 112 | 19533 | 825 | 68706 | 817 |
| 1624 | 920 | 2873 | 221 | 4226 | 135 | 19593 | 846 | 68761 | 813 |

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| DIN  | SRN | DIN  | SRN | DIN  | SRN | DIN   | SRN | DIN   | SRN |
|------|-----|------|-----|------|-----|-------|-----|-------|-----|
| 1626 | 213 | 2950 | 209 | 4235 | 132 | 19594 | 846 | 68763 | 813 |
| 1629 | 213 | 2980 | 204 | 4271 | 846 | 19596 | 846 | 68764 | 813 |
| 1754 | 205 | 2986 | 203 | 4279 | 202 | 19597 | 846 | 68791 | 131 |
| 1986 | 652 | 2987 | 204 | 4279 | 303 | 19630 | 653 | 68792 | 131 |

4.2 **BSS**

| BSS       | SRN | BSS         | SRN | BSS         | SRN | BSS  | SRN | BSS  | SRN |
|-----------|-----|-------------|-----|-------------|-----|------|-----|------|-----|
| 4         | 913 | 1188        | 835 | 2494        | 308 | 4466 | 129 | 5486 | 020 |
| 12        | 103 | 1189        | 831 | 2499        | 137 | 4483 | 128 | 5493 | 900 |
| 12        | 106 | 1192        | 703 | 2439        | 122 | 4504 | 207 | 5493 | 908 |
| 12        | 105 | 1192        | 704 | 2569        | 900 | 4514 | 862 | 5493 | 917 |
| 21        | 203 | 5911        | 410 | 2640        | 937 | 6811 | 012 | 5506 | 835 |
| 21        | 223 | 1199        | 130 | 2757        | 023 | 4550 | 603 | 5514 | 021 |
| 21        | 823 | 1199        | 136 | 2871        | 206 | 4568 | 052 | 5626 | 045 |
| 5685      | 014 | 1200        | 135 | 2871        | 205 | 4592 | 850 | 5642 | 142 |
| 65        | 414 | 1203        | 818 | 3148        | 114 | 4607 | 054 | 5669 | 813 |
| 78 (4772) | 224 | 1211 (4772) | 200 | 3284 (6811) | 307 | 4622 | 200 | 5685 | 015 |
| 143       | 824 | 1212        | 508 | 3382        | 921 | 4624 | 401 | 5728 | 510 |
| 144       | 872 | 1212        | 827 | 3382        | 922 | 4624 | 858 | 5834 | 513 |
| 159       | 053 | 1217        | 871 | 3402        | 875 | 4625 | 408 | 5856 | 009 |
| 308       | 705 | 1243        | 857 | 3416        | 904 | 4652 | 901 | 5886 | 405 |
| 336       | 512 | 1244        | 836 | 3444        | 810 | 4660 | 309 | 5911 | 407 |
| 368       | 859 | 1247        | 845 | 3505        | 311 | 4670 | 938 | 5911 | 409 |
| 410       | 146 | 1254        | 834 | 3505        | 310 | 4800 | 902 | 5911 | 413 |
| 416       | 829 | 1256        | 824 | 3505        | 300 | 4870 | 670 | 5911 | 854 |
| 417       | 830 | 1363        | 059 | 3505        | 305 | 4871 | 671 | 5927 | 404 |
| 437       | 844 | 1369        | 933 | 3505        | 312 | 4999 | 030 | 5930 | 650 |
| 437       | 842 | 1377        | 601 | 3506        | 305 | 4999 | 033 | 5977 | 861 |
| 459       | 817 | 1387        | 203 | 3535        | 028 | 4999 | 034 | 6004 | 055 |
| 499       | 919 | 1362        | 060 | 3600        | 213 | 4999 | 031 | 6072 | 600 |
| 534       | 210 | 1387        | 823 | 3600        | 228 | 4999 | 010 | 6073 | 804 |
| 534       | 212 | 1438        | 870 | 3601        | 213 | 4999 | 029 | 6100 | 707 |
| 569       | 860 | 1449        | 920 | 3643        | 923 | 4999 | 025 | 6100 | 750 |
| 594       | 934 | 1521        | 124 | 3656        | 839 | 5000 | 011 | 6180 | 864 |
| 604       | 150 | 1521        | 856 | 3676        | 058 | 5000 | 022 | 6231 | 041 |
| 690       | 807 | 1553        | 701 | 3680        | 661 | 5000 | 036 | 6263 | 868 |
| 729       | 903 | 1554        | 229 | 3690        | 866 | 5000 | 035 | 6282 | 505 |
| 743       | 803 | 1564        | 909 | 3692        | 924 | 5000 | 050 | 6297 | 659 |
| 747       | 936 | 1579        | 820 | 3889        | 600 | 5041 | 517 | 6316 | 660 |
| 750       | 509 | 1707        | 935 | 3921        | 805 | 5070 | 706 | 6346 | 024 |
| 775       | 061 | 1722        | 849 | 3921        | 806 | 5075 | 149 | 6367 | 664 |
| 812       | 107 | 1740        | 204 | 3941        | 003 | 5135 | 919 | 6398 | 804 |
| 812       | 112 | 1740        | 824 | 3943        | 873 | 5150 | 502 | 6431 | 802 |
| 812       | 113 | 1881        | 139 | 3988        | 063 | 5151 | 503 | 6464 | 317 |
| 842       | 005 | 1881        | 140 | 3974        | 406 | 5152 | 504 | 6500 | 056 |
| 882       | 108 | 1881        | 141 | 4027        | 104 | 5153 | 505 | 6510 | 821 |
| 882       | 109 | 1881        | 116 | 4147        | 214 | 5154 | 511 | 6626 | 037 |
| 882       | 110 | 1881        | 117 | 4147        | 908 | 5163 | 501 | 6722 | 915 |
| 882       | 111 | 1924        | 673 | 4211        | 847 | 5212 | 879 | 6746 | 024 |
| 890       | 801 | 1968        | 874 | 4248        | 148 | 5311 | 004 | 6925 | 851 |

| <b>BSS</b> | <b>SRN</b> | <b>BSS</b> | <b>SRN</b> | <b>BSS</b> | <b>SRN</b> | <b>BSS</b> | <b>SRN</b> | <b>BSS</b> | <b>SRN</b> |
|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| 952        | 822        | 2011       | 042        | 4293       | 006        | 5316       | 016        | 8007       | 102        |
| 1010       | 826        | 2048       | 001        | 4320       | 925        | 5316       | 017        | 8010       | 316        |
| 1010       | 832        | 2494       | 318        | 4335       | 702        | 5328       | 100        | 8110       | 101        |
| 1105       | 815        | 2521       | 877        | 4346       | 301        | 5328       | 115        | 8110       | 143        |
| 1142       | 809        | 2456       | 828        | 4395       | 930        | 8007       | 138        |            |            |
| 1186       | 816        | 2494       | 222        | 4449       | 126        | 5419       | 007        |            |            |
|            |            |            |            |            |            |            |            |            |            |

### 4.3 OTHER STANDARDS

| OTHER STANDARDS                        | SRN | OTHER STANDARDS                  | SRN |
|--|-----|----------------------------------|-----|
| AAS 2602:83, 2603:03                   | 926 | ISO 2035, 2044                   | 301 |
| AGMA 5T 510                            | 907 | ISO 2045, 2048, 2536             | 301 |
| ANSI A10 9-1983                        | 663 | ISO 2063                         | 900 |
| AP15LS                                 | 234 | ISO 2505, 3114, 3472, 3473, 3474 | 315 |
| APS 650                                | 928 | ISO 2531                         | 202 |
| AS 2813-85                             | 867 | ISO 2531                         | 207 |
| ASTM A 47-77                           | 911 | ISO 2548 ICE 198                 | 016 |
| ASTM A 48, No. 308                     | 916 | ISO 272, 4759-1, 3               | 914 |
| AWWA C. 508-82                         | 505 | ISO 3046, PARTS 1, 2             | 021 |
| AWWA C.104A, C602-76                   | 211 | ISO 3114, 3606                   | 300 |
| AWWA C.200-75                          | 210 | ISO 3127                         | 310 |
| AWWA C.200-75                          | 230 | ISO 4042                         | 922 |
| AWWA C.203-78                          | 221 | ISO 4179, 6600, DVGW W342        | 211 |
| AWWA C.205 DVGW-W-342-71               | 212 | ISO 4200                         | 228 |
| AWWA C.214-83                          | 232 | ISO 4633                         | 222 |
| AWWA C.602-83                          | 212 | ISO 49                           | 209 |
| AWWA C.602-89                          | 413 | ISO 7/2                          | 203 |
| CP 1004                                | 062 | ISO 7005/2, 3                    | 207 |
| CP 112, 2                              | 666 | ISO 7-1/2                        | 223 |
| CP 2004                                | 665 | ISO 7186                         | 411 |
| CP 2005                                | 658 | ISO 7194                         | 662 |
| CP 301                                 | 652 | ISO 7268                         | 231 |
| CP 310                                 | 651 | ISO 752                          | 918 |
| CP 312                                 | 302 | ISO 7751                         | 412 |
| CP 499                                 | 848 | ISO 7752/5                       | 929 |
| IEC 60072                              | 011 | ISO 8493                         | 205 |
| IEC 60072, 72A                         | 010 | ISO 881                          | 402 |
| IEC 600805                             | 046 | ISO 885, 888                     | 914 |
| IEC 600827                             | 048 | ISO 887                          | 925 |
| IEC 60085                              | 023 | ISO 898/2, 898/1                 | 914 |
| IEE W. REGS (15 <sup>TH</sup> EDITION) | 018 | ISO 965/3, 262                   | 923 |
| ISO 1106-3, 7438                       | 924 | ISO DIS 4042                     | 921 |
| ISO 1167                               | 306 | DIN 18153                        | 804 |
| ISO 128, 2162, 2203, 5455, 5457        | 705 | KS 04-290                        | 049 |
| ISO 13                                 | 200 | KS 05-459:5                      | 606 |
| ISO 160                                | 401 | KS 06-149:2                      | 300 |
| ISO 161/1                              | 300 | KS 06-248 1, 2                   | 510 |
| ISO 161-1                              | 825 | VDB 2                            | 101 |
| ISO 185                                | 906 | VDB PART C                       | 902 |
| ISO 1920, 4012, 4108, 4013             | 117 | VDMA 6280                        | 035 |
| ISO 196 (TESTS)                        | 206 |                                  |     |