



## **COAST WATER WORKS DEVELOPMENT AGENCY (CWWDA)**

### **PROJECT NAME – IMPROVEMENT OF DRINKING WATER AND SANITATION SYSTEMS IN MOMBASA – MWACHE PROJECT (CKE 1103)**

**Contract Name - Construction of Water Distribution Pipelines and  
Sanitation Facilities in Mombasa**

**Contract No.: CWWDA/AFD/W2/2022**

## **Bidding Document Volume III of IV:**

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- General Specifications
- Particular Specifications
- Standard Reference Numbers

**OCTOBER 2022**

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# BIDDING DOCUMENTS

for

## Procurement of Services For

Construction of Water Distribution Pipelines and Sanitation  
Facilities in Mombasa

Contract No.: **CWWDA/AFD/W2/2022**

Project Name: **Improvement of Drinking Water and  
Sanitation Systems in Mombasa – Mwache  
Project (CKE 1103)**

Employer: **Coast Water Works Development Agency**

Country: **Kenya**

Issued on **18<sup>th</sup> October 2022**



**This bidding document consists of the following volumes**

- **Volume I of IV:**
  - **Instruction to Bidders and Bid Data Sheets**
  - **Evaluation and Qualification Criteria**
  - **Bidding Forms (Except BoQ)**
  - **Works Requirements**
  - **General Conditions of Contract**
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Coast Water Works Development Agency - Improvement of Drinking Water and Sanitation Systems in Mombasa  
– Mwache Project (CKE 1103): Construction of Water Distribution Pipelines and Sanitation Facilities in  
Mombasa (Contract No.: CWWDA/AFD/W2/2022)

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

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## 1. GENERAL

All materials, equipment and testing apparatus etc. to be furnished and Works to be executed by the Contractor in this Contract shall conform to the requirements of the latest 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. OFFICES FOR THE RESIDENT ENGINEER

For Supervision of the Works, 1Nr. Rented Office will be established in Mombasa. The Contractor to 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 150 square metres and shall be provided with minimum equipment and furniture detailed as following, all furniture to revert to Contractor at the end of the Project:-

Id	Description	Unit	Qty
1	Writing Desk Type 1: 1800mm long x 750mm wide executive Desk with Side Return Table	Nr	2
2	Writing Desk Type 2: 1800mm long x 750mm wide office	Nr	2

<b>Id</b>	<b>Description</b>	<b>Unit</b>	<b>Qty</b>
	Desk with Side Return Table		
3	Workstation: 4-Seater Multiple Way Workstation	Nr	2
4	Chairs Type 1: Medium Back, Mesh, Swivel Office Chair	Nr	10
5	Chairs Type 2: Normal Office Visitors Chairs	Nr	6
6	Lockable Office Filing Cabinets	Nr	3
7	16-seater conference table with cable management	Nr	1
8	Conference Chairs: Airmesh Medium Back Chairs	Nr	16
<b>A. Office Equipment</b>			
9	A3 Colour Photocopier / Printer / Scanner / Fax Machine	Nr	1
10	Projector	Nr	1
11	Power Back-up: Battery Backup Power and Surge Protection for Computers and other electronics	Nr	4
12	Fridge: 213 litre capacity	Nr	1
13	Cooker: 2 burner plus 13kg gas cylinder (filled), regulator and pipe connection	Set	1
14	Self-Standing Water Dispenser: Hot-Warm-Cold	Nr	2
15	Floor standing fans 18 inches, low noise	Nr	5
16	Kitchen Microwave, min 1200W	Nr	1
<b>B. Other Office Equipment and Furnishes</b>			
17	Wall Mounted Pin Board – 2.4m x 1.2m.	Nr	1
18	Wall Mounted White Board – 2.4m x 1.2m.	Nr	1
19	Fire Fighting Equipment <ul style="list-style-type: none"> <li>• 1Nr. CO2 fire extinguishers 9 litres</li> <li>• 1Nr. H2O fire extinguishers 9 litres.</li> <li>• 1Nr. Fire blanket</li> </ul>	set	1
20	Binding Machine suitable to bind up to 40mm spirals.	Nr	1
21	Heavy Duty Stapler	Nr	1
22	Hot Water Kettle, 3lts, cordless	Nr	1
23	Electrical extension cables minimum 4 plug, 5meters	Nr	4
24	Assorted Kitchen Utensils	Lot	1
<b>C. Digital Equipment</b>			
25	Desktop Computer 2.7GHz, Intel Core i7, 11th Gen PC, 16GB RAM, 1TB HDD, No TFT, Intel UHD Graphics 630, DVDrw, USB Ports, Ethernet, HDMI, Card Reader, DOS, Keyboard, Mouse, Power Cord, 27 Inch Quad HD Monitor and 1 Year Warranty. One for secretary and 3No. for interns	Nr	4
26	Ditto but a "GENUINE" Laptop Computer; Core i7 11th Generation 2.6GHz 1TB+500GB SSD+16GB, 15.6" (1920×1080) BT WIN11 Webcam NVIDIA® GTX 1650 4096MB; with a dedicated graphics card of minimum 4 GB.	Nr	3

<b>Id</b>	<b>Description</b>	<b>Unit</b>	<b>Qty</b>
27	Provide "GENUINE" heavy duty printer with wireless capability, which can Print, Copy, Scan and Fax as Kyocera TASKalfa 2552ci or similar equivalent. Printer to be used exclusively by the Resident Engineer and revert to Contractor upon completion of contract.	Nr	1
28	1-2 TB Network Attached Storage Drive. For central document storage.	Nr	1
29	Digital camera for the exclusive use of the Resident Engineer as a Nikon D3500 DSLR Camera with 18-55mm Lens inclusive of bag	Nr	1
30	Handheld GPS for the Resident Engineer's use as Garmin GPSMAP® 78sc Handheld or similar.	Nr	1

The Office shall have burglar proofing to all windows and external doors.

In addition to the above, provision will be made for shaded parking (carports) for at least three (3) vehicles.

The Contractor shall arrange for the provision of telephones (and if necessary extensions) with suitable privacy for conversation for the exclusive use of the Resident Engineer and his Staff by means of a separate connection to the Telephone Exchange. 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.

Security Guards hired from a reputable Security Firm approved by the Engineer shall be provided for day and night security at these Offices. The Office, furniture and equipment shall be insured against fire, theft and natural calamity.

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

Stationery required **regularly are** as follows:

<b>Stationery</b>	<b>Quantity for Office</b>
Photocopy paper A4	4 Reams
A3 paper	2 Ream
Biro pens blue/black	½ Doz.
Clutch Pencils	½ Doz.
Box files	6 Nr
Spring Files	6 Nr
Document Wallets	6 Nr
Spirals (various sizes of Reports)	2 Doz.
Embossed (hardback cover)	2 Doz.
Perspex covers	2 Doz.
Cello tape (medium)	1 Nr

<b>Stationery</b>	<b>Quantity for Office</b>
Masking tape (medium)	1 Nr
Staples	2 Pac.
Paper clips (various sizes)	2 Pac.
Pencil leads (0.5/0.7)	2 Sets
C-DR (Pack of 12)	1 Pac.
CD-RW (Pack of 12)	1 Pac.
Highlighters (set of all colours)	2 Sets
A6 hardcover notebooks	2 Nr
Soft Pencil Erasers (Staedtler or equivalent)	3 Nr
Envelopes (all sizes)	3 Doz.
Batteries for flashlights	3 Sets
Black ink cartridge/ toner for the A4/A3 printer	1 Set
Colour cartridges/toner for the A4/A3 printer	1 Set

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

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

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

#### **101.(b) STAFF FOR THE RESIDENT ENGINEER’S OFFICES**

The Contractor shall provide as listed under the relevant items in Bill No. 1 – Preliminaries and General

- (i) Drivers
- (ii) Office Secretaries
- (iii) Office cleaners / tea people
- (iv) Chain men/women
- (v) Data clerks/AutoCAD Technicians
- (vi) Surveyor
- (vii) Sociologist

for the exclusive use of the Resident Engineer for the duration of the Contract. The secretary shall be English speaking, with a minimum 5 years’ experience in secretarial / office administration work. The secretary shall be conversant with standard office computer hardware and software (MS-Word, Excel, PowerPoint, etc.). The Secretary shall be interviewed and tested by the Resident Engineer prior to deployment on the Works.

Office Assistants (messenger / tea boy / office cleaner) shall also be provided by the Contractor exclusively for the Resident Engineer's Office.

Data Clerks/AutoCAD Technician with Civil Engineering Diploma from a recognized College and minimum 3years experience in a Design Office will also be provided exclusively for the Resident Engineer's Office.

The Contractor shall provide the services of Surveyor (with minimum Diploma in Surveying from a recognized Institution) and one Chainman as and when requested for the sole use of the Engineer and Engineer's Representative for the whole period of the Contract.

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

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

The Contractor shall ensure that all vehicles are 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 vehicles available for use in good serviceable condition. In the event of the vehicles being unserviceable for whatsoever reason, the Contractor shall provide alternative vehicles at his own cost of the same model in compliance with the provisions of this clause. The cost for such replacement vehicle to be covered by his rates.

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

The makes, models and colours of the vehicles shall be 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. A Prime Cost item has 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 Employer at the end of the Contract.

Vehicles shall be at the site and ready for use within four (4) months of commencement. Until then, the Contractor shall provide equivalent alternative vehicles as specified in the Bills of Quantities . If vehicles are not ready for use after four (4) months of commencement, the Contractor shall, at his own expense, provide equivalent alternative vehicles for the Resident Engineers staff. All alternative vehicles shall be as good as new and be equivalent to the vehicles to be procured by the Contract.

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

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

The drivers shall have a minimum 10 years of clean driving record and a Certificate of Good Conduct from the 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) 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 Contractor at completion of all Works.

<b>Equipment</b>	<b>Quantity</b>
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	10 Nr
Survey umbrellas with stand	2 Nr
Work boots	8 sets
Rain Gear (trousers and jacket type, complete with rain hat)	8 sets
Hard hats	12 sets
5 metre retractable pocket steel tapes	8 Nr
30 metre metal tapes	4Nr
100 metre metal tapes	3Nr
Builders spirit levels 1000mm long	4 Nr
Hammers 3 kg each	4 Nr



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

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

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

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

#### **101.(f) ACCOMMODATION**

The Contractor to make provision for accommodation for the Resident Engineer (RE), Assistant Resident Engineer (ARE) and Inspectors of Works. 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.

List of minimum furnishings

Details			Quantity
<b>Sitting &amp; Dining Room</b>			
1	Couch	7-seater	1
2	Coffee Table		1
3	TV + TV connection	42 inches	1
4	Dining table (Reading table)	6-seater	1
5	Water dispenser	1 Nr	1
6	Wall Clock	1 Nr	1
<b>Kitchen</b>			
7	4 burner gas cooker + 13kg gas and connection	-	1
8	2 door fridge	min 213 litres	1
9	Utensils	lot	1
10	Electric Kettle	3lts	1
11	Microwave	1200W	1
<b>Bedrooms</b>			
12	Bed + beddings	5' x 6'	3
13	Reading Desk + Chair + lamp	1 Nr	1
<b>Utilities</b>			
14	Electricity, Water and Garbage Collection	Full time	Lot
15	Security	Day/Night	Lot

## **102. OFFICE FOR CONTRACTOR**

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

## **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 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 / Sewer line 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 topo 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 at all times maintain the free flow of rivers and drains and prevent excavated material from the Works from being deposited in them.

## **113. REINSTATEMENT OF ROADS AND FOOTWAYS FOR 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 of the Works until the substantial completion of the Works.

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

### **128. TIPS**

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



## **129. TROPICALISATION**

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

## **130. MONTHLY SITE MEETINGS**

Throughout the project period, site meetings will be held at the 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 substantial completion of the scheme and official inspection which agrees to this, the Contractor shall operate the entire scheme or completed and taken over sections for the test period indicated in the Bill of Quantities.

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

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

The Contractor shall provide 2 Nr Digital Cameras, 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 Cameras 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 will be compiled prior to substantial completion and Handing Over of the Works.

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.

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

### **140. CONSTRUCTION PROGRAMME**

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

- (1) Within thirty (30) days after receiving the Letter of Acceptance, the Contractor shall submit to the Engineer for approval, a detailed Programme based on the key date stated hereinafter or other dates which are given in the Letter of Acceptance in the form of a Critical Path Method (hereinafter referred to as CPM Network) showing the order of procedure in which he proposes to carry out the Works including design, manufacture, delivery

to the site, transport, storage, survey, construction, commissioning and maintenance. This Programme shall clearly indicate all activities and its duration along with the earliest and the latest event, times and the first and last dates of the submission of the Drawings and each date of shop inspection by the Engineer for the section or portion of the Works.

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

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

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

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

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

Whenever the Contractor proposes to change the Contractual

Programme, approval of the revision shall be obtained in writing from the Engineer.

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

#### **141. 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 and which is given in Chapter 12. 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 Mobilisation, Construction and Demobilisation

- 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) including decommissioning of the Existing Asbestos Cement (AC) Mains;
  - 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 landowners 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) Organisation 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.).

## 142. 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 Phases 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 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, dusk 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 the Bid.



### **143. PROGRESS REPORTS**

The Contractor shall submit a monthly progress report to the Engineer. The formal, 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.

### **144. 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.

### **145. 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.

## **146. 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.

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

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

If, during the Defects 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 Clause 15 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 of as directed by the Engineer.

### **204. HEDGES**

Where directed by the Engineer, hedges shall be uprooted and disposed of 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 pickaxes and hand levers shall be classified as common excavation. Waterlogged material shall be included in this class. Murram in any form shall be classified as common excavation.
- 2) Rock  
The decision of the Engineer in classifying rock shall be final and binding. Rock in the 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.

Coral shall be classified as rock of the appropriate Class as described above depending on the hardness.

#### 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 of 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 of 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 subsidence's and overbreak's 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 in order to comply with the provisions of the Specifications in general and this Clause in particular.

- a) The Contractor shall excavate the pipe trenches in the line and to the

depths indicated on drawings or as indicated by the Engineer. Except where otherwise indicated on the drawings or directed by the Engineer, it is intended that the trench shall be excavated to such a depth as will allow of a minimum cover of 600mm over the top of the barrel of the pipe when laid. All trenches shall be excavated in open cuttings and for trenching to uPVC piping, shall not be opened too far in advance of pipe laying.

- b) For the purpose of measurement, the width of trench shall be taken as the nominated width for the particular size of sewer, irrespective of the width of trench the Contractor may choose to excavate.

Nominated trench width for:

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

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

- c) Where the trench passes through grassland, arable land or gardens, whether enclosed or otherwise, the turf, if any, shall be carefully pared off and stacked, and the productive soil shall be carefully removed for a width of 600mm greater than the nominated trench width, or equal to the overall width of track of excavating machine, whichever is greater, and laid aside to be subsequently used in reinstating the surface of the ground after the trench has been refilled.
- d) The bottom of the trench shall be properly trimmed off, and all low places or irregularities shall be levelled up with fine material. Where rock or large stones are encountered, they shall be cut down to a depth of at least 100mm below the level at which the bottoms of the barrel of the pipes or flanges are to be laid, and covered to a like depth with fine material, 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 Class 15/20 concrete or other material approved by the Engineer. No payment shall be made for any over excavation carried out by the Contractor nor for the cost of filling up to required levels.
- j) If a mechanical excavator is used by the Contractor, he shall indemnify the Employer against all claims for damage which in the opinion of the Engineer, may be caused by the use of this plant.
- k) The Contractor shall fix Sight Rails for use with boning rods at intervals of not more than 30 metres and temporary Benchmarks related to the 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 side fill 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 side fill 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 Class 15/20 shall be placed in anchor blocks at all changes of direction of the pipeline exceeding 6 degrees and wherever else required to withstand thrust resulting from internal water pressure e.g., at blank ends. Concrete in plinths shall be placed where specified.

#### **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 p.p.m. 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, a bacteriological sample or samples will be taken by the Engineer's Representative and only on receipt of a satisfactory certificate from a Medical Research Laboratory or similar organisation will the main or section of main be permitted to be put into supply and be considered as having been substantially completed.

Any expenditure involved in providing facilities or materials for the taking of samples shall be included in the Contractor's Bidding 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**

Unplasticised 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:	Polyethylene PE100 (MRS100), density $\geq 0.95$ kg/dm <sup>3</sup>
	Colour:	<b>Blue</b> <b>Black with Blue stripes</b> <b>Black with Blue outer coextruded layer</b>
	Pressure Rating:	SDR 17 – PN10 SDR 11 – PN16
	Supply Lengths:	All pipe sizes up to and including OD 110 mm shall 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 – PN6.3 up to SDR7.4 – PN25
<b>Diameters:</b>	<i>as per EN 12201-2</i>	

**DIMENSIONAL CHART FOR HDPE PE100 PRESSURE PIPES - ISO 4427 - 2: 2007**

Outer Diameter				6.3 Bar		8 Bar		10 Bar		12.5 Bar		16 Bar		20 Bar		25 Bar	
Min		Max		Sdr 26		Sdr 21		Sdr 17		Sdr 13.6		Sdr 11		Sdr 9		Sdr 7.4	
mm	Std Length of Roll (mtrs)	mm	mm	MIN WALL THK (mm)	WT / Mtr (kg/ mtrs)	MIN WALL THK (mm)	WT / Mtr (kg/ mtrs)	MIN WALL THK (mm)	WT / Mtr (kg/ mtrs)	MIN WALL THK (mm)	WT / Mtr (kg/ mtrs)	MIN WALL THK (mm)	WT / Mtr (kg/ mtrs)	MIN WALL THK (mm)	WT / Mtr (kg/ mtrs)	MIN WALL THK (mm)	WT / Mtr (kg/ mtrs)
16.00	16.30	1.20												2.00	0.09	2.30	0.10
20.00	20.30	1.20	100.00							1.90	0.10	2.00	0.12	2.30	0.13	3.00	0.16
25.00	25.30	1.20	100.00					1.60	0.12	2.00	0.15	2.30	0.17	3.00	0.21	3.50	0.24
32.00	32.30	1.30	100.00	1.60	0.16	1.60	0.16	2.00	0.19	2.40	0.23	3.00	0.28	3.60	0.33	4.40	0.39
40.00	40.40	1.40	100.00	1.60	0.20	2.00	0.25	2.40	0.29	3.00	0.36	3.70	0.43	4.50	0.51	5.50	0.61
50.00	50.40	1.40	100.00	2.00	0.31	2.40	0.37	3.00	0.45	3.70	0.55	4.60	0.67	5.60	0.79	6.90	0.94
63.00	63.40	1.50	100.00	2.50	0.49	3.00	0.58	3.80	0.72	4.70	0.88	5.80	1.06	7.10	1.27	8.60	1.48
75.00	75.50	1.60	100.00	2.90	0.67	3.60	0.83	4.50	1.02	5.60	1.24	6.80	1.48	8.40	1.78	10.30	2.11
90.00	90.60	1.80	100.00	3.50	0.98	4.30	1.19	5.40	1.47	6.70	1.78	8.20	2.14	10.10	2.57	12.30	3.03
110.00	110.70	2.20	50.00	4.20	1.44	5.30	1.78	6.60	2.18	8.10	2.64	10.00	3.17	12.30	3.81	15.10	4.54
125.00	125.80	2.50	12.00	4.80	1.85	6.00	2.28	7.40	2.78	9.20	3.40	11.40	4.12	14.00	4.93	17.10	5.84
140.00	140.90	2.80	12.00	5.40	2.33	6.70	2.85	8.30	3.49	10.30	4.26	12.70	5.13	15.70	6.18	19.20	7.34
160.00	161.00	3.20	12.00	6.20	3.06	7.70	3.74	9.50	4.56	11.80	5.56	14.60	6.73	17.90	8.05	21.90	9.55
180.00	181.10	3.60	12.00	6.90	3.81	8.60	4.70	10.70	5.76	13.30	7.05	16.40	8.51	20.10	10.18	24.60	12.07
200.00	201.20	4.00	12.00	7.70	4.73	9.60	5.83	11.90	7.11	14.70	8.65	18.20	10.50	22.40	12.59	27.40	14.93
225.00	226.40	4.50	12.00	8.60	5.94	10.80	7.36	13.40	9.02	16.60	10.98	20.50	13.29	25.20	15.94	30.80	18.88
250.00	251.50	5.00	12.00	9.60	7.34	11.90	9.01	14.80	11.06	18.40	13.53	22.70	16.34	27.90	19.59	34.20	23.30
280.00	281.70	9.80	12.00	10.70	9.18	13.40	11.37	16.60	13.89	20.60	16.95	25.40	20.49	31.30	24.62	38.30	29.22
315.00	316.90	11.10	12.00	12.10	11.70	15.00	14.29	18.70	17.59	23.20	21.48	28.60	25.93	35.20	31.14	43.10	36.99
355.00	357.20	12.50	12.00	13.60	14.78	16.90	18.15	21.10	22.39	26.10	27.24	32.20	32.92	39.70	39.56	48.50	46.90
400.00	402.40	14.00	12.00	15.30	18.74	19.10	23.14	23.70	28.29	29.40	34.54	36.30	41.79	44.70	50.18	54.70	59.56
450.00	452.70	15.60	12.00	17.20	23.70	21.50	29.27	26.70	35.85	33.10	43.75	40.90	52.92	50.30	63.53	61.50	75.35
500.00	503.00	17.50	12.00	19.10	29.23	23.90	36.11	29.70	44.29	36.80	53.98	45.40	65.30	55.80	78.28		
560.00	563.40	19.60	12.00	21.40	36.64	26.70	45.19	33.20	55.49	41.20	67.73	50.80	81.81	62.50	98.22		
630.00	633.80	22.10	12.00	24.10	46.43	30.00	57.09	37.40	70.28	46.30	85.60	57.20	103.65	70.30	124.29		

**Performance Characteristics**

The pipes shall have the following basic minimum performance characteristics:

Paramet	Unit	Val
Average Density as per ISO 1183	Gm/cm <sup>3</sup>	≥
Melt Flow Index MFI 190°C / 50N as per ISO 1133	Gm/10 min.	0.4-0.55
Minimum Tensile Strength	N/mm <sup>2</sup>	2
Elongation at Break	%	≥ 600%
E-Modulus (Modulus of Elasticity)	N/mm <sup>2</sup>	12
Minimum Radius of Curvature at 20°C		25 x OD
Linear Coefficient of Thermal Expansion (VDE 0304)	°K <sup>-1</sup>	1.3 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 stony soil. Such material shall be over excavated to a depth of not less than 0.1m and shall be removed and replaced by non-cohesive soil or a special pipe support. This shall initially be recompact 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 radii 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 pull-out.
  - 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 pipes shall be made by spiral seam pipe forming process with submerged arc as its main method of pipe manufacture.

### **Typical Specifications**

Application	Specifications
Oil and Gas	API 5L, ASTM A 139, DIN 17172, BS EN 10208, GB 9711, AS 1579
Water	API 5L, AWWA C200, ASTM A139, AS1579, BS EN 10244/BS3601, DIN 1626/DIN 2460, NFA 49-150, JIS G3457, UNI 6363, SABS 719
Sewerage	BS EN 10224/BS 3601, AWWA C300, AWWA C301
Steam	API 5L, ASTM A 139, DIN 1626 & DIN1628 (<300°C)
Piling	ASTM A252, JIS A 5525, ST/Y 5040
Structural & Mechanical Engineering	ASTM A134, DIN 1626, DIN 1628

### **Pipe Ends**

Spherical socket and spigot joints: These fillet welded slip joints covered under BS EN 10224 and UNI 6363 offer 5° joint deflection. Ends (shown right) are formed to give a spherical surface and spigot ends can have a double wall that protects the lining from external welding of the joint. Another variation of this is the parallel socket and spigot joint where deflection is limited to 10. These are covered under BS EN 10224, AWWA C200, NFA 49-150, and UNI 6363.

Spigots and plain ended pipes 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.

### **Surface Preparation**

Except for cement mortar lining and coating, all surfaces are grit blasted to ISO 8501-1 SA 2.5 to remove all rust and mill scale before application of coatings and linings. Steel grit is used as the abrasive media in order to achieve a roughness profile of 38-102 microns, as this is required for good adhesion of coatings. All equipment is automated to ensure consistent high-quality blasting.

### **Protective Coatings and Linings**

#### Internal

Type of Lining	Liquid Epoxy	Cement Mortar	Fusion Bonded Epoxy
Standards	API PR 5 L2 AWWA C210 NFA 49-709 SABS 1217 EN 10289	AWWA C205 AWWA C303 EN 10298 DIN 2614 DIN 2880 NF A 49-701	AWWA C213 SABS 1217
Typical Lining Thickness	200 - 400 microns	5 – 19 mm	200 - 400 microns

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.

#### External

Type of coating	Fusion Bonded Epoxy	Extruded Polyethylene/ Polypropylene
Standards	AWWA C213 DIN 30671 NF A 49-706 SABS 1217	AWWA C215 BS EN 10288 DIN 30670 DIN 30678 NF A 49-704 NF A 49-710 NF A 49-711
Typical Coating Thickness	200 - 400 microns	1.2 – 3.5 mm
Remarks	Exposed and buried	Buried

#### **Jointing**

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 NP10 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, 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. SLUICE VALVES / GATE VALVES DN50 - DN400

#### Product description

The valve shall be a resilient seated, clear way, flanged gate type, designed for installation in water supply systems to enable isolation of separate lines for maintenance or repair.

#### Basic Design

Face-to-face shall be according to EN 558, ser. 3 (BS).

All dimensions shall be clear way and full bore.

End connections shall be flanges drilled acc. to EN 1092.

#### Coating

Valve body and bonnet shall be both internally and externally corrosion protected with 250-300µm fusion bonded epoxy coating complying with DIN 30677-2 and GSK.

Colour shall be blue RAL 5017.

No uncoated parts of the iron surfaces may be in contact with the fluid or the environment.

Surface preparation, coating material, application process and final result shall be quality checked and documented by the valve manufacturer, approved by the GSK and frequently supervised through notified body inspections.

#### Body/Bonnet

Valve body and bonnet shall be ductile iron, grade GJS-500-7.

Bonnet-body bolt holes shall be designed as threaded bottom holes, i.e., not going through the casting.

Bonnet bolts shall be socket head, stainless steel A4, counterbored into the bonnet casting, sealed with hot melt glue and with no contact to environment or fluid.

Bonnet-body gasket shall be EPDM with a circular cross shape, positioned in a groove in the bonnet and encircling the bonnet bolts completely.

Body shall have internal rails or grooves for wedge open/close travel guidance.

Internal body seats shall have plane surfaces in symmetric angles to position and support the wedge into closed position.

Body waterway shall be smooth and unobstructed with no internal pockets in the dome above the seating area.

Following information shall be cast into the body:

- Manufacturer's brand
- Size
- Pressure-class
- Cast material

Following information shall be shown on the label

- Stem material
- Additional information for product standard
- Product number
- Barcode

- Fluid type
- Max. application temperature
- Operation direction (CTO/CTC)

#### Stem

Stem shall be stainless steel, 1.4404 (AISI 316L) with the thread rolled on in a trapezoidal profile to DIN 103.

A wedge stop shall block the upward movement before the rubber parts touch the inner coating.

Thrust bearing shall be a 2-piece collar made of hot forged, dezincification resistant brass, CW602N.

Radial bearing shall be a PA6.6 bushing with two outer and two inner NBR O-rings.

Stem seal shall consist of three systems:

- Innermost a lip seal in EPDM shall act as main seal against the internal fluid pressure.
- In the middle the radial bearing O-rings shall back up the inner main seal
- Outermost an NBR wiper ring shall seal against dust and dirt from outside.

Interface to operating equipment shall be a square.

#### Wedge

The wedge shall consist of an inner ductile iron core fully encapsulated in drinking water approved EPDM.

It shall have no closed or poorly ventilated hollow areas where the fluid can accumulate. The stem-space below the wedge nut shall go all the way down through the bottom.

The surface shall be smooth with no grooves, splits or pockets.

Except for the point of closure, the only contact between wedge and body shall be via polyamide travel guides vulcanized into the wedge.

The wedge shall be marked with logo, time of manufacture and rubber material.

The wedge nut shall be an integral part of the design, firmly fixed and not able to move within the wedge core. The joint between nut and wedge shall be tightly sealed in the rubber encapsulation process.

Material shall be dezincification resistant brass, CW602N or CW626N.

#### Installation

The body shall be fitted with feet for upright standing, but the design shall allow for installation with the stem in both vertical and horizontal position.

Flow can vertical or horizontal and bi-directional.

For inspection purpose it shall be possible to remove the valve bonnet without having to remove the valve body from the pipeline.

#### Operation

Operation shall be manual by hand wheel, T-key or extension spindle.

Clockwise to Close (CTC).

Lifetime according to EN 1074 when used under normal conditions, including installation buried underground without a special valve chamber.

Maximum operating temperature shall be at least 70°C.



Apart from regular exercising no maintenance shall be required during the lifetime.

#### Quality

The complete valve shall be type approved to EN-Standards.

The manufacturer shall have an ISO 9000 certified quality system and be audited by an independent third party.

Each finished product shall be inspected and tested for compliance with the product standards and local market specification.

#### Standards and Approvals

The design and testing shall be according to following:

- EN 1074-1 and -2 (water supply, isolating valves)
- EN 1171 (industrial cast iron gate valves)
- EN 558 (face-to-face)
- EN 1092-2 (flanges)

Materials and manufacturing shall be according to following:

- EN 1563 (cast iron)
- EN 10088 (stainless steel)
- EN 12165 (brass)
- EN 12164 (brass)
- DIN 30677-2 (coating)
- GSK (coating)
- EN 681 (rubber seals water)

#### Other

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.

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 or AWWA C203-78, or handwheels if so specified.

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. Where specified, valves for replacement washouts shall be in accordance with specification Clause 202 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 5155 basic series 14 (short).

The gate valves shall be subject to “Closed End Tests” in accordance with the procedure set out in BS 5163, AWWA C203-78, 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 bounded 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

### Description

Combination Air Valve has the features of both an air release valve and an air & vacuum valve. The air release component is designed to automatically release small pockets of air to the atmosphere as they accumulate along a pipeline or piping system when it is full and operating under pressure. The air and vacuum component is designed to automatically discharge or admit large volumes of air during the filling or draining of a pipeline or piping system. This valve will open to relieve negative pressures whenever water column separation occurs.

### Product Features

- Combines the features of both an air & vacuum valve and an air release valve.
- Triple function:
  - Air & vacuum component discharges large volumes of air during filling of the system.
  - Air & vacuum component admits large volumes of air during drainage and at water column separation.
  - The air release component releases entrapped air in pressurized systems.
- Dynamic design allows for high velocity air discharge while preventing premature closure.
- Rolling seal mechanism.
- Available in sizes: 25mm, 50mm and 80mm threaded male connections, NPT or BSPT.

### Materials and Corrosion Protection

- The body is made of high-strength composite materials.
- All operating parts are made of corrosion- resistant materials.
- Body protected by a shell made of Cast Iron ASTM A48 CL.35B.

### Application Range

- Working pressure range: 10bar and 16 bar
- Maximum operating temperature: 60°C.
- Maximum intermittent temperature: 90° C.

## 515. CHECK VALVES (NON-RETURN or DIRECTIONAL VALVES)

### Product Description

The valve shall be designed for installation in water supply to secure flow in one direction only.

### Basic design

A valve disc hinged on a shaft shall turn to either open or closed position.

Housing design shall be acc. to EN 1074 with end connections as flanges drilled to EN 1092.

Housing and disc shall be free of flow obstruction or pockets.

The main seal shall be the resilient rubber on the disc closing directly against the iron housing.

### Coating

Valve body and bonnet shall be both internally and externally corrosion protected with 250 µm, blue RAL 5017, fusion bonded epoxy approved for drinking water and complying with DIN 30677-2.

No uncoated parts of the iron surfaces may be in contact with the fluid or the environment.

Surface preparation, coating material, application process and final result shall be quality checked and documented by the valve manufacturer and frequently supervised through notified body inspections.

### Body/Bonnet

Valve body and bonnet shall be ductile cast iron acc. to EN 1563 grade GJS-500-7.

Face-to-face distance shall be according to EN 558 ser. 48.

Bonnet-body bolt holes shall be designed as threaded bottom holes, i.e., not going through the casting. Bolts shall be stainless steel grade A2.

Bonnet-body gasket shall be drinking water approved EPDM with a near circular cross shape, positioned in a groove in the bonnet and encircling the bonnet bolts completely to protect the bolts against the fluid and prevent gasket blow-out.

The body waterway shall be smooth and unobstructed with no closed internal pockets.

A set of bosses shall be cast adjacent to each flange to enable later installation of e.g., a pressure gauge or a by-pass valve.

Following information shall be cast into the body:

- Manufacturer
- DN-class
- PN-class
- Cast material

Following information shall be shown on the label

- Additional information for product standard
- Product number
- Barcode
- Fluid type

- Max. application temperature

#### Disc and rubber

The valve disc shall be completely enclosed in drinking water approved EPDM.

#### Hinge

The disc shall be mounted on a hinge made of stainless steel for sizes  $\leq$  DN 200; ductile iron coated with drinking water approved epoxy for larger. The connection shall be a loosely fitting polyamide bushing that makes the disc able to tilt slightly in all directions and adjust exactly to the valve seat.

#### Shaft

The shaft shall be made of 1.4021 (AISI 420) stainless steel.

The bearings shall be dezincification resistant brass bushings, CW602N, CW626N or equivalent.

The shaft shall protrude to the right for lever attachment. The shaft end shall be hexagonal to allow for 6 different positions of the lever.

The shaft seal in protruding side shall consist of at least two O-rings.

#### Main Seal

The main seal shall be the resilient rubber on the disc closing directly against the iron housing.

#### Installation

The body shall be fitted with feet for upright standing, but the design shall allow for installation in both vertical and horizontal position.

Flow can be horizontal or rising vertical.

Items weighing more than 15 kg shall be fitted with lifting ribs or lugs.

#### Operation

The valve shall operate automatically.

Lifetime shall acc. to EN 1074.

Maximum operating temperature shall be at least 70°C.

The bonnet shall be easy to remove to gain access to the inner parts of the valve for cleaning or inspection.

#### Quality

The manufacturer shall have an ISO 9000 certified quality system which is audited by an independent third party.

Each finished item shall be inspected and tested for compliance with the product standards and local market specification.

#### Other

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 body and cover material of the valves shall be made of carbon steel conforming to ASTM A216, Grade WCB. 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 single jet meters specifically designed for measuring cold water.

Must have accurate metering capability, particularly with low flow rates, ruggedness and resistance to clogging.

The meter shall have a profiled inlet nozzle to make it immune to disturbances in the piping before or after the meter. Meters must comply with the European regulations and hold a sanitary conformity certificate.

The meters shall be modular, capable of being fitted at any time with an IZAR clip-on module, converting it into a communicating meter ready for mobile or fixed (radio/wired) network reading.

### Features:

- DN 15
- $Q_3=2.5 \text{ m}^3 / \text{h}$
- MID approval up to R=200H & R=40V
- Starting flow rate:  $< 6 \text{ l/h}$
- Cold water
- Composite body
- Integrated plastic inlet filter
- Tamper-proof ring

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

- Meter (calibrated in litres or cubic metres);
- Meters are to be corrosion proof polymer plastic where specified;
- 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 <sup>3</sup> /h	1.5	2.5	3.5	10
Maximum Flow Rate..... $Q_{max}$	m <sup>3</sup> /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

### **Meteorological 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	$Q_n$ =Lessthan15m <sup>3</sup> /h	$Q_n$ =15m <sup>3</sup> /hormore
<u>Class C</u>		
Value of: $Q_{min}$	0.01Q	0.006 $Q_n$
Value of: $Q_t$	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 meteorological class of the meters offered.

### **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 degree Celsius.

### **Head loss**

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. MECHANICAL BULK WATER FLOW METERS**

### **Application**

- The bulk water meter used for measuring volumes of cold water (up to 50°C) in supply lines with high flow at low pressure loss.
- The measuring chamber shall be replaceable without removing the meter from the pipe.
- It shall be equipped with a rotating glass metal register as standard,

- Same or equivalent to WESAN WP meters which can be fitted with different pulse emitters.

#### Features

- For horizontal and vertical installation
- Calibratable and exchangeable measuring insert
- Sealed measuring inserts for better accuracy
- Hydraulic bearing relief
- Encapsulated and rotating glass/copper counter, IP68
- Integrated measurement outputs as standard
- 2 low frequency pulse emitters (index) and 1 high frequency pulse emitter (flow)
- Display range 5.0lts to 99,999,999m<sup>3</sup>
- Accuracy Class-B

### **518. ELECTROMAGNETIC FLOW METERS**

#### Description

the meters shall feature processor-based signal conversion with accuracies of  $\pm 0.4\%$ , with no moving parts in the flow stream. Its accuracy shall not be affected by temperature, pressure, viscosity, or density. It shall operate practically with no maintenance required. It shall be encased in an IP68 housing to make it reliable meter even when submerged.

#### Application

The meters shall be able to operate without power line access. It shall indicate flow rate and flow totalization.

The meter shall be equipped with an internal datalogger or M-Bus interface, or in future with an externally powered RS485 interface with Modbus®. The collected data can be retrieved via radio frequency or GSM/GPRS.

#### Operating Principle

The flow meter is a stainless-steel tube lined with a non-conductive material. Outside the tube are two DC-powered electromagnetic coils positioned opposite each other. Perpendicular to the coils are two electrodes inserted into the flow tube. The energized coils create a magnetic field across the diameter of the pipe. As a conductive fluid flows through the magnetic field, a voltage is induced across the electrodes. This voltage is proportional to the average flow velocity of the fluid and is measured by the two electrodes. This induced voltage is then amplified and digitally processed by the converter to produce an accurate analogue or digital signal. The signal can then be used to indicate flow rate and totalization, or to communicate to remote sensors and controllers. In addition, the processor controls zero-flow stability, frequency outputs, serial communications, and other parameters.

#### Features

- Battery powered, with battery life up to 20 years.
- $\pm 0.4\%$  of measured value  $\pm 2$  mm/s accuracy independent of fluid viscosity, density, and temperature.
- Unaffected by most solids contained in fluids

- LCD Display
- Pulsed DC magnetic field for zero-point stability
- No pressure loss for low operational costs
- Corrosion resistant liners for long life
- Calibrated in state-of-the art facilities
- Integral and remote signal converter availability
- Optional grounding rings or grounding electrode
- Measurement largely independent of flow profile
- Low-power digital microcontroller (16 bit)
- Simple programming procedure
- Digital and infrared outputs
- Automatic zero-point stability
- Non-volatile programming
- NSF, OIML and MID certified
- Data logging
- Verification device
- IP68 protection class
- Modbus RTU (RS232), IRDA, M-Bus, optional Modbus RTU (RS 485)

Electromagnetic flowmeters shall be sized and installed in accordance with the manufacturer's recommendations as approved by the Engineer

**Specifications**

<b>Flow Range</b>	0.1...32.8 ft/s (0.03...10 m/s)	
<b>Accuracy</b>	± 0.4% of measured value ± 2 mm/s OIML/MID: 2...12 in. (DN50...300) with 0d up and 0d downstream ±1% ≥ 1.2 ft/s (0.35 m/s)	
<b>Repeatability</b>	± 0.1%	
<b>Data Logging</b>	About 7,000 records (read out by Modbus or IrDA interface) Logging interval from 1 min to 24 h	
<b>Ambient Temperature</b>	-4...140° F (-20...60° C)	
<b>Flow Direction</b>	Uni-directional or bi-directional. Two separate programmable totalizers for uni-directional measurement.	
<b>Digital Outputs (4)</b>	Galvanically isolated open collector, 30V DC maximum, 20 mA each, maximum output frequency at 100 Hz	
<b>Status Outputs</b>	ADE, High/low flow alarm (0...100% of flow), error alarm, empty pipe alarm, flow direction	
<b>Communication</b>	RS232, Modbus RTU, IrDA, M-Bus, RS 485 (optional), External AMR or GSM/GPRS module (optional)	
<b>Empty Pipe Detection</b>	Separate electrode, field-tunable for optimum performance based on specific application	
<b>Min-Max Flow Alarm</b>	Programmable outputs 0...100% of flow	
<b>Low Flow Cut-Off</b>	Programmable 0...10% of maximum flow	
<b>Galvanic Separation</b>	Functional 500 volts	
<b>Pulse Width</b>	Programmable 5...500 ms	
<b>Coil Power</b>	Pulsed DC	
<b>Sampling Rate</b>	Programmable from 1 to 63 seconds. Standard sampling period is 15 seconds.	
<b>Display</b>	Two lines x 15 characters (7 on top + 8 on bottom), LCD display	
<b>Programming</b>	Three external buttons	
<b>Units of Measure</b>	Gallons, ounces, MGD, liters, cubic meters, cubic feet, imperial gallon, barrel, hectoliter and acre feet	
<b>Battery Life</b>	<i>Standard:</i> 10 years with one battery pack; <i>optional:</i> up to 20 years with two battery packs for sizes 6 in. (DN 150) or smaller.	
<b>Power Supply</b>	<i>Standard:</i> Internal lithium batteries 3.6 volt, optional external battery pack <i>Optional:</i> battery back-up model (100...240V AC or 9...36V DC)	
<b>Processing</b>	Low power microcontroller (16 bit)	
<b>Amplifier Housing</b>	NEMA 4X (IP67, optional IP68), cast aluminum, powder-coated paint	
<b>Mounting</b>	Detector-mount or remote wall mount (bracket supplied)	
<b>Meter Enclosure Classification</b>	<i>Standard:</i> NEMA 4X (IP67); <i>Optional:</i> Submersible NEMA 6P IP68, remote amplifier required	
<b>Junction Box Enclosure Protection</b>	For remote amplifier option:	<i>Standard:</i> Powder coated die-cast aluminum, NEMA 4 (IP67) <i>Optional:</i> Stainless steel housing 304, Submersible NEMA 6P (IP68)
<b>Approvals</b>	NSF-61 OIML R49-1 MID MI-001	

### Other

The flow meters shall be supplied with a verifiable calibration certificate.

Electromagnetic flow meters shall be of new technology microprocessor based electronic water flow meter and be capable of monitoring instantaneous and cumulative flows and flow rate in both forward and reverse flow direction. The flow meter shall have no moving parts to ensure that there is no damage from particulate matter, e.g., stones, weed, etc., nor cause any restriction in the flow path and be capable of setting adjustments without the need to stop the flow. Each metering system shall comply with BS 5792 and comprise a flow sensor mounted in the pipework line and a signal converter, wither integrally mounted or remotely located preferably within the main control panel.

The meter shall be suitable for 85 to 265 Volt AC, 40 to 400 Hz supply without the need for link setting or voltage selection and shall be supplied with an uninterrupted power supply (UPS) inclusive of voltage protector. In addition, automatic battery backup must be included to ensure no loss of metering during AC power loss periods.

Alternatively, the meter shall be suitable for operation from two internal 3.6V Lithium batteries which provide an uninterrupted operating life of five years. It shall be possible to change the batteries in the field.

The accuracy of  $\pm 0.25\%$  for AC meters and  $\pm 0.5\%$  for battery meters shall be achieved. The meters shall be suitable for maximum working temperature to  $70^{\circ}\text{C}$  at pressure up to at least 16 bars. The electronics of the E/M bulk water meter should be watertight in submerged condition of 10 m water head

The meters shall have GSM- equipped transmitters capable of operating in 850/ 900/ 1800/ 1900 Quad Band Ranges. The meters should have USB-Type Data output port with a USB connector cable supplied together with the meter for data downloads.

The manufacturer shall also supply a detailed list of all parts comprising the proposed meter, duly labelled in English and numbered together with the indicative unit prices for each separate component. This is to enable normal usage and cost of the spares to be taken into consideration when assessing the cost of each meter which will be factored in the selection of the meter to be used in the project.

The warranty offered for each component should be explicitly indicated.

## **519. FLANGED Y-STRAINERS**

### **Product description**

A filter designed to remove pebbles and other impurities from water supply

### **Basic Design**

Basic design shall be a Y-formed strainer in cast iron with detachable screen in stainless steel.

Face-to-face shall be according to EN 558.

### **Coating**

The body shall be both internally and externally corrosion protected with fusion bonded epoxy coating, 250 µm blue RAL 5017, approved for drinking water.

No uncoated parts of the iron surfaces may be in contact with the fluid or the environment.

Surface preparation, coating material, application process and final result shall be quality checked and documented by the valve manufacturer and frequently supervised through notified body inspections.

### **Body**

Body and cap shall be made of ductile cast iron acc. to EN 1563, grade GJS 450-10.

Cap bolts shall be made of stainless steel, A2.

A flow direction shall be marked so that the filtered impurities are collected on the inside of the screen cylinder.

Following information shall be cast into the body:

- Manufacturer
- DN-class
- PN-class
- Cast material
- Flow direction

Following information shall be shown on the label

- Product number
- Barcode
- Max. application temperature

### **Screen**

The filter screen shall be a 1.4301 (304) stainless steel cylinder with punched holes.

Hole diameter shall be from 1.5 mm for the smallest DN-sizes to 2.7 mm for the largest.

Wall thickness shall be from 0.8 for the smallest DN-sizes to 1.2 mm for the largest. The open area ratio (total-hole-area to piping area) shall be greater than 2.

### **Flow Coefficient**

Pressure drop across a clean unit with no impurities shall not exceed following approximation:

$$P \approx 2400 \times DN^{-4} \times Q^2$$

where P is measured in bar, DN is the nominal diameter in mm and Q is the flow in m<sup>3</sup>/h.

### **Seals**

The sealing shall be an O-ring in high temperature (130°C), EPDM

### **Installation**

Installation shall be possible in both vertical and horizontal position. Items weighing more than 15 kg shall be fitted with lifting eyes.

### **Operation**

The strainer itself shall not need operation.

A drain plug in stainless steel, A2 shall be fitted to make it possible to empty the system before removing the filter cylinder for cleaning.

### **Quality**

The manufacturer shall have an ISO 9000 certified quality system and be audited by an independent third party.

Each finished product shall be inspected and tested for compliance with the product standards and local market specification.

### **Standards and Approvals**

Materials and processes shall be according to following:

- EN 1563 (cast iron)
- EN 10088 (stainless steel)
- EN 681 (rubber seals water)
- DIN 3476 (coating)

## **520. COUPLINGS AND FLANGE ADAPTORS**

Tensile couplings, flange adaptors and end caps dedicated for PE and uPVC pipes. Coupling/adaptors shall offer a great flexibility be easy to mount by having a combined compression gasket which enables  $\pm 3.5^\circ$  angular deflection and makes it easy to insert the pipe ends even in the large dimensions.

They shall have external M16 bolts of anti-friction coated stainless steel and high-quality coating to offer a durable corrosion protection.

### **Standards**

Designed according to EN 12842, designed according to AS4020, designed according to 4158, Designed according to AS4130

Standard flange drilling to EN1092-2 (ISO 7005-2), PN10/16

### **Features**

The combined gasket of drinking water approved EPDM rubber with tensile grip segments of RG5 bronze enables  $\pm 3.5^\circ$  angular deflection

- The design with external bolts prevents corrosion between sleeve and bolts.
- The M16 bolts of stainless steel A2 and the nuts of acid-resistant stainless steel A4 are anti-friction coated to offer easy tightening and to prevent galling

- The bolt ends are protected with plastic caps
- The compression type gasket makes it easy to insert the pipe end, even in large dimensions
- Sleeve and bracket of ductile iron with fusion bonded epoxy coating in compliance with DIN 3476 part 1 and EN 14901.
- Manufactured to suit nominal pipe OD, with a sealing range of nominal diameter +2mm to - 5mm.
- Zinc Plated and Passivated fasteners
- Corrosion resistant construction
- Fusion bonded epoxy coating
- EPDM seals
- Maximum Working Pressure: 16 Bar
- Temperature Range: -10°C to +70°C Insulation essential for temperatures of 0°C and below.

## 521. 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.

## **522. 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 250mm 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)	
			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 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. In order to meet the strength requirements in the Specification higher contents may be required.

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

Moderate exposure Surface sheltered from severe rain; buried concrete, concrete continuously under water

Intermediate 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



+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.
After 50 batches	1.7	2.5	5

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 weights 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 water stops, reinforcement, embedded steelwork and similar items which protrude above the surface of the completed pour.

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

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

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

When concrete is discharged above its place of final deposition, segregation shall be prevented 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 of 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 possibly have a uniform thickness over the plan area of the pour. Concrete shall be placed to the full planned height of all pours except in the circumstances described in sub-clause 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 -

**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 scrubbed by mechanical means or wet sand blasted and then washed with clean water. The indentations produced by scrubbing 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 water stops include grout stops.

Water stops shall be of the material and form shown on the drawings. No water stop 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.

Water stops 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 water stops 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) water stops shall be extruded from an unfilled plasticised PVC polymer or copolymer which does not contain any reclaimed or scrap PVC. PVC water stops 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 water stops 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.

Water stops 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.

Water stop material shall be stored carefully on site to avoid damage and



contamination with oil, grease, or other pollutants. Rubber and plastic water stops shall be stored in cool well-ventilated places away from direct sunlight.

Rubber and plastic water stops 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.

Water stops 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 water stop is fixed. In no circumstances shall a water stop be punctured with nails etc. as a means of fixing.

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

Formwork around water stops shall be carefully removed to avoid damage. If water stops suffer any damage which cannot be properly repaired in-situ the Engineer may require a section of concrete to be removed and the water stop 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 into the reinforcement shall be 1.6mm diameter soft annealed iron.

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

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

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

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

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

Bars complying with SRN 127 or other high tensile bars shall not be bent after

placing in the Works.

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

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

## **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 of by the Contractor.

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

**c) Fine Aggregate**

Fine aggregate shall be clean, hard and durable and shall be natural sand, crushed gravel sand or crushed rock sand complying with SRN 108. All the material shall pass through a 5mm standard sieve and the grading shall be in accordance with Zones 1, 2 or 3 of SRN 109. 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 AASHTO 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 called for 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 formworks 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, 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	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 perpends, 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 cantering, 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.
- j) 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.
- k) 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.

- l) 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's Representative.

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 B.S. 4993  
and Screws, with Nuts

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's Representative.

### **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, sand holes, veins, laminations or other imperfections.

The stone shall be chisel dressed into true rectangular blocks, with each surface even and at right angles to all adjoining surfaces, to the size specified. For exposed stonework the maximum permissible variation of any of the specified dimensions shall be 6mm provided that cut stone, supplied as 'rock face' stone may be hammer dressed on one face only, or on one face and one end, if in other respects it conforms with this specification. Stones shorter than 375mm will not be accepted.

Unless the Engineer allows otherwise the Contractor shall at his own expense

provide and dress four 100mm cubes of stone for testing.

The stone shall be sound when tested in accordance with SRN 870 except that:-

- i) The treatment shall be repeated for 10 cycles only; 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 Byelaws.



- 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 an 80mm 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 80mm 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 pelleting to sub-frames with matching hardwood pellets. 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
Mesh wire	2.7	260
Binding and connecting wire	2.2	240
Selvedge wire	3.4	275

All wire used in the fabrication of gabions and in the wiring operations during construction shall, after galvanising, have extruded onto it a coating of polyvinyl chloride compound referred to as PVC. The coating shall be black in colour, not less than 0.4 mm thickness and shall be capable of resisting deleterious effects of exposure.

Gabions shall be of the following standard sizes:

2m x 1m x 0.5m

2m x 1m x 1m

6m x 2m x 0.3m

Gabions shall be provided with diaphragms to divide the boxes in compartments with a maximum dimension in any direction of 1m.

Joints shall be flexible and shall consist of not less than one and a half full turns of wire, at each mesh point of the joint line.

Gabions 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 filling 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's Representative. 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's Representative. Samples shall be submitted before ordering and the articles ordered shall match up with the approved samples. Screws of a like metal shall be used for all fittings.

## **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 halving's, 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:

<u>Test Cone Penetration</u>	<u>Hot-poured Materials</u>	<u>Cold-poured Materials</u>
0.15 kg. for 5 secs. at 25° centigrade using standard grease cone	Penetration not to exceed 9mm	Penetration to be not less than 5mm not more than ---
<u>Flow</u>		
On a plane inclined at 75° to the horizontal, 5 hours at 60° centigrade	Flow not to exceed 5mm	Flow not to exceed 20mm

### Bond

25mm wide joint extended 12mm at rate of 4mm per hour at 18° centigrade. No more than one specimen in three to develop a crack separation or other opening more than 4mm deep.	Five cycles of extension and recompression	Three cycles of extension and recompression
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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%	

#### **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's Representative at the Contractor's expense.

The fabrication and erection of the steelwork shall be carried out in accordance with Part 5 of B.S. 449.

#### **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 “Dumbbell” 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.

## 11. PROJECT SPECIFIC INFORMATION AND CONTRACTOR'S GENERAL RESPONSIBILITY

### 1101. PROJECT LOCATION

The Project Site is within Mombasa County.

### 1102. SCOPE OF WORKS

The Works comprise of construction of the following Primary, Secondary, and Tertiary Mains including requisite Appurtenances (Air Valve, Washout Valves, Section Valves, Bulk Zonal Water Meters etc.):

Detail	South Mainland	West Mainland		Total
	Lot 2A	Lot 4A	Lot 4B	
Primary and Secondary Pipelines (km)	23.8	29.6	27.7	81.1
Tertiary Pipelines (km)	35.9	15.3	12.5	63.7
Bulk Water Meters (No.)	55	49	-	104
Consumer connection pipelines (km)	57.5	15.5	48.3	121.3
New Consumer metered connections (No.)	1,000	1,000	1,000	3000
Relocated Consumer metered connections (No.)	1,050	1,600	700	3350
Fire Hydrants (No.)	47	35	29	111
Ablution Blocks (No.)	2	-	-	-

### 1103. ADDITIONAL CONTRACTOR'S RESPONSIBILITIES

The Pipelines are to be laid within highly built up and congested Urban Areas.

Briefly, the Contractor's Additional Responsibilities will include:

- Setting out and verification survey of pipeline routes;
- Preparation of "As-Built" drawings and O&M manuals for the whole Project;
- Compliance with the project specific Environmental and Social Management Plan, all according to NEMA Conditions. This shall include issues such as disposal of wastes, health and safety of workers, safety of public, access and

avoid nuisance to the public and property owners, confirm to emissions requirements, drainage and excessive erosion, among others;

- Maintaining the works for a pre-determined period (12 months) following hand-over, to ensure that the materials and workmanship are performing as intended.
- The Client has no land available for Contractor's Camp or Camps. The Contractor will procure / rent adequate land for his camps including offices, workshops, stores, labour camp and other facilities within the vicinity of the Project Site. The Contractor will submit probable camp site(s) location details with the Bid.
- The Client has no land available for Storage of Materials including Pipes, Valves, Fittings, etc. The Contractor will procure / rent adequate land for proper storage and protection of all pipes, valves, fittings, etc. The Contractor will submit probable storage site(s) location details with the Bid.
- The Contractor shall be responsible for locating and protecting existing utilities and services, including existing bulk water supply trunk mains, electrical power cable routes (KPLC/Kenya Power), telephone (KPTC/Telekom) and other service providers), water and sewerage pipes (the water company), roads and drains (KeNHA, KURA, KERRA). In this respect, the Contractor shall be responsible for obtaining all Permits and Approvals, and in general complying with the requirements of the individual utilities and agencies.
- The new works will be connected to the existing, operational water distribution systems. The Contractor will be required to liaise closely with the Water Company when executing the works activities. Further, strict "rules" will apply to all such tie-in works since, in general, they may require for some time, a partial shut-down of the supply system and affected consumers to be informed well in advance.
- The pipelines traverse along roads and densely populated commercial and residential areas. Working in these areas will require provision of safety barriers, warning signs and lighting, temporary accesses to properties, etc. The Contractor should indicate the cost of these works under Bill No. 1, Item 6 – Other Works, Obligations, Method Related Charges. If this item is not priced or inadequately priced, the Contractor's rates for Other Works will be deemed to cover this requirement.
- The Contractor shall be responsible for identifying and paying all Government Levies and Statutory costs such as training levy, licencing fee, etc. The costs of these are deemed to be covered in the Contractor's rates for the Works.

#### 1104. CONDITIONS OF CONTRACT

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

#### 1105. CONSTRUCTION PERIOD

The proposed construction period will be **18 months**. Potential Contractors will note that multiple teams will be required to comply with this requirement, and will provide documentation to demonstrate adequacy of resources in this respect. Additionally, potential Contractors to note that some disruptions to scheduled work may be

expected to occur during the rainy seasons. This to be allowed for in their programme of implementation.

#### **1106. SITE AND OTHER DATA**

- The works are to be executed along roads and densely populated commercial and residential areas. Working in these areas will require provision of safety barriers, warning signs and lighting, temporary accesses to properties, diversion management of traffic, etc.
- There are several major hospitals within the Project Area. The Contractor will be required to maintain basic medical facilities and transport on site for emergency use;
- Design, manufacture and construction standards will conform to recognize international Codes and Standards. Local Kenyan Codes and Regulations shall also apply.

#### **1107. WAYLEAVE / EASEMENT FOR PIPELINE WORKS**

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

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

The Employer will obtain and pay for the requisite permissions from Road Authorities - KeNHA, KURA, KERRA and the County Government to lay the pipes within the road reserves. However, the Contractor will allow in his rates all costs for conditions prescribed by the authorities during the construction of the pipeline and reinstatement of all reserve areas to the original condition.

#### **1108. RESTRICTIONS ON USE OF ROADS**

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

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

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

### **1109. PREVAILING CONDITIONS**

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

i) Climatic Conditions

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

ii) Access

The works are to be executed along roads and densely populated commercial and residential areas. The pipelines also cross a number of rivers/ streams. Bidders to visit the Project Areas and familiarize themselves with the specific conditions in each area.

iii) Services

The Contractor shall make provision for the temporary supply of all services necessary for the execution of the works, including water, electricity, communications including Internet, fuels and consumables etc. The Contractor shall make all such applications and payments as necessary in order to obtain these services.

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

iv) Local Materials

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

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



v) Laws and Regulations

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

vi) Local Labour

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

vii) Ground Conditions

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

No geotechnical information is available along the pipeline's routes. Approximate rock excavation quantities have been appropriately provided for in the Bills of Quantities. These quantities are re-measurable. Contractor to verify site conditions through site inspections prior to tendering.

In addition, the Contractor shall be aware of maximum flood levels in all Rivers along which works will be carried out and schedule the construction works accordingly.

## 1110. PROGRAM OF WORKS

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

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

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

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

Once a Work Program has been approved by the Engineer it shall remain as the current version until such time as the Engineer instructs the Contractor to update or

revise the program. The Contractor shall not modify his program without such instruction from the Engineer. Specifically, the Contractor's progress reports shall relate to the current program, and any delays shall be duly indicated.

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

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

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

### **1111. METHOD STATEMENTS**

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

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

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

### **1112. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN**

***[Refer to Clause 141 in Chapter 1]***

## **1113. HEALTH AND SAFETY MANAGEMENT PLAN**

*[Refer to Clause 142 in Chapter 1]*

## **1114. PROGRESS REPORTS**

The Contractor shall submit a Monthly Progress Report to the Engineer. The formal, content and level of detail shall be determined and agreed with the Engineer.

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).

## **1115. 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.

## **1116. 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.

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

## **1117. MISCELLANEOUS FORMS**

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

- i. Site Instruction Form;
- ii. Request for Information / Inspection / Approval Form;

- iii. Materials Supply Form;
- iv. Setting Out Works Form;
- v. Pipeline Final Excavation Level Form;
- vi. Pipeline Laying Form;
- vii. Pipeline Backfilling Form;
- viii. Pipeline Testing Form;
- ix. Dayworks Form; and
- x. Concrete Pour Form; etc.

### **1118. CERTIFICATES OF COMPLETION**

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

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

### **1119. VERIFICATION BY CONTRACTOR**

#### **Survey and Dimensional Checking**

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

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

### **1120. CONSUMER CONNECTION WORKS**

#### **a) Types/ Classification of Consumer Connections**

Consumer Connections under the proposed Works are classified into two groups:

**i) New Connections**

New Connections are Connections on new Mains in areas where the Network did not exist before or new customers being connected to the Network for the first time.

New Connections can only be made by the Water Services Provider (WSP) upon receipt and processing of applications by potential customers and payment of the requisite Connection Fee.

**ii) Existing Connections**

Existing Connections are Connections that are already present within the Existing Distribution Network.

Where an existing Tertiary/ Service Main is replaced with a new Main, the Existing Connections need to be located, verified/ documented and then reconnected to the New Main.

**b) Supply of Pipes, Fittings and Accessories for New Consumer Connections**

New Connections are dependent on applications being made by potential customers to the WSP, processing of applications and payment of requisite Connection Fees.

The WSP will carry out the work of installing New Connections. and will be facilitated to kick-start the process by being provided with materials for a specified number of New Connections under the Main Contract. The Main Contractor will procure the requisite Pipes, Fittings and other Accessories for the specified number of New Connections and hand over the materials to the WSP to carry out the Connection Works.

**c) Reinstatement of Existing Consumer Connections**

Reinstatement of Existing Consumer Connection on the new Tertiary/ Service Mains once they have been activated by the Main Contractor to be carried out by a Nominated Sub-Contractor. This will require close coordination between the WSP, Main Contractor and Nominated Sub-Contractor as illustrated in the attached Schematic Diagram.

The sequence of activities will be as follows:

- i. All pipes, fittings, valves, meters and other accessories for Reinstatement of Existing Consumer Connections will be procured by the Main Contractor and handed over to Water Service Provider's (WSP) Stores as directed by the Engineer.
- ii. After confirmation of number of Existing Consumer Connections to be reinstated, Bidding Documents including Specifications and Bills of Quantities will be prepared by the Supervising Engineer for approval by WSP.
- iii. WSP will invite selected local Contractors to bid for the Reinstatement of Existing Consumer Connection Works.
- iv. On evaluation of bids and selection of suitable Contractor(s) for Reinstatement of Existing Consumer Connection Works, the WSP (Client) will instruct the Main Works Contractor to enter into a Contract with the Nominated Sub-Contractor(s). This Item is included as a P.C. Sum Item in the BoQ under the Main Works Contract. Depending on the number of Connections and their spread, one or more Sub-Contractors may be selected for the Works.
- v. WSP will issue pipes and fittings for installation of Consumer Connections to the Nominated Sub-Contractor(s) as and when required. Accountability for these fittings will be the responsibility of the WSP.
- vi. The Nominated Sub Contractor will be responsible for costs stemming from transportation of issued pipes, fittings and other accessories from WSP store, laying and jointing pipes in trenches, including excavation, preparation of surface, disposal of excavated material, backfilling and final reinstatement.
- vii. Nominated Sub Contractor will then liaise with the WSP to expose and tap existing water mains to connect to the new network as directed by the Engineer.
- viii. After testing and commissioning of reinstated existing consumer connections, Nominated Sub Contractor will disinfect and hand over the connections to the WSP.
- ix. On completion of Connections in an area/ zone, the WSP and the Engineer will verify and certify the completed works and on this basis, the Nominated Sub-Contractor(s) will be paid through the Main Works Contractor.

A Summary Responsibility Matrix for the key activities is given on Page 11-11.

**Responsibility Matrix for Key Activities on the Consumer Connection Works**

Responsibility	Supervising Engineer	Nominated Sub-Contractor	WSP	Main Contractor	Remarks
Review detailed design of primary & secondary distribution network	X				
Design of network configuration, diameter & appurtenances of tertiary mains (structured into DMAs), based on base/topography/areal maps	X				Limited survey is required to verify local conditions, lengths and location of appurtenance. In hilly terrain (variation >7 m), elevation data is required for the sizing of the diameter
Locating existing connections (on existing secondary & tertiary mains) along water mains being replaced.			input	X	Ahead or at least parallel to detailed survey or excavation by the main contractor  Nominated Sub-Contractor will only carry out Consumer Connections
Status verified and reconciliation of customer database and located connection			X		
Locating existing secondary & tertiary mains			input	X	
New secondary mains constructed and tested, based on reviewed detailed designs				X	
Survey of alignment, construction and testing of new tertiary mains, based on designs of D&CS consultants				X	Excluding (vertical) profiles Estimated quantities included under Works Contract
Replacement of existing tertiary mains				X	Quantities included under Works Contract
Indicate <u>all</u> abandoned <u>existing</u> mains on as-built drawings/GIS				X	
Plan for commissioning of new secondary & tertiary mains.			A	X	
Plan for reconnecting of existing consumer connections			A	X	Related to commissioning plan of new secondary & tertiary mains.
Reconnection of existing customers. Geo-referencing of connection and entered in GIS-file		X	A		To minimize transition time, the installation capacity of nominated contractor required
New Consumer Connections in extended / infill areas			X		WSPs to install New Consumer Connections. Materials for a specified number of New Connections to be supplied by the Main Contractor under the Works Contract.

Responsibility	Supervising Engineer	Nominated Sub-Contractor	WSP	Main Contractor	Remarks
					Implementation Horizon is dependent on additional water supply from Mwache Dam. It is likely that this may have to be delayed until after the Works Contract. World Bank to advise.
Update customer database			X		

*x = action      A= Approval*



## **1121. ASBESTOS CEMENT (AC) PIPES**

The Project involves replacement of Asbestos Cement (AC) Mains. To mitigate Environmental Health and Safety issues associated with handling and disposal of AC Mains, the mains will be decommissioned and left below the ground.

In the event decommissioning and disposal has to be carried out, the following mitigation measures shall be implemented within the Project Area:

- i. Proper mapping of existing asbestos cement pipes as provided in the layout plans in the Project Design Report. A work plan will be developed prior to demolition work, to protect workers and provide for proper waste disposal
- ii. Asbestos Cement Material (ACM) should be transported in leak-tight containers to a secure landfill operated in a manner that precludes air and water contamination that could result from ruptured containers. The waste will be disposed appropriately by a licensed NEMA hazardous waste handler.
- iii. Protection from “retaliatory and disciplinary measures” of workers who remove themselves from work because they believe ACM poses a danger to their health
- iv. Provision of appropriate Personal Protective Equipment (PPEs) for workers
- v. Provision of adequate changing rooms on site and at campsite and wash facilities to prevent dust from being carried to homes
- vi. Training of workers about the health hazards of ACM to themselves and their families. The training shall further involve inspections, maintenance, removal, or laboratory analysis of waste material.
- vii. Periodic medical examination of workers during the contract period
- viii. Periodic air monitoring of the work environment with records filed at the local NEMA office in Mombasa.



## 12. ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MONITORING PLAN (ESMMP)

### 1201. MANAGEMENT PLAN PRINCIPLES

This project is geared towards enhancing social and economic benefits to the people living in the project area however; the project should also observe environmental protection requirements in accordance with the established laws and regulations to ensure sustainability. To realize this goal, acceptability by a majority of the beneficiaries and minimal effects to the physical environment will require to be integrated in the project through constant consultations, evaluations and review of the design aspects throughout the project coverage. Among the factors that need to be considered in this particular project implementation will include:

- The Contractor shall hire qualified Community Liaison Officers who will be act as an inter-phase between the contractor and community. The Community Liaison Officers will be responsible for continuous engagement of the community.
- Ensure prevention of pollutants discharge into the drainage systems and pollution of public water bodies,
- Enhance integration of environmental, social and economic functions in the project implementation.
- Consider preventive measures towards possible social and economic disruptions that may arise from the project implementation in accordance with the laid down guidelines.
- The contractors and other players in the project activities be prevailed upon to implement the EMP through a sustained supervision and continuous consultations.

### 1202. SPECIFIC MANAGEMENT ISSUES

#### Management Responsibilities

In order to implement the management plan, it is recommended that a supervisor is identified to oversee environment and management aspects during construction of the project. The supervisor would also be expected to co-ordinate and monitor environmental management during construction and provide monitoring schedules during operations.

The contractor shall be required to submit, under due consideration of the ESMMP as part of the ESIA the below listed management plans.

- Occupational health and safety plan
- Traffic management plan
- Public health and safety management plan
- The provisions for the workers grievance mechanism

- Environmental and social monitoring plan (with further detail to the outline of monitoring indicators as presented in the ESMMP) below.

### **Environmental Management Guidelines**

Upon completion and commissioning the priority projects, it will be necessary to establish appropriate operational guidelines on environmental conservation and social linkages to enable the operations' management to identify critical environmental and social issues and institute appropriate actions towards minimizing associated conflicts.

Basically, the guidelines should cover among other areas environmental management programmes, standard operation procedures, compliance monitoring schedule and environmental audit schedules as required by law. Social harmony of the facilities and associated component will be achieved through collaborations with the stakeholders and settlement executive committees at the project level.

### **Environmental Education and Awareness Rising**

The county government field staff and the other beneficiaries will need to understand the basic environmental principles associated with the projects. In this regard, therefore, the following steps will need to be considered:

- Creation of liaisons on all matters related to environment management of the facilities once commissioned
- Encourage contribution of improvement ideas from the beneficiaries on specific issues related to the management of the facilities
- Establish initiatives that would instil a sense of ownership of the facilities and related components to all beneficiaries,

### **Decommissioning Process**

Due to the long-term life of the intervention facilities and related components, a decommissioning audit will be undertaken at least 1 year before the process for any of the components commences, following a notice to decommission. The decommissioning process will be guided by a comprehensive decommissioning plan developed through the decommissioning audit process. However, the following features will need to be decommissioned upon completion of the works:

- Contractor's camp and installations that will need to be removed without compromising on the safety and general welfare of the immediate residents. Special care to be given to associated wastes and dust emitted in the process,
- Materials stores that will comprise fresh materials and used items. Each category will be moved safely out of site ensuring minimal or no impacts to the related environment and social setting,
- Wastes and debris holding sites will be cleared with maximum re-use of the debris either on surfacing the passageways or other grounds such as schools and church compounds.



**Table 12.1: Construction Phase: Environmental and Social Management and Monitoring Plan**

Activity	Associated Impacts	Impact Levels	Management Actions	Target Areas& Responsibilities	Monitoring Indicator
<b>Seeking approvals from NEMA for ESIA, approval of campsite by Directorate of Occupational Health and Safety (DOSH)</b>	Delay in implementation of the Project due to objections and stop orders	Low	<ul style="list-style-type: none"> <li>The Contractor shall ensure that all pertinent permits, certificates and licences have been obtained prior to any activities commencing on site and are strictly enforced/ adhered to;</li> <li>The Contractor shall maintain a database of all pertinent permits and licences required for the contract as a whole and for pertinent activities for the duration of the contract</li> </ul>	All the Project components  <u>Responsibility</u> MOWASSCO & Contractor	<ul style="list-style-type: none"> <li>Number of approvals / permits issued</li> </ul>
<b>Construction campsites</b>	Environmental degradation risks	Medium	<ul style="list-style-type: none"> <li>Isolate through fencing the camp sites from access by the public for their safety</li> <li>Preferably to be located on land already cleared land wherever possible</li> <li>The Contractor's Camp layout shall take into account availability of access for deliveries and services and any future works</li> </ul>	Campsites  <u>Responsibility</u> Contractor	<ul style="list-style-type: none"> <li>Number of public outcry due to accidents</li> </ul>
<b>Access to campsites and construction sites</b>	Environmental degradation risks and risks to female workers of sexual harassment	Medium	<ul style="list-style-type: none"> <li>Utilize to the extent possible the existing public roads to avoid social and economic disruption</li> <li>Ensure road safety measures for the construction vehicles to the extent possible by observing all traffic regulations</li> <li>All workers to sign Code of Conduct which addresses SH at the workplace and penalties;</li> <li>Sensitize workers on dangers and consequences of sexual harassment.</li> </ul>	Access Roads  <u>Responsibility</u> Contractor	<ul style="list-style-type: none"> <li>Cases of private land required</li> <li>Accident's occurrence incidences</li> </ul>
<b>Environmental and Social Training and Awareness</b>	Risks of Environmental and Social degradation risks and occupational health and safety related accidents and risk mitigation of SH and SEA	Medium	<ul style="list-style-type: none"> <li>The Contractor and sub-contractors shall be aware of the environmental requirements and constraints on construction activities contained in the provisions of the ESMMP</li> <li>An initial environmental awareness training session shall be held prior to any work commencing on site, with the target audience being all project affected persons</li> <li>The Contractor will be required to provide for the appropriate Social Risk Management Training and Awareness as described in this ESMMP, including specific and ongoing training on the COC in his costs and programming</li> <li>An initial social risk awareness training on SH and SEA shall be held prior to any work commencing on site, with the target audience being all project affected persons.</li> </ul>	All Workers  <u>Responsibility</u> Contractor	<ul style="list-style-type: none"> <li>Number of Trainings Held</li> <li>Availability of Training reports</li> <li>Attendance list of participants during the training sessions</li> </ul>
<b>HIV/AIDS awareness and prevention</b>	Risks of Increased HIV and Aids transmission in the	Medium	<ul style="list-style-type: none"> <li>The Contractor shall institute HIV/AIDS awareness and prevention campaign amongst his workers for the duration of the contract, contracting and implementing organisation, with</li> </ul>	All Workers	<ul style="list-style-type: none"> <li>Number of Trainings Held</li> <li>Availability of</li> </ul>

Activity	Associated Impacts	Impact Levels	Management Actions	Target Areas& Responsibilities	Monitoring Indicator
<b>campaign</b>	area		<p>preference for an organisation already working on this issue in the Project area;</p> <ul style="list-style-type: none"> <li>The campaign shall include the training of facilitators within the workers, information posters in more frequented areas in the campsite and public areas, availability of promotional material (T-shirts and caps), availability of condoms (free), coordination with GBV prevention messages and theatre groups.</li> </ul>	<p><u>Responsibility</u> Contractor</p>	<p>Training reports</p> <ul style="list-style-type: none"> <li>Attendance list of participants during the training sessions</li> </ul>
<b>Local Labour / Employment</b>	Delay in Project implementation due to opposition from aggrieved community members	Medium	<ul style="list-style-type: none"> <li>Wherever possible, the Contractor shall use local labour, and women must be encouraged to be involved in construction work</li> <li>The contractor shall ensure compliance to the gender balance as required by the 2/3 gender rule</li> <li>The contractor shall implement strategies to reduce risk of GBV (e.g., through backlash by husbands, etc.) at the community level related to employment of women</li> </ul>	<p>All the Project Lots</p> <p><u>Responsibility</u> Contractor</p>	<ul style="list-style-type: none"> <li>Number of workforce employed from the local community</li> <li>Number of females employed</li> </ul>
<b>Setting out and clearance of Project routes and site</b>	Delay in Project implementation due to opposition from PAPs	High	The ARAP estimated the number of Project Affected Persons (PAPs) within the target supply areas of Mombasa Island, North Mainland, West Mainland and South Mainland is 109 PAPs out of which 44 PAPs are women and 65 PAPs are male while 7 PAPs are vulnerable.	<p>All the Project water lines</p> <p><u>Responsibility</u> MOWASSCO</p>	<ul style="list-style-type: none"> <li>Numbers of satisfied PAPs</li> <li>Extend of route opened to the contractor</li> </ul>
<b>Earth moving and excavations (Vegetation clearance, channelling and site preparations)</b>	Vegetation Cover destruction	Low to medium	<ul style="list-style-type: none"> <li>Construction activities will be limited to Project sites / routes which already exist therefore limited destruction to vegetation cover,</li> <li>Compensatory planting of trees i.e., plant at least twice the number of trees this will be achieved through a tree planning program to be initiated under the works contractor.</li> </ul>	<p>All work areas</p> <p><u>Responsibility</u> Contractor</p>	<ul style="list-style-type: none"> <li>Soil erosion extend and intensity on site</li> </ul>
	Impacts on Water Resources - water pollution	Low to medium	<ul style="list-style-type: none"> <li>No grey water runoff or uncontrolled discharges from the site/working areas (including wash down areas) to adjacent storm water shall be permitted;</li> <li>Water containing such pollutants as cements, concrete, lime, chemicals and fuels shall be discharged into a conservancy tank for removal from site where applicable</li> <li>The Contractor shall also prevent runoff loaded with sediment and other suspended materials from the site/working areas from discharging to storm water channels</li> </ul>	<p>All work areas</p> <p><u>Responsibility</u> Contractor</p>	<ul style="list-style-type: none"> <li>Water quality flowing through storm</li> </ul>
<b>Earth moving and excavations (Vegetation clearance, channelling and site preparations)</b>	Siltation and Sedimentation Control	Low	<ul style="list-style-type: none"> <li>Any work along storm water channels will be isolated to prevent silt propagating downstream;</li> <li>Debris and other material will be prevented from entering Storm water channels; contamination by other pollutants);</li> <li>Sand/silt traps should be used so as to prevent silt and any other sediments from getting into storm water channels</li> </ul>	<p>civil works areas</p> <p><u>Responsibility</u> Contractor</p>	<ul style="list-style-type: none"> <li>Silt load in storm water channels</li> </ul>

Activity	Associated Impacts	Impact Levels	Management Actions	Target Areas& Responsibilities	Monitoring Indicator
			<ul style="list-style-type: none"> <li>Site compounds and stockpiles will be located away from shallow wells and storm water channels</li> </ul>		
	Soil Erosion Impacts	Low	<ul style="list-style-type: none"> <li>Earthworks should be controlled so that land that is not required for the Project works is not disturbed;</li> <li>Wherever possible, earthworks should be carried out during the dry season to prevent soil from being washed away by the rain.</li> <li>Excavated materials and excess earth should be kept at appropriate sites approved by the Supervising Engineer.</li> <li>The contractor should adhere to specified cut and fill gradients and planting embankments with shrubs and grass to reduce erosion</li> </ul>	Civil works areas  <u>Responsibility</u> <ul style="list-style-type: none"> <li>Contractor</li> <li>Supervising Engineer</li> </ul>	<ul style="list-style-type: none"> <li>Extend of soil erosion on site</li> </ul>
Site Activities	Risk of Accidents at Work Sites	High	<ul style="list-style-type: none"> <li>Contractor to provide a Healthy and Safety Plan (HSP) prior to the commencement of works to be approved by the Supervising Engineer.</li> <li>Provide Personal Protective Equipment (PPE) including gloves, gum boots, overalls and helmets to workers. Use of PPE to be enforced by the Supervising Engineer.</li> <li>Fully stocked First Aid Kits to be provided within the Sites, Camps and in all Project Vehicles</li> <li>Strict use of warning signage and tapes where the trenches are open and at other active construction sites</li> <li>Contractor to Employ and train Road Safety Marshalls who will be responsible for management of traffic on site</li> </ul>	Civil works areas  <u>Responsibility</u> <ul style="list-style-type: none"> <li>Contractor</li> <li>Supervising Engineer</li> </ul>	<ul style="list-style-type: none"> <li>Number of fatalities and accidents recorded in the incidence book</li> </ul>
	Solid Wastes impacts	High	<ul style="list-style-type: none"> <li>The contractor shall develop a comprehensive Waste Management Plan (WMP) prior to commencement of works</li> <li>Properly labelled and strategically placed waste disposal containers shall be provided at all places of work</li> <li>Litter bins should have secured lids to prevent animals and birds from scavenging</li> <li>All personnel shall be instructed to dispose of all waste in a proper manner</li> <li>Recycling of construction material shall be practiced where feasible e.g., containers and cartons</li> <li>Earth spoils shall be disposed of in pre identified sites</li> </ul>	Civil works areas  <u>Responsibility</u> <ul style="list-style-type: none"> <li>Contractor</li> <li>Supervising Engineer</li> </ul>	<ul style="list-style-type: none"> <li>Quantity of solid Wastes Generated and appropriately disposed</li> </ul>
Site Activities	Sexual Harassment between project workers		<ul style="list-style-type: none"> <li>The contractor will ensure clear human resources policy against sexual harassment that is aligned with national law</li> <li>The contractor will integrate provisions related to sexual harassment in the employee COC</li> <li>The contractors will ensure appointed human resources personnel to manage reports of sexual harassment according to policy</li> </ul>	Civil works areas  <u>Responsibility</u> Contractor Supervision	<ul style="list-style-type: none"> <li>SH Policy</li> <li>Number of trainings for staff on SH</li> <li>HR trained in SH</li> </ul>



Activity	Associated Impacts	Impact Levels	Management Actions	Target Areas& Responsibilities	Monitoring Indicator
	Liquid Wastes Impacts	High	<ul style="list-style-type: none"> <li>Water containing pollutants such as concrete or chemicals should be directed to a conservancy tank for removal from the site where applicable</li> <li>Potential pollutants of any kind and form shall be kept, stored and used in such a manner that any escape can be contained</li> <li>In case of any form of pollution the contractor should notify the Resident Engineer (RE)</li> <li>Wash areas shall be placed and constructed in such a manner so as to ensure that the surrounding areas including groundwater are not polluted</li> <li>No grey water runoff or uncontrolled discharges from the site or working areas to any adjacent Storm water channels.</li> </ul>	<p>Civil works areas</p> <ul style="list-style-type: none"> <li>Contractor Supervising Engineer</li> </ul>	<ul style="list-style-type: none"> <li>Quantity of liquid Wastes Generated and appropriately disposed</li> </ul>
	<p><b>Sanitation issues resulting from both solid and liquid wastes on site</b></p> <p>Risks associated with water borne diseases exposed to community and workforce</p>	High	<ul style="list-style-type: none"> <li>The Contractor shall -laws relating to public health and sanitation</li> <li>All temporary/ portable toilets or pit latrines shall be secured to the ground to the satisfaction of the RE to prevent them from toppling over</li> <li>A wash basin with adequate clean water and soap shall be provided alongside each toilet. Staff shall be encouraged to wash their hands after use of the toilet, in order to minimise the spread of possible disease</li> <li>Toilets will be sex-segregated in order to ensure the privacy, safety and dignity of women and men</li> </ul>	<p>All work areas</p> <p><u>Responsibility</u></p> <ul style="list-style-type: none"> <li>Contractor Supervising Engineer</li> </ul>	<ul style="list-style-type: none"> <li>Incidence of reported cases of water related diseases among the workforce and neighbour community</li> </ul>
Site Activities	Fuels, Oils and other hydrocarbons	High	<ul style="list-style-type: none"> <li>The contractor shall ensure that the machines and equipment are in good condition when on site.</li> <li>Ensure proper handling of lubricants, fuels and solvents while maintaining the plant and equipment.</li> <li>Any chemical or fuel spills shall be cleaned up immediately. The spilled liquid and clean-up material shall be removed, treated and transported to an appropriate site licensed for its disposal.</li> </ul>	<p>civil works areas</p> <p><u>Responsibility</u></p> <ul style="list-style-type: none"> <li>Contractor Supervising Engineer</li> </ul>	<ul style="list-style-type: none"> <li>Quantity of waste fuels and oils appropriately disposed</li> </ul>
	<p><b>Storage of fuel oils, lubricants, chemicals and flammable materials</b></p> <p><b>Hazards of fire outbreak, oil and chemical spills.</b></p>	High	<ul style="list-style-type: none"> <li>Follow specifications of the Occupational Health and Safety Act 2007, EMCA 2015 and others in the development and operation of stores.</li> </ul>	<p>All work areas</p> <p><u>Responsibility</u></p> <ul style="list-style-type: none"> <li>Contractor Supervising Engineer</li> </ul>	<ul style="list-style-type: none"> <li>Incidence of reported cases of fuel leaks and fire incidences</li> </ul>
	<p><b>Noise and Vibration control from plant and</b></p>	High	<ul style="list-style-type: none"> <li>The Contractor shall keep noise level within acceptable limits and construction activities shall, where possible, be confined to normal working hours in the residential areas</li> </ul>	<p>civil works areas and access roads</p>	<ul style="list-style-type: none"> <li>Reported complaints from neighbour</li> </ul>

Activity	Associated Impacts	Impact Levels	Management Actions	Target Areas& Responsibilities	Monitoring Indicator
	<b>equipment</b> Risk to health and safety of community and workers		<ul style="list-style-type: none"> <li>hospitals and other noise sensitive areas shall be notified by the Contractor at least 5 days before construction is due to commence in their vicinity</li> <li>Any complaints received by the Contractor regarding noise will be recorded and communicated to the RE</li> <li>The Contractor must adhere to Noise Prevention and Control Rules of April 2005</li> </ul>	<u>Responsibility</u> <ul style="list-style-type: none"> <li>Contractor Supervising Engineer</li> </ul>	community and institutions
	<b>Air Quality Control</b> Air pollution causing respiratory disorders to human	High	<ul style="list-style-type: none"> <li>Workers shall be trained on management of air pollution from vehicles and machinery. All construction machinery shall be maintained and serviced in accordance with the contractor's specifications</li> <li>The removal of vegetation shall be avoided until such time as clearance is required and exposed surfaces shall be re-vegetated or stabilised as soon as practically possible</li> <li>The contractor shall not carry out dust generating activities (excavation, handling and transport of soils) during times of strong winds</li> <li>Vehicles delivering soil materials shall be covered to reduce spills and windblown dust</li> <li>Water sprays shall be used on all earthwork areas within 200metres of human settlement.</li> </ul>	All work areas  <u>Responsibility</u> <ul style="list-style-type: none"> <li>Contractor Supervising Engineer</li> </ul>	<ul style="list-style-type: none"> <li>Cases of respiratory complication at nearby health centre</li> </ul>
<b>Traffic management on site</b>	Risks of Accidents, Injuries or death of workers or community member	high	<ul style="list-style-type: none"> <li>Strict use of warning signage and tapes where the trenches are open and active sites</li> <li>Employ and train road safety Marshalls who will be responsible for management of traffic on site</li> <li>Contractor to provide a traffic management plan during construction to be approved by the resident engineer</li> </ul>	Civil works areas and access roads  <u>Responsibility</u> <ul style="list-style-type: none"> <li>Contractor Supervising Engineer</li> </ul>	<ul style="list-style-type: none"> <li>Accident's occurrence incidences</li> </ul>
<b>Materials sourcing, from burrow pits and quarries delivery and storage</b>	Environmental and Safety risks associated with burrowing and opening up of new quarry sites	Medium to High	<ul style="list-style-type: none"> <li>Ensure that appropriate authorization to use the proposed borrows pits and quarries has been obtained before commencing,</li> <li>This should be achieved through preparation of specific Environment and Social Impact Assessment for identified quarries and burrow pits to inspected and approved by NEMA.</li> <li>Carry out inspection of each of the site's soil stability before excavation;</li> <li>Borrow pits and quarries shall be located more than 20 meters from watercourses in a position that will facilitate the prevention of storm water runoff from the site from entering the watercourse;</li> <li>The Contractor shall give a 14-day notice to nearby communities</li> </ul>	Burrow Pits and Quarry Site  <u>Responsibility</u> <ul style="list-style-type: none"> <li>Contractor Supervising Engineer</li> </ul>	<ul style="list-style-type: none"> <li>Environmental Status of reinstated burrow pits</li> <li>Complains from the community on burrow pits and material transportation</li> </ul>

Activity	Associated Impacts	Impact Levels	Management Actions	Target Areas& Responsibilities	Monitoring Indicator
			of his intention to begin excavation in the borrow pits or quarries		
	Labour Influx	Medium to High	<ul style="list-style-type: none"> <li>The contractor awarded the Project will develop a labour Management Plan (LMP) in consultation with local leaders.</li> <li>The contractor will ensure effective community engagement and strong grievance mechanisms on matters related to labour including sexual exploitation and abuse</li> <li>Effective contractual obligations for the contractor to adhere to the mitigation of risks against labour influx, the contractor should engage a local community liaison person.</li> <li>The contractor will ensure proper records of labour force on site while avoiding child and forced labour</li> <li>The contractor will ensure comply to provisions of Workplace Injuries and Benefits Act (WIBA) 2007 <ul style="list-style-type: none"> <li>The contractor shall require his/her employees, sub-contractors, sub-consultations and any personnel thereof engaged in construction works to individually sign and comply with a Code of Conduct, with specific prevision on protection from sexual exploitation and abuse</li> </ul> </li> </ul>	<p>Project Corridor</p> <p><u>Responsibility</u></p> <ul style="list-style-type: none"> <li>Contractor Supervising Engineer</li> </ul>	<ul style="list-style-type: none"> <li>Number of grievances recorded by disgruntled works force and community</li> </ul>
	Gender Inclusivity in Project activities	Low	<ul style="list-style-type: none"> <li>The contractor will mainstream Gender Inclusivity in hiring of workers and entire Project Management as required by Gender Policy 2011 and 2/3 Gender Rule.</li> <li>Special provisions for reporting and addressing any GBV risks at the community level (i.e.. backlash in the home) related to employment of women</li> <li>The existing community structures headed by location chiefs should be involved in local labour hire, emphasize the requirement of hiring women, youth and people with disability and VMGs</li> <li>Protecting Human Risk areas Associated with, Disadvantaged Groups, Interfering with Participation Rights and interfering with Labour Rights <ul style="list-style-type: none"> <li>To include promotion of human rights, including gender equality and equity in Employee's Code of Conduct</li> </ul> </li> </ul>	<p>Project Corridor</p> <p><u>Responsibility</u></p> <ul style="list-style-type: none"> <li>Contractor Supervising Engineer</li> </ul>	<ul style="list-style-type: none"> <li>women and Men employed by the Project</li> </ul>
	Children abuse impacts	High	<ul style="list-style-type: none"> <li>The contractor will develop and implement a Children Protection Strategy that will ensures minors are protected against negative impacts associated by the Project.</li> <li>All staff of the contractor must sign, committing themselves towards protecting children, which clearly defines what is and is not acceptable behaviour <ul style="list-style-type: none"> <li>Children under the age of 18years should be hired on site as provided by Child Rights Act (Amendment Bill) 2014</li> </ul> </li> </ul>	<p>Project Corridor</p> <p><u>Responsibility</u></p> <ul style="list-style-type: none"> <li>Contractor Supervising Engineer</li> </ul>	<ul style="list-style-type: none"> <li>Number of cases reported involving abuse of children</li> </ul>

Activity	Associated Impacts	Impact Levels	Management Actions	Target Areas& Responsibilities	Monitoring Indicator
	Gender-based violence at the community level		<p>The contractor will implement provisions that ensure that gender-based violence at the community level is not triggered by the Project, including:</p> <ul style="list-style-type: none"> <li>• Effective and on-going community engagement and consultation, particularly with women and girls;</li> <li>• Review of specific project components that are known to heighten GBV risk at the community level, e.g., compensation schemes for women, employments schemes for women, etc.;</li> <li>• Specific plan for mitigating these known risks, e.g., sensitization around gender-equitable approaches to compensation and employment</li> <li>▪ The contractor will ensure adequate referrals mechanisms are in place if a case of GBV at the community level is reported related to project implementation</li> </ul>		<ul style="list-style-type: none"> <li>• plan for GBV occurring at the community level as a result of project implementation</li> <li>• Number of GBV cases happening at the community level that receive survivor-centred referral and care</li> </ul>
	Sexual Exploitation and Abuse by project workers against community members		<ul style="list-style-type: none"> <li>• Develop and implement a SEA action plan with an Accountability and Response Framework as part of the C-ESMP. The SEA action plan will follow guidance on the World Bank’s Good Practice Note for Addressing Gender-based Violence in Investment Project Financing involving Major Civil Works (Sept 2018).</li> <li>• The SEA action plan will include how the project will ensure necessary steps are in place for: <ul style="list-style-type: none"> <li>• Prevention of SEA: including COCs and ongoing sensitization of staff on responsibilities related to the COC and consequences of non-compliance; project-level IEC materials;</li> <li>• Response to SEA: including survivor-centred coordinated multi-sectoral referral and assistance to complainants according to standard operating procedures; staff reporting mechanisms; written procedures related to case oversight, investigation and disciplinary procedures at the project level, including confidential data management;</li> <li>• Engagement with the community: including development of confidential community-based complaints mechanisms discrete from the standard GRM; mainstreaming of PSEA awareness-raising in all community engagement activities; community-level IEC materials; regular community outreach to women and girls about social risks and their PSEA-related rights;</li> </ul> </li> <li>• Management and Coordination: including integration of</li> </ul>		<ul style="list-style-type: none"> <li>• SEA Action Plan</li> <li>• Code of Conduct</li> <li>• Number of staff trainings</li> <li>• SEA FP</li> <li>• Community Liaison Officer trained in PSEA</li> <li>• IEC materials for workers sites and community</li> <li>• Discrete SEA reporting pathway</li> <li>• Relevant policies, e.g., investigations and discipline and whistle-blower protection</li> <li>• Monthly minutes from SEA coordination meetings</li> </ul>

Activity	Associated Impacts	Impact Levels	Management Actions	Target Areas& Responsibilities	Monitoring Indicator
			SEA in job descriptions, employments contracts, performance appraisal systems, etc.; development of contract policies related to SEA, including whistle-blower protection and investigation and disciplinary procedures; training for all project management; management of coordination mechanism for case oversight, investigations and disciplinary procedures; supervision of dedicated PSEA focal points in the project and trained community liaison officers.		
	Increase of communicable diseases including HIV and Aids	High	<ul style="list-style-type: none"> <li>• HIV/AIDS Awareness Program and other communicable diseases to be instituted and implemented as part of the Contractor's Health and Safety Management Plan to be enforced by the Supervising Engineer.</li> <li>• This will involve periodic HIV/AIDS and other communicable diseases Awareness Workshops for Contractor's Staff</li> <li>• Access to Contractor's Workforce Camps by outsiders to be controlled</li> <li>• Contractor to provide standard quality condoms to personnel on site</li> </ul>	<p>All Workers</p> <p><u>Responsibility</u> Contractor</p>	<ul style="list-style-type: none"> <li>• Number of Trainings Held</li> <li>• Availability of Training reports</li> <li>• Attendance list of participants during the training sessions</li> </ul>
<b>Contractor de-mobilization and site reinstatement</b>	Associated risks of environmental degradation	Medium	<ul style="list-style-type: none"> <li>▪ The site is to be cleared of all construction materials, including litter prior to hand over</li> <li>▪ Fences, barriers and demarcations associated with the construction phase must be removed from the site</li> <li>▪ Fences, barriers and demarcations associated with the construction phase must be removed from the site</li> <li>▪ Rehabilitation Activities of Environmental Cases identified must continue throughout the defect liability period</li> </ul>	<p>All work areas</p> <p><u>Responsibility</u></p> <ul style="list-style-type: none"> <li>• Contractor Supervising Engineer</li> </ul>	<ul style="list-style-type: none"> <li>• Closeout audit report findings</li> </ul>

## **SECTION 2: STANDARD REFERENCE NUMBERS**

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## 1. **Introduction**

The Engineer has agreed to use a method of modifying the text of Engineering specifications by referring to a Standard Specification Reference Number (SRN) instead of a National Standard and then providing a tabulated comparison between British and German Standards, cross-referenced further where appropriate to an International Standard (ISO), an International Electro-technical Standard (IEC), to an American Waterworks Standard (AWWA) or other appropriate National Standards.

## 2. **General Clause on Standard Specification**

A general introductory clause to be inserted into general specification documents has been prepared. It is quoted below to assist in the preparation of Future Specification Volumes.

### **Standards**

The Contractor shall observe these Specifications and shall carry out all work in a skilled and workmanlike manner in keeping with modern methods of mechanical and construction Engineering.

In addition, the Contractor shall conform with all conditions currently in force 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 complied with. As the National Standards referred to in the table of comparison may expand on or strengthen further the requirements of ISO, Bidders choosing not to comply with one of the National Standards indicated may either indicate an alternative National Standard with which they shall comply or provide with their Bid a full and detailed description of the Standards they propose to attain.

Where a Bidder offers a particular item to a National Standard not specified in the table of comparison he shall comply with the requirements of the Instructions to Bidders in this respect and shall enclose a copy in English of the alternative National Standard offered with his Bid. Alternative National Standards or Bidder's own detailed description of the Standards they propose shall be subject to the approval of the Engineer.

### 3. **List of National Specification Cross Referenced**

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

<u>SRN No.</u>	<u>Specification</u>
001-099	Electrical and Mechanical
100-199	Concrete
200-299	Metallic Pipes and Fittings
300-399	Plastic Pipes and Fittings
400-499	Other Pipes and Fittings
500-599	Valve, Meters, Hydrants and Other Specials
600-649	Testing Methods and Equipment
650-699	Site Work Codes of Practice
700-749	Drawing Practice, Standard Symbols, etc.
750-799	Glossary
800-899	Building Materials (exclude. In-situ Concrete)
900-999	Miscellaneous

In case the following code have been superseded or withdrawn the latest or its replacement code shall be considered/adopted.



### 3.1 CONCRETE

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
100	METHOD FOR SPECIFYING	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		SUB. NO.	8007			
103	ORDINARY PORTLAND CEMENT	1164	1	12		KS 02-1262 & KS 02-	
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
107	SAMPLING AND TESTING OF	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	4226		882	CL.4.1		
110	COARSE AGGREGATES FOR CONCRETE	1045					
111	COARSE AGGREGATES FOR CONCRETE	4226		882	TBL.2		
111	COARSE AGGREGATES FOR CONCRETE	1045					
112	COARSE AGGREGATES FOR CONCRETE	4226		812	2	ISO 6783 BS EN 1367	BS 812 Part 120 Replaced by BS EN
112	COARSE AGGREGATES FOR CONCRETE	1045					
113	COARSE AGGREGATES FOR CONCRETE	4226		812	105.1		
113	COARSE AGGREGATES FOR CONCRETE	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	1045		8110	1		
121	CONCRETE TRUCK-MOUNTED	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
126	STEEL R/F HOT-ROLLED STEEL	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			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	1084	1				
134	DESIGN OF CONCRETE MIXES	52171		See HMSO		HMSO RD	
135	SAND FOR MORTAR	4226		1200			

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
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			1881	121		
140	TESTING CONCRETE - WATER ABSORPTION			1881	122		
141	TESTING CON-SAMPLING, TESTING FRESH CONCRETE.	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 &			8110	1		
144	STRUCTURAL USE OF CONCRETE - SPECIAL CIRC.						
145	IN-SITU CONCRETE DIAPHRAGM	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			4482			
152	FUSION BONDED EPOXY COATED CARBON STEEL BARS FOR THE			7295	1 & 2		Part 1: Coated bars Part 2: Coatings

### 3.2 METALLIC PIPES AND FITTINGS

SRN	SUBJECT	DIN	PAR	BSS	PART	OTHER	REMARKS
200	GREYCAST IRON PRESSURE PIPES AND FITTINGS			1211		ISO 13; ISO 49	BS 1211 Obsolete Partially replaced by BS 4772
200	GREY IRON PIPES AND FITTINGS (CONT)			4622		ISO 13	BS 4622 Obsolete
201	CAST IRON FLANGED PIPES & FITTINGS			2035		ASME/AN SI B16.1 -	BS 2035 Obsolete 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					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;	
204	WROUGHT STEEL PIPE FITTINGS TO SSRN 203			1740	1	ISO 4145	
204	TH. STEEL PIPE FITTINGS TO SSRN	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	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
207	FLANGES FOR FERROUS PIPES - STEEL BY CLASS	2501	1	1560	3-3.1	ISO 7005:1988;	
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-	
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					

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
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	
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-	
211	CEMENT MORTAR LINING - D.I. PIPES			EN 545		EN 545, AWWA	
211	CEMENT MORTAR LINING - D.I. PIPES	2614					
211	CEMENT MORTAR LINING - D.I. PIPES (CONT)					DVGW W343 ISO 4179:1985,	
212	CEMENT MORTAR LINING - STEEL PIPES	2614		534		AWWA C 205, NFA 49-701DVGW	
212	CEMENT MORTAR LINING - STEEL PIPES (CONT)	2614				AWWA C 602-95	
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	
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					See SSRN 219	
219	D.I. PIPES & FITT.-S & S JOINTS			8010	2-2.1		
219	D.I. PIPES & FITT.-S & S JOINTS					EN 545	
219	D.I. PIPES & FITT.-S & S JOINTS	28603					
219	PIPELINES ON LAND; DESIGN, CONSTRUCTION AND INSTALLATION: STEEL FOR OIL			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				1	EN 681	
222	ELASTOMERIC JOINTS RINGS- DRAINS & SEWERS	4060					
223	PIPE THREADS-TUBES & FITT. (WATERTIGHT	See ISO DIN		21		ISO 711:1982;	

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
224	CAST IRON S & S PIPES AND FITTINGS			78	2		BS 78 Withdrawn, Replaced by BS 4622 Part 2 Obsolescent Partially
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	none		none		ISO 8180:1985	
227	POLYTHENE SLEEVING FOR D. I.	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	2460		CP2010-2		EN 10224, ISO 559	
230	STEEL PIPES FOR WATER FLEXIBLE SOCKET & SPIGOT	2460		CP2010-2		EN 10224, AWWA C200-	
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			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	

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
251	STEEL PIPES - POLYPROPYLENE COATING	30678		none		EN 10286, NFA 49-711	
252	STEEL TUBES - ELECTROMAGNETIC TESTING -				1	EN 10246	
253	TWO- & THREE-LAYER POLYTHENE COATINGS FOR STEEL PIPES	30670		534		AWWA C215, NFA 49-704, NFA	
254	LIQUID EPOXY COATINGS FOR STEEL PIPES					AWWA C210	
255	LIQUID EPOXY LININGS FOR STEEL PIPES					AWWA C210, NFA	
256	LIQUID POLYURETHANE COATINGS FOR STEEL PIPES	30671				AWWA C222	
257	LIQUID POLYURETHANE LININGS FOR STEEL PIPES					AWWA C222, NFA	
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.			EN 545		EN 545	
261	FUSION BONDED EPOXY COATINGS & LININGS FOR D.I.					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					EN 10310, AWWA	

### 3.3 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					ISO 161/1	
300	uPVC PIPES FOR COLD WATER					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
307	HDPE PIPES, JOINTS, FITTINGS	16963	1-3	3284 (6572)			Obsolescent - Partially replaced by BS
308	RUBBER RINGS FOR MECHANICAL JOINTS			2494			
309	uPVC UNDERGROUND DRAINPIPES & 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	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			4962			
318	POLYPROPYLENE WASTE PIPE AND FITTINGS (EXTERNAL DIAMETER 34.6MM.			5254			
319	THERMOPLASTICS WASTE PIPE AND FITTINGS			5255			
320	GLASS REINFORCED PLASTICS (GRP) PIPES, JOINTS AND FITTINGS FOR USE FOR WATER			5480			
321	UNPLASTICIZED PVC PIPE AND FITTINGS FOR GRAVITY SEWERS			5481			
322	PLASTICS PIPEWORK (THERMOPLASTICS MATERIALS)			5955	6		Part 6: Installation of unplasticized PVC pipework for gravity drains and sewers
323	BLUE POLYETHYLENE PIPES UP TO NOMINAL SIZE 63 FOR BELOW GROUND USE FOR POTABLE			6572			
324	BLACK POLYETHYLENE PIPES UP TO NOMINAL SIZE 63 FOR ABOVE GROUND USE FOR COLD			6730			

### 3.4 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	4279	1, 6, 9, 10	5886		ISO 4483	
406	PIPE SUPPORTS	See DVGW		3974	1	DVGW 310 PT. 2	
407	UNREINFORCED CONCRETE PIPES (OGEE)	4032		5911	3		
408	PRESTRESSED CONCRETE PRESSURE PIPES	4035		4625			
409	PRECAST CONCRETE PIPES - DRAINS & SEWERS	4032		5911	1, 3		
409	PRECAST CONCRETE PIPES - DRAINS & SEWERS (CONT.)	4035					
410	CONCRETE POROUS PIPES - UNDER DRAINS			5911	114		
411	NON-PRESSURE DUCTILE IRON PIPES ETC.					ISO 7186	
412	RUBBER AND PLASTIC HOSES AND ASSEMBLIES					ISO 7751	
413	CONCRETE CYLINDRICAL PIPES & FITTINGS METRIC			5911	1-3	AWWA C602-83	BS 5911 Part I: 1981 Withdrawn 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					BS EN 639	



### 3.5 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	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.			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 &	14244		336			
513	SURFACE BOXES			5834	2, 3		
513	SURFACE BOXES (CONT. 1)						
513	SURFACE BOXES (CONT. 2)						
513	SURFACE BOXES (CONT. 3)						
513	SURFACE BOXES (CONT. 4)						
514	METALLIC BALL VALVES	3357	1-7				DIN 3357 Part 6, 7 Withdrawn
515	uPVC VALVES	3441	2				
517	FIRE HYDRANT SYSTEMS FOR BUILDINGS			5041	1-5		
518	BUTTERFLY VALVES			5155			
519	DIAPHRAGM VALVES			5156			
520	CAST IRON PLUG VALVES			5158			
521	UNDERGROUND STOPVALVES FOR WATER SERVICES			5433			

**3.6 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 -	18196		1377			
602	TESTING OF PIPELINE FOR WATER (INTERNAL	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	
605	MEASUREMENT OF WATER FLOW (WATER METERS)					ISO 4064/3	
606	DRINKING WATER QUALITY -					KS 05-459:5	
607	RECOMMENDATIONS AND CLASSIFICATION FOR			3882			
608	METHODS OF TESTING MORTARS, SCREEDS AND			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
610	SIZE OF HARDWOODS AND METHODS OF MEASUREMENT			5450			
611	RECOMMENDATIONS FOR TESTING OF AGGREGATES			5835	1		Part 1: Compactibility test for graded aggregates

### 3.7 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
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
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 3I, 8F, 8G
662	MEASUREMENT OF FLOW IN CLOSED CONDUITS (BY CURRENT METERS OR PITOT					ISO 7194	
663	CONSTRUCTION AND DEMOLITION OF CONCRETE					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	
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
675	CONSTRUCTION AND TESTING OF DRAINS AND					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			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

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
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
681	INTERNAL PLASTERING			5492			
682	GUIDE TO ACCURACY IN BUILDING			5606			
683	SAFE USE OF EXPLOSIVES IN THE CONSTRUCTION			5607			
683	USE OF MASONRY			5628	3		Part 3: Materials and components, design and
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			6700			
689	GUIDE FOR STRUCTURAL DESIGN OF PAVEMENTS CONSTRUCTED WITH CLAY OR CONCRETE BLOCK			7533			
690	SEWERAGE			8005	1		Part 1: Guide to new sewerage construction
691	PROTECTION OF STRUCTURES AGAINST WATER FROM THE			8102			
692	DESIGN AND INSTALLATION OF DAMP- PROOF COURSES IN THE MASONRY CONSTRUCTION			8215			
693	CODE OF PRACTICE FOR BUILT-UP FELT ROOFING			8217			

### 3.8 DRAWING PRACTICE, STANDARD SYMBOLS ETC.

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
700	IDENTIFICATION OF PIPELINE ACCORDING TO FLUID	2403					
701	GRAPHICAL SYMBOLS FOR GENERAL ENGINEERING -	2406		1553	1		
701	GRAPHICAL SYMBOLS FOR GENERAL ENGINEERING - PIPING SYSTEMS (CONT.)	2429	1				
702	PROJECT NETWORK TECHNIQUES			4335			
703	DRAWING OFFICE PRACTICE - ARCHITECTS			1192	1-4		BS 1192 Part 2 Obsolescent
704	CONSTRUCTION DRAWING			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
707	BUILDING AND CIVIL ENGINEERING TERMS			6100	1-6		
708	WATER SUPPLY - MAPS AND PLANS	2425	3, 5				
709	CARTOGRAPHIC REPRESENTATION OF CLIMATE	50019	1				
750	CONCRETE (INC. R/F) - GLOSSARY			6100	6.2, 6.3		
751	VALVES - GLOSSARY						
752	IRON AND STEEL - GLOSSARY FOR PIPES			6562	1-2		

### 3.9 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
803	DAMP-PROOF COURSE (BITUMINOUS FELT)			743 (6398: BS 6398, BS 6515 and 6398			BS 743 Partially Replaced by
804	CONCRETE BLOCKS			6073	1, 2	KENYA M.O.W. ST.	
804	CONCRETE BLOCKS (CONT.)			3921			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
808	FIXING BOLTS & SCREENS FOR ROOFING						
809	INSULATION BOARD AND HARD BOARD			1142	1, 2, 3	ISO 7667/9, 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:
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
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
		68763					
		68764					

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
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
815	WOOD WOOL SLABS (CONT. 1)	1102					
816	QUALITY OF TIMBER -	68141		1186	2		
817	MATERIAL FOR FLUSH DOORS	68706		459			BS 459 Part 3 Withdrawn
817	MATERIAL FOR FLUSH DOORS	18101					
817	MATERIAL FOR FLUSH DOORS						
818	WATERPROOF ADHESIVE	53255		1203	TYPE MR		
819	STRUCTURAL STEEL & METALWORK			4360 7316 7668		ISO 630, 6891 BS EN 10029: 1-3 BS EN 10113 BS EN 10155	BS 4360 Withdrawn - Replaced by BS 7316, BS 7668, BS EN 10029 Parts 1 to 3 BS EN 10113, BS EN 10155 and
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	2440		1387		ISO 65, 7/1, 7/2	
823	GALVANISED M.S. TUBING (MILD STEEL) (CONT. 1)	2441		21			
823	GALVANISED M.S. TUBING (MILD STEEL) (CONT. 2)	2442					
823	GALVANISED M.S. TUBING (MILD STEEL) (CONT. 3)	2999	1				
824	FITTINGS TO M.S. TUBING MILD	2460		1256, 143			
824	FITTINGS TO M.S. TUBING MILD			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 (CONT. 1)			416			
829	CAST IRON SOIL, WASTE & VENT PIPES (CONT. 2)						
829	CAST IRON SOIL, WASTE & VENT PIPES (CONT. 3)	19522	1, 2				
830	GALVANISED MILD STEEL COLD WATER TANKS			417	2 CL.A		
831	ENAMELLED CAST IRON BATH			1189			
831	ENAMELLED CAST IRON BATH						
831	ENAMELLED CAST IRON BATH	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 DRAINPIPES AND FITTINGS	19831		3656		BS EN 588-1	BS 3656 Withdrawn Replaced by BS EN 588-1
839	A/C DRAINPIPES AND FITTINGS (CONT. 1)	19841					
839	A/C DRAINPIPES AND FITTINGS (CONT. 2)	19850	1, 2				

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
840	CONCRETE DRAINPIPES	See 409		2870			
841	PITCH FIBRE DRAINPIPES			2760			BS 2760 Withdrawn
842	CAST IRON DRAINPIPES	19500		437		ISO 6594	
		19501					
		19502					
		19503					
		19504					
		19505					
		19506					
		19507					
		19508					
		19509					
		195010					
		195011					
		195014					
195019							
19521							
843	JOINTING COMPOUND FOR C.I. DRAINPIPES			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
		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
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
855	PRECAST CONCRETE KERBS & CHANNELS	483		7263	1		
856	WATERPROOF BUILDING PAPERS	4122		1521			
		52126					
		52127					
		52128					
		52129					
52130							
857	METAL TIES FOR CAVITY WALL			1243			
858	A/C BUILDING PRODUCTS (TESTS)	274	1-4	4624			
859	PRECAST CONCRETE FLAGSTONES	485		7263	1		
860	ASBESTOS CEMENT RAINWATER GOODS	19831	1-9	569			
860	ASBESTOS CEMENT RAINWATER GOODS (CONT.)	19841	1-6				
860	ASBESTOS CEMENT RAINWATER GOODS (CONT.)	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			

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
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 -			144			
873	WASTE TRAPS - PLASTIC			3943			
874	COPPER FLOATS FOR FLOAT OPERATED VALVES			1968			
875	VITREOUS CHINA SANITARY			3402			
876	PAINTS - LEAD BASED			2523 (5082, 5358)			BS 2523 Obsolescent, Partially Replaced by BS 5082 and BS
877	READY MIXED OIL-BASED PRIMING PAINTS			2521/4 (See			
878	READY MIXED OIL-BASED UNDERCOATING AND FINISHING						
879	COLD POURED SEALING MATERIALS FOR CONCRETE			5212			
880	GULLY TOPS AND MANHOLE TOPS FOR VEHICULAR PEDESTRIAN AREAS. DESIGN REQUIREMENTS, TYPE TESTING.					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.			435			
885	CONCRETE ROOFING TILES AND FITTINGS. PRODUCT					BS EN 490	
886	AIR BRICKS AND GRATINGS FOR WALL VENTILATION			493			
887	EAVES GUTTERS AND FITTINGS MADE OF PVC-C					BS EN 607	
888	EAVES GUTTERS AND RAINWATER DOWN-PIPES OF					BS EN 612	
889	PLYWOOD					BS EN 635	
890	TIMBER IN JOINERY					BS EN 942	
891	PRESSED STEEL GUTTERS, RAINWATER PIPES, FITTINGS AND			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:
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			3380			
896	LIGHTWEIGHT AGGREGATES FOR MASONRY UNITS AND STRUCTURAL CONCRETE			3797			
897	TERRAZO TILES			4131			
898	WELDABLE STRUCTURAL STEELS			4360			
899.1	UNPLASTICIZED POLYVINYL CHLORIDE (PVC-U) RAINWATER GOODS AND ACCESSORIES			4576			
899.2	INDUSTRIAL TYPE METAL FLOORING, WALKWAYS AND STAIRS TREADS			4592	1, 2, 3 & 4		Part 1: Open bar gratings Part 2: Expanded metal grating panels Part 3: Cold formed planks Part 4: Glass reinforced
899.3	READY-MIX BUILDING MORTARS			4721			
899.4	INTERNAL AND EXTERNAL WOOD DOORSETS, DOOR LEAVES AND			4787	1		Part 1: Dimensional requirements
899.5	HOT-ROLLED STRUCTURAL STEEL SECTIONS			4848	2 & 4		Part 2: Hot-finished hollow sections
899.6	URINALS			4880	1		Part 1: Stainless steel slab urinals
899.7	MORTAR ADMIXTURES			4887	1 & 2		Part 1: Air-entraining (plasticizing) admixtures



SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
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			
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
899.15	STONE MASONRY			5390			
899.16	SPECIFICATION FOR LOW-RESISTANCE SINGLE TAPS AND COMBINATION TAP ASSEMBLIES SUITABLE FOR OPERATION AT PN 10 MAX. AND A MINIMUM FLOW PRESSURE OF 0.01 MPa (0.1 BAR)			5412			
899.17	VITREOUS CHINA WASHDOWN WC PANS WITH HORIZONTAL OUTLET			5503	1 & 2		Part 1: Connecting dimensions Part 2: Materials, quality, performance and dimensions other than connecting
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			6446			
899.24	POLYETHYLENE DAMP-PROOF COURSES FOR			6515			
899.25	INSTALLATION OF CHMICAL DAMP- PROOF COURSES			6576			
899.26	PORTLAND PULVERIZED-FUEL ASH CEMENTS			6588			
899.27	PRECAST CONCRETE PAVING			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			7263	1 & 2		Part 1: Specification Part 2: Code of practice for
899.30	IN-SITU FLOORINGS			8204	2		Part 2: Concrete wearing

**3.10 ELECTRICAL / MECHANICAL**

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
001	FRACTIONAL HORSE-POWER MOTORS (DIMENSIONS)	42021		2048	1		
002	CURRENT TRANSFORMERS			7626		IEC 60185	
003	VOLTAGE TRANSFORMERS			7625		IEC 60186/186A	
004	CIRCUIT BREAKERS 1 kV A.C.			5311		IEC 60056/267	
005	CIRCUIT BREAKERS A.C. VOLT. OPERATED			842		BS EN 61008-1	
006	CIRCUIT A.C. CURRENT OPERATED			4293		BS IEC 1008-2-2	BS 4293 Partially Replaced by BS EN 61008-1 & BS IEC 1008-
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
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
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
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> )	
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	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
022	MACHINES FOR MISCELLANEOUS			5000	99		
023	INSULATING MATERIALS FOR ELECTRICAL			2757		IEC 85	
024	PCV INSULATED CABLES NOT EXCEEDING 1900	57207	4, 5	6346			
025	ROTATING ELECTRICAL MACHINES - GENERAL			4999	1, 2, 3	IEC 34-1, 34-8, 72,	Renumbered as EN 60034-4
026	CONCRETE CABLE COVERS			2484			BS 2484 Obsolescent
027	ELECTRIC POWER SWITCHGEAR (LOW VOL. N.E. 1kV)	57660		5486 5727 7354			
028	SAFETY ISOLATING			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	See E DIN		4999	32	IEC 60034-1 E DIN	
033	ROTATING ELECTRICAL MACHINES - VIBRATION	See DIN		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	22418		5000	17		
037	MAINTENANCE OF ELECTRICAL SWITCHGEAR			6626			

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
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 60204-1 (1993) but remains current for use as a reference standard for
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
043	DEFINITIONS AND GENERAL					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					IEC 600805	
047	RUBBER INSULATED CABLES					IEC 600245	
048	VOLTAGE FLUCTUATION LIMITS -					IEC 600827	
049	ELECTRIC CABLES - ARMOURING - WIRE FOR					KS 04-290	
050	ROTATING ELECTRICAL MACHINES FOR HARZARDOUS			5000	16		
051	POWER TRANSFORMERS - GENERAL					BS EN 60076-1	
052	ELECTRIC CONDUIT - STEEL			4568	2		
053	BUS BARS			159			
054	NON-METALLIC CONDUITS			4607 (6099)	2		Partially Replaced by BS 6099 Part 1 and BS 6099 Section
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
060	FUSED SPUR BOXES			1362			
061	CONTACTORS			775			Part 1 (1969) Withdrawn Replaced by BS 5424: Part 1
062	SECURITY LIGHTING INSTALLATION					CP 1004	Renumbered as BS 5498
063	ALUMINIUM SOLID CONDUCTORS			3988			

**3.11 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
901	METALLIC ZINC RICH PRIMER			4652			
902	COLOUR OF FINISH (BUILDING MATERIALS)	See VOB		4800		VOB pt. C	
903	HOT DIP GALVANIZING ON IRON &			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
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	30673		4147			
908	BITUMEN - HOT APPLIED - COATINGS FOR IRON AND			5493			
909	PRESSED STEEL RECTANGULAR			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					ISO 885, 888	
914	ISO METRIC BLACK HEXAGONAL BOLTS, SCREWS AND NUTS					ISO 898/2, 898/1	
915	SIZES FOR FERROUS & NON- FERROUS BARS			6722			
916	MECHANITE IRON, GRADE E					ASTM A48, No. 308	
917	CORROSION PROTECTION OF STEEL STRUCTURES - GENERAL	55928	1-9	5493		BS EN ISO 12944	BS 5493 Proposed for Obsolescence Partially Replaced by Parts 1-8 of
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
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					

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
921	ELECTROPLATED COATINGS ON THREADS -			3382	1-6		
922	ELECTROPLATED COATINGS ON THREADS -			3382	7	ISO-DIS 4042	
923	ISO METRIC SCREW THREADS			3643	1-2	ISO 68, 261, 724 965/1, 965/3, 262	
923	ISO METRIC SCREW THREADS					ISO 1106-3,	
924	ISO METRIC PRECISION HEXAGON BOLTS, SCREWS			3692		ISO 887	BS 3692 Obsolescent
925	METAL WASHERS FOR GENERAL ENGINEERING			4320		ASS 2602: 83 2603: 83 - ISO/12	
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					ISO 7752/5	
930	HIGH STRENGTH FRICTION GRIP			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			
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			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
941	BONDING AGENTS FOR USE WITH GYPSUM PLASTERS AND CEMENT			5270	1		Part 1: Polyvinyl acetate (PVAC) emulsion bonding agents for indoor use with
942	FALSEWORK			5975			
943	TUBULAR POLYETHYLENE FILM FOR USE AS A PROTECTIVE SLEEVING FOR BURIED IRON PIPES			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 sheet/plate and strip for general purposes

4.1 **DIN**

DIN	SRN	DIN	SRN	DIN	SRN	DIN	SRN	DIN	SRN
105	806	2000	651	2988	204	4279	405	19630	651
106	806	2403	700	2990	204	4279	602	19648	510
267	914	2406	701	2991	204	4281	845	19800	401
278	805	2410	213	2993	204	4325	017	19850	402
459	119	2413	210	2999	203	4325	016	19850	839
483	855	2413	228	2999	823	7572	832	19850	860
488	128	2425	708	3202	502	7865	138	22418	036
488	127	2425	651	3202	505	8061	305	28500	201
488	126	2429	701	3202	501	8061	314	28500	200
488	125	2440	203	3221	509	8061	313	28601	217
1025	905	2440	823	3230	501	8062	300	28602	218
1025	913	2441	203	3352	501	8062	305	28603	219
1045	108	2441	823	3352	502	8063	301	30670	227
1045	107	2442	203	3352	511	8072	825	30671	215
1045	110	2442	823	3354	506	8073	825	30672	221
1045	120	2444	225	3356	504	8074	825	30673	214
1045	111	2448	213	3357	514	8075	825	30673	908
1045	113	2458	213	3441	515	8528	919	30674	220
1045	112	2460	210	3620	847	8553	919	40050	012
1048	116	2460	213	4030	114	855	919	40050	030
1048	117	2460	824	4032	407	8564	600	42021	001
1060	801	2500	207	4032	409	8565	220	42673	010
1084	115	2501	207	4033	655	1045	100	42673	011
1084	121	2505	216	4034	854	16450	301	42961	029
1084	133	2519	207	4035	409	16451	301	46062	008
1101	815	2526	207	4035	408	16922	814	46062	013
1102	815	2559	210	4046	651	16928	302	50019	709
1164	103	2566	207	4060	222	16963	307	50120	600
1164	106	2605	226	4078	811	16970	304	50120	919
1164	105	2615	226	4085	667	18101	817	50141	927
1164	104	2615	216	4124	654	18195	668	50976	903
1187	862	2616	226	4126	145	18196	601	52128	856
1199	849	2616	216	4226	109	18196	650	52129	856
1211	845	2617	216	4226	110	18203	657	52130	856
1212	845	2617	226	4226	108	18301	822	53255	818
1229	846	2632	207	4226	107	18307	650	55928	900
1230	414	2633	207	4226	130	18330	656	55928	917
1249	822	2673	207	4226	111	18540	812	57207	024
1381	833	2693	208	4226	136	19522	829	57660	027
1387	833	2695	208	4226	114	19532	300	57670	020
1614	920	2696	208	4226	113	19532	305	68705	811
1623	920	2697	208	4226	112	19533	825	68706	817
1624	920	2873	221	4226	135	19593	846	68761	813
1626	213	2950	209	4235	132	19594	846	68763	813
1629	213	2980	204	4271	846	19596	846	68764	813
1754	205	2986	203	4279	202	19597	846	68791	131
1986	652	2987	204	4279	303	19630	653	68792	131

4.2 **BSS**

BSS	SRN	BSS	SRN	BSS	SRN	BSS	SRN	BSS	SRN
4	913	1188	835	2494	308	4466	129	5486	020
12	103	1189	831	2499	137	4483	128	5493	900
12	106	1192	703	2439	122	4504	207	5493	908
12	105	1192	704	2569	900	4514	862	5493	917
21	203	5911	410	2640	937	6811	012	5506	835
21	223	1199	130	2757	023	4550	603	5514	021
21	823	1199	136	2871	206	4568	052	5626	045
5685	014	1200	135	2871	205	4592	850	5642	142
65	414	1203	818	3148	114	4607	054	5669	813
78 (4772)	224	1211 (4772)	200	3284 (6811)	307	4622	200	5685	015
143	824	1212	508	3382	921	4624	401	5728	510
144	872	1212	827	3382	922	4624	858	5834	513
159	053	1217	871	3402	875	4625	408	5856	009
308	705	1243	857	3416	904	4652	901	5886	405
336	512	1244	836	3444	810	4660	309	5911	407
368	859	1247	845	3505	311	4670	938	5911	409
410	146	1254	834	3505	310	4800	902	5911	413
416	829	1256	824	3505	300	4870	670	5911	854
417	830	1363	059	3505	305	4871	671	5927	404
437	844	1369	933	3505	312	4999	030	5930	650
437	842	1377	601	3506	305	4999	033	5977	861
459	817	1387	203	3535	028	4999	034	6004	055
499	919	1362	060	3600	213	4999	031	6072	600
534	210	1387	823	3600	228	4999	010	6073	804
534	212	1438	870	3601	213	4999	029	6100	707
569	860	1449	920	3643	923	4999	025	6100	750
594	934	1521	124	3656	839	5000	011	6180	864
604	150	1521	856	3676	058	5000	022	6231	041
690	807	1553	701	3680	661	5000	036	6263	868
729	903	1554	229	3690	866	5000	035	6282	505
743	803	1564	909	3692	924	5000	050	6297	659
747	936	1579	820	3889	600	5041	517	6316	660
750	509	1707	935	3921	805	5070	706	6346	024
775	061	1722	849	3921	806	5075	149	6367	664
812	107	1740	204	3941	003	5135	919	6398	804
812	112	1740	824	3943	873	5150	502	6431	802
812	113	1881	139	3988	063	5151	503	6464	317
842	005	1881	140	3974	406	5152	504	6500	056
882	108	1881	141	4027	104	5153	505	6510	821
882	109	1881	116	4147	214	5154	511	6626	037
882	110	1881	117	4147	908	5163	501	6722	915
882	111	1924	673	4211	847	5212	879	6746	024
890	801	1968	874	4248	148	5311	004	6925	851
952	822	2011	042	4293	006	5316	016	8007	102
1010	826	2048	001	4320	925	5316	017	8010	316
1010	832	2494	318	4335	702	5328	100	8110	101
1105	815	2521	877	4346	301	5328	115	8110	143
1142	809	2456	828	4395	930	8007	138		
1186	816	2494	222	4449	126	5419	007		

### 4.3 OTHER STANDARDS

OTHER STANDARDS	SRN	OTHER STANDARDS	SRN
AAS 2602:83, 2603:03	926	ISO 2035, 2044	301
AGMA 5T 510	907	ISO 2045, 2048, 2536	301
ANSI A10 9-1983	663	ISO 2063	900
AP15LS	234	ISO 2505, 3114, 3472, 3473, 3474	315
APS 650	928	ISO 2531	202
AS 2813-85	867	ISO 2531	207
ASTM A 47-77	911	ISO 2548 ICE 198	016
ASTM A 48, No. 308	916	ISO 272, 4759-1, 3	914
AWWA C. 508-82	505	ISO 3046, PARTS 1, 2	021
AWWA C.104A, C602-76	211	ISO 3114, 3606	300
AWWA C.200-75	210	ISO 3127	310
AWWA C.200-75	230	ISO 4042	922
AWWA C.203-78	221	ISO 4179, 6600, DVGW W342	211
AWWA C.205 DVGW-W-342-71	212	ISO 4200	228
AWWA C.214-83	232	ISO 4633	222
AWWA C.602-83	212	ISO 49	209
AWWA C.602-89	413	ISO 7/2	203
CP 1004	062	ISO 7005/2, 3	207
CP 112, 2	666	ISO 7-1/2	223
CP 2004	665	ISO 7186	411
CP 2005	658	ISO 7194	662
CP 301	652	ISO 7268	231
CP 310	651	ISO 752	918
CP 312	302	ISO 7751	412
CP 499	848	ISO 7752/5	929
IEC 60072	011	ISO 8493	205
IEC 60072, 72A	010	ISO 881	402
IEC 600805	046	ISO 885, 888	914
IEC 600827	048	ISO 887	925
IEC 60085	023	ISO 898/2, 898/1	914
IEE W. REGS (15 <sup>TH</sup> EDITION)	018	ISO 965/3, 262	923
ISO 1106-3, 7438	924	ISO DIS 4042	921
ISO 1167	306	KENYA M.O.W. STANDARD SPEC.	804
ISO 128, 2162, 2203, 5455, 5457	705	KS 04-290	049
ISO 13	200	KS 05-459:5	606
ISO 160	401	KS 06-149:2	300
ISO 161/1	300	KS 06-248 1, 2	510
ISO 161-1	825	VDB 2	101
ISO 185	906	VDB PART C	902
ISO 1920, 4012, 4108, 4013	117	VDMA 6280	035
ISO 196 (TESTS)	206		