

**REPUBLIC OF KENYA**



**NORTHERN WATER WORKS DEVELOPMENT AGENCY**

**Bidding Document for Procurement of Works  
for**

**Equipping of Exploratory Boreholes Project - Lot 1- Sarman Tarbaj Water  
Supply project**

**(VOLUME II – TECHNICAL SPECIFICATIONS)**

**Country: KENYA**

**Credit No. 60300**

**RFB No: KE-NWWDA-541055-CW-RFB**

**Issued on: 14<sup>TH</sup> APRIL ,2026**

**REPUBLIC OF KENYA**

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## **SECTION 1: GENERAL AND PARTICULAR SPECIFICATIONS**

## 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 Kenya Standards, International Standards Organization (ISO), European Norm (EN), Deutsches Institut für Normung (DIN), British Standards (BS) or other approved applicable Standards in Kenya.

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

All equipment and furnishings detailed under this Clause shall be provided by the Contractor under item for Resident Engineer's offices under Bill No. 1. All the equipment and furnishings will revert to the Contractor at the end of the Contract.

Provision shall also be made by the Contractor for all necessary gas, electricity, kerosene, water, light, attendance and stationery required in connection with execution of the Contract.

The Resident Engineer's offices shall be regularly and properly cleaned to the satisfaction of the Engineer. Also, day and night security shall be provided at the office. The office, furniture and equipment shall be insured against fire, theft and natural calamity.

**For Supervision of the Works, 1Nr. Rented Office will be established in Wajir Town.** The Contractor shall provide the rented office from the date of Commencement of Work. The Office including location shall be to the Resident Engineer's approval.

The Office shall be of a design and construction 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 have a floor area of at least 120 square metres and 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 be open and attended to at all hours during which work is in progress.

#### 101.(a) PROVISIONS AND CONSUMABLES FOR THE RESIDENT ENGINEER'S OFFICES

The following office equipment will be required in the quantities indicated below.

S/Nr	Description	Quantity
1	Writing Desk with 3 lockable drawers with side table for printer	2Nr
2	Writing Desk without Locks	1Nr
3	Fabric, Swivel adjustable height chairs with arm rests	7Nr
4	Wooden Conference Table, 4.8m x 1.2m – Interlinked / Configured system of tables	1Nr
5	Metal Plan Chest suitable for A1 size drawings, Size 886 x 510 x 1315mm	Nil

6	Lockable Steel Cupboard (Size 1m x 1.8m x 0.5m deep)	1Nr
7	Office paper punch	1Nr
8	Pin board 2.4m x 1.2m	1Nr
9	Office Tray (3 tier)	4Nr
10	Office Stapling Machines	1Nr
11	Heavy Duty Stapler	1Nr
12	Steel File Cabinet with locks / 4 drawers ('Mecol' or equivalent approved)	1Nr
13	Casio' or similar small portable scientific electronic calculator	1Nr
14	First Aid kit (for 10 persons) in Metal Box	1Nr
15	Potable Fire Extinguisher (5 litres)	1Nr
16	Small office scissors	1Nr
17	Waste paper baskets	2Nr
18	Electric kettle (capacity to make 12 cups of tea)	1Nr
19	Coffee/Tea making facility including crockery for all supervisory staff 6 Nr. and 12 additional guests	1Nr
20	Pedestal electric fan, size 400mm	1Nr
21	Samsung' or equivalent approved Refrigerator (0.2 cu.m. capacity)	1Nr
22	Wooden bookshelves with lockable glass frontage 2.0m x 1.5m	1Nr
23	Desktop – "DELL" or approved equivalent OptiPlex GX520, Intel Pentium Dual Core 3.0 GHz, 80GB HDD, 512MB RAM, DVD R/CD-RW Optical Drive, with 15" Flat Panel Monitor. Win XP Professional and Microsoft Office 2010 or latest Version	1Nr
24	Laptop intel core i7 2.2 GHz, 700GB HDD, 6GB RAM, DVD + RW Optical Drive, 15.4" Wide Screen, WiFi / 56K Modem, Bluetooth, with Win XP Professional and Microsoft Office 2010 or latest Version	Nil
25	HP LaserJet Printer A4	1Nr
26	HP Colour Inkjet Printer A3	Nil
27	HP Colour LaserJet Printer, 1200 x 1200 dpi, 20ppm, with Largest Supported Paper Size – A3 (Project Office)	Nil
28	Photocopier - Nashua or approved equivalent, A3, 35 pages per minute	Nil
29	Orange/Safaricom modem	Nil
30	Digital Camera as specified	Nil
31	Wall Clock	Nil

The Contractor shall provide a Secretary who can speak English and is conversant in the use of above-mentioned software for the duration of the Contract.

Stationery required **may be** as follows:

Stationery	Quantity
Photocopy paper A4	18 Reams
A3 paper	3 Reams
Biro pens blue/black	1 Doz.
Clutch Pencils	1 Doz.
Box files	2 Nr
Spring Files	2 Nr

Stationery	Quantity
Document Wallets	2 Nr
Spirals (various sizes of Reports)	2 Doz.
Embossed (hardback cover)	2 Doz.
Perspex covers	2 Doz.
Cellotape (medium)	1 Nr
Masking tape (medium)	1 Nr
Staples	2 Pacs.
Paper clips (various sizes)	2 Pacs.
Pencil leads (0.5/0.7)	2 Sets
CD-R (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.
A4 Carbon papers	1 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

Supply of clean towels every day, soap, lavatory paper, disinfectant and cleaning materials are to be provided and maintained throughout the Contract Period.

The cost of all the above services shall be included by the Contractor under item for Maintenance and attendance for 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) SURVEY EQUIPMENT

Listed below are the principal items of survey equipment to be made available for use during the whole duration of Project Implementation. All equipment shall be as new and with all necessary carrying containers, manuals, insurances, etc. The Equipment to revert to Employer at completion of all Works.

Equipment	Quantity
Total Station including tripods, complete with reflectors, poles, brackets and carrying case (Wild or similar)	1 Nr
Automatic Level (Wild or Similar) with legs and metric staff, complete with carrying case	1 Nr
Metric extending levelling staffs with vertical bubble	2 Nr
30m (enamelled or otherwise protected) steel bands	2 Nr
3 metre ranging rods	2 Nr
Survey umbrellas with stand	2 Nr
Work boots	2 sets
Rain Gear (trousers and jacket type, complete with rain hat)	2 sets
Hard hats	2 sets
5 metre retractable pocket steel tapes	2 Nr

Equipment	Quantity
30 metre metal tapes	2 Nr
100 metre metal tapes	2 Nr
Builders spirit levels 1000mm long	2 Nr
Hammers 3 kg each	2 Nr

Supply of pegs, crayons, spray paint, nails and all other items required for setting out and measuring the work.

The Contractor shall provide the services of two Chainmen as and when requested for the sole use of the Engineer for the whole period of the Contract.

The cost for provision of the above for use of the Resident Engineer is deemed to be covered in the Bidder's Rates.

### **101.(c) PROJECT VEHICLES**

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

The Contractor shall ensure that the vehicle is licensed, comprehensively insured at all times, serviced and maintained in good condition to the satisfaction of the Resident Engineer or his authorized representative, so that the Resident Engineer shall at all times have the vehicle available for use in good serviceable condition. In the event of the vehicle being unserviceable for whatsoever reason, the Contractor shall provide alternative vehicle 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 vehicle shall be approved by the Resident Engineer prior to ordering.

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:

- Inspection by the Government Inspection Unit, if applicable.
- Inspection and Valuation by the Automobile Association (AA) of Kenya

The Contractor shall hand over the respective Inspection / Valuation Reports to the Employer together with the vehicles. Costs have been included in the Preliminary and General Items bill to cover running and maintenance costs of the Project Vehicles. The vehicles will revert back to the Contractor at the end of the Contract.

### **101.(d) DRIVERS**

The Contractor shall provide licensed driver for the exclusive use of the Resident Engineer or his authorized representative. The driver 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 Kenya Police. 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.

### **101.(e) ACCOMMODATION**

The Contractor to make provision for accommodation for the Resident Engineer (RE) and Assistant Resident Engineer (ARE). The furnished rented houses shall be to the approval of the Resident Engineer and shall comply

with all his requirements. All costs in connection with the rental of house, supply, consumption and maintenance of water supply, electrical power, house help, etc., shall be borne by the Contractor. Provisions of full-time security guards shall be made for the houses for day and night security. The provision for this is made under the relevant item in Bill No. 1 – Preliminaries & General.

## **102. OFFICE FOR CONTRACTOR**

The Contractor shall have an office in Wajir Town which shall require to be approved by the Engineer, and which shall be open and attended to at all hours during which work is in progress. Notwithstanding anything contained in the General Conditions of Contract, any notice to be given to or served upon the Contractor shall be deemed and taken to be efficiently given or served by the delivery thereof at such office on the site.

## **103. CLIMATE CONDITIONS**

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

## **104. LEVEL DATUM**

Before the commencement of Construction Work the Contractor shall establish, in a position to the approval of the 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 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 Engineer.

Where possible construction drawings and all levels used for construction shall be referred to the national height datum as defined by the Survey of Kenya. 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 Engineer.

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

The Contractor shall carry out confirmatory survey for the pipelines and other hydraulic structures. He shall submit to the Engineer who shall assess, inspect and advice on need for contractor redesign with no additional costs to the client. Any design revisions shall be deemed to have been captured in the contract sum and quantities submitted by the contractor.

The Site Layout Drawings show indicative Site Layouts. Prior to commencing construction, the 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 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 Engineer.

For water pipelines, sewers, etc. the Contractor shall in the presence of the 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 Engineer, confirming the locations of all valves, air valves, washouts, hydrants, bends, manholes, etc.

The Contractor shall prepare and submit to the Engineer, at an approved scale, Plans of the Water Pipeline 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 valves, fittings, 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 1.0m interval. The contours shall be generated from a 10x10m grid topographic survey.

## **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 Engineer. Manually operated "Stop-Go" signs will only be permitted if approved by the 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 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 or other land the Contractor shall provide such fencing, as required.

## **112. RIVERS AND DRAINS**

The Contractor shall always maintain the free flow of rivers and drains and prevent excavated material from the Works from being deposited in them. Where diversions are needed the Contractor shall be responsible for all statutory approvals and diversion works as well as public awareness at no additional costs.

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

The Contractor shall allow in his rates for liaison with the relevant Roads Authority and obtain a Road 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 by manual or mechanical excavation the Contractor shall at his own expenses ascertain in writing from Telkom Kenya, Kenya Power & Lighting Co. Ltd., Data Cables Companies, the Water Services Provider and all other Public Bodies, 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 effectually 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 require 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 operations connected with the 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 arrange to employ watchmen to guard the Works both during the day and night from the Commencement Date until the issuance of the Taking-Over Certificate for the Works or the relevant Section in accordance with the Conditions of Contract.

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 Resident Engineer'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. The meetings will be attended by Representatives of the Client, Supervision Team and the Contractor. Costs of holding the meetings shall be deemed to be covered under the Contractor's rates.

### **131. INSPECTION BY ENGINEER DURING DEFECTS LIABILITY PERIOD**

The Engineer will give the Contractor due notice of his intention to carry out inspection during the Defects Liability 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 Resident Engineer for 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 Resident Engineer 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 will be deemed 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 of 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. For all goods to be supplied including pipes, fittings valves, meters etc., factory and site Acceptance Inspection and Tests will be carried out. In addition, 3<sup>rd</sup> party independent inspection and testing will be carried out as directed by the Engineer. The cost of this has been allowed for in the Preliminary and General Bill.

### **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 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 completion of the Works and successful completion of the Tests on Completion in accordance with the Conditions of Contract, and prior to the issuance of the Taking-Over Certificate under the Conditions of Contract, the Contractor shall operate the entire Scheme, or any completed Section thereof, for the test period stated in the Bill of Quantities.

The Contractor shall supply all necessary personnel, equipment and consumables for the test running and together with the Engineer 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 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.

### **138. EQUIPMENT FOR THE RESIDENT ENGINEER**

The Contractor shall provide 1 Nr Digital Camera, Sony or approved equivalent, suitable for Construction Sites with splash and shock proof casing for exclusive use of the Resident Engineer and his Staff for the purpose of taking record photographs of the progress of the Works. The Camera should have picture capture resolution of 7.1 megapixels or more, both optical and digital zoom capabilities, storage capacity of 128 MB, downloading facility by means of USB port, neck strap and hard cover pouch. The Contractor shall further provide 1 Nr suitable photo printer with necessary photo paper and colour ink cartridges for prints production for Monthly, Quarterly Progress Reports as directed by the Resident Engineer. The cost for this service is deemed to be covered by the Contractor in his rates in the Bills of Quantities.

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 MANUALS**

Draft Operation and Maintenance Manuals shall be compiled and submitted prior to the completion of the Tests on Completion in accordance with the Conditions of Contract and in any event before the issuance of the Taking-Over Certificate.

The Manuals have to 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.

The Taking-Over Certificate for the Works under the Conditions of Contract shall not be issued until such detailed information, 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 indicate clearly 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 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 Resident Engineer prior to the commencement of the Tests on Completion of Works.

In addition, the Contractor shall prepare and submit to the Resident Engineer "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 Resident Engineer for his inspection. The Contractor shall obtain the consent of the Resident Engineer as to their format, size, the reference system, and other pertinent details such as compatibility with the Water Service Provider's GIS application.

Prior to the issuance of the Taking-Over Certificate for the Works under the Conditions of Contract, 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 Liability 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 Resident Engineer one full-size original copy, six printed copies of the relevant "as-built-drawings" and the corresponding computer files (AutoCAD, Shapefiles, 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 Resident Engineer.

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

## **2. CLEARING SITE**

### **201. 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, subject to the provisions of the Conditions of Contract: 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 has to 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.

### **202. 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 held to be included in the rates entered in the Bill of Quantities.

### **203. 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.

### **204. HEDGES**

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

### **205. 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 the purpose of 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 felling trees.

### **206. 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.

### **207. 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 works and maintenance. 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.

### **3. EXCAVATION**

#### **301. 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 pick axes and hand levers shall be classified as common excavation. Waterlogged material shall be included in this class. Murrum 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 Bills 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.

#### **302. STORAGE AND HANDLING OF EXPLOSIVES AND BLASTING**

The removal of hard materials by use of explosives will only be permitted where specified in the Bills of Quantities subject to compliance by the Contractor in all respects with the Explosives Laws of Kenya.

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

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 unauthorised 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 by other means and payment will be made at the rate for rock for 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 amount of approved materials for fill, 1 cubic metre of rock in-situ being taken to equal 1.5 cubic metre of material in embankment.

### **303. 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.

### **304. 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 be more than 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 such 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, House Drives and Car Parks the 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.

### **305. 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.

### **306. 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.

### **307. 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.

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

Artificial deposits of industrial waste or shale found on the site shall be removed and disposed off as directed by the Engineer. Should any particular deposits 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.

### **309. LAND SLIPS**

Remedial works and/or the removal of materials in slips, slides or subsidences 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.

### **310. 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.

### **311. 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.

### **312. 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.

### **313. 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 deposited and compacted as directed by the Engineer.

### **314. 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 so as to carry off the water to the outlet to be provided. The material excavated from the ditches shall be disposed of as directed by the Engineer.

### **315. 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.

### **316. 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.

### **317. 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.

### **318. 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.

### **319. 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.

### **320. 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.

### **321. 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 so as 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.

## **4. PIPELINE CONSTRUCTION WORKS**

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

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

### **402. 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.

### **403. 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.

### **404. 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.

### **405. 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.

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

The Contractor shall ensure the proper reinstatement of fences, drains, telephone lines, KP&L 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.

### **407. METHOD OF EXCAVATION**

The Contractor is deemed to have covered in his excavation rates all the work that is necessary 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
900mm main	1.4 m
1200mm main	1.6m
1400mm main	1.8m

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 external radii of the flanged fittings 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, so as 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) The 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 in excess of 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 C15/20 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 Survey of Kenya Datum shall be provided at such intervals as directed by the Engineer.

#### **408. 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 so that there is a continuous rise from each washout to air valve.

When laying uPVC pipes, final connection at any fixed joints shall be deferred until the majority 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.

The bolts shall be tightened up gradually and equally in the customary manner in order 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.

- e) The Contractor shall fix the gate valves, air valves and washout pipes all in accordance with the drawings.
- 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.

#### **409. BACKFILLING OF TRENCH**

- a) When a section of the main has been jointed, the ends shall be temporarily closed with caps, plugs or flanges to prevent ingress of foreign matter into the pipe to the satisfaction of the Engineer. The trench shall be properly backfilled and rammed for its whole length so that the soil cover to the main shall not be less than 600mm except at joint holes which shall be kept clear of all backfilling, if necessary, by the use of timbering, so that each joint is left fully exposed for the Engineer's inspection. Special care shall be exercised when using surround to A.C. and uPVC pipes which shall be free from any stones and well compacted in layers to not less than 100mm above the crown of the pipe.
- b) The Contractor's attention is drawn to the special requirements for bedding and sidefill to uPVC pipes. Clay should not be used. Soils which are of a granular nature and provide adequate support after compaction shall be used. If unavailable from excavated material the Contractor should provide suitable material for which an item in the Bill has been included.

With flexible pipes it is important that the sidefill should be firmly compacted between the pipe and the soil sides of the trench. The bedding material shall be placed in 75mm layers up to the crown of the pipe with adequate compaction and then to a minimum height of 100mm or two thirds of the pipe diameter. The progress of filling and tamping should proceed equally on either side of the pipe so as to maintain an equal pressure on both sides.

- c) Where a main is laid across a road or is in such a position as to interfere seriously with the normal use of the road, the Contractor may, with the consent of the Engineer and at his own risk, fill such holes as may be necessary. Due consideration is to be given to compaction of section of the trench across the road to prevent undue settlement. In the event of damage at this section the Contractor is required to re-excavate and repair the pipeline all at his own expense.

#### **410. ANCHOR BLOCKS AND SUPPORTS**

Concrete C15/20 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.

#### **411. 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.

#### **412. PRESSURE TESTING OF PIPELINES**

- a) The Contractor shall test a section of main as long as possible subject to the maximum length of open trench approved by the Engineer. The test shall be carried out within 12 working days of the completion of such section of the main.
- b) The pipeline shall be adequately anchored during the test at stop ends or valves to prevent movement under the test pressures.
- c) The test section shall be filled with water and great care should be taken to drive out all air through air valves, ferrules etc. The test pressure is to be at least 1.5 times the nominal working pressure for the class of pipe being tested and is to be applied for at least 2 hours.
- d) The leakage from the mains and connections from each section tested shall be according to SRN 316, i.e. not exceeding 0.02 litres per millimetre of nominal bore per kilometre of pipeline per 24 hour per bar of applied pressure head.

To determine the rate of leakage, the Contractor shall furnish a suitable hydraulic test pump, pressure gauge, connections and water meter or other appliance, for measuring the amount of water pumped. The pressure shall be raised to the amount required and specified by the Engineer and shall be so maintained for a period of not less than two hours or whatever longer period as required by the Engineer to examine every joint to satisfy himself that they are sound.

If the leakage is at a greater rate than that specified, the Contractor shall re-excavate the trench where necessary and shall re-make the joints and replace defective work until the leakage shall be reduced to the allowable amount.

- e) The Employer shall charge the Contractor the cost of any couplings required to join up tested lengths of main if, in the Engineer's opinion, greater lengths could reasonably have been tested or if failure under test, requires the pipe to be cut, or other methods of laying should have been adopted.

Water used in testing the main shall be supplied by the Contractor. The Contractor shall carry out all work which may be necessary for making temporary connections to the existing mains to obtain water for testing at his own expense.

In carrying out the test for water tightness the Employer only shall authorize the operation of all valves, but the Contractor shall provide all the necessary labour to assist in the opening and closing of the valves to the Engineer's instructions, and he shall allow in his prices for all his expenses in connection with testing on completion.

The Engineer shall be the sole judge of water tightness.

#### **413. CLEANING AND STERILISING OF PIPELINES**

- a) When a pipeline is complete and where applicable, has successfully passed the test, it shall be thoroughly washed out, using, if possible, an open end. Thereafter it shall be sterilized by being filled with a suitable solution containing not less than 20 ppm. of free available chlorine or such other sterilizing agent as the Engineer shall approve. After standing for 24 hours the main shall again be washed out and refilled with mains water prior to the taking of bacteriological samples. The Contractor shall provide all necessary stop-ends, fittings and chemicals for this work.

- b) Emptying and washing out of the pipes shall be done in such a manner as not to damage the trench or cause undue flooding of the vicinity, and the Contractor shall supply and use piping, specials and/or hose as may be necessary to facilitate the flow of water to the nearest drain or watercourse. Water used for washing out and sterilizing may be supplied by the Employer when a suitable supply is available, but all expenses should be payable by the Contractor.

Before any section of the main is put into use, bacteriological samples shall be taken by the Engineer. Only upon receipt of a satisfactory bacteriological certificate issued by an approved Medical Research Laboratory or equivalent authority shall the main, or section thereof, be permitted to be put into supply and be eligible for Taking-Over in accordance with the Conditions of Contract.

Any expenditure involved in providing facilities or materials for the taking of samples shall be included in the Contractor's rates and the Engineer will specify and shall be the sole judge as to the number of samples required and the points at which they are to be taken.

The cost of the bacteriological examination will be borne by the Employer but if the sample or samples are not satisfactory, the cost of any subsequent analysis will be borne by the Contractor.

#### **414. 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.

## 5. PIPES, FITTINGS, VALVES AND METERS

### 501. GENERAL

The approval in writing or otherwise by the Consultant of any material shall not in any way whatsoever relieve the Supplier from any liability or obligation under the Contract and no claim by the Supplier on account of the failure, insufficiency or unsuitability of any such materials will be entertained.

- a) All items shall be suitable for water 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 Consultant provides for a quality of material and workmanship. The Standard or Specification must be submitted to the Consultant 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 Supplier shall supply to the Purchaser 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 Supplier shall provide adequate protection to all piping, flanged items and valves so as to guard effectively against damage in transit and storage and ingress of foreign matter inside the valves.
- f) All pipework and fittings shall be subjected to a works hydrostatic test pressure which shall be not less than twice the maximum operating pressure.
- g) The Supplier should exercise diligence to provide the best material.
- h) Where applicable, the manufacturer's Specification should accompany all offers. The name of the manufacturer must in every case be stated.
- i) Where necessary the Supplier shall provide rubber gaskets to comply with EN 1514, DIN 2693 or DIN 2697 and all other bolts, nuts, washers, etc. to undertake jointing at fittings etc.
- j) 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 Purchaser be liable for any charges in respect of such an article. Where any such rejected article can, in the opinion of the Consultant, be rendered usable, the Supplier 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 Consultant, 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.
- k) Wherever possible, samples of pipes and fittings shall be submitted for approval of the Consultant prior to the Supplier obtaining the total requirements.

### 502. UNPLASTICISED PVC (uPVC) PIPES

Unplasticized PVC piping shall be in accordance with BS EN 1452.

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 up to 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 sufficient quantity 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 DIN 4060, BS2494 or EN 681.

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.

### 503. 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 other acceptable International Standard. The Pipes and Fittings shall comply with the following:

<b>Pipes:</b>	Material: Colour:	Polyethylene PE100 (MRS100), density $\geq 0.95$ kg/dm <sup>3</sup> Blue Black with Blue stripes Black with Blue outer coextruded layer
	Pressure Rating:	SDR 26 – PN6 SDR 17 – PN10 SDR 11 – PN16
	Supply Lengths:	All pipe sizes up to and including OD 75 mm shall be supplied in coils of 50 or 100 meters. All pipes, OD 90mm and above shall be supplied in straight lengths not exceeding 12metres.
<b>Fittings:</b>	Material:	Polyethylene PE100 (MRS100), density $\geq 0.95$ kg/dm <sup>3</sup>
	Colour:	Black or Blue
	Type of Joint:	Electrofusion / Spigot type for Butt Fusion / Compression (for sizes 110mm and below)
	Pressure Rating:	SDR 26 – PN6 SDR 17 – PN10 SDR 11 – PN16
<b>Diameters:</b>	as per EN 12201-2	

PE 100 (MRS10), $\sigma_{all} = 8.0$ MPa			PN 10.0		PN 16.0	
Outside Diameter (d) (mm)	Tolerance on OD (mm)	Maximum Ovality (mm)	SDR 17 Series 8		SDR 11 Series 5	
			Min. WT (mm)	Tolerance (mm)	Min. WT (mm)	Tolerance (mm)
16.0	0.3	1.2	-	-	-	-
20.0	0.3	1.2	-	-	2.0	0.3
25.0	0.3	1.2	-	-	2.3	0.4
32.0	0.3	1.3	2.0	0.3	3.0	0.4
40.0	0.4	1.4	2.4	0.4	3.7	0.5
50.0	0.4	1.4	3.0	0.4	4.6	0.6
63.0	0.4	1.5	3.8	0.5	5.8	0.7
75.0	0.5	1.6	4.5	0.6	6.8	0.8
90.0	0.6	1.8	5.4	0.7	8.2	1.0
110.0	0.7	2.2	6.6	0.8	10.0	1.1
125.0	0.8	2.5	7.4	0.9	11.4	1.3
140.0	0.9	2.8	8.3	1.0	12.7	1.4
160.0	1.0	3.2	9.5	1.1	14.6	1.6
180.0	1.1	3.6	10.7	1.2	16.4	1.8
200.0	1.2	4.0	11.9	1.3	18.2	2.0
225.0	1.4	4.5	13.4	1.5	20.5	2.2
250.0	1.5	5.0	14.8	1.6	22.7	2.4
280.0	1.7	9.8	16.6	1.8	25.4	2.7
315.0	1.9	11.1	18.7	2.0	28.6	3.0
355.0	2.2	12.5	21.1	2.3	32.2	3.4
400.0	2.4	14.0	23.7	2.5	36.3	3.8
450.0	2.7	15.6	26.7	2.8	40.9	4.2
500.0	3.0	17.5	29.7	3.1	45.4	4.7
560.0	3.4	19.6	33.2	3.5	50.8	5.2
630.0	3.8	22.1	37.4	3.9	57.2	5.9
710.0	6.4	24.9	42.1	4.4	64.5	6.6
800.0	7.2	28.0	47.4	4.9	72.6	7.4

**Performance Characteristics**

The pipes shall have the following basic minimum performance characteristics:

Parameter	Unit	Value
Average Density as per ISO 1183	Gm/cm <sup>3</sup>	≥ 0.95
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>	25
Elongation at Break	%	≥ 600%

E-Modulus (Modulus of Elasticity)	N/mm <sup>2</sup>	1200
Minimum Radius of Curvature at 20°C		25 x OD
Linear Coefficient of Thermal Expansion (VDE 0304)	°K <sup>-1</sup>	1.3 x 10 <sup>-4</sup>

### 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)
- Standard Dimension Ratio and Pressure Rating (SDR17 PN10 or SDR11 PN16)
- 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 stoney 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:** Moulded 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.

**Testing**

- a. Hydrostatic leakage testing is recommended and shall comply with ASTM F 2164, ASTM F 1412, AWWA Manual of Practice M55 Chapter 9.
- b. If the test section fails this test, the Contractor shall repair or replace all defective materials and/or workmanship at no additional cost to the Owner.
- c. Pneumatic (compressed air) leakage testing of HDPE pressure piping is prohibited for safety reasons.

**Cleaning and Disinfecting**

- a. Cleaning and disinfecting of potable water systems shall be in accordance with AWWA C651 and AWWA Manual of Practice M55 Chapter 10.
- b. After installation and pressure testing, new water mains should be disinfected according to AWWA C651.
- c. The disinfection chemicals should be limited to less than 12% active chlorine. The duration of the disinfection should not exceed 24 hours.
- d. Upon completion, the system should be thoroughly flushed with fresh water and retested to verify the disinfectant chlorine level has been reduced to potable drinking water concentrations in all service water tubing and branch lateral pipes.

## **504. POLYPROPYLENE PIPES**

Propylene co-polymer pressure pipe shall comply with the relevant provisions of BS 4991 and DIN standards and, where it is to be in contact with potable water, shall be Series 1.

Polypropylene pipes shall be available in diameters from 12mm to 1400mm and shall be suitable for working use at temperatures up to 90°C, and withstand short-term use at a maximum 110°C.

## **505. 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 BS EN 14164.

The pipes shall be welded or seamless and shall conform to BS EN 10216.

All the pipes shall be internally protected with epoxy coatings for internals and externals of steel pipes in accordance with AWWA C210. External protection to be as specified in DIN 30671, EN 10309, AWWA C213 or NFA 49-706.

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 conform / fit 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.

All flanges on specials shall conform to NP 16 or NP 25, as specified in the Price Schedules in accordance with BS EN 1092, unless otherwise detailed.

All flanged joints shall be protected from corrosion by wrapping with Denso paste and tape or some similar approved material.

## **506. G.R.P. PIPES AND SPECIALS**

Glass Reinforced Plastic piping shall be in accordance with SRN 317.

## **507. 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.

## **508. 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.

## **509. 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 trademark, or test certificates shall be furnished by the manufacturers.

## **510. CONCRETE POROUS PIPES**

Concrete porous pipes shall comply with the requirements of SRN 410: Concrete Porous Pipes for Under-drainage.

## **511. FLANGED JOINTS**

Where specifically called for or deemed appropriate, flanged joints shall be utilised. They shall conform to DIN Standards 2500, 2501, 2519, 2576, 2627, 2566, 2655-56, 2673, 2526, 2527, BS EN 1092, BS 1560 or ISO 7005: 1988., drilled to NP 16 / NP 25 except where otherwise indicated in Price Schedules, with gaskets made of reinforced elastomer rubber to DIN Standards 2693, 2697 or EN 1514 and minimum thickness of 3mm.

All flanges on fittings and pipework where flanged connections are required must comply with the requirements of DIN Standards 2500, 2501, 2519, 2576, 2627-38, 2566, 2655-56, 2673, 2526, 2527, BS EN 1092, BS 1560 or ISO 7005: 1988 and drilled to NP 16 / NP 25, unless otherwise specified.

Inspection gaskets for flanged joints shall be rubber reinforced with cotton, 3mm thick and shall be in accordance with DIN Standards 2693, 2697 or EN 1514. Bolts, washers and nuts for flanged joints shall be of mild steel complying with ISO 898/1, ISO 898/2.

## **512. FLEXIBLE JOINTS**

All flexible couplings (Viking Johnson or other approved type) shall be supplied and shall be coated with fusion bonded epoxy layer 350 microns thick, 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.

Flexible couplings shall be of a mechanical type coupling consisting of a centre sleeve, two end ring flanges, two wedge shaped sealing rings of grade T Nitrile rubber, and with galvanized nuts bolts. The main components shall be made from malleable cast iron to ASTM A 47-77 for larger diameters. If specifically called for, couplings shall be provided with a suitably sized screw plugged hole in the sleeve to allow for the introduction of molten bitumen for additional internal protection. The manufacturer shall then include the necessary removable internal backing-up rings of rubber composition and shall further include for all materials for in-situ jointing and protecting both for remedial works and for internal and external protection at such joints. After jointing, the exposed part of the bolt shall be provided with a tight-fitting polythene protection cap.

## 513. GATE VALVES

Gate valves shall comply with the requirements of BS 5163, AWWA C500, AWWA C509/C515, DIN 3230 Part 1-3, DIN 3352 Part 1-4.

The gate valves shall be suitable for use in pipelines and for the operating pressure to a head of 160 metres or 250 metres of water (NP 16) or NP 25.

Unless otherwise specified, gate valves of nominal diameters up to and including DN 300 shall be made of epoxy coated cast ductile iron in accordance with BS EN 1074. The epoxy coating shall be not less than 150 microns thickness. The gate shall be completely rubber encapsulated, the gate valve being of pocketless type with a straight through port.

The gate valves shall be double flanged. The dimensions and drilling of flanges shall be in accordance with BS EN 1092. Flanges shall be machined flat. Flanges shall be NP 16 / NP 25 complying with BS EN 1092, unless otherwise indicated Price Schedules.

Spindles of the gate valves shall be provided with cast iron caps conforming to the requirements as specified under "Valve Caps" in DIN 3230, DIN 3352, BS 5163, AWWA C500, or AWWA C509/C515, or handwheels if so specified.

Unless otherwise specified the face-to-face dimensions of gate valves with integral flanged ends shall be in accordance with BS 5163 basic series 14 (short) or basic series 15 (long) as indicated in the Price Schedules.

Where specified, valves for replacement washouts shall be in accordance with this specification except that the valve bodies shall be of epoxy coated ductile iron and the flanges shall be undrilled. Face to face dimensions for these valves shall be to BS 5163 basic series 14 (short).

The spindles of the gate valves shall be of the non-rising type, except where specifically indicated otherwise 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 hand-wheel.

The gate valves shall be subject to "Closed End Tests" in accordance with the procedure set out in BS 5163, AWWA C500, AWWA C509/C515, DIN 3230 Part 1-3, DIN 3352 Part 1-4.

The gate valves shall be suitable for opening and closing against an unbalanced head by manual operation.

The gate shall be of ductile iron fully rubber encapsulated, the gate sealing in the body being ensured by compressing of the rubber.

The gate valves shall be works cleaned and shot-blasted in accordance with BS 2640. They shall be coated internally and externally with fusion bonded powder epoxy or equivalent suitable for potable water and to a minimum thickness of 150 microns. The body, the bonnet and the gate of the valve shall be made of ductile iron to BS EN 1563 OR BS EN 1564, the gate being encapsulated with elastomer EPDM, nitrile or equivalent.

## 514. AIR VALVES

The Supplier 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 BS EN 1074.

The body, cover, splash cowl and joint support ring of the air valve shall be of mechanite cast iron with flanges drilled to BS EN 1092.

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 dexine 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 DIN 3230, DIN 3352, BS 5163, AWWA C500, or AWWA C509/C515.

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.

## 515. CHECK VALVES (DIRECTIONAL VALVES)

Check valves shall be suitable for waterworks purposes and shall be manufactured to comply with the general requirements of BS EN 12334. They shall be double flanged type, non-slamming and recoilless on flow reversal. Valves of DN 700 and larger shall be of the multi-disc type or tilting disc type. The valves shall have a high-grade cast-iron body and cover to BS EN 1561 Grade 220/260 with gun metal nickel bronze alloy door seating. The hinge pin shall be of stainless steel carried on non-corrodible bearings.

The hinge pin material shall conform to ASTM A479, the disc carrier material shall conform to ASTM A217, the seat material shall conform to ASTM A106, and the disc material shall conform to ASTM A216.

## 516. CONSUMER WATER METERS

### General

Domestic water meters for house connection shall comply with BS 5728, KS 06-248 1, 2 and ISO 4064/2 & 2 /Add.1. In addition, it shall comply with the EEC Council Directive No. 75/33/EEC.

The domestic water meters shall be suitable for both Vertical and Horizontal installation and shall be of approved rotary piston volumetric type - Class C. The meter shall provide the specified flow accuracy when installed as detailed here below.

The domestic meters shall be supplied as a complete kit comprising the following items:

- Meter, Semi-positive rotary (grooved) piston volumetric type, calibrated in cubic metres.
- Meters are to be corrosion proof copper alloy or polymer plastic where specified.
- The outer body casing shall be of the split case type. The outer casing may consist of two parts which are screwed together and a watertight seal between the two.
- Isolating/disconnection valve.
- Union sockets.
- DN 15 BSP threaded inlet and outlet tail pieces complete with unions on each end, suitable for connection to galvanised iron pipe.
- Built-in strainer.
- Built-in non return valve to prevent meter reversal.
- "small dial".

The meter shall be complete as a package for instant connection and use. The domestic meters shall have threaded connections.

### Performance

The maximum flowrate ( $Q_{max}$ ) is the highest flowrate at which the meter can function over limited periods without damage, and without exceeding the maximum permissible errors (+/-2%) and the maximum permissible value for loss of pressure (1 bar).

The nominal flowrate ( $Q_n$ ) is equal to half the maximum flowrate,  $Q_{max}$ . It is expressed in cubic metres per hour and is issued to designate the meter.

At the nominal flowrate ( $Q_n$ ) the meter should be able to function in normal use, i.e. in continuous and intermittent operating conditions, without exceeding the maximum permissible errors (+/-2%).

The minimum flowrate ( $Q_{min}$ ) is the flowrate above which the meter must not exceed the maximum permissible errors (+/-5%), and is fixed as a function of  $Q_n$ .

The transitional flowrate ( $Q_t$ ) is the flowrate which divides the upper and lower regions of the flow range, and the rate of the maximum permissible error is +/-2%.

Performance Parameter	Nominal Diameter (mm)			
	15	20	25	40

Nominal Flow Rate - $Q_n$	$m^3/h$	1.5	2.5	3.5	10
Maximum Flow Rate..... $Q_{max}$	$m^3/h$	3	5	7	20
Minimum Flow Rate..... $Q_{min}$	l/h	15	25	35	100
Transitional Flow Rate..... $Q_t$	l/h	22.5	37.5	52.5	150

### **Metrological Classes**

The meters performance specification shall be to ISO 4064/1 or BS 5728/1 Part 1, Class C or to equivalent internationally recognized Standard according to the value of  $Q_{min}$  and  $Q_t$  as shown in the following table:

Class	$Q_n = \text{Less than } 15 m^3/h$	$Q_n = 15 m^3/h \text{ or more}$
Class C		
Value of: $Q_{min}$	$0.01 Q_n$	$0.006 Q_n$
Value of: $Q_t$	$0.015 Q_n$	$0.015 Q_n$

The meters must be able to retain their accuracy when installed in either horizontal, vertical or inclined planes.

Contractor shall provide certificate of the metrological class of the meters offered.

### **Sizes**

For each meter size designated the corresponding fixed set of dimensions must correspond to BS 5728, ISO 7858/1:1985 and no deviations from this shall be accepted. The lengths of water meters shall not exceed the following:

Parameter		Nominal Diameter (mm)			
		15	20	25	40
Length	mm	165	165	199	300

### **Tightness, Pressure and Temperature Resistance**

The water meter shall permanently sustain (without leakage, malfunctioning or permanent deformation) a minimum working pressure of 10 bar (DN 15 mm) or 16 bar (DN 20 mm) and be suitable for water temperatures up to 50 degrees Celsius.

### **Headloss**

Characteristic curves of head losses plotted against the rate of flow from the minimum flow rate shall be provided by the Tenderer. The meters shall show a loss of head not exceeding 1 Bar at  $Q_{max}$  and 0.25 bar at  $Q_n$  in accordance with ISO 7858/1:1985 and ISO 4064/1.

### **Materials**

The materials used in the construction shall be designed to withstand raw and treated (potable) water and operate for at least 5 years without normal need for maintenance or repair and without the maximum error exceeding the specified limits.

Tenderer shall specify the optimum pH and the water quality for which the meters have been designed.

They must be constructed throughout of materials which are resistant to internal and external corrosion and if necessary be protected by some suitable surface treatment. All materials of the water meter which are in contact with the water flowing through the water meter shall be non-toxic and non-tainting. Water temperature variations within the working range shall not adversely affect the materials used in the construction of the water meter.

The outer body casing shall be of the split case type. The outer casing may consist of two parts which are screwed together and a watertight seal between the two. The meter body casing must be made from materials with a life expectancy under normal use in excess of 20 years.

The water meter shall be made with materials appropriate to each specific use. The body of domestic meters (DN15 - DN25) shall be manufactured from copper alloy or polymer.

The measuring element shall be of high grade polymer to ensure minimum wear and a high degree of reliability.

### **Counter**

The indicator shall provide for reliable and unambiguous direct reading of the volume of water measured in cubic metres or in cubic meters and litres.

The indications of volume shall be by any of the two types as follows:

- Type 1 By a row of inline consecutive digits in one or more apertures (drum counters); or
- Type 2 A combination of drum counters for whole units of cubic meters and pointers on circular scales for fractions of cubic meters.

Drum counters shall be black for indication of a cubic metre and its multiples shall be red for indication of fractions of a cubic metre. Visible movements of the digits shall be upwards and the actual or apparent height of the digits on the drums shall be not less than 4 mm. The advance of a digital unit shall be completed while the next lower valued digit is within the last tenth of its travel. The drums showing digits of lowest value shall move continuously in Type 1 and may move continuously in Type 2. Indicators with pointers (Type 2) shall rotate in a clockwise direction. The value of each division on the scales shall be expressed in multiples or sub-multiples of ten. Each scale shall be graduated in cubic meters or accompanied by a multiplying factor (x0.01, x0.1, x10, x100) according to the value of the scale. The symbol m<sup>3</sup> shall appear on the dial. The gear unit and the counter shall be combined and completely sealed.

The number drums shall be contained in a non-toxic fluid for lubrication and protection. The counter shall be placed in a window in the meter body and be placed so as to allow for ease of meter reading. Counter window shall be of minimum 7mm thickness. Black numbers on white shall denote cubic metres and white numbers on red shall denote litres. The counter shall reset to zero at a reading of not less than 10,000 m<sup>3</sup>.

The indicator shall, as minimum requirement, record the following values:

Size of Meter (DN)	Minimum Registration (m <sup>3</sup> )	Maximum Registration Before Set Re-Set (m <sup>3</sup> )
15mm	0.001	10,000
20mm to 40mm	0.001	100,000

### **Protection**

A suitable in-built strainer (0.75 mm aperture and 2.844 mm<sup>2</sup> mesh area) shall protect the measuring mechanism and an in-built non return valve shall prevent meter reversal.

### **Marking**

Each water meter shall be marked on the casing with the following information:

- Direction of flow of water on both sides of the meter
- Maximum flow rate (3m<sup>3</sup>/hr)
- Individual Serial number (engraved)
- Manufacturer's name
- Country of Origin
- Year of manufacture
- WSP's name (max 10 letters)

### **Sealing**

Water meters shall be provided with a means of sealing so that after sealing, both before and after the water meter has been properly installed, there shall be no possibility of dismantling or altering the water meter or its adjustment device without visibly damaging the seal. The meters shall be sealed subsequent to manufacture and before delivery to the purchaser.

The preferred method of sealing is by a corrosive resistant wire inserted through 2.5 mm diameter holes in the halves of the body and secured by a circular metal seal impressed by a device which provides a unique imprint on the seal.

Tenderers shall provide details of the sealing wire type with proof of corrosive resistant, and method proposed.

### **Pre-Shipment Testing**

A representative sample of the meters shall undergo Pre-shipment testing at the manufacturers premise as directed by the Engineer.

### **Packing**

Packing shall be made of strong wooden crates, and inside such crate, each meter shall be packed in its own carton box.

### **Workmanship**

The meters shall be guaranteed against defects in materials and workmanship for a minimum period of one year from date of delivery. Parts to replace those in which a defect may develop within such period shall be supplied without charge, piece for piece, upon the return of such defective parts to the supplier thereof or upon proof of such defects.

Meters should be designed for easy disassembly and re-assembly without the use of special tools or equipment and should be easy to maintain and repair. Meters designed to resist vandalism will be preferred.

## **517. ELECTRO-FUSION JOINTING MACHINE**

The fusion jointing machine shall be suitable for carrying out electro- fusion welding for HDPE pipes and fittings up to 110mm diameter. The welding process is controlled and regulated with energy output compensation to account for variations in ambient temperatures.

The Unit should be complete with all accessories and shall have the following minimum general specifications:

- An internal memory with a capacity of at least 350 jointing records.
- Support for USB data transfer. A USB connector cable should be supplied together with the jointing machine.
- The Unit Display should be scratch resistant and dust proof, easily readable with an adjustable contrast function and give relevant information (in English) such as:
  - Recognition of fitting type, dimension and manufacturer
  - Resistance of connected fitting
  - Primary voltage and frequency
  - Actual running and final fusion duration
  - Ambient temperature, appropriate cooling time etc.
- Minimum operating range of ambient temperature of between -10°C and +45°C.
- Two pairs of 4mm and 4.7mm angle adapter clips.
- The complete control unit must not exceed a maximum weight of 25 kilograms including all standard primary and secondary cables.
- The unit should have the relevant software and system accessories necessary for data processing and transmission.
- Recognition support for different manufacturer products.
- The unit should have a minimum of IP 54 Protection rating.

- The unit should be supplied with a detailed operation manual written in English with clear step wise operating instructions, troubleshooting procedures, error codes and other relevant information.

Site demonstration and training of the Water Company Staff on use of the equipment should be carried out.

## **518. BUTT-WELDED FUSION JOINTING MACHINE**

The fusion jointing machine shall be self-aligning, suitable for welding under-pressure pipes for water, gas and other fluids up to 110mm diameter. The machine body shall be able to assume two working positions; inclined or horizontal and have a supporting frame, four clamps and two hydraulic cylinders with fast non-drip coupling connections.

The machine shall have the possibility to choose the best configuration for the working conditions by adjusting only 4 screws on the machine frame. Fast-locking adapters shall speed up the welding preparation time without using any additional equipment. The automatic detaching of the heating plate from the pipes / fittings shall be applicable on every welding configuration. This shall enable two rollers to be lodged very quickly on the sides of the machine body, allowing lifting of the welded pipes to make them roll and prepare a new weld.

The fusion machine shall include a Teflon-coated (PTFE) heating plate with a built-in independent thermometer, to check the working temperature, and a high-precision electrical thermoregulator ( $\pm 1^{\circ}\text{C}$ ) with digital display and regulating buttons. This system shall include Led indicators to check if the machine is working normally (live tension and working temperature), contingent probe's failures and/or temperature anomalies.

The machine shall include an extractable electric milling cutter to face the heads of the pipes and/or fittings. It includes a safety micro-switch and a thermal circuit breaker. The machine shall include an electro-hydraulic gearcase protected from crashes and atmospheric corrosion by a plastic box. The gearcase shall consist of a control lever, to open and close the clamps, maximum pressure and discharge valves (useful also for the "Dual Pressure" welding process), hydraulic connection hoses with non-drip fast couplings and timer (to check the warming and welding time). The machine shall be pre-set for the connection of the electronic controller.

A milling cutter / heating plate support which shall include a high-temperature-proof bag shall be included in the components of the fusion machine as it shall be required to protect the heating element from being scratched.

## **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 be kept free from water at all times 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 so as 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 1010 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 shall be applied evenly to the ends for jointing so as 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 619.

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

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

Concrete porous pipes 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. CAST IRON PIPES**

Cast iron pipes and special castings shall be supplied, laid and jointed with lead wool properly caulked to form perfectly uniform and watertight joints, and when laid and jointed they shall be true to line and level.

Where cast iron pipe drains are laid on unstable ground or ground which is likely to settle appreciably over a period of years they shall be pointed by means of an approved self-adjusting or screwed gland joint as directed by the Engineer.

## **608. 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.

## **609. 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.

## **610. 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.

## **611. 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 1007 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 1032 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 as specified in Clause 1040 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, step irons as specified in Clause 1033 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.

## **612. PRECAST CONCRETE MANHOLES**

Precast concrete manholes as specified in Clause 1040 shall be supplied and laid generally in accordance with Clause 611 and the drawings.

## **613. GULLY CONNECTIONS**

Connections from gullies to sewers and surface water drains or ditches shall consist of concrete pipes and fittings as specified in Clause 509 jointed with cement mortar 1 to 3 as specified in Clause 1010. All pipes, bends and junctions shall be laid to the lines and levels shown on the drawings or as directed by the Engineer.

## **614. 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.

## **615. GULLIES**

Gullies complete with gratings and with rodding eyes where necessary all as specified in Clause 1024 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. 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.

## **616. COMPLETION OF DRAINAGE WORKS**

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

## **617. 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.

## **618. 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 611 and during the placing of the concrete they shall be adequately supported.

## **619. SURROUNDING OR HAUNCHING OF PIPES WITH CONCRETE**

Surrounding or haunching of pipes shall be carried out using concrete of the appropriate grade. 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.

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

Precast concrete invert blocks and side slabs shall be formed of concrete of the appropriate grade 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 murrum 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.

## **621. 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.

## **622. 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.

## **623. 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 609 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

### 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.

### 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 also to the volume which has to be filled. Pours in vertical succession are referred to as lifts.

### 701. THE DESIGN OF CONCRETE MIXES

#### a) Cement

Cement for structural concrete shall be CEM I – 42.5 to KS EAS 18-1 and KS EAS 183.

#### 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 7.1, 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

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 N/mm <sup>2</sup>	Maximum Nominal Size of Aggregate mm	Maximum Water / Cement Ratio		Trial Mixes Target Mean Strength (Clause 401 c) N/mm <sup>2</sup>	Early Works Test Cubes (Clause 401 d)	
			A	B		Any one Cube N/mm <sup>2</sup>	Average of any Group of 4 Cubes 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:**

1. Under water/cement ratio, column A applies to moderate and intermediate exposure, and column B applies to severe exposure. See NOTE after Table 7.2.
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.
  - i) 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 7.1 but in any case, not less than the minimum necessary for impermeability and durability shown in Table 7.2.
  - 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 take into account 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 in order to achieve impermeability and durability. 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 drying:** Surface exposed to driving rain; alternate wetting exposure and drying; exposure 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.

#### **d) 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:

- a. The slump of the concrete shall be determined.
- b. 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.
- c. Three cubes from each batch shall be tested for compressive strength at seven days and the remaining three at 28 days.
- d. 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.

#### **e) 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 7.1 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 7.1 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 7.3) 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 701(b) and 701(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.

## 702. 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.

Concrete for the Works specifically for Treatment Works Units and Storage Reservoirs shall be and mixed using an automatic batching plant in one or more central location. If the Contractor proposes to use ready mixed concrete, he shall submit to the Engineer for his approval full details and test results of the concrete mixes. The Engineer may approve the use of ready mixed concrete provided that:

- a) the proposed mixes, the material to be used and the method of storage and mixing comply with the requirements of the Specification.

And

- 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.

### **703. 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.

### **704. TRANSPORT 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.

### **705. 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 714. 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 by the use of 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 so as 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, taking into account 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 so as 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 waterstops, 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 by the use of 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 706. 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 readily available at all times 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 so as 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 possible 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 705(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.

## **706. 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. Particular care shall be taken at arises 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 compactive effort is not reduced.

A sufficient number of vibrators shall be operated to enable the entire quantity of concrete being placed to be vibrated for the necessary period and, in addition, standby vibrators shall be available for instant use at each place where concrete is being placed.

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.

## **707. 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 above objectives but in any case for at least seven days or until the concrete is covered by later construction whichever is the shorter period.

The above objectives are dealt with in sub-clause 707(b) and (c) but nothing shall prevent both objectives 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 707(c). Water used for curing shall be of the same quality as that used for concrete mixing as stated in Clause 702.

**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 sub-clause 709(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.

**708. 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 Clause 701.

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 in order to estimate the time at which the nominal strength is reached.

**709. 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.

## 710. 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.

## **711. 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 721 c) and ordinary Portland cement complying with SRN 103. 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.

## **712. 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 SRN 103 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.

## **713. 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.

## **714. 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 with regard to 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 711 all as set out in sub-clause 705(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.

## **715. 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.

## **716. WATERSTOPS**

All references to waterstops include grout stops.

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 plasticised 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 waterstop 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.

## **717. 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.

## **718. 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 710 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.

## **719. 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.

## **720. 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 in to 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.

## **721. 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 Kenya 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 dry and well ventilated at all times. 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 so as 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 tons 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 laboratory of the Materials Branch of the Ministry of Transport & Communications or at the Kenya 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 off 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. In order 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 Clause 721 (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 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 in Clause 721 (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 percent when tested in accordance with SRN 107. Ten percent 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 percent.

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 percent when tested as set out in SRN 112.

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

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

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 percent 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 in SRN 107.

Tests to determine compliance of the aggregates with the requirements of Clause 721(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 on the basis of 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 in order 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 in order to avoid sudden fluctuations in water content. Storage of fine aggregates shall be arranged so that they can drain sufficiently before use in order 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.

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.

#### **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 manner in which he proposes to add it to the mix.

The information provided shall include but not be limited to:

- i. The typical dosage, the method of dosing and the detrimental effects of an excess or deficiency in the dosage.
- ii. The chemical names of the main active ingredients in the admixture.
- iii. Whether or not the admixture contains chlorides, and if so the chloride ion content expressed as a percentage by weight of admixture.
- iv. 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.
- v. Details of previous uses of the admixture in Kenya.

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 together without the consent of the Engineer.

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

##### **ii) Workability Agents**

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

##### **i) Reinforcement Steel**

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 so as 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 806.

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.

In order 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 below, 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	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**

### **901. GENERAL**

All masonry work shall be constructed from building stone as specified in Clause 1007.

For culvert headwalls and other small works, the stone shall, unless otherwise specified, be rough dressed. For walls, facing and other exposed works the stone shall unless otherwise specified, be medium chisel dressed.

### **902. WORKMANSHIP**

The Contractor shall provide and use proper setting out rods for all work.

Stones shall be well soaked before use and the tops of walls shall be kept wet as the work proceeds. The stones shall be properly bonded so that no vertical joint in a course is within 115mm of a joint in the previous course. Alternate courses of walling at angles and intersections shall be carried through the full thickness of the adjoining walls. All perpend, reveals and other angles of the walling shall be built strictly true and square.

The stones shall be bedded, jointed and pointed in 1:3 cement: sand mortar in accordance with Clause 1009 with beds and joints 9mm thick flushed up and grouted solid as the work proceeds.

All masonry work shall be cured in accordance with the relevant requirements to acceptable International Standards and/or as directed by the Engineer.

### **903. CAST STONWORK**

Cast stone shall be as specified in Clause 1008. Facing stones shall be brought up in courses to a height not exceeding 1 metre at a time, the concrete backing being then brought up and well incorporated into and round the backs of the stones and the projecting metal ties to ensure a complete bond. The stones shall be bedded and jointed as shown on the drawings.

All materials, moulds, mixing, casting and surface treatment, setting, jointing and pointing, and all centering, scaffolding and labour required to complete the cast stonework specified or as shown on the drawings, shall be included in the rates for such work.

## 10. MISCELLANEOUS ITEMS AND 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 water 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 so as to guard effectively against damage in transit and storage and ingress of foreign matter inside the valves.
- f) All pipework and fittings shall be subjected to a works hydrostatic test pressure which shall be not less than twice the maximum operating pressure.
- g) The Contractor should exercise diligence to provide the best material.
- h) Where applicable the manufacturer's Specification should accompany all offers. The name of the manufacturer must in every case be stated.
- i) 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.
- j) 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.
- k) Wherever possible, samples of pipes and fittings shall be submitted for approval of the Engineer prior to the Contractor obtaining the total requirements.

### 1002. 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.

### **1003. ARCHITRAVES AND STOPS**

Architraves and stops shall be Class 1 Mvuli matching to the frames and linings.

### **1004. 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.

Blocks shall be carefully handled and stored on site and protected from the weather at all times.

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 perpends 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.

### **1005. 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.

### **1006. 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.

### **1007. 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, sandholes, 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; and
- 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.

### **1008. 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.

### **1009. 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.

### **1010. 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.

### **1011. 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 712. 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.

### **1012. 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.

### **1013. 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 7.2 using maximum 12mm size aggregates. If required, cube test certificates shall be supplied by the manufacturer.

### **1014. 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 7.2 using maximum 12mm size aggregates. If required, cube test certificates shall be supplied by the manufacturer.

### **1015. 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.

## 1016. 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%).

## 1017. 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) Electric Power Act.
- c) The Kenya Power Company's Bye-Laws.
- d) Relevant current British Standards and Codes of Practice.
- e) All the relevant clauses in this Specification.

## 1018. 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.

## 1019. 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.

## 1020. 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 pelling to sub-frames with matching hardwood pellites. Architraves and stops shall be pinned on, heads punched and filled with tinted filler.

## 1021. 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.

## 1022. 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
Selvage 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 shall be as manufactured by Maccaferri, or equivalent. 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 in order to present a reasonably closed surface. All assembly, erection, stretching, filling with rock and final filing shall be in accordance with the instructions as issued by the manufacturer.

## 1023. 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.

## 1024. 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.

## 1025. 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. Moisture content shall be 12% (+ or - 2%).

## 1026. HYDRATED LIME

Hydrated lime shall comply with SRN 801: Building Limes and shall be of the semi- hydrated type.

## 1027. IRONMONGERY

All ironmongery shall be obtained from a source approved by the Engineer. 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.

## 1028. 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.

## 1029. JOINT PRIMER

Joint priming compound shall be entirely in accordance with the manufacturer's recommendations for the joint sealant to be used.

## 1030. 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:

Test Cone Penetration	Hot-poured Materials	Cold-poured Materials
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
Flow		
On a plane inclined at 75° to the horizontal, 5 hours at 60° centigrade	Flow not to exceed 5mm	Flow not to exceed 20mm
Bond		
25mm wide joint extended 12mm at rate of 4mm per hour at 18° centigrade. No more	Five cycles of extension and recompression	Three cycles of extension and recompression

than one specimen in three to develop a crack separation or other opening more than 4mm deep

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 that they meet the requirements of this clause relating to cold-poured joint sealing compounds.

### **1031. 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 1010. The constituent materials shall be accurately gauged and mixed in an approved manner.

### **1032. 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 mild steel, concrete filled, 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.

### **1033. MANHOLE STEP IRONS**

Step irons of general-purpose type shall comply in all respects with SRN 845: Malleable Step Irons.

### **1034. 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.

### **1035. MURRAM**

Murram shall be from an approved source quarried so as to exclude vegetable matter, loam, topsoil or clay. The California Bearing Ratio 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%. This C.B.R. is a guide to quality only and the compaction in the work will be judged by density.

### **1036. 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.

### **1037. 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.

### **1038. 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.

### **1039. 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.

### **1040. 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.

### **1041. 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 721 i) and 719-720. 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 that there are no laps in the paired lengths.

#### **c) Casting of Units**

Concrete for precast units shall comply with Clauses 1039/1040 and 701-710 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 707.

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 805c) 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 by the use of 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 in excess of 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  $1/40^{\text{th}}$  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.

### **1042. 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.

### **1043. 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.

### **1044. 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%
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### **1045. 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.

### **1046. 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.

### **1047. 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 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.

### **1048. 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.

### **1049. 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.

### **1050. 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.

### **1051. 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.

Detailed drawings of the steel tank should be submitted to the Engineer for approval prior to acceptance.

The pressed steel tank to SRN 909 (B.S. 1564 Type A (2) or similar approved) shall be supplied complete with:

- a) All stays, cleats, bolts, nuts, washers, jointing compound and associated materials and fittings.
- b) Connections for inlet, outlet, washout and overflow.
- c) Galvanized access ladder 450mm wide.
- d) Steel roof cover to fit the tank complete with access manhole and mosquito-proof cowl ventilators.
- e) Water level indicator.

Jointing material to the tank to be a non-toxic plastic compound which does not impart taste, colour nor odour to the water.

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.

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.

The tank tower shall be supplied complete with:

- a) Anchor bolts.
- b) Bolts, nuts, washers and associated materials and fittings.
- c) Access ladder 450mm wide extending from ground level to the top of the tank. Safety rings shall be at 1.2m centres.

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.

The columns of the tank shall consist of rolled steel joist sections or similar. Four such columns shall be provided with adequate bracing.

Internal surfaces of the tank shall be painted with approved non-toxic primer and non-toxic bituminous paint or epoxy-based NSF 61/BS 6920 approved coatings.

External surfaces of the tank and tower shall be painted with approved primer and approved bituminous aluminium paint.

## **11. ELECTRICAL AND MECHANICAL WORKS**

### **1101. GENERAL**

The equipment selected for this project must be able to operate in the particular altitude and weather conditions of Wajir. The minimum guaranteed technical specifications must be achieved with the worst weather conditions. All values stated in the bills of quantities are meant to be achieved at the site conditions and NOT at standard temperature and pressure.

The Specific Technical Specifications described in this section are to be read in conjunction with General Technical Specifications. In case of inconsistency between the 'particular and the 'general' Technical Specifications, the particular technical specifications take priority.

### **1102. PROJECT SCOPE**

The range of services to be provided in the project scope comprises the pump attached to the motor, solar power installation, electrical power cables with earthing cables included, bonding and earthing, control panels, labour, installation, various costs, fittings, and commissioning.

Forms verifying compliance with the standards outlined in the general specifications, particular specifications, drawings, and bills of quantities shall be completed by the contractor and submitted with the tender, or he can create his own forms.

Due to the efficiency-sensitive nature of this project, any equipment whose efficiency falls short of what is listed in the bills of quantities will be immediately rejected. There will be no room for less tolerance.

For this contract, the following pump stations will be fitted with pump sets.

- a. Qara station.
- b. Nurgows station.
- c. Sarman station.
- d. Sarman-Tarbaj station.

The Contractor shall be required to submit to the Engineer for approval all confirmation calculations for pump ratings, heads, and switchgear busbar and breaker ratings.

The borehole pumps shall be designed to reliably serve for a long time, ensuring high-efficiency operations to minimize energy consumption.

Bidders shall additionally be given water samples test results to ensure they select appropriate pump materials.

### **1103. QARA STATION**

#### **1103.(a) POWER SUPPLY**

The primary source of power shall be solar.

#### **1103.(b) SOLAR POWER**

The primary source of power will be solar energy. The following components shall be required:

- a. 100 no. 310W 24 V monocrystalline solar panels.
- b. 1 No. Switchgear with an automatic transfer switch.
- c. 1 No. Charge controller.
- d. 1 No. 22Kw 3-phase hybrid inverter.

### 1103.(c) SWITCHGEAR

400 volts, metal clad, wall-mounted type, and Main LV and Instrumentation Panel complete with instrumentation, integral mains phase failure panel, motorised breakers, status indicators, and all accessories, and 50 Amps TP & N rated busbars at full load integrated using 50 Amps TP&N minimum MCCB adjustable incomer complete with 50Amp TPN rated ATS. The board is to be fabricated using a minimum of 16 SWG or two mm-thick galvanised steel sheets. The instrumentation panel will comprise:

- a. 1 No. Flush AC voltmeter size 95x95mm, 0-500 V ac c/w selector switch and HRC protection fuses.
- b. 1 No. flush ac meter for the incomer size 95x95mm, 0-63 Amps c/w CTS rated 5VA, 80/5 Amps c/w selector switch and HRC protection fuses.
- c. 2 No. flush ac meter for the pump size 95x95mm, 0-20 Amps c/w CTS rated 5VA, 25/5 Amps c/w selector switch and HRC protection fuses.

The board shall be to form two type A separation. The design of the board must be submitted to the Engineer for approval before fabrication.

The switchgear shall have the following outgoers:

- a. 1 No. 16 Amps TPN MCCB for the QARA submersible pump.
- b. 2 No. 16 Amps TPN MCCB for the QARA surface pump.
- c. 1 No. 10A SPN MCCB for general loads (local distribution panel).
- d. 2 No. 6 Amps TPN MCCB for the Compressor starter.
- e. Spares 1 No. 16 Amps TPN, 1 No. 10 Amps SPN & 1 No. 6 Amps TPN.

The unit shall be earthed and bonded to all other equipment to IEC standards.

Approval by the Engineer for all busbar ratings and all ratings of the switchgear components shall be allowed.

### 1103.(d) PUMP

#### a. Submersible Pump

The pump shall be a vertically installed, multi-stage, ring-sectioned, radial-impeller centrifugal pump with mating flanges to DIN, ISO, BS, or ANSI standards for a submersible water pump, delivering a capacity of 25 m<sup>3</sup>/hr against 54m head. The system duty point shall be Q =25 m<sup>3</sup>/hr and H = 54m. The pump, complete with the motor, so selected shall have a minimum overall efficiency of 60% at the system duty point. The motor shall have a minimum efficiency of at least class IE3. The minimum impeller passage shall be 14mm. The motor shall be rated to a minimum IP 68 and run at 2900 rpm with a 50Hz frequency. The pump must be capable of maintaining efficiency over an extensive pumping range but shall not lose efficiency by more than 5% on 10% either side of the duty point. The delivery pipe set up shall be as shown in the drawings. Bidders shall include for all the valves, non-return valves, elbows and all other fittings as shown in the drawings. Bidders shall allow for the supply, installation, and commissioning of the Variable Frequency Drive starter, complete with all accessories to be used for starting and managing these pumps as well but located in the switchgear. The motors of the pump are set to be earthed to IEE/IEC standards.

#### b. Surface Pump

The pump shall be vertically or horizontally installed, single-stage, axially split volute casing pump with double entry radial impeller, mating flanges to DIN, ISO, BS or ANSI standards pontoon mounted water pumps of capacity 25m<sup>3</sup>/hr. Against 60m head. The Contractor shall include for all excavation, backfilling, demolition, pipe work, concrete works, connect to the Control panel for the pumps (the controls units shall be housed in a wall mounted dust and damp-proof sheet steel enclosure with hinged and lockable front door, and door switched power isolator) The system duty point shall be Q=25m<sup>3</sup>/hr. and H=60 m). The pumps so selected complete with the motor shall have a minimum overall efficiency of 65% at system duty point. The motors shall be minimum class IE3 efficiency class. The minimum impeller passage shall be 20mm. The motor shall be to minimum IP 54 running at 2900rpm with 50Hz frequency. The pump must be capable of maintaining efficiency over a large pumping range but shall not lose efficiency by more than 5% on 10% either side of the duty point. The suction and delivery pipe set up shall be

as shown in the drawings. The quotation shall include for all the valves, non-return valves, elbows and all other fittings as shown in the drawings. The net positive suction head available is 8.4m. Bidders shall allow for supply, installation and commissioning of the soft starters complete with all accessories to be used for starting and managing these pumps as well but located in the switchgear. The motors of the pump are set to be earthed to IEE/IEC standards.

### 1103.(e) PUMP STARTER PANEL

#### a. Submersible Pump

The pump Motor control shall be via a 6KW Solar Pump Inverter or Variable Frequency Drive Starter (MPPT-based), rated appropriately with integrated controls and protection. A 16A TPN adjustable MCCB breaker shall protect the pump. It shall serve 1No. Pump delivering 25 m<sup>3</sup>/hr. at 54m head. **The pump Motor control shall be via a 7kW Solar Pump Inverter or Variable Frequency Drive Starter (MPPT-based)**, rated appropriately with integrated controls and protection. The protection shall at the very minimum include phase fault, phase failure relay, thermal overload, overcurrent protection, earth leakage and dry run protection. The protection settings shall be to the latest standards of ISO or IEC standards. Ammeter and voltmeter for each pump prominently displayed at the front face. The board shall be designed for automatic operation but with an override to allow manual selection of pump. The controls shall use level or pressure switches to achieve start stop operations for the pump. The IP rating for the panels shall be minimum IP65 and possible to monitor through RS232, 485, wi-fi and GPRS 4G. The inverter minimum efficiency shall be 95%. The panels shall be air cooled.

The panel shall also have bulbs at the front of the panel illuminating the pump. The lamps shall be green for pump running, red for pump tripped and amber when pump is not on running but available for duty. The Pump shall be fitted with an emergency switch to enable immediate stop in case of a problem.

#### b. Surface Pump

The pump Motor control shall be via a Solar Pump Inverter or Variable Frequency Drive Starter (MPPT-based), rated at 7.5KW with integrated controls and protection. A 16A TPN adjustable MCCB breaker shall protect the pump. The protection shall at the very minimum include phase fault, phase failure relay, thermal overload, over-current protection, earth leakage and dry run protection. The IP rating for the panels shall be minimum IP65 and possible to monitor through RS232, 485, wi-fi and GPRS 4G. The inverter minimum efficiency shall be 95%. The panels shall be air cooled.

The protection settings shall be to the latest standards of BS or IEC standards. The panels shall also have run hour meter, ammeter and voltmeter for each pump prominently displayed at the front face. The board shall be designed for automatic operation but with an override to allow manual selection of pumps. The controls shall use level switches to achieve start stop operations for the pumps. The panel shall have an audible alarm that sounds whenever there is an electrical fault. The panel shall also have bulbs at the front of the panel illuminating for each pump. The lamps shall be green for pump running, red for pump tripped and amber when pump is not on running but available for duty. Additionally, the panel shall be fitted with a selector switch to enable the operator to physically select the duty pumps while at the same time retaining the automatic rotational selection capacity to ensure uniform run hours. Each pump set shall be fitted with an emergency switch adjacent to it to enable immediate stop and another emergency stop button at the panel. These panels can be domiciled in the main switchgear and earthed to IEC standards.

### 1103.(f) PUMP DETAILS

#### a. Submersible Pump

Table 11-1: Qara BH Pump Details

Parameter	Value	Remarks
Total Pumps in Station	1	
Duty Pump Sets	1	
Pump Head (m)	54	

Flow (m <sup>3</sup> /hr.) / Pump	25	
Minimum Pump Efficiency-%.	65	
Motor Rating (kW)	7	
Motor Efficiency Class	IE3	
Pump Casing	Grey Cast Iron	
Alignment	Vertical	
Type of Pump	Multi-stage, ring-sectioned, radial-impeller centrifugal pump with mating flanges.	
Impeller Material	Cast Iron ERN	
Switchgear Rating	50A TPN	
Control	Level/Pressure Switches	

### b. Surface Pump

**Table 11-2: Qara Surface Pump Details**

Parameter	Value	Remarks
Total Pumps in Station	2	
Duty Pump Sets	1	
Pump Head (m)	60	
Flow (m <sup>3</sup> /hr.) / Pump	25	
Minimum Pump Efficiency-%.	65	
Motor Rating (kW)	<b>7.5</b>	
Motor Efficiency Class	IE3	
Pump Casing	Grey Cast Iron	
Alignment	Horizontal/Vertical	
Type of Pump	Single Stage radial impeller Centrifugal	
Impeller Material	Cast Iron ERN	
Net Positive Suction Head Available (m)	8.4	
Switchgear Rating	<b>50A TPN</b>	
Control	Level/Pressure Switches	

### 1103.(g) PUMP STATION FITTINGS

All pump station fittings shall be of the material stipulated and approved by the engineer. The dual plate non-return valves shall be manufactured to API 594 and 598 and shall be flange type suitable for vertical installation to aid in surge suppression. Gate valves shall be used to control the flow of water in and out of the station.

### 1104. NURGOWS STATION

#### 1104.(a) POWER SUPPLY

The primary source of power shall be solar.

## 1104.(b) SOLAR POWER

The primary source of power will be solar energy. The following components shall be required:

- a. 140 no. 310W 24 V monocrystalline solar panels.
- b. 1 No. Switchgear with automatic transfer switch.
- c. 1 No. Charge controller.
- d. 32Kw 3-phase hybrid inverter.

## 1104.(c) SWITCHGEAR

400 volts, metal clad, wall-mounted type, and Main LV and Instrumentation Panel complete with instrumentation, integral mains phase failure panel, motorised breakers, status indicators and all accessories, 63 Amps TP & N rated busbars at full load integrated using 63 Amps TP&N minimum MCCB adjustable incomer with ATS rated at 63 Amps TPN. The board is to be fabricated using a minimum of 16 SWG or two mm-thick galvanised steel sheets. The instrumentation panel will comprise:

- a. 1 No. Flush ac voltmeter size 95x95mm, 0-500 V ac c/w selector switch and HRC protection fuses.
- b. 1 No. flush ac meter for the incomer size 95x95mm, 0-80 Amps c/w CTS rated 5VA, 100/5 Amps c/w selector switch and HRC protection fuses.
- c. 1 No. flush ac meter for the pump size 95x95mm, 0-40 Amps c/w CTS rated 5VA, 50/5 Amps c/w selector switch and HRC protection fuses.
- d. 1 No. flush ac meter for the pump size 95x95mm, 0-20 Amps c/w CTS rated 5VA, 25/5 Amps c/w selector switch and HRC protection fuses.

The board shall be to form two type A separation. The design of the board must be submitted to the Engineer for approval before fabrication.

The switchgear shall have the following outgoers:

- a. 1 No. 32 Amps TPN MCCB for the borehole pump.
- b. 1 No. 16 Amps TPN MCCB for the surface pump.
- c. 1 No. 10A SPN MCCB for general loads (local distribution panel).
- d. 2 No. 6 Amps TPN MCCB for the compressor starter.
- e. Spares 1 No. 32 Amps TPN, 1 No. 16 Amps TPN, 1 No. 10 Amps SPN & 1 No. 6 Amps TPN.

The unit shall be earthed and bonded to all other equipment to IEC standards.

Approval by Engineer for all busbar ratings and all ratings of the switchgear components shall be allowed.

## 1104.(d) PUMP

### a. Submersible Pump

The pump shall be a vertically installed, multi-stage, ring-sectioned, radial-impeller centrifugal pump with mating flanges to DIN, ISO, BS, or ANSI standards for a submersible water pump, delivering a capacity of 64 m<sup>3</sup>/hr, against 48m head. The system duty point shall be Q= 64 m<sup>3</sup>/hr and H = 48m. The pump, complete with the motor, shall have a minimum overall efficiency of 65% at the system duty point. The motor shall have a minimum efficiency of class IE3. The minimum impeller passage shall be 14mm. The motor shall be rated to a minimum IP 68 and run at 2900 rpm with a 50Hz frequency. The pump must be capable of maintaining efficiency over a wide pumping range but shall not lose efficiency by more than 5% on either side of the duty point, within a 10% range. The suction and delivery pipe set up shall be as shown in the drawings. Bidders shall include all valves, non-return valves, elbows, and other fittings as shown in the drawings. Bidders shall allow for the supply, installation and commissioning of the Variable Frequency Drive starter complete with all accessories to be used for starting and managing these pumps as well but located in the switchgear. The motors of the pump are set to be earthed to IEE/IEC standards.

## **b. Surface Pump**

The pump shall be vertically or horizontally installed, single-stage, axially split volute casing pump with double entry radial impeller, mating flanges to DIN, ISO, BS or ANSI standards pontoon mounted water pumps of capacity 64m<sup>3</sup>/hr. Against 84m head. The Contractor shall include for all excavation, backfilling, demolition, pipe work, concrete works, connect to the Control panel for the pumps (the controls units shall be housed in a wall mounted dust and damp-proof sheet steel enclosure with hinged and lockable front door, and door switched power isolator) The system duty point shall be Q=64m<sup>3</sup>/hr. and H=84 m). The pumps so selected complete with the motor shall have a minimum overall efficiency of 60% at system duty point. The motors shall be minimum class IE3 efficiency class. The minimum impeller passage shall be 20mm. The motor shall be to minimum IP 66 running at 2900rpm with 50Hz frequency. The pump must be capable of maintaining efficiency over a large pumping range but shall not lose efficiency by more than 5% on 10% either side of the duty point. The suction and delivery pipe set up shall be as shown in the drawings. The quotation shall include for all the valves, non-return valves, elbows and all other fittings as shown in the drawings. The net positive suction head available is 8.4m. Bidders shall allow for supply, installation and commissioning of the soft starters complete with all accessories to be used for starting and managing these pumps as well but located in the switchgear. The motors of the pump are set to be earthed to IEE/IEC standards.

## **1104.(e) PUMP STARTER PANEL**

### **a. Submersible Pump**

The pump Motor control shall be via a 14KW Solar Pump Inverter or Variable Frequency Drive Starter (MPPT-based), rated at appropriately with integrated controls and protection. A 32A TPN (400V) adjustable MCCB breaker shall protect the pump. It shall serve one pump delivering 64 m<sup>3</sup>/hr. at 48m head. The protection shall at the very minimum include phase fault, phase failure relay, thermal overload, overcurrent protection, earth leakage and dry run protection. The IP rating for the panels shall be minimum IP65 and possible to monitor through RS232, 485, wi-fi and GPRS 4G. The inverter minimum efficiency shall be 95%. The panels shall be air cooled.

The protection settings shall be to the latest standards of ISO or IEC standards. Ammeter and voltmeter for each pump prominently displayed at the front face. The board shall be designed for automatic operation but with an override to allow manual selection of pump. The controls shall use level or pressure switches to achieve start stop operations for the pump. The panel shall also have bulbs at the front of the panel illuminating the pump. The lamps shall be green for pump running, red for pump tripped and amber when pump is not on running but available for duty. The Pump shall be fitted with an emergency switch to enable immediate stop in case of a problem.

### **b. Surface Pump**

The pump Motor control shall be via a Solar Pump Inverter or Variable Frequency Drive Starter (MPPT-based), rated at 7.5KW with integrated controls and protection. A 16A TPN adjustable MCCB breaker shall protect the pump. The protection shall at the very minimum include phase fault, phase failure relay, thermal overload, over-current protection, earth leakage and dry run protection. The IP rating for the panels shall be minimum IP65 and possible to monitor through RS232, 485, wi-fi and GPRS 4G. The inverter minimum efficiency shall be 95%. The panels shall be air cooled.

The protection settings shall be to the latest standards of BS or IEC standards. The panels shall also have run hour meter, ammeter and voltmeter for each pump prominently displayed at the front face. The board shall be designed for automatic operation but with an override to allow manual selection of pumps. The controls shall use level switches to achieve start stop operations for the pumps. The panel shall have an audible alarm that sounds whenever there is an electrical fault. The panel shall also have bulbs at the front of the panel illuminating for each pump. The lamps shall be green for pump running, red for pump tripped and amber when pump is not on running but available for duty. Additionally, the panel shall be fitted with a selector switch to enable the operator to physically select the duty pumps while at the same time retaining the automatic rotational selection capacity to ensure uniform run hours. Each pump set shall be fitted with an emergency switch adjacent to it to enable immediate stop and another emergency stop button at the panel. These panels can be domiciled in the main switchgear and earthed to IEC standards.

## 1104.(f) PUMP DETAILS

### a. Submersible Pump

Table 11-3: Nurgows BH Pump Details

Parameter	Value	Remarks
Total Pumps in Station	1	
Duty Pump Sets	1	
Pump Head (m)	48	
Flow (m <sup>3</sup> /hr.) / Pump	64	
Minimum Pump Efficiency-%.	70	
Motor Rating (kW)	<b>14</b>	
Motor Efficiency Class	IE3	
Pump Casing	Grey Cast Iron	
Alignment	Vertical	
Type of Pump	Multistage, ring-sectioned, radial-impeller centrifugal pump with mating flanges	
Impeller Material	Cast Iron ERN	
Switchgear Rating	<b>63A TPN</b>	
Control	Level/Pressure Switches	

### b. Surface Pump

Table 11-4: Nurgows Surface Pump Details

Parameter	Value	Remarks
Total Pumps in Station	2	
Duty Pump Sets	1	
Pump Head (m)	84	
Flow (m <sup>3</sup> /hr.) / Pump	64	
Minimum Pump Efficiency-%.	65	
Motor Rating (kW)	<b>7.5</b>	
Motor Efficiency Class	IE3	
Pump Casing	Grey Cast Iron	
Alignment	Horizontal	
Type of Pump	Single Stage radial Impeller Centrifugal	
Impeller Material	Cast Iron ERN	
Net Positive Suction Head Available (m)	8.4	
Switchgear Rating	<b>63A TPN</b>	
Control	Level/Pressure Switches	

## **1104.(g) PUMP STATION FITTINGS.**

All pump station fittings shall be of the material stipulated and approved by the engineer. The dual plate non-return valves shall be manufactured to API 594 and 598 standards and shall be flange-type, suitable for vertical installation to aid in surge suppression. Gate valves shall be used to control the flow of water in and out of the station.

## **1105. SARMAN STATION**

### **1105.(a) POWER SUPPLY**

The primary source of power shall be solar.

### **1105.(b) SOLAR POWER**

The primary source of power will be solar energy. The following components shall be required:

- a. 30 No. 310W 24 V monocrystalline solar panels.
- b. 1 No. Switchgear with automatic transfer switch.
- c. 1 No. Charge controller.
- d. 10Kw 3-phase hybrid inverter.

### **1105.(c) SWITCHGEAR**

400 volts, metal clad, wall-mounted type, and Main LV and Instrumentation Panel complete with instrumentation, integral mains phase failure panel, motorised breakers, status indicators and all accessories, 10 Amps TP & N rated busbars at full load integrated using 10 Amps TP&N minimum MCCB adjustable incomer with ATS rated at 10 Amps TPN. The board is to be fabricated using a minimum of 16 SWG or two mm-thick galvanised steel sheets. The instrumentation panel will comprise:

- a. 1 No. Flush ac voltmeter size 95x95mm, 0-500 V ac c/w selector switch and HRC protection fuses.
- b. 1 No. flush ac meter for the incomer size 95x95mm, 0-15 Amps c/w CTS rated 5VA, 16/5 Amps c/w selector switch and HRC protection fuses.
- c. 2 No. flush ac meter for the pump size 95x95mm, 0-10 Amps c/w CTS rated 5VA, 16/5 Amps c/w selector switch and HRC protection fuses.

The board shall be to form two type A separation. The design of the board must be submitted to the Engineer for approval before fabrication.

The switchgear shall have the following outgoers:

- a. 1 No. 6 Amps TPN MCCB for the borehole pump.
- b. 1 No. 6 Amps TPN MCCB for the surface pump.
- c. 1 No. 10A SPN MCCB for general loads (local distribution panel).
- d. Spares 1 No. 6 Amps TPN, 1 No. 6 Amps TPN, 1 No. 10 Amps SPN & 1 No. 6 Amps TPN.

The unit shall be earthed and bonded to all other equipment to IEC standards.

Approval by Engineer for all busbar ratings and all ratings of the switchgear components shall be allowed.

### **1105.(d) PUMP**

#### **a. Submersible Pump**

The pump shall be a vertically installed, multi-stage, ring-sectioned, radial-impeller centrifugal pump with mating flanges to DIN, ISO, BS, or ANSI standards for a submersible water pump, delivering a capacity of 2.5 m<sup>3</sup>/hr, against

35m head. The system duty point shall be  $Q= 2.5 \text{ m}^3/\text{hr}$  and  $H = 35\text{m}$ . The pump, complete with the motor, shall have a minimum overall efficiency of 50% at the system duty point. The motor shall have a minimum efficiency of class IE3. The minimum impeller passage shall be 14mm. The motor shall be rated to a minimum IP 68 and run at 2900 rpm with a 50Hz frequency. The pump must be capable of maintaining efficiency over a wide pumping range but shall not lose efficiency by more than 5% on either side of the duty point, within a 10% range. The suction and delivery pipe set up shall be as shown in the drawings. Bidders shall include all valves, non-return valves, elbows, and other fittings as shown in the drawings. Bidders shall allow for the supply, installation and commissioning of the Variable Frequency Drive starter complete with all accessories to be used for starting and managing these pumps as well but located in the switchgear. The motors of the pump are set to be earthed to IEE/IEC standards.

#### **b. Surface Pump**

The pump shall be vertically or horizontally installed, single-stage, axially split volute casing pump with double entry radial impeller, mating flanges to DIN, ISO, BS or ANSI standards pontoon mounted water pumps of capacity  $2.5\text{m}^3/\text{hr}$ . Against 47m head. The Contractor shall include for all excavation, backfilling, demolition, pipe work, concrete works, connect to the Control panel for the pumps (the controls units shall be housed in a wall mounted dust and damp-proof sheet steel enclosure with hinged and lockable front door, and door switched power isolator) The system duty point shall be  $Q=2.5\text{m}^3/\text{hr}$  and  $H=47 \text{ m}$ ). The pumps so selected complete with the motor shall have a minimum overall efficiency of 50% at system duty point. The motors shall be minimum class IE3 efficiency class. The minimum impeller passage shall be 20mm. The motor shall be to minimum IP 54 running at 2900rpm with 50Hz frequency. The pump must be capable of maintaining efficiency over a large pumping range but shall not lose efficiency by more than 5% on 10% either side of the duty point. The suction and delivery pipe set up shall be as shown in the drawings. The quotation shall include for all the valves, non-return valves, elbows and all other fittings as shown in the drawings. The net positive suction head available is 8.4m. Bidders shall allow for supply, installation and commissioning of the soft starters complete with all accessories to be used for starting and managing these pumps as well but located in the switchgear. The motors of the pump are set to be earthed to IEE/IEC standards.

### **1105.(e) PUMP STARTER PANEL**

#### **a. Submersible Pump**

The pump Motor control shall be via a 0.5KW Solar Pump Inverter or Variable Frequency Drive Starter (MPPT-based), rated at appropriately with integrated controls and protection. A 6A TPN (400V) adjustable MCCB breaker shall protect the pump. It shall serve 1 pump delivering  $2.5 \text{ m}^3/\text{hr}$  at 35m head. The protection shall at the very minimum include phase fault, phase failure relay, thermal overload, overcurrent protection, earth leakage and dry run protection. The IP rating for the panels shall be minimum IP65 and possible to monitor through RS232, 485, wi-fi and GPRS 4G. The inverter minimum efficiency shall be 95%. The panels shall be air cooled.

The protection settings shall be to the latest standards of ISO or IEC standards. Ammeter and voltmeter for each pump prominently displayed at the front face. The board shall be designed for automatic operation but with an override to allow manual selection of pump. The controls shall use level or pressure switches to achieve start stop operations for the pump. The panel shall also have bulbs at the front of the panel illuminating the pump. The lamps shall be green for pump running, red for pump tripped and amber when pump is not on running but available for duty. The Pump shall be fitted with an emergency switch to enable immediate stop in case of a problem.

#### **b. Surface Pump**

The pump Motor control shall be via a Solar Pump Inverter or Variable Frequency Drive Starter (MPPT-based), rated at 1.1KW with integrated controls and protection. A 6A TPN adjustable MCCB breaker shall protect the pump. The protection shall at the very minimum include phase fault, phase failure relay, thermal overload, over-current protection, earth leakage and dry run protection. The IP rating for the panels shall be minimum IP65 and possible to monitor through RS232, 485, wi-fi and GPRS 4G. The inverter minimum efficiency shall be 95%. The panels shall be air cooled.

The protection settings shall be to the latest standards of BS or IEC standards. The panels shall also have run hour meter, ammeter and voltmeter for each pump prominently displayed at the front face. The board shall be designed for automatic operation but with an override to allow manual selection of pumps. The controls shall use level

switches to achieve start stop operations for the pumps. The panel shall have an audible alarm that sounds whenever there is an electrical fault. The panel shall also have bulbs at the front of the panel illuminating for each pump. The lamps shall be green for pump running, red for pump tripped and amber when pump is not on running but available for duty. Additionally, the panel shall be fitted with a selector switch to enable the operator to physically select the duty pumps while at the same time retaining the automatic rotational selection capacity to ensure uniform run hours. Each pump set shall be fitted with an emergency switch adjacent to it to enable immediate stop and another emergency stop button at the panel. These panels can be domiciled in the main switchgear and earthed to IEC standards.

## 1105.(f) PUMP DETAILS

### a. Submersible Pump

Table 11-5: Sarman BH Pump Details

Parameter	Value	Remarks
Total Pumps in Station	1	
Duty Pump Sets	1	
Pump Head (m)	35	
Flow (m <sup>3</sup> /hr.) / Pump	2.5	
Minimum Pump Efficiency-%.	60	
Motor Rating (kW)	<b>0.5</b>	
Motor Efficiency Class	IE3	
Pump Casing	Grey Cast Iron	
Alignment	Vertical	
Type of Pump	Multistage, ring-sectioned, radial-impeller centrifugal pump with mating flanges	
Impeller Material	Cast Iron ERN	
Switchgear Rating	<b>10A TPN</b>	
Control	Level/Pressure Switches	

### b. Surface Pump

Table 11-6: Sarman Surface Pump Details

Parameter	Value	Remarks
Total Pumps in Station	2	
Duty Pump Sets	1	
Pump Head (m)	47	
Flow (m <sup>3</sup> /hr.) / Pump	2.5	
Minimum Pump Efficiency-%.	60	
Motor Rating (kW)	<b>1.1</b>	
Motor Efficiency Class	IE3	
Pump Casing	Grey Cast Iron	
Alignment	Horizontal/Vertical	

Type of Pump	Single Stage radial Impeller Centrifugal	
Impeller Material	Cast Iron ERN	
Net Positive Suction Head Available (m)	8.4	
Switchgear Rating	<b>10A TPN</b>	
Control	Level/Pressure Switches	

### 1105.(g) PUMP STATION FITTINGS

All pump station fittings shall be of the material stipulated and approved by the engineer. The dual plate non-return valves shall be manufactured to API 594 and 598 standards and shall be flange-type, suitable for vertical installation to aid in surge suppression. Gate valves shall be used to control the flow of water in and out of the station.

### 1106. SARMAN-TARBAJ STATION

#### 1106.(a) POWER SUPPLY

The primary source of power shall be solar.

#### 1106.(b) SOLAR POWER

The primary source of power will be solar energy. The following components shall be required:

- a. 110 No. 310W 24 V monocrystalline solar panels.
- b. 1 No. Switchgear with automatic transfer switch.
- c. 1 No. Charge controller.
- d. 25Kw 3-phase hybrid inverter.

#### 1106.(c) SWITCHGEAR

400 volts, metal clad, wall-mounted type, and Main LV and Instrumentation Panel complete with instrumentation, integral mains phase failure panel, motorised breakers, status indicators and all accessories, 50 Amps TP & N rated busbars at full load integrated using 50 Amps TP&N minimum MCCB adjustable incomer with ATS rated at 50 Amps TPN. The board is to be fabricated using a minimum of 16 SWG or two mm-thick galvanised steel sheets. The instrumentation panel will comprise:

- a. 1 No. Flush ac voltmeter size 95x95mm, 0-500 V ac c/w selector switch and HRC protection fuses.
- b. 1 No. flush ac meter for the incomer size 95x95mm, 0-63 Amps c/w CTS rated 5VA, 80/5 Amps c/w selector switch and HRC protection fuses.
- c. 1 No. flush ac meter for the pump size 95x95mm, 0-30 Amps c/w CTS rated 5VA, 32/5 Amps c/w selector switch and HRC protection fuses.
- d. 1 No. flush ac meter for the pump size 95x95mm, 0-15 Amps c/w CTS rated 5VA, 16 /5 Amps c/w selector switch and HRC protection fuses.

The board shall be to form two type A separation. The design of the board must be submitted to the Engineer for approval before fabrication.

The switchgear shall have the following outgoers:

- a. 1 No.10 Amps TPN MCCB for the borehole pump.
- b. 1 No.25 Amps TPN MCCB for the surface pump.

- c. 1 No. 10A SPN MCCB for general loads (local distribution panel).
- d. 2 No.6 Amps TPN MCCB for the compressor starter.
- e. Spares 1 No. 10 Amps TPN, 1 No. 25 Amps TPN, 1 No. 10 Amps SPN & 1 No. 6 Amps TPN.

The unit shall be earthed and bonded to all other equipment to IEC standards.

Approval by Engineer for all busbar ratings and all ratings of the switchgear components shall be allowed.

## **1106.(d) PUMP**

### **a. Submersible Pump**

The pump shall be a vertically installed, multi-stage, ring-sectioned, radial-impeller centrifugal pump with mating flanges to DIN, ISO, BS, or ANSI standards for a submersible water pump, delivering a capacity of 10 m<sup>3</sup>/hr, against 67m head. The system duty point shall be Q= 10 m<sup>3</sup>/hr and H = 67m. The pump, complete with the motor, shall have a minimum overall efficiency of 55% at the system duty point. The motor shall have a minimum efficiency of class IE3. The minimum impeller passage shall be 14mm. The motor shall be rated to a minimum IP 68 and run at 2900 rpm with a 50Hz frequency. The pump must be capable of maintaining efficiency over a wide pumping range but shall not lose efficiency by more than 5% on either side of the duty point, within a 10% range. The suction and delivery pipe set up shall be as shown in the drawings. Bidders shall include all valves, non-return valves, elbows, and other fittings as shown in the drawings. Bidders shall allow for the supply, installation and commissioning of the Variable Frequency Drive starter complete with all accessories to be used for starting and managing these pumps as well but located in the switchgear. The motors of the pump are set to be earthed to IEE/IEC standards.

### **b. Surface Pump**

The pump shall be vertically or horizontally installed, single-stage, axially split volute casing pump with double entry radial impeller, mating flanges to DIN, ISO, BS or ANSI standards pontoon mounted water pumps of capacity 10m<sup>3</sup>/hr. Against 152m head. The Contractor shall include for all excavation, backfilling, demolition, pipe work, concrete works, connect to the Control panel for the pumps (the controls units shall be housed in a wall mounted dust and damp-proof sheet steel enclosure with hinged and lockable front door, and door switched power isolator) The system duty point shall be Q=10m<sup>3</sup>/hr and H=152 m). The pumps so selected complete with the motor shall have a minimum overall efficiency of 60% at system duty point. The motors shall be minimum class IE3 efficiency class. The minimum impeller passage shall be 20mm. The motor shall be to minimum IP 66 running at 2900rpm with 50Hz frequency. The pump must be capable of maintaining efficiency over a large pumping range but shall not lose efficiency by more than 5% on 10% either side of the duty point. The suction and delivery pipe set up shall be as shown in the drawings. The quotation shall include for all the valves, non-return valves, elbows and all other fittings as shown in the drawings. The net positive suction head available is 8.4m. Bidders shall allow for supply, installation and commissioning of the soft starters complete with all accessories to be used for starting and managing these pumps as well but located in the switchgear. The motors of the pump are set to be earthed to IEE/IEC standards.

## **1106.(e) PUMP STARTER PANEL**

### **a. Submersible Pump**

The pump Motor control shall be via a 4KW Solar Pump Inverter or Variable Frequency Drive Starter (MPPT-based), rated at appropriately with integrated controls and protection. A 10A TPN (400V) adjustable MCCB breaker shall protect the pump. It shall serve 1 pump delivering 10 m<sup>3</sup>/hr. at 67m head. The protection shall at the very minimum include phase fault, phase failure relay, thermal overload, overcurrent protection, earth leakage and dry run protection. The IP rating for the panels shall be minimum IP65 and possible to monitor through RS232, 485, wi-fi and GPRS 4G. The inverter minimum efficiency shall be 95%. The panels shall be air cooled.

The protection settings shall be to the latest standards of ISO or IEC standards. Ammeter and voltmeter for each pump prominently displayed at the front face. The board shall be designed for automatic operation but with an override to allow manual selection of pump. The controls shall use level or pressure switches to achieve start stop operations for the pump. The panel shall also have bulbs at the front of the panel illuminating the pump. The lamps

shall be green for pump running, red for pump tripped and amber when pump is not on running but available for duty. The Pump shall be fitted with an emergency switch to enable immediate stop in case of a problem.

**b. Surface Pump**

The pump Motor control shall be via a Solar Pump Inverter or Variable Frequency Drive Starter (MPPT-based), rated at 11KW with integrated controls and protection. A 25A TPN adjustable MCCB breaker shall protect the pump. The protection shall at the very minimum include phase fault, phase failure relay, thermal overload, over-current protection, earth leakage and dry run protection. The IP rating for the panels shall be minimum IP65 and possible to monitor through RS232, 485, wi-fi and GPRS 4G. The inverter minimum efficiency shall be 95%. The panels shall be air cooled.

The protection settings shall be to the latest standards of BS or IEC standards. The panels shall also have run hour meter, ammeter and voltmeter for each pump prominently displayed at the front face. The board shall be designed for automatic operation but with an override to allow manual selection of pumps. The controls shall use level switches to achieve start stop operations for the pumps. The panel shall have an audible alarm that sounds whenever there is an electrical fault. The panel shall also have bulbs at the front of the panel illuminating for each pump. The lamps shall be green for pump running, red for pump tripped and amber when pump is not on running but available for duty. Additionally, the panel shall be fitted with a selector switch to enable the operator to physically select the duty pumps while at the same time retaining the automatic rotational selection capacity to ensure uniform run hours. Each pump set shall be fitted with an emergency switch adjacent to it to enable immediate stop and another emergency stop button at the panel. These panels can be domiciled in the main switchgear and earthed to IEC standards.

**1106.(f) PUMP DETAILS**

**a. Submersible Pump**

**Table 11-7: Sarman Tarbaj BH Pump Details**

Parameter	Value	Remarks
Total Pumps in Station	1	
Duty Pump Sets	1	
Pump Head (m)	67	
Flow (m <sup>3</sup> /hr.) / Pump	10	
Minimum Pump Efficiency-%.	60	
Motor Rating (kW)	<b>5</b>	
Motor Efficiency Class	IE3	
Pump Casing	Grey Cast Iron	
Alignment	Vertical	
Type of Pump	Multistage, ring-sectioned, radial-impeller centrifugal pump with mating flanges	
Impeller Material	Cast Iron ERN	
Switchgear Rating	<b>50A TPN</b>	
Control	Level/Pressure Switches	

**b. Surface Pump**

**Table 11-8: Sarman Tarbaj Surface Pump Details**

Parameter	Value	Remarks
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Total Pumps in Station	2	
Duty Pump Sets	1	
Pump Head (m)	152	
Flow (m <sup>3</sup> /hr.) / Pump	10	
Minimum Pump Efficiency-%.	60	
Motor Rating (kW)	<b>11</b>	
Motor Efficiency Class	IE3	
Pump Casing	Grey Cast Iron	
Alignment	Horizontal	
Type of Pump	Multistage radial impeller Centrifugal	
Impeller Material	Cast Iron ERN	
Net Positive Suction Head Available (m)	8.4	
Switchgear Rating	50A TPN	
Control	Level/Pressure Switches	

### **1106.(g) PUMP STATION FITTINGS**

All pump station fittings shall be of the material stipulated and approved by the engineer. The dual plate non-return valves shall be manufactured to API 594 and 598 standards and shall be flange-type, suitable for vertical installation to aid in surge suppression. Gate valves shall be used to control the flow of water in and out of the station.

## 12. PARTICULAR SPECIFICATIONS FOR WATER TREATMENT

### 1201. GENERAL

This Chapter specifies the requirements for water treatment systems to be provided under the Contract for the community water supply schemes. The Contractor shall provide all treatment systems, equipment, accessories, and interfaces necessary to ensure that potable water supplied complies with applicable drinking water quality standards.

Water treatment under this Contract comprises nanofiltration, where specified, and chlorination. These treatment systems shall be provided as separate and distinct systems, each complete in itself, but hydraulically compatible where installed within the same scheme.

### 1202. SCHEMES AND GENERAL TREATMENT REQUIREMENTS

#### 1202.(a) COMMUNITY WATER SUPPLY SCHEMES AND APPLICABLE TREATMENT

The community water supply schemes covered under this Chapter and the applicable forms of treatment are summarised in the table below.

**Table 12-1: Community Water Supply Schemes and Applicable Water Treatment**

S/No	Community Water Supply Scheme	Applicable Treatment	Remarks
1	Nurgows Community Water Supply Scheme	Chlorination only	Raw water quality compliant.
2	Qara Community Water Supply Scheme	Chlorination only	Raw water quality compliant.
3	Sarman Community Water Supply Scheme	Chlorination only	No membrane treatment required.
4	Sarman–Tarbaj Community Water Supply Scheme	Nanofiltration (NF) and chlorination	Potable and non-potable supplies segregated.

#### 1202.(b) SCHEME INDEPENDENCE

Each water supply scheme shall operate as a standalone system. No interconnection, blending, or cross-supply between schemes shall be permitted.

#### 1202.(c) TREATMENT PROPORTIONALITY

Only water quality parameters requiring correction shall be treated. Where raw water quality complies with potable standards, no physico-chemical or membrane treatment shall be introduced.

#### 1202.(d) POTABLE AND NON-POTABLE SEGREGATION

Where both potable and non-potable water demands exist, the Contractor shall ensure physical and hydraulic segregation of treated and untreated water streams. Only potable water shall be treated and disinfected.

#### 1202.(e) POWER SUPPLY COMPATIBILITY

All treatment equipment shall be compatible with solar-powered operation and shall operate reliably under intermittent power conditions.

## 1202.(f) MATERIALS AND CORROSION RESISTANCE

All materials in contact with water or treatment chemicals shall be suitable for potable water use and resistant to corrosion under the prevailing site conditions.

## 1202.(g) WATER QUALITY STANDARDS

All potable water produced shall comply with the most stringent of the standards listed in the table below.

**Table 12-2: Applicable Water Quality Standards**

Standard	Description
WHO	Guidelines for Drinking-water Quality (latest edition)
KEBS	KS EAS 12 – Drinking Water Specification
WASREB	Applicable potable water quality requirements

Compliance shall apply at the treatment outlet and at points of delivery after disinfection.

## 1202.(h) EQUIPMENT AND INSTALLATION STANDARDS

All treatment equipment shall be new, unused, and supplied by recognised manufacturers. Equipment shall comply with applicable ISO, IEC, BS, or equivalent standards and shall be certified for potable water applications.

## 1203. NANOFILTRATION (NF) SYSTEM

### 1203.(a) APPLICABILITY

Nanofiltration shall be provided only where specified in the Bills of Quantities. Nanofiltration shall be applied solely to the potable fraction of the water supply. No nanofiltration shall be provided for non-potable uses.

### 1203.(b) SCOPE

Where required, the Contractor shall supply, install, test, and commission a complete nanofiltration system, including all equipment, housing, pipework, electrical works, and interfaces necessary for reliable operation. Chlorination equipment shall not form part of the nanofiltration system.

### 1203.(c) CAPACITY AND OPERATION

The nanofiltration system shall have a nominal permeate capacity of 5 m<sup>3</sup>/hr. The system shall be suitable for intermittent operation under solar power. Operating recovery shall be in accordance with membrane manufacturer recommendations.

### 1203.(d) PROCESS ARRANGEMENT

The nanofiltration system shall be arranged in the following sequence:

**Raw water tank → feed/booster pump → multimedia filter → cartridge filter → high-pressure NF feed pump → NF membranes → treated (permeate) water tank.**

Concentrate (reject) shall be discharged through a dedicated pipeline to a soakaway or other approved disposal facility.

### 1203.(e) PRE-TREATMENT AND CHEMICAL CONDITIONING

Pre-treatment is mandatory. It shall include multimedia (sand) filtration and cartridge filtration with a nominal rating of 5–20 microns. Provision shall be made for drainage and cartridge replacement.

Where required by membrane supplier recommendations, chemical dosing equipment shall be provided for membrane protection or conditioning. Chemical dosing shall not be used for disinfection.

### 1203.(f) NANOFILTRATION EQUIPMENT

The nanofiltration treatment skid shall be factory assembled and shall include nanofiltration membranes, pressure vessels, interconnecting pipework, valves, and a corrosion-resistant skid or frame.

The system shall include a high-pressure NF feed pump, a raw water feed or booster pump, and a CIP/flushing pump. All pumps shall be supplied complete with motors, baseplates, isolation valves, and accessories.

### 1203.(g) STORAGE TANKS

The nanofiltration system shall include a raw water tank of 10 m<sup>3</sup> capacity and a treated (permeate) water tank of 5 m<sup>3</sup> capacity. Tanks shall be plastic, UV-stabilised, and installed within or immediately adjacent to the nanofiltration housing in a secured arrangement.

### 1203.(h) HOUSING AND PLANT ROOM

The nanofiltration system shall be installed within a dedicated housing, container, or plant room. The housing shall protect the equipment from weather, dust, and unauthorised access and shall allow safe operation and maintenance.

The housing shall provide adequate working space, access for maintenance, segregation of electrical panels from wet areas, an impervious floor with drainage, adequate ventilation, and internal lighting.

### 1203.(i) ELECTRICAL, CONTROL, AND INSTRUMENTATION

The nanofiltration system shall be provided with a control panel complete with associated electrical and instrumentation works. Instrumentation shall allow monitoring of conductivity, pressure, and flow. All equipment shall be compatible with solar-powered operation.

## 1204. CHLORINATION SYSTEM

### 1204.(a) SCOPE AND APPLICABILITY

Chlorination is provided for all potable water supplies under the Project as the mandatory disinfection process. Depending on raw water quality and scheme configuration, chlorination is applied either as the sole treatment process or as a post-treatment disinfection step following nanofiltration.

For the Nurgows, Qara, and Sarman Community Water Supply Schemes, raw water quality is compliant with drinking water standards, and chlorination constitutes the only treatment process. For the Sarman-Tarbaj Community Water Supply Scheme, chlorination is applied only to the potable water stream downstream of nanofiltration, with non-potable supplies hydraulically segregated and not chlorinated.

The applicable role of chlorination by scheme is summarised in the table below.

**Table 12-3: Role of Chlorination by Scheme**

Scheme	Role of Chlorination	Location of Application
Nurgows	Sole treatment	Upstream of storage
Qara	Sole treatment	Upstream of storage
Sarman	Sole treatment	Inlet to elevated tank
Sarman-Tarbaj	Post-NF disinfection (potable only)	Upstream of potable storage

## 1204.(b) DISINFECTANT AND BASIS OF SELECTION

The disinfectant used for all schemes is sodium hypochlorite solution (NaOCl). Liquid hypochlorite is selected because it allows controlled dosing, is readily available, and is well suited to small and medium community water supply schemes. Chlorine gas and tablet-based systems are not permitted under this Contract due to safety, operational, and logistical considerations.

## 1204.(c) CHLORINE DOSE AND RESIDUAL REQUIREMENTS

Chlorination systems are designed to achieve a free residual chlorine concentration of 0.2–0.5 mg/L at points of water dispensing. To achieve this residual after accounting for chlorine demand, decay during storage, and distribution losses, an applied dose of 1.5–2.0 mg/L is adopted at the point of injection.

The applied dose is adjustable and shall be confirmed during commissioning and refined during operation based on measured residual chlorine levels.

## 1204.(d) POINT OF APPLICATION AND CONTACT TIME

Chlorine is injected upstream of potable water storage so that the storage tank provides the required contact time prior to distribution. For schemes without nanofiltration, injection is made into the rising main or inlet pipe immediately upstream of the storage tank. For the Sarman–Tarbaj scheme, injection is made downstream of the nanofiltration units and upstream of potable storage at both the Sarman and Tarbaj treatment nodes.

Storage tanks are sized to provide a minimum effective contact time of 30 minutes under peak potable flow conditions. No separate contact tanks are required.

## 1204.(e) CHLORINE DOSING MECHANISM

Chlorination is achieved by continuous liquid dosing of sodium hypochlorite into the water stream using positive-displacement metering dosing pumps. Each dosing installation comprises a hypochlorite storage container, a metering pump, chemical injection fittings, non-return and anti-siphon valves, and calibration fittings.

The dosing pump delivers a controlled and adjustable volume of hypochlorite solution per unit time into the flowing water stream. Dosing is linked to water abstraction so that chlorine is injected only when water is flowing. As a minimum, dosing pumps are interlocked to the abstraction or transfer pump. Where flow measurement is provided, flow-proportional dosing may be applied.

## 1204.(f) INDICATIVE CHLORINE DEMAND

Indicative chlorine demand has been calculated based on 70% of tested borehole yield, up to 10 hours of effective pumping per day, and an applied dose of 1.5–2.0 mg/L.

For schemes where chlorination is applied to the full stream, the indicative daily chlorine requirements are shown in the table below.

**Table 12-4: Indicative Chlorine Demand – Full-Stream Chlorination**

Scheme	Design Volume (m <sup>3</sup> /day)	NaOCl 10% (L/day)
Nurgows	434	5.4 – 7.2
Qara	218	2.7 – 3.6
Sarman	22	0.3 – 0.4

For the Sarman-Tarbaj scheme, chlorination applies only to the potable fraction downstream of nanofiltration. Indicative chlorine demand for typical potable fractions is shown in the table below.

**Table 12-5: Indicative Chlorine Demand – Sarman–Tarbaj Potable Fraction**

Potable Fraction	Potable Volume (m <sup>3</sup> /day)	NaOCl 10% (L/day)
20%	81	1.0 – 1.4

30%	122	1.5 – 2.0
40%	162	2.0 – 2.7

Final dosing rates shall be confirmed during commissioning based on measured residual chlorine and actual potable demand patterns.

## 1204.(g) CHLORINATION EQUIPMENT HOUSING, CONTAINERS, AND PLATFORMS

### a. General Arrangement

All chlorination equipment shall be installed within a dedicated, secure, and weather-protected arrangement to ensure safe operation, chemical integrity, and ease of routine maintenance. The installation shall be robust, compact, and suitable for unattended rural operation.

Each chlorination installation comprises a sodium hypochlorite storage container, a metering dosing pump, injection fittings and associated pipework, and a mounting or platform arrangement that allows safe access for operation, inspection, and container replacement.

### b. Chemical Storage Containers

Sodium hypochlorite shall be stored in purpose-designed plastic chemical storage tanks manufactured from UV-stabilised polyethylene or an approved equivalent suitable for hypochlorite service. Containers shall be opaque or UV-resistant to limit chemical degradation and shall be fitted with secure, lockable lids.

Each container shall include clear level markings or a level indicator to allow operators to monitor chemical usage and plan refilling. Storage capacity shall be sufficient to provide not less than 7–14 days of operational autonomy at the design dosing rate, considering site accessibility and supply logistics.

Indicative minimum container sizes for design purposes are given in the table below.

**Table 12-6: Indicative Sodium Hypochlorite Container Sizes**

Scheme	Minimum Container Size
Nurgows	200 L
Qara	100 L
Sarman	50 L
Sarman–Tarbaj (per treatment node)	100 L

Final container sizes shall be confirmed based on approved dosing calculations and operational arrangements.

### c. Dosing Pump Mounting and Spill Containment

Dosing pumps shall be mounted on rigid brackets, frames, or shelves fixed to permanent structural elements. Where practicable, pumps shall be positioned above the chemical container to minimise siphoning risk and to facilitate visual inspection of suction lines.

All chemical containers and dosing pumps shall be installed within a bunded or spill-containment tray capable of retaining at least 110% of the volume of the largest container. Bunds or trays shall be constructed from corrosion-resistant materials and arranged to prevent uncontrolled discharge of spilled chemicals. Where drainage is provided, it shall discharge to a controlled and approved location.

### d. Platforms and Access

Where chlorination equipment is installed at elevated tanks, borehole headworks, or confined locations, a dedicated working platform shall be provided. Platforms shall be designed to allow safe access for routine operation, adjustment of dosing pumps, and replacement of chemical containers.

Platforms shall provide a level and stable working surface and shall be constructed from reinforced concrete, steel grating, or another durable material suitable for outdoor conditions. Where the working height exceeds 1.0 m, handrails shall be provided. Access ladders, steps, or stairs shall comply with applicable occupational safety requirements and shall allow safe handling of chemical containers without dismantling equipment.

#### **e. Enclosures and Environmental Protection**

All chlorination equipment shall be housed within a lockable enclosure, cabinet, or room, or within a dedicated compartment of a pumphouse or tank structure. The enclosure shall protect equipment from rain, dust, direct sunlight, and vandalism, while allowing adequate ventilation to prevent the accumulation of chemical vapours.

The arrangement shall allow clear visual inspection of the dosing system and shall ensure appropriate segregation between chemical storage and unrelated equipment where co-located.

#### **f. Injection Arrangement**

Chemical injection shall be carried out using corrosion-resistant injection quills or saddles installed into the pipeline upstream of potable water storage. Injection points shall be accessible for inspection and maintenance and shall be fitted with non-return valves to prevent backflow.

Injection locations shall be selected to ensure adequate mixing of chlorine prior to entry into the storage tank.

#### **g. Monitoring and Adjustment**

Residual chlorine is monitored at storage tank outlets and representative kiosk dispensing points using portable field test kits. Dosing rates are adjusted as required to maintain the specified residual chlorine levels throughout the distribution system.

### **1205. TRAINING, COMMISSIONING, HANDOVER, AND WARRANTY**

The Contractor shall provide on-site operator training covering system operation, routine maintenance, monitoring, troubleshooting, and safe handling of chemicals.

Following commissioning, a familiarisation period shall be provided during which operators participate in normal system operation under supervision.

Prior to handover, the Contractor shall submit operation and maintenance manuals, manufacturer's data sheets, as-installed drawings, electrical schematics, and recommended spare parts lists.

A minimum twelve-month warranty shall apply to nanofiltration membranes and all mechanical, electrical, and control equipment. The Employer and/or Engineer shall have the right to inspect treatment equipment at the manufacturer's facility and witness factory acceptance testing.

Final handover shall occur only after successful commissioning, completion of training, approval of documentation, and rectification of all defects. The warranty period shall commence upon Taking-Over.

## 13. PARTICULAR SPECIFICATION ON ENVIRONMENTAL ISSUES

### 1301. PROTECTION OF THE ENVIRONMENT

The Contractor must ensure that there are no adverse effects on the environment during the execution of the Works. In particular, the Contractor's Method Statement, as required by the Technical Specification, shall adequately detail the steps that he will take to deal with sub-surface water pollution. **The Method Statement should also detail the method and location for the disposal of debris. No deviation from his approved Method Statement will be allowed, except with the approval of the Engineer.**

**It is the responsibility of the Contractor to ensure that no public nuisance and no harm to the environment result from his working practices.**

In addition to the general provisions, the Contractor shall recognize that the Project Area is located within an arid and semi-arid environment characterized by fragile soils, sparse vegetation, and heavy reliance on groundwater and communal grazing land.

Special care shall be taken to:

- Minimize the footprint of construction activities within communal grazing areas in Arbajahan and Sarman;
- Avoid obstruction of traditional livestock movement routes and access to water points;
- Prevent land degradation through uncontrolled vehicle movements outside approved access routes.

### 1302. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

Within 42 days of Commencement, the Contractor shall submit a Project Specific Environmental and Social Management Plan (ESMP) for approval of the Engineer.

The Contractor must carry out all works in accordance with Kenyan Environmental Laws and Regulations, and the requirements of this document.

It is also a contractual obligation for the Contractor to take full cognizance of the environmental and social concerns and requirements as stipulated in the Employer's Environmental and Social Management Plan (ESMP) prepared for this Project. The full Environmental and Social Impact Assessment (ESIA) Report will also be issued to the Contractor on Award.

Accordingly, the Contractor shall be required to prepare a site-specific Environmental and Social Management Plan (ESMP) for the project. This site-specific ESMP shall be based on the Contractor's evaluation of the requirements of these Specifications and the Employer's ESMP. The site-specific ESMP shall be submitted to the Engineer for approval within 42 days of Commencement.

The site-specific ESMP shall generally comply with the guidelines set out below.

The site-specific ESMP is the Contractor's operative document on how to enforce, mitigate, inspect and monitor potential Project impacts during mobilization, construction and demobilization. In this sense, it is an eminently practical and concrete instrument.

Based on the above, the structure and content of the site-specific ESMP shall emphasize the following aspects:

- i) **Executive Summary**
- ii) **Introduction**
- iii) **Project Description**
  - Focus on impact-generating activities (e.g. demand of water and permanent materials, earth movement, etc.);
  - Environmental liabilities: identify and include a photographic registry of pre-existing environmental liabilities (e.g. gully erosion areas, abandoned borrow pits, unauthorized dumping sites, etc.) that are not attribute to the implementation of the Project.

**iv) Potential Impacts during Mobilization, Construction and Demobilization**

- Apply simple rating of significance;
- Quantity/quality impacts (e.g. surface and type of vegetation to be removed, amount and type of wastes to be generated, noise levels, etc.);
- Identify places where specific impacts will manifest

**v) Mitigation Plan**

- Specify the detailed measures to mitigate the identified impacts (also by location)
- Include designs for measures requiring structural solutions (e.g. gabions, etc.);
- Include the schedule of implementation of mitigation measures in relation to the general construction schedule;
- Health and Safety Plan (detailed);
- Waste Management Plan (detailed);
- Traffic Management Plan (detailed);
- Training Program (detailed);
- Accident and Emergency Response Plan (detailed);
- HIV/AIDS Awareness and Prevention Program (include only a reference to this program to be prepared by an NGO);
- Community Relations Program;
- Location and technical specifications for installation and operation of campsites, including workshops, garages, laboratories, offices, communal kitchenette / dining facilities, sanitary installations, etc.;
- Location, and technical specifications for operation of quarries and borrow pits, and procedures for negotiation with and compensation of land owners where they are located;
- Location and technical specifications for installation and operation of concrete batching, stone crushing, cement mixing and asphalt plants;
- Location and technical specifications for installation and operation of temporary and permanent dump sites.

**vi) Inspection Plan**

- Inspection function: specify frequency, locations and instruments (e.g. checklists, site reports, photo registry, etc.) to conduct site inspections;
- Permitting: required environmental permits and schedule to obtain them;
- Specific actions and responsibilities: what, who, where, when, how and why

**vii) Monitoring Plan**

- Specify, for each variable: frequency of measurement, locations, methods/equipment, units/measures, quality standards, and reporting requirements and periodicity, including establishment of trends.
- Specific actions and responsibilities: what, who, where, when, how and why.

**viii) Organization and Management**

- Specify organizational structure, personnel, resource and equipment requirements, reporting requirements and periodicity, and inter-institutional communication and coordination mechanisms.

- Specific actions and responsibilities: what, who, where, when, how and why

**ix) Annexes**

- If the Contractor wishes to incorporate information beyond the indicated above, such as the policy, institutional and regulatory framework for environmental management in Kenya, biophysical and socio-economic characteristics of the area of influence of the Project, etc., that information should be included as an annex and not in the body of the site-specific ESMP. Preferably, such information should not be attached and, further, if necessary, the pertinent chapter of the ESIA should be referenced.
- Annexes should be used, if necessary, to include detailed information on the specific topics of the ESMP (e.g. inspection forms or checklists, design of structural mitigation measures, photographic registry of environmental liabilities, etc.).

The Contractor's Environmental and Social Management Plan (C-ESMP) shall explicitly incorporate mitigation measures identified in the ESIA for:

- Borehole sites, pump stations, storage tanks, and pipeline corridors;
- Temporary construction camps and material storage areas.

The C-ESMP shall include **site-specific method statements** for:

- Borehole headworks construction;
- Pipeline trenching in sandy and collapsible soils;
- Works near settlements, schools, and health facilities.

### **1303. HEALTH AND SAFETY MANAGEMENT PLAN**

Within 42 days of Commencement, the Contractor shall submit a project specific Health and Safety Management Plan (HSMP) for approval of the Engineer.

The Contractor must at all times comply with the National and County Laws and Regulations during the Construction and Commissioning of the Project.

#### **Site-Specific Health and Safety Management Plan**

The Contractor shall appoint a full-time qualified Health and Safety Manager who shall have responsibility for all health and safety issues on the Project. The Contractor must submit a site-specific Health and Safety Management Plan (HSMP), which shall, as a minimum, address the following:

- 1) Introduction (including objectives of the HSMP)
- 2) Hazard Prevention and Control
  - i) Risk assessment (including description of risk assessment method used);
  - ii) Prevention, protection and control measures (based on risk assessment performed):
    - a) Personal protective equipment and clothing: safety goggles, ear plugs, work boots, dust masks, protective clothing etc.;
    - b) H&S and sanitary facilities, equipment, materials and personnel: first-aid kits and stations, health personnel, safe drinking water, sanitary facilities, accommodation, washing facilities, domestic waste disposal, etc.;
    - c) On-site safety measures and procedures to protect workers against accidents and health risks in the performance of construction-related activities:
      - Site security: access, safety of visitors, separation of work and rest areas, signage, etc.
      - Handling of raw materials: earthwork, gravel, crushed rock, sand, etc.
      - Handling of other materials causing dust development, such as cement;

- Handling of hydrated lime and other activators and additives;
  - Handling of asphalt;
  - Hazardous materials management
  - Handling of inflammable materials;
  - Maintenance of vehicles and machinery;
  - Deep Excavation and trenching;
  - Emergency prevention, preparedness and response.
- iii) Contractor's participation in Health and Safety Training Program
- iv) Contractor's participation in HIV/AIDS Awareness and Prevention Program
- v) Provide specifics of training and instruction: topics, frequency, modalities, target audiences, instructors, training materials, etc.
- vi) Potential Topics:
- Occupational safety risks and prevention
  - Health risks and prevention
  - Use of personal protective equipment
  - Safe work procedures: general and specific.
  - Organization and Management
- vii) Organizational structure, personnel, equipment, communication and reporting requirements, accident and incident reports, and procedures and tools to verify and ensure compliance with occupational health and safety requirements.
- viii) Annexes should be used, if necessary, to include detailed information on the specific topics of the HSMP, such as (illustrative list):
- Accident Report forms.
  - Dangerous Occurrence forms (near misses).
  - Safety Audit Forms.
  - Safety Check List.
  - Safety Rules.
  - List of hospitals, emergency evacuation strategy and other arrangements to treat seriously injured staff.
  - List of personnel trained in first aid and their places of deployment.
  - List of first aid kits and locations where these will be held.

The Compliance of this Clause by the Contractor is deemed to be covered in his rates quoted in Volume I of the Bid Document, Section VI - Bills of Quantities, Bill No. 1 (Preliminaries and General).

The Health and Safety Management Plan shall address risks specific to:

- Deep excavations in loose sandy soils prone to collapse;
- High ambient temperatures and heat stress;
- Interaction between construction activities, livestock, and the public.

The Contractor shall ensure:

- Adequate trench support or sloping where required;

- Provision of potable drinking water, shaded rest areas, and heat-stress management measures for workers;
- Clear demarcation and guarding of excavations to prevent injury to people and livestock.

### **1304. METHOD STATEMENT**

Two weeks before commencing any Works, the Contractor shall submit to the Engineer a Method Statement showing full details of the procedures and methods that he proposes to adopt in carrying out the Works.

The Method Statement shall include the procedure and programmed duration of the work, details of plant and labour, traffic control measures, environmental precautions, safety aspects, and the proposed method of dealing with existing wastewater flows. The Contractor's methods of operation should ensure safety both on and off site and should avoid nuisance to persons or to public property.

The Engineer may require the Contractor to furnish him with supplementary information if, in his opinion, the Method Statement is not acceptable or is not sufficiently detailed. The Engineer shall reserve the right to modify the Method Statement if, in his opinion, it is a potential source of environmental hazard.

**Approval of the Method Statement by the Engineer shall not relieve the Contractor of his responsibilities under the Contract.**

Method Statements submitted under this Clause shall demonstrate how ESIA mitigation measures are integrated into construction sequencing, particularly for:

- Pipeline construction through settled areas;
- Crossing of seasonal drainage channels (laghas);
- Construction activities adjacent to existing water supply infrastructure.

### **1305. SAFETY OF THE CONTRACTOR'S PERSONNEL**

The Contractor shall ensure that all personnel employed by him and involved in the Works have received training to increase their awareness of the hazards associated with their work, so that they are able to recognize potential dangers and their effects.

The training shall include, but shall not be limited to, general construction site safety, highway safety, and the specific hazards of dealing with wastewater.

The Contractor shall also provide training to his personnel as to the correct methods to use, and the hazards associated with, particular items of equipment, such as mechanical bucket machines, pumping and lifting equipment.

In addition to employees' training, the Contractor shall provide his personnel with the necessary safety clothing and equipment, such as gloves, reflective jackets, boots, overalls, torches, gas meters, gas masks, etc. **The Contractor shall have at least one person in each working gang who is properly trained and certified in aspects of First Aid and Safety Procedures.**

The costs for complying with this requirement of the Specification shall be deemed to have been included in Volume I of the Bid Document, Section VI, Bill No. 1 (Preliminaries and General).

The Contractor shall ensure that all personnel receive induction training covering:

- Environmental sensitivities of the Project Area;
- Community interaction protocols;
- Cultural norms and practices of local communities.

### **1306. SITE ACCESS AND SECURITY**

The Bidder is responsible for establishing the potential difficulties of access and security at each site and for establishing access to the sites for his personnel, materials and equipment. The rates entered in the Bills of Quantities by the Bidder are deemed to include all costs associated with establishing access for carrying out the

works and for providing security for the Contractor's personnel, equipment, materials etc. and for close liaison with the Local Administration, Community Leaders and Police.

Temporary access routes shall be selected to avoid:

- Sensitive grazing areas where practicable;
- Damage to existing community paths and tracks.

Where access restrictions are unavoidable, the Contractor shall provide alternative safe access arrangements acceptable to the Engineer and the affected communities.

### **1307. WORKING SPACE AND STORAGE SPACE**

No specific areas have been designated for the storage of Contractor's equipment and materials. Where equipment and materials need to be stored, the Contractor should allow in his rates for any costs relating to such storage facilities, and for the temporary use of land and the security for such facilities.

The Contractor shall make adequate provision for working space including demolition of temporary structures. The Contractor should be aware of the difficulties that might be caused by the demolition of such structures and should minimize the removal of any existing structures as far as is possible. The Contractor is responsible for carrying out any negotiations with the owners of such structures prior to their removal. The costs for executing these works are deemed to be included in the Contractor's rates.

Construction camps, storage yards, and fuel storage areas shall:

- Be located away from boreholes, water pans, and seasonal drainage paths;
- Be restored to original condition upon completion of works.

Fuel and lubricant storage areas shall be bunded to prevent soil and groundwater contamination.

### **1308. CODE OF CONDUCT**

Two weeks before commencement of the Works, the Contractor will be required to provide his own Code of Conduct which will basically comprise of commitment statements on the following:

- i) Forced Labour (ILO convention 29 and 105)
- ii) Children Protection including Child Labour
- iii) Hours of Work
- iv) Discrimination
- v) Harassment Abuse and Disciplinary Action
- vi) Gender Exclusivity
- vii) Wages Benefits and Terms of Employment
- viii) Freedom of Association and Collective Bargain
- ix) Health and Safety Compliance
- x) Compliance to Environment Standards (Waste Management, etc.)

The Contractor's Code of Conduct shall explicitly include:

- Prohibition of sexual exploitation, abuse, and harassment (SEA/SH);
- Respect for community property, livestock, and water sources;
- Zero tolerance for conflict with local residents.

The Code of Conduct shall be displayed at construction sites and camps in a language understood by workers.

**SECTION 2: STANDARD REFERENCE NUMBERS**

## 14. STANDARD REFERENCE NUMBERS

### 1401. 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.

### 1402. 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.

### 1403. 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 with regard to 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.

### 1404. LIST OF NATIONAL SPECIFICATION CROSS REFERENCED

The list has been sub-divided into sections as follows:

<b>SRN No.</b>	<b>Specification</b>
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 (excluding In-situ Concrete)
900-999	Miscellaneous

## 1.1 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 & 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 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 BS EN 932-1	BS 812 Part 1 Replaced by BS 882 Part 2 Replaced by BS EN 1097-3 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 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				
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 7668	Grade NDI, CL.B		BS 4360 Withdrawn. Replaced by BS 7613, BS 7668, BS EN 10029 Parts 1 to 3 of BS EN 10113, 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. 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		
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 Part 2: Coatings

## 1.2 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 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 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; 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. Replaced by BS EN 1092-2 (1997)
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 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 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 ISO 4179:1985, ISO 6600:1980,	
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 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. (WATERTIGHT)	See ISO DIN		21		ISO 7/1:1982; ISO 7/2:1982	
224	CAST IRONS & S PIPES AND FITTINGS			78	2		BS 78 Withdrawn, Replaced by BS 4622 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
		2615	1, 2				
		2616	1, 2				
		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			
				4825	1	ISO 2037:1980	
				6362		ISO 7598	

		17457					
		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	
				4825	3	ISO 2852:1974	
				4825	4	ISO 2853:1976	
				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	
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/CW6		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	

### 1.3 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	
		16450				ISO 2045, 2048, 2536	
		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)			Obsolescent - Partially replaced by BS 6572, BS 6730
308	RUBBER RINGS FOR MECHANICAL JOINTS			2494			
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			
319	THERMOPLASTICS WASTE PIPE AND FITTINGS			5255			
320	GLASS REINFORCED PLASTICS (GRP) PIPES, JOINTS AND FITTINGS FOR USE FOR WATER SUPPLY OR SEWERAGE			5480			

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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			

## 1.4 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 BS EN 512	BS 486 Withdrawn Replaced by BS EN 512
401	ASBESTOS CEMENT (A/C) PRESSURE PIPES (CONT.)			4624			
402	A/C SEWER PIPES, JOINTS, FITTINGS			3656		ISO 881 BS EN 588-1	BS 3656 Withdrawn 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	

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413	CONCRETE CYLINDRICAL PIPES & FITTINGS METRIC			5911	1-3	AWWA C602-83	BS 5911 Part I: 1981 Withdrawn Replaced by BS 5911 Part 100: 1988 BS 5911 Part 200: 1989 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	

## 1.5 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 Replaced by BS EN 593,: 1998
507	BOURDON TYPE PRESSURE GAUGES			1780		BS EN 837:1998	BS 1780 Withdrawn 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

							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			

## 1.6 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 EDIN EN75, 112, 114, 15	BS 4550 Part 1 & Part 2 Withdrawn Replaced by BS EN 196-7: 1992
604	MATERIAL TESTING - DOCUMENTATION					ISO 404, 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 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

## 1.7 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 Replaced by BS 6007
651	WATER SUPPLY (CONT. 1)	2425	3, 5	BS 8301		CP 301	CP 301 Withdrawn 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 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 5628		CP 121	CP 121 Withdrawn Replaced by BS 5390 and BS 5628 Part 3
657	USE OF STRUCTURAL STEEL IN BUILDING	18203	1, 2	449 BS 5950	2	GB 7101-91 SABS 1431	BS 449 Parts 1 and 2 Withdrawn Part 2: Addendum No. 1 (1975) 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 BS ISO 1100-2 ISO TR 8363	BS 3680 Part 3A Withdrawn Replaced by BS ISO 748: 1997 BS 3680 Part 3C Withdrawn Replaced by BS ISO 1100-2 BS 3680 Part 3G Withdrawn Replaced by ISO TR 8363 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 Replaced by BS 8004
666	STRUCTURAL USE OF TIMBER			5268		CP 112, 2	CP 112, 2 Withdrawn Replaced by BS 5268 Part 2 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 BS EN 288-4	BS 4870 Part 1 Withdrawn Replaced by BS EN 288-3

							BS 4870 Part 2 Withdrawn Replaced by BS EN 288-4
671	WELDING - APPROVAL TESTING			4871	1	BS EN 287-1 BS EN 287-2	BS 4871 Part 1 Withdrawn Replaced by BS EN 287-1 BS 4871 Part 2 Withdrawn 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 Part 2: Performance requirements 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

							Part 3: Trussed rafter roof Part 5: Preservative treatment of structural timber
680	STAIRS, LADDERS AND WALKWAYS			5395	1, 2 & 3		Part 1: Design of straight stairs Part 2: Design of helical and spiral stairs Part 3: Design of industrial type stairs, permanent ladder and walkways
681	INTERNAL PLASTERING			5492			
682	GUIDE TO ACCURACY IN BUILDING			5606			
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			

### 1.8 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  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		
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## 1.9 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, BS EN ISO 10545-3 BS EN ISO 10545-4 BS EN ISO 10545-6 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		KENYA M.O.W. ST. SPEC.	
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						

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
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
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
		68763					
		68764					
814	LAMINATED PLASTIC SHEETING	16922		3794		BS EN 438	BS 3794 Withdrawn 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

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
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 7316 7668		ISO 630, 6891 BS EN 10029: 1-3 BS EN3 10113 BS EN 10155 BS EN 10210-1	BS 4360 Withdrawn - Replaced by BS 7316, BS 7668, BS EN 10029 Parts 1 to 3 BS EN 10113, BS EN 10155 and 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					

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
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			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 BS ISO 4065 BS ISO 11922-1	
825	POLYTHENE TUBING FOR COLD WATER SERVICES (CONT. 1)	8072		6572 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 (CONT. 1)						
829	CAST IRON SOIL, WASTE & VENT PIPES (CONT. 2)						

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
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 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	

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
		19501					
		19502					
		19503					
		19504					
		19505					
		19506					
		19507					
		19508					
		19509					
		195010					
		195011					
		195014					
		195019					
		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 Replaced by BS EN 124

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
		4271	1, 3				
		19593	1, 2, 3				
		19594	1, 2				
		19596					
		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		
851	MASTIC ASPHALT FOR ROOFING			6925			
852	ALUMINIUM FOR LOUVRE WINDOWS			1470		BS EN 485 BS EN 515 BS EN 573	BS 1470 Withdrawn Replaced by BS EN 485 Parts 1-4, 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 Replaced by BS 5911 Part 100 (1988) Bs 5911 Part 200 (1989) and BS 5911 Part 200 (1994)
855	PRECAST CONCRETE KERBS & CHANNELS	483		7263	1		
856	WATERPROOF BUILDING PAPERS	4122		1521			
		52126					
		52127					
		52128					

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
		52129					
		52130					
857	METAL TIES FOR CAVITY WALL			1243			
858	A/C BUILDING PRODUCTS (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 (5950)	2		BS 449 Part 2 Withdrawn 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						
870	BUILDING STONE			1438			
871	CAST STONE			1217			
872	WOOD PRESERVATIVES - CREOSOTE			144			

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
873	WASTE TRAPS - PLASTIC			3943			
874	COPPER FLOATS FOR FLOAT OPERATED VALVES			1968			
875	VITREOUS CHINA SANITARY FITTINGS			3402			
876	PAINTS - LEAD BASED			2523 (5082, 5358)			BS 2523 Obsolescent, Partially Replaced by BS 5082 and BS 5358
877	READY MIXED OIL-BASED PRIMING PAINTS			2521/4 (See 2523)			
878	READY MIXIED OIL-BASED UNDERCOATING AND FINISHING PAINTS						
879	COLD POURED SEALING MATEIALS 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	

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
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 Part 2: Copper nails Part 3: Aluminium nails
893	FIXING ACCESSORIES FOR BUILDING PURPOSES			1494	1		Part 1 Fixings for sheet, roof and wall coverings
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			4576			

SERN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
	GOODS AND ACCESSORIES						
899.2	INDUSTRIAL TYPE METAL FLOORING, WALKWAYS AND STAIRS TREADS			4592	1, 2, 3 & 4		Part 1: Open bar gratings Part 2: Expanded metal grating panels Part 3: Cold formed planks 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 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 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 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			

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
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 Part 2: Design and installation of external ceramic wall tiling and mosaics (including terra cotta and faience tiles) Part 3: Design and installation of ceramic floor tiles and mosaics Part 4: Tiling and mosaics in specific conditions Part 5: Design and installation of terrazzo tile and slab, natural stone and composition block floorings
899.15	STONE MASONRY			5390			
899.16	SPECIFICATION FOR LOW-RESISTANCE SINGLE TAPS AND COMBINATION TAP ASSEMBLIES (NOMINAL SIZE ½ AND ¾)			5412			
	SUITABLE FOR OPERATION AT PN 10  MAX. AND A MINIMUM FLOW PRESSURE OF 0.01 MPa (0.1 BAR)						
899.17	VITREOUS CHINA WASHDOWN WC PANS WITH HORIZONTAL OUTLET			5503	1 & 2		Part 1: Connecting dimensions  Part 2: Materials, quality, performance and dimensions other than connecting dimensions

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
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 CHEMICAL 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 Part 2: Code of practice for laying
899.30	IN-SITU FLOORINGS			8204	2		Part 2: Concrete wearing surfaces

### 1.10 ELECTRICAL / MECHANICAL

SERN	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 & BS IEC 1008-2-2
007	FUSE SWITCHES (AIR BREAK)			5419		IEC 408	BS 5419 Withdrawn Replaced by BS EN 60947-3
008	MOTOR STARTERS AND CONTROLLERS	46062		587			BS 587 Withdrawn 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 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 Replaced by BS EN 60947-4-1

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
014	ELECTRICITY METERS			37	1, 5, 8		BS 37 Withdrawn 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 Obsolescent
016	ACCEPTANCE TESTS FOR PUMPS (CLASS C)	4325		5316	1	ISO 2548 IEC 198	
017	ACCEPTANCE TESTS FOR PUMPS (CLASS B)	4325		5316	2	ISO 3555 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 Replaced by BS EN 60439-1
021	RECIPROCATING INT/COMB. ENGINES			5514	1, 2	ISO 3046, PT. 1, 2	BS 5541 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			
025	ROTATING ELECTRICAL MACHINES - GENERAL			4999	1, 2, 3	IEC 34-1, 34-8, 72,	Renumbered as EN 60034-4

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
						72A	
026	CONCRETE CABLE COVERS			2484			BS 2484 Obsolescent
027	ELECTRIC POWER SWITCHGEAR (LOW VOL. N.E. 1kV)	57660		5486 5727 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 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, BS EN 60529	BS 5490 Withdrawn Replaced by BS EN 60529
039	ELECTRICAL EQUIPMENT OF INDUSTRIAL MACHINES			2771		EN 60204, Part 1	BS 2771 Part 1 Replaced by EN

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
							60204-1 (1993) but remains current for use as a reference standard for BS EN 60204-3-1: 1992
040	SWITCHGEAR AND CONTROL GEAR UPTO 1000V			4752		IEC 600157-1, 600157-1A	BS 4752 Withdrawn 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	
050	ROTATING ELECTRICAL MACHINES FOR HARZARDOUS AREAS ("N")			5000	16		
051	POWER TRANSFORMERS - GENERAL					BS EN 60076-1	

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
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 Replaced by BS 5424: Part 1 1977
062	SECURITY LIGHTING INSTALLATION					CP 1004	Renumbered as BS 5498
063	ALUMINIUM SOLID CONDUCTORS			3988			

### 1.11 MISCELLANEOUS

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
900	ZINC SPRAY PROTECTION	55928	1-9	2569	1	ISO 2063 BS EN 22063	BS 2569 Withdrawn Replaced by BS EN 22063
900	ZINC SPRAY PROTECTION (CONT.)			5493		BS EN ISO 12944	BS 5493 Proposed for Obsolescence Partially Replaced by Parts 1-8 of BS EN ISO 12944
901	METALLIC ZINC RICH PRIMER			4652			
902	COLOUR OF FINISH (BUILDING MATERIALS)	See VOB		4800		VOB pt. C	
903	HOT DIP GALVANIZING ON IRON & STEEL			729		ISO 1459	
903	HOT DIP GALVANIZING ON IRON & STEEL (CONT.)			5493		ISO 1461 BS EN ISO 12944	BS 5493 Proposed for Obsolescence Partially Replaced by Parts 1-8 of BS EN ISO 12944
904	BLACK BITUMEN SOLUTION (COLD APP.) FOR WATER TANKS		See DVGW	3416	TYPE II	DVGW-GWS	
905	WELDABLE STRUCTURAL STEELS	1025	1-5	4360		ISO 630	BS 4360 Withdrawn - Replaced by BS 7613, BS 7668, BS EN 10113, BS EN 10155 & BS EN 10210
906	CLASSIFICATION OF GREY CAST IRON			1452		ISO 185	BS 1452 Withdrawn Replaced by BS EN 1561
907	BEARING DESIGN LIFE						
908	BITUMEN - HOT APPLIED COATINGS FOR IRON AND STEEL	30673		4147			

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
908	BITUMEN - HOT APPLIED - COATINGS FOR IRON AND STEEL (CONT.)			5493			
909	PRESSED STEEL RECTANGULAR TANKS			1564			
910	GREY IRON CASTINGS FOR MANHOLE COVERS			1452	GRADE 10		
911	MALLEABLE CAST IRON			6681		ISO 5922	BS 6681 Withdrawn - Replaced by BS EN 1562
911	MALLEABLE CAST IRON (CONT.)					ASTM A 47-77	
912	ROLLED STEEL			4360		ISO 630	BS 4360 Withdrawn - Replaced by BS 7613, BS 7668, BS EN 10113, BS EN 10155 & BS EN 10210
912	ROLLED STEEL (CONT.)						
913	STRUCTURAL STEEL SECTIONS	1025	1-5	4	1		BS 4 Part 2 (1969) Withdrawn Replaced by BS 4848 Part 2
914	ISO METRIC BLACK HEXAGONAL BOLTS, SCREWS AND NUTS	267	1, 2	4190		ISO 272, 4759-1, 3	BS 4160 Obsolescent
914	ISO METRIC BLACK HEXAGONAL BOLTS, SCREWS AND NUTS (CONT 1)					ISO 885, 888	
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	

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS	
917	CORROSION PROTECTION OF STEEL STRUCTURES - GENERAL	55928	1-9	5493		BS EN ISO 12944	BS 5493 Proposed for Obsolescence Partially Replaced by Parts 1-8 of BS EN ISO 12944	
918	INGOT ZINC			3436		ISO 752 BS EN 1179 (1996)	BS 3436 Withdrawn 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 Replaced by BS EN 10111, 10209, BS EN 10149-2 & 3, 10051, 10131,10139, 10149-2 & 3, 10048, 10140, 10029, 10258 & 10259	
						ISO 3574		
		1614						
		1632	2					
		1624						
921	ELECTROPLATED COATINGS ON THREADS - STANDARD			3382	1-6			
922	ELECTROPLATED COATINGS ON THREADS - THICKENED			3382	7	ISO-DIS 4042		

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
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	
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 2603: 83 - 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 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			

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
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 VENTILATING 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

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
							sheet/plate and strip for general purposes





