



REPUBLIC OF KENYA



**NORTHERN WATER WORKS
DEVELOPMENT AGENCY**

TENDER DOCUMENT FOR IJARA WATER SUPPLY PROJECT

**CONSTRUCTION OF RUQA IJARA WATER MAIN,
DISTRIBUTION LINES AND ASSOCIATED WORKS**

TENDER NO. NWWDA/T/CW/002/2025-2026-Lot 3

**BIDDING DOCUMENT
VOLUME II**

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**NORTHERN WATER WORKS DEVELOPMENT AGENCY
P. O. BOX 495-70100, GARISSA
MAJI HOUSE, KISMAYU ROAD,
GARISSA TOWN, KENYA**

FEBRUARY 2026

BID DOCUMENT

VOLUME II

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SECTION 1

GENERAL AND SPECIFIC SPECIFICATIONS

GENERAL AND SPECIFIC 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 Organisation (ISO) Standards, DIN, British Standards or other approved applicable Standard in Kenya, unless otherwise specifically stated.

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 Contractor may propose to the Engineer an alternative Standard other than specified, in which case he shall submit six (6) copies of the English translation of the proposed Standard and all other information for the materials, equipment and testing, together with written proof from a recognized Standards Organization that the proposed Standard is equivalent in all significant respects to the Standard specified.

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

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

101. OFFICE AND ACCOMMODATION FOR ENGINEER'S REPRESENTATIVE

The Contractor is required to provide the Office within 10 weeks **and within the 1st week avail the allowance for the provision for Accommodation of the Engineer's Representative from the date of Commencement of Work.** The Contractor to provide suitable rented furnished Office for the Engineer's Representative and his Staff in a location convenient to the Engineer's Representative till the Office mentioned above has been constructed. The Contractor shall make arrangement for Offices to the satisfaction of the Engineer's Representative.

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 and in conformity to National Building By Laws for permanent Buildings.

The Office shall have a floor area of at least 200 square metres, and shall be provided with equipment and furniture detailed under the following clauses. Should the need arise to increase or decrease the floor area of the Office, then a cost adjustment (upwards or downwards) will be made to compensate for the increase or decrease in size of the Office.

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

The floor shall be concrete float finish and shall be at least 200mm above surrounding ground level. 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 vehicles. Details to be submitted with the Bid.

The Resident's Office shall be separate from the Contractor's Yard and shall be situated in a compound fenced with 1.5m chain link fence on cedar posts or precast posts complete with gate including padlock and chain. Hard-standing and access drives (not exceeding 20% of the area of the compound) shall be provided within the compound and constructed with murram or other stable road making materials. The areas so provided shall be shaped to falls to provide adequate drainage and incidental kerbing and outfall drainage shall be provided where necessary, a lean-to corrugated iron shelter shall be provided as covered parking.

All equipment and furnishings detailed under this Clause shall be provided by the Contractor under item for Equipment for Resident Engineer's Office, Item 3.4 of Bill No. 1 – Preliminaries and General. **All the equipment and furnishings will revert to the Employer at the end of the Contract.**

The office shall be provided at all times with an adequate and safe electricity supply with lighting and a minimum of two 13 amp double-sockets in each room. The electrical cabling and switches will be installed using three compartment plastic/ metal trunking. The Contractor shall provide generator backup in order to ensure a continuous supply of electricity. The generator shall be located away from the offices to avoid nuisance from noise and/or diesel fumes. The generator shall be sufficiently sized to allow simultaneous use of all appliances.

The Contractor shall arrange for the provision of telephones (and if necessary extensions) with suitable privacy for conversation for the exclusive use of the Engineer's Representative and his Staff by means of a separate connection to the Telephone Exchange. The Contractor shall include in the sum for provision of the Office Equipment and Furnishings and all charges for installation, maintenance and removal of the telephones. All charges for hiring and telephone calls shall be under Item 3.23 Bill No. 1 – Preliminaries and General. Provision shall also be made by the Contractor for all necessary gas, electricity, kerosene, water, light, attendance and stationery required in connection with execution of the Contract.

The offices shall have telephone and 24-hour Internet connections with hard wired networking between all work stations.

Security Guards shall be provided for day and night security at this Office. The Office, furniture and equipment shall be insured against fire, theft and natural calamity.

The Contractor shall be responsible for maintaining the Resident Engineer's Site Offices throughout the contract period and Defects Liability Period. This shall include, but not be limited to:

- i) Payment for all services including water, electricity, sewerage, Telephone and Internet;
- ii) One dedicated office secretary, English speaking, able to use a computer, do filing, receive and make telephone calls, maintain delivery / receipt registers, organize meetings, maintain office supplies, etc. (Clause 101(c));
- iii) One dedicated Office Assistant / cleaner / kitchen attendant (Clause 101(c));
- iv) 24 hour guarding of the premises;
- v) Maintaining insurance against theft of equipment and other materials from the offices;
- vi) Provide box files, lever files, paper, toner cartridges, pens, CDs, and other office consumables (Clause 101(b));
- vii) Service, maintain / repair office equipment and appliances;
- viii) Provide clean towels in washroom and kitchen, soaps and cleaning agents, and toilet paper for the WC;
- ix) Refreshments

101.(a) PROVISIONS FOR ENGINEER'S REPRESENTATIVE'S OFFICE AND SUB OFFICE

The offices/ kitchenette shall be suitably furnished with the following as minimum requirements (all shall revert to the Client at the end of Project):

<u>Furniture</u>	<u>Quantity</u>
Writing Desk with 3 lockable drawers	3 Nr
2.4m Executive desk with drawers and side desk. Include a chair	1Nr
Conference table with 12Nr chairs	1 set
Writing Desk without Locks	1 Nr
Metal Chairs with arm rests	5 Nr
Plan Chest with 4 lockable drawers suitable for A1 size drawings	1 Nr
Drawing racks suitable for A1 drawings	1 Nr
Lockable Steel Cupboard (Size 1m x 1.8m x 0.5m deep)	3 Nr
Office paper punch	3 Nr
Pin board 2.4m x 1.2m	1 Nr
Office Tray (3 tier)	4 Nr
Office Stapling Machines	4 Nr
Steel File Cabinet with locks / 4 drawers ('Mecol' or equivalent approved)	1 Nr
'Casio' or similar small portable scientific electronic calculator	3 Nr
'Casio' or similar small portable electronic calculator	1 Nr
First Aid kit (for 10 persons) in Metal Box	1 Nr
Potable Fire Extinguisher (5 litres)	2 Nr
Small office scissors	2 Nr
Wastepaper baskets	4 Nr
Electric kettle (capacity to make 6 cups of tea)	1 Nr
Coffee/Tea making facility including crockery for all supervisory staff 6 Nr. And 6 additional guests	1 Nr
Split high wall AC system	1Nr
Pedastal electric fan, size 400mm	3 Nr

<u>Furniture</u>	<u>Quantity</u>
Samsung or equivalent approved Refrigerator (0.2 cu.m. capacity)	1 Nr
Desktop – “HP” or approved equivalent 11 th Generation Intel core i7, 2.5GHz, 1TB SSD, 16GB RAM, DVD R/CD-RW Optical Drive, with 15” Flat Panel Monitor. Windows 11 professional 64 bit and Microsoft Office 2019 or latest Version	1 Nr
Laptop – “HP” or approved equivalent 11 th Generation Intel core i7, 2.5GHz, 1TB SSD, 16GB RAM, Optical Drive, 15.4” Wide Screen, WiFi / 56K Modem, Bluetooth, with Windows 11 professional 64 bit and Microsoft Office 2019 or latest Version	2 Nr
HP LaserJet Printer A4	1 Nr
Printer and Photocopier – RICOH or approved equivalent, A3, 42 pages per minute	1 Nr
Binding machine	1Nr
Petty Cash Box with security lock	1 Nr
Wall Clock	2 Nr
Flashlights (Electric powered)	2 Nr
Digital Camera as specified- Canon EOS R, Specifications- 30.3 Megapixels, Dual Pixel CMOS AF sensor, 8fps continuous shooting, 100-40000 ISO, Wi-Fi and Bluetooth connectivity, USB 3.1 port	3 Nr
Smart Phones 2 No.– Samsung Note 23 or approved equivalent	2Nr
Soap dispenser	1 Nr
Sanitizer dispenser	1 Nr
Electric hand ‘air dryer’ machine	1 Nr

101.(b) MAINTENANCE AND ATTENDANCE TO THE RESIDENT ENGINEER’S OFFICES

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

<u>Stationery</u>	<u>Quantity</u>
Photocopy paper A4	2 Reams
A3 paper	0.5 Reams
Biro pens blue/black	½ Doz.
Clutch Pencils	½ Doz.
Box files	2 Nr
Spring Files	2 Nr
Document Wallets	2 Nr
Embossed (hardback cover)	2 Doz.
Perspex covers	2 Doz.
Cellotape (medium)	1 Nr
Masking tape (medium)	1 Nr
Staples	2 Pac.
Paper clips (various sizes)	2 Pac.
Pencil leads (0.5/0.7)	2 Sets
C-DR (Pack of 12)	1 Pac.

<u>Stationery</u>	<u>Quantity</u>
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 printer	1 Set

In addition, the Contractor to supply clean towels **every day**, soap, lavatory paper, disinfectant and cleaning materials, coffee/tea, milk, sugar, drinking water, etc. is to be provided and maintained throughout the Contract Period, adequate for 6 Supervision Staff and 12 additional guests. The List of Provisions and Consumables to be given by the Resident Engineer every month is tabulated above for which the contractor shall be compensated for against a provisional sum item included in the Bill of Quantities.

The cost of all the above services shall be included by the Contractor under Item 3.7, Bill No. 1 – Preliminaries and General for Maintenance and Attendance for Engineer's Representative's Offices. Apart from the consumables, the rest of equipment will revert to the Employer at the end of the Contract.

101.(c) SECRETARIES AND OFFICE ASSISTANTS

The Contractor shall provide 1Nr. Secretary for the exclusive use of the Resident Engineer for the duration of the Contract. The secretary shall be conversant in English, 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.

101.(d) ACCOMMODATION

The Contractor to make provision for accommodation for the Resident (RE), the Assistant Resident Engineers (AREs), Surveyor and Inspector of Work (IoW)s. All costs in connection with the accommodation, inclusive of the house consumables, consumption and maintenance of water supply, electrical power, house help, etc., shall be borne by the Contractor. The provision of this is made under Bill No. 1 – Preliminaries & General.

101.(e) MAINTENANCE OF VEHICLE

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.

The Contractor shall provide licensed drivers - minimum 10 years of clean driving record, for the exclusive use of and to the satisfaction of the Resident or his authorized representative. The drivers shall be available at all times during normal working hours and when specifically required by the Resident or his authorized representative, outside these hours.

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. The costs for Inspection and Valuation Reports are deemed to be covered in the Contractor's Rates. The vehicles will revert back to the Employer at the end of the Contract.

101.(f) 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.(g) 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.

<u>Equipment</u>	<u>Quantity</u>
Complete GPS surveyor system with receivers and downloading cables (RTK Machine)	1 Nr
Total Station with accessories i.e. 1 tripod, 2 prisms and 2 tracking rods with bubbles.	1 Nr
Level Machine and metallic tripod	1 Nr
1 Levelling stave	1 Nr
Metric extending levelling staffs with vertical bubble	1 Nr
30m (enamelled or otherwise protected) steel bands	1 Nr
3 metre ranging rods	6 Nr
Survey umbrellas with stand	1 Nr
5 metre steel tapes	4 Nr
Builders spirit levels 1000mm long	1 Nr
Hammers 3 kg each	1 Nr

GPS SPECIFICATIONS

Supported GNSS Systems

GPS L2, GLONASS,

RTK performance

DGPS / RTCM, RTK unlimited, Network RTK, Position update & data recording, 5 Hz positioning, 20 Hz positioning

Raw data logging

RINEX logging, NMEA out

Additional features

RTK Reference Station functionality, GSM 111, UHF Radio

TOTAL STATION SPECIFICATIONS

Angle measurement

Distance measurement to prism

Distance measurement to any surface (reflector-less)

Wide-Angle Camera

RS232, USB and SD card interface

Bluetooth

Internal Flash Memory (1GB)

Guide Light (EGL)

Arctic Option

Smart Station GS15 GNSS receiver

Smart Station GS12 GNSS receiver

CS10/CS15 (Radio) field controller

LEVEL MACHINE SPECIFICATION(S)

Leica with accuracies of +/- 0.001

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

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

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 make available such labour, materials, equipment and consumables as the Resident Engineer may require from time to time, for checking the Contractor's setting out and/or survey works.

The cost for provision of the above for use of the Resident Engineer is made under Items 3.6, 3.11 and 3.12, Bill No. 1 – Preliminaries & General.

102. OFFICE FOR CONTRACTOR

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

Notwithstanding anything contained in Clause 1.3 of the General Conditions of Contract, any notice to be given to or served upon the Contractor shall be deemed and taken to be efficiently given or served by the delivery thereof at such office on the site.

103. LEVEL DATUM

Before the commencement of Constructional Work the Contractor shall establish, in a position to the approval of the Engineer, a bench mark 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 bench marks. In cases where such bench marks do not exist, the site datum shall be agreed with the Engineer.

104. 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, centre-lines and base-lines sufficient for the Contractor to locate the Works.

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

For water pipelines, sewers, etc. the Contractor shall in the presence of the Engineer set-out the pipeline alignments in accordance with the indicative alignments shown on the drawings

taking into account physical features on the ground, any existing services, any requirements of relevant Authorities and any changes deemed necessary by the Engineer, confirming the locations of all valves, air valves, washouts, hydrants, bends, manholes, etc.

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

The Contractor shall also be required to carry out Site / Engineering Survey of demarcated land where permanent structures / appurtenances will be constructed as directed by the Engineer after initial clearance of sites. The Contractor shall prepare an updated layout plan with contours at 0.5m interval. The contours shall be generated from a 10x10m grid topographic survey.

105. 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 106. 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 authorised. The Contractor shall be responsible for liaison with Police.

106. 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 Resident.

107. 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.

108. PROTECTION OF WORKS

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

109. 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 authorise 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.

110. 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.

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.

111. 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.

112. REINSTATEMENT OF ROADS AND FOOTWAYS FOR WATER MAINS, STORM WATER AND SEWER CROSSINGS

Water Mains laid under roads shall be of ferrous material.

Sewer Lines laid under roads shall be flexible jointed uPVC or concrete pipes

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 upto 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 liaisons with the Police for traffic control during execution of the works.

113. 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.

114. 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 106.

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.

115. 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. 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.

116. 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.

117. 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.

118. 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.

119. 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.

120. 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.

121. 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.

122. 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.

123. 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.

124. 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.

125. 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 Tender.

126. 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.

127. 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 site of the tips must be approved by the Engineer.

128. 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.

129. MONTHLY SITE MEETINGS

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

130. 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.

131. SUBMISSION OF SAMPLES

Before incorporating in the finished work any materials or articles which he supplies under the terms of the Contract, the Contractor shall submit to the Engineer's Representative for his approval a sample of each respective material or article, and such samples shall be delivered to and kept at his office for reference. All the respective kinds of materials and articles used in and upon the Works, shall be at least equal in quality to the approved samples. Each and every sample shall be a fair average of the bulk material or of the article which it represents. The Engineer's Representative may decide the method by which each sample to be taken from the bulk material shall be obtained.

132. 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.

133. 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. The cost of special tests ordered by the Engineer to be carried out by an independent person at a place other than the site or place of manufacture or fabrication shall be borne by the Contractor.

134. 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.

135. 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.

136. TEST RUNNING OF THE SCHEME

Upon substantial completion of the scheme and official inspection which agrees to this, the Contractor shall operate the entire scheme for the test period indicated in the Bill of Quantities i.e. 1 month (30 calendar days).

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

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

137. EQUIPMENT FOR THE ENGINEER'S REPRESENTATIVE

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 Engineer's Representative and his Staff for the purpose of taking record photographs of the progress of the Works. The Cameras should have picture capture resolution of 20 megapixels or more, both optical and digital zoom capabilities, storage capacity of 8 GB, 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 Engineer's Representative. 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.

138. OPERATION AND MAINTENANCE MANUAL

A draft Operation and Maintenance Manual will be compiled prior to Commencement of Construction of the Works.

This Manual has to be revised and brought to a final draft state prior to the test running of the Scheme. 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 Scheme 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.

139. CONSTRUCTION PROGRAMME

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

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

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

(2) The CPM Network shall be in accordance with commonly accepted practices and shall show graphically the chain of activities / sub-activities and their sequential relationship with each other from the start of construction to the completion of the Contract. The Time Bar-chart Schedule shown in weeks shall list all main activities and its applicable sub-activities.

(3) In preparing the CPM Network and the Time Bar-chart Schedule the Contractor shall make due allowances for possible delays. Under no circumstances shall the CPM

Network or the Time Bar-chart Schedule show a completion in excess of the “Time for Completion” stated in the Form of Bid.

(4) The Programme once approved by the Engineer shall thereafter be referred to as the Contractual Programme. The Engineer’s approval of such programme shall not relieve the Contractor of any of his duties or responsibilities under the Contract.

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

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

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

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

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

140. CONTRACT DOCUMENTS

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

141. AS-BUILT AND RECORD DRAWINGS

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

In addition, the Contractor shall prepare and submit to the Engineer’s Representative “as-built-drawings” of the works, showing all works as executed. The drawings shall be prepared as the works proceed, and shall be submitted to the Engineers Representative for his inspection. The Contractor shall obtain the consent of the Engineers Representative as to their size, the referring system, and other pertinent details.

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

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

2. 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 27 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 top soil has to be excavated this shall be removed and stacked on site. After completion of construction, it shall be spread over the disturbed ground, any surplus being disposed of as directed by the Engineer.

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

202. VEGETATION

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

203. BUSHES AND SMALL TREES

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

204. HEDGES

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

205. FELLING TREES

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

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

206. GRUBBING-UP ROOTS

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

depth, to the same dry density as that of the adjoining soil. For the purpose of measurement, tree roots shall be classified according to the mean diameter of the stump measured across the cut.

207. WEED CONTROL

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

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

3. EXCAVATION

301. DEFINITION AND CLASSIFICATION OF EXCAVATED MATERIALS

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

1) Common Excavation

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

2) Rock

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

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

Class 'A'

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

Class 'B'

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

Class 'C'

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

302. STORAGE AND HANDLING OF EXPLOSIVES AND BLASTING

The removal of hard materials by use of explosives will normally be permitted subject to compliance by the Contractor in all respects with the Explosives Laws of 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 authorised 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 85% of maximum dry density at optimum moisture contents. For excavation under Roads, House Drives and Car Parks the backfilling shall be compacted in 150mm layer to 100% maximum dry density.

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

305. EMBANKMENTS OVER SEWERS

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

306. STONE REVETMENTS (STONE PITCHING)

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

307. TIPPED REFUSE ON SITE

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

308. REMOVAL OF INDUSTRIAL WASTE, ETC.

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

309. LAND SLIPS

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

310. CLASSIFICATION OF MATERIAL FROM SLIPS

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

311. BORROW PITS

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

312. STREAMS, WATERCOURSES AND DITCHES

Excavations carried out in the permanent diversion, enlargement, deepening, or straightening of streams, watercourses, or ditches shall be performed as directed by the Engineer. The rates for such excavations shall include for excavated materials and all pumping, timbering works, and materials necessary for dealing with the flow of water.

313. FILLING OLD WATERCOURSES

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

314. OPEN DITCHES

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

315. CLEARING EXISTING DITCHES

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

316. EXCAVATION FOR FOUNDATIONS BELOW OPEN WATER

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

317. TRENCHES OF GREATER WIDTH AND DEPTH THAN NECESSARY

The Contractor shall not be entitled to payment in respect of excavation to any greater extent, whether horizontally or vertically, than is necessary to receive any structure for which the excavation is intended, except where a separate item is provided for additional excavation for working space, timbering, or other temporary work. Excavation to a greater depth or width

than directed shall be made good with suitable materials to the satisfaction of the Engineer and at the Contractor's cost.

318. SUPPORTS FOR TRENCHES

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

319. PROVISION OF SPOIL HEAPS

The Contractor shall provide spoil heaps at his own expense for the disposal of surplus material and all rubbish collected when clearing the site and during the construction of the works. The sites for these shall be approved by the Engineer.

320. USE OF VIBRATORY COMPACTION PLANT

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

Unless otherwise permitted by the Engineer, the frequency for vibration shall be maintained within the range of amplitude and frequency recommended by the manufacturers of the plant for the material to be compacted. The frequency shall be recorded by a tacheometer 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.

322. SUBMARINE PIPELINE

The Pipeline shall be laid with adequate anchor and lateral support to prevent lateral movement due to currents, waves or ground movement and avoiding long suspended spans. The pipeline may be laid exposed on the sea bed with adequate support or laid in trench. Trenching can be done prior to pipeline lay (pre-trenching), or afterward by seabed removal from below the pipeline (post-trenching). The materials for the pipes and fittings, jointing and concrete works shall be as per Chapter 7 of the Specifications.

The Contractor shall provide a Detailed Method Statement of Pipe Laying, Support, etc. prior to commencement of works for approval by the Engineer.

4. 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.

401. 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 4.1, in which the class designation includes two figures. The first figure is the nominal strength at 28 days expressed in N/mm² 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 4.1 - CONCRETE CLASSES AND STRENGTHS

Class of Concrete	Nominal Strength N/mm ²	Maximum Nominal Size of Aggregate mm	Maximum Water / Cement Ratio		Trial Mixes Target Mean Strength (Clause 401 c) N/mm ²	Early Works Test Cubes (Clause 401 d)	
			A	B		Any one Cube N/mm ²	Average of any Group of 4 Cubes N/mm ²
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 4.2.

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 4.1 but in any case not less than the minimum necessary for impermeability and durability shown in Table 4.2.

- 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 4.1 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 4.2 - MINIMUM CEMENT CONTENT

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

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

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

Moderate exposure	Surface sheltered from severe rain; buried concrete, concrete continuously under water
Intermediate exposure	Surface exposed to driving rain; alternate wetting and drying; traffic; corrosive fumes; heavy condensation
Severe exposure	Surface exposed to sea water, moorland water having a pH of 4.5 or less, groundwater containing sulphates.

c) Trial mixes

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

For each mix of concrete for which the Contractor has proposed a design, he shall prepare three separate batches of concrete using the materials which have been approved for use in the works and the mixing plant which he proposes to use for the Works. The volume of each batch shall be the capacity of the concrete mixer proposed for full production.

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

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

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

The average strength of the nine cubes tested at 28 days shall be not less than the target mean strength shown in Table 4.1.

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

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

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

d) Quality control of concrete production

i) Sampling

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

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

Each sample shall be taken from one batch selected at random and at intervals such that each sample represents not more than 20m³ of concrete unless the Engineer agrees to sampling at less frequent intervals.

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

ii) Testing

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

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

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

For value of 0.9 or more	+0.03
For value of between 0.8 and 0.9	+0.04
For values of 0.8 or less	+0.05

2) The water/cement ratio as estimated from the results of (a) above, determined by samples from any batch shall not vary by more than five per cent from the value established during the trial mixes.

3) The air content of air entrained concrete in any batch shall be within 1.5 units of the required value and the average value of four consecutive measurements shall be within 1.0 unit of the required value, expressed as a percentage of the volume of freshly mixed concrete.

4) Until such time as sufficient test results are available to apply the method of control described in (e) 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 4.1 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 4.1 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 4.3) 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 4.3 - MINIMUM CURRENT MARGIN FOR TEST CUBES

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

Failure to comply with requirements:

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

If more than one cube result in a group of four consecutive results is less than 85% of the nominal strength or if the average strength of the group fails to satisfy the strength requirement then all the batches between those represented by the first and last cubes in the group shall be deemed not to comply with the Specification, and the Contractor shall immediately adjust the mix design subject to the agreement of the Engineer to restore compliance with the Specification. After adjustment of the mix design the Contractor will again be required to comply with sub-clauses 401(b) and 401(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.

402. 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.

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 weights 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.

403. 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.

404. 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 and consistency 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.

405. 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 day's 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 414. 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 pipe line 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 pipe line or any other part.

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

e) Placing procedures

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

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

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

All work shall be completed on each batch of concrete before its initial set commences and thereafter the concrete shall not be disturbed before it has set hard. No concrete that has partially hardened during transit shall be used in the Works and

the transport of concrete from the mixer to the point of placing shall be such that this requirement can be complied with.

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

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

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

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

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

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

f) Interruptions to placing

If concrete placing is interrupted for any reason and the duration of the interruption cannot be forecast or is likely to be prolonged, the Contractor shall immediately take the necessary action to form a construction joint so as to eliminate as far as possible feather edges and sloping top surfaces and shall thoroughly compact the concrete already placed in accordance with Clause 406. All work on the concrete shall be completed while it is still plastic and it shall not thereafter be disturbed until it is hard enough to resist damage. Plant and materials to comply with this requirement shall be readily available at all times during concrete placing.

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

If it becomes possible to resume concrete placing without contravening the Specification and the Engineer consents to a resumption, the new concrete shall be

thoroughly worked in and compacted against the existing concrete so as to eliminate any cold joints.

g) Dimensions of pours

Unless otherwise agreed by the Engineer, pours shall not be more than two metres high and shall as far as possible have a uniform thickness over the plan area of the pour. Concrete shall be placed to the full planned height of all pours except in the circumstances described in sub-clause 405(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.

406. 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.

407. 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 407(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 407(c).

Water used for curing shall be of the same quality as that used for concrete mixing as stated in sub-clause 724(g).

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 409(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.

408. 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 401.

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.

409. 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.

410. 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 4.4 - SURFACE TOLERANCES

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

Notes:

1. Col. A is the maximum allowable value of any sudden change of level in the surface.
2. Col. B is the maximum allowable value of any gradual irregularity of the surface, as indicated by the gap between the surface and a three metre long straight edge or correctly shaped template placed on the surface.
3. Col. C is the maximum allowable value of the difference in level or position between a three metre long straight edge or correctly shaped template placed on the surface and the specified level or position of that surface.

Where dimensional tolerances are given on the drawings or in this Special Specification they shall take precedence over those given in Table 4.4.

411. 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 sub-clause 702(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.

412. 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.

413. 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.

414. CONSTRUCTION JOINTS

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

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

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

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

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

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

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

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

If instructed by the Engineer the surface of the concrete shall be thoroughly brushed with a thin layer of mortar composed of one part of cement to two parts of sand by weight and complying with Clause 411 all as set out in sub-clause 405(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.

415. 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.

416. WATERSTOPS

All references to waterstops include grout stops.

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

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

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

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

Low modulus waterstops shall be of rubber or PVC as described above but shall have an elongation of at least 200 percent at 25 degrees centigrade under a tensile stress of 6 N/mm² and shall allow a joint movement of at least 50mm.

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

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

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

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

Waterstops shall be firmly fixed in the formwork so that they cannot be displaced during concrete placing and shall be completely free of all dirt, grease, oil, etc., before placing

concrete. Where eyelets are provided these shall be fully wired to the reinforcement and be the only means whereby the waterstop is fixed. In no circumstances shall a waterstop be punctured with nails etc. as a means of fixing.

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

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

417. 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.

418. REMEDIAL WORK TO DEFECTIVE SURFACES

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

Defective surfaces shall not be made good by plastering.

Areas of honey combing (of a mild nature) which the Engineer agrees may be repaired shall be cut back to sound concrete or to 75mm whichever is the greater distance. In the case of reinforced concrete the area shall be cut back to at least 25mm clear distance behind the reinforcement or to 75mm, whichever is the greater distance. The cavity shall have sides at right angles to the face of the concrete. After cleaning out with water and compressed air, a thin layer of cement grout shall be brushed on to the concrete surface in the cavity and it shall then be filled immediately with concrete of the same class as the main body but with

aggregate larger than 20mm nominal size removed. A form shall be used against the cavity, provided with a lip to enable concrete to be placed. The form shall be filled to a point above the top edge of the cavity.

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

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

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

419. 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.

420. FIXING REINFORCEMENT

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

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

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

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

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

No splices (laps) shall be made in the reinforcement except where shown on the drawings or agreed by the Engineer. Splice lengths shall be as shown on the drawings.

Reinforcement shall not be welded except where required by the Contract or agreed by the Engineer. If welding is employed, the procedures shall be as set out in SRN 937 for gas welding or SRN 919 for metal arc welding. Full strength butt welds shall only be used for steel complying with SRN 126, and if used on high yield deformed bars complying with SRN 126 the permissible stresses in the vicinity of the weld shall be reduced to those applicable to plain bars complying with that Specification.

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

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

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

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

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

5. FORMWORK

501. 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.

502. CONSTRUCTION OF FORMWORK AND FALSEWORK

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

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

Ground supports shall be properly founded on footings designed to prevent settlement.

Joints in formwork for exposed faces shall, unless otherwise specified, be evenly spaced and horizontal or vertical and shall be continuous or form a regular pattern.

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

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

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

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

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

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

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

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

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

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

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

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

503. 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.

504. 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 5.1 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 5.1, 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 5.1 - MINIMUM PERIODS FOR FORMWORK REMOVAL

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

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 KENYA 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.

505. 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 here under:-

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 thicknessed 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 discolouration 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.

506. TOLERANCES

All parts of formed concrete surfaces shall be in the positions shown on the drawings within the tolerances set out in Table 5.2.

In cases where the drawings call for tolerances other than those given in Table 5.2 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 5.2 - 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

6. MASONRY

601. GENERAL

All masonry work shall be constructed from building stone as specified in Clause 804.

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.

602. 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 mortar 1 to 3 in accordance with Clause 729 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 of Clause 407.

603. CAST STONEWORK

Cast stone shall be as specified in Clause 735. Facing stones shall be brought up in courses to a height not exceeding 1 metre at a time, the concrete backing being then brought up and well incorporated into and round the backs of the stones and the projecting metal ties to ensure a complete bond. The stones shall be bedded and jointed as shown on the drawings.

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

7. MATERIALS

701. 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.

- 1) Wherever possible, samples of pipes and fittings shall be submitted for approval of the Engineer prior to the Contractor obtaining the total requirements.

702. GALVANISED PIPES AND SPECIALS

All piping shall conform to SRN 823 and SRN 903 for “Medium” Piping. The pipes shall be screwed and socketted, coupled or flanged.

All specials shall be of such dimensions as will mate with the piping supplied. Screwdown stopvalves 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.

703. 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.

704. ASBESTOS CEMENT PIPES AND SPECIALS

All piping and bends shall be plain ended suitable for use with flexible couplings and shall comply with the requirements of SRN 401. Fittings shall be of asbestos cement or cast iron complying with requirements of SRN 201, or mild steel complying with SRN 210.

Where possible, fittings shall have plain ends of an external diameter equal to that of the asbestos cement pipes and shall be suitable for use with asbestos cement, cast iron or mild steel mechanical joints. Where compatible external diameters of fittings and pipes cannot be supplied, suitable stepped couplings of approved manufacturer shall be used.

Flexible couplings shall be supplied complete with bolts, nuts, washers and joint rings as may be required. All metal parts of the joints shall be adequately protected with rust-proof paint.

The couplings shall, if required by the Engineer, be protected from corrosion by wrapping with Denso paste and tape or by some similar approved material.

The Contractor shall submit full details of the type of joint and a full description of the method of jointing.

The lengths of piping supplied shall be in accordance with SRN 401.

All pipes and bends supplied shall be certified by the manufacturer to have been tested in accordance with the relevant clauses of Standard Specification.

Unless specified, the pipes, joints and bends shall be coated internally with cement mortar lining complying with SRN 212. This lining should not impart any taste or odour to the water. External protection for pipes, joints and bends to be as specified in SRN 212.

Precautions shall be taken to avoid damage to the pipes and fittings during handling and storing and during laying, all to the satisfaction of the Engineer.

Where ferrules are tapped into the piping, saddles should be used, otherwise service connections can be incorporated by use of suitable long collar joints.

705. STEEL PIPES AND SPECIALS

All piping shall be plain ended unless otherwise specified and suitable for use with flexible mechanical couplings. The grade of steel used shall comply with the requirements of SRN 213.

The pipes shall be welded or seamless and shall conform to SRN 210.

All the pipes shall be internally protected with cement mortar lining in accordance with SRN 212. External protection to be as specified in SRN 241.

All joints shall be of the flexible mechanical type and shall be supplied complete with all bolts, nuts, washers and joint rings as may be required. All metal parts of joints shall be adequately protected with rust-proof paint. The joints shall be protected from corrosion by wrapping with Denso paste and tape or by some similar approved material.

All fittings and specials shall be of such dimensions as will mate up with the piping supplied.

Flanged adaptors shall be pieces suitable for connecting a flanged gate valve etc. to the type of piping supplied and shall be supplied complete with all bolts, nuts, washers and joint rings.

The spigot ends of all Tees shall be suitable for connection to the pipework supplied using the aforementioned flexible mechanical joints. Branches shall be flanged with flanges drilled to NP 16 or NP 25, as specified in the drawings in accordance with SRN 207, unless otherwise detailed.

All flanges on specials shall conform to NP 16 or NP 25, as specified in the drawings in accordance with SRN 207, unless otherwise detailed.

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

706. UNPLASTICISED uPVC PIPES

Unplasticised PVC piping shall be in accordance with SRN 300.

The maximum sustained working pressures to which the pipes and fittings will be subjected is based on water at a temperature of 20 degrees centigrade.

The Contractor shall submit full details of the pipes he intends to supply.

The pipes upto and including 40mm diameter can be of a solvent weld type. The pipe shall be supplied with interchangeable sockets preformed at the factory and of such internal diameter that it takes the plain end of the pipe with the same nominal diameter.

The joint shall sustain the end thrust to which the pipe shall be subjected. The Contractor 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 upto 3 degrees.

The sealing ring shall be of first grade natural rubber and the physical properties of the mix shall meet the requirements of SRN 222.

The Contractor 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 Contractor 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 Contractor 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.

707. G.R.P. PIPES AND SPECIALS

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

708. GATE VALVES

Gate valves shall comply with the requirements of SRN 501.

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

The gate valves shall be double flanged. The dimensions and drilling of flanges shall be in accordance with SRN 207. Flanges shall be machined flat. Flanges shall be NP 16 / NP 25 complying with SRN 207.

Spindles of the gate valves shall be provided with cast iron caps conforming to the requirements as specified under "Valve Caps" in SRN 501 or handwheels if so specified.

The spindles of the gate valves shall be of the non-rising type and screwed so as to close the valves when rotated in a clockwise direction. The direction of closing shall be clearly cast on the valve cap or handwheel.

The gate valves shall be subject to "Closed End Tests" in accordance with the procedure set out in SRN 501.

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

709. 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 cast iron cap conforming to dimensions under "Spindle Cap" in SRN 501.

The spindle of the fire hydrant shall be of the non-rising type and screwed so as to close the hydrant when rotated in a clockwise direction viewed from above. The direction of closing shall be clearly cast on the valve cap.

The flanged outlet of the outlet bend shall have a Bayonet Joint Outlet for a 63mm standpipe. The outlet of the hydrant shall be of the hooked type with hooks 112mm apart.

The outlet shall have a gun metal standpipe seating and be covered by a loose cast iron cap which shall be attached to the hydrant by means of a chain.

Both flanges shall be 63mm drilled to requirements of SRN 207.

The outlet bends shall be subject to a hydrostatic test in accordance with procedure set out in SRN 509 and shall be water-tight against a test pressure of 1.85 Pa. head of water.

710. AIR VALVES

The Contractor shall provide air valves to suit the site on which the main is located and the maximum water pressure specified. The body and cover of air valves shall comply with SRN 906 and SRN 916.

The body, cover, splash cowl and joint support ring of the air valve shall be of mechanite cast iron with flanges drilled to SRN 207.

The internal screwed isolating valve shall have the valve and seating of gun metal, operating screws of bronze, nuts of gun metal, and glands and cap of mechanite.

The large orifice valve shall have a vulcanite covered ball closing on a moulded dexion seat ring. The bush may be in gun metal.

The double orifice type of air valve shall comprise a small and large orifice unit with common connection to the main and screw down isolating valve to permit inspection of the valve. The spindle of the isolating valve shall be screwed so as to close the valve when rotated in a clockwise direction and be provided with a Spindle Cap to dimensions as specified in SRN 501.

Design of the air valves shall be such that the balls do not blow shut under any working or test conditions when large volumes of air are being released.

711. WATER METERS

All water meters upto 50mm size shall be of the rotary piston positive action type with all moving parts composed of non-corrosive material.

75mm diameter and over meters shall be of the inferential helix full flow type.

The body of the 12mm to 25mm size of meter shall be of brass, the larger sizes in cast iron. The external surface of the brass bodies shall be coated with baked enamel and the cast iron bodies shall be painted to suit.

The working chamber of the rotary type meter shall be made of bronze or similar non-corrosive material and the piston shall be in ebonite or similar material.

The working parts of the Helix type meter shall facilitate removal for repair or replacement without removing the meter body from the pipeline. The working parts shall be interchangeable and the working chamber so designed as to be full of water under all conditions of flow.

The dial of the meter shall be of the direct reading type registered in cubic metres with suitable lid locking device.

The capacities of the piston type meter shall not be less than the following amounts per month:-

12mm meter	250 cubic metres
18mm meter	350 cubic metres
25mm meter	600 cubic metres
38mm meter	1100 cubic metres
50mm meter	1700 cubic metres

The Helix type meter shall be capable of continuous working with a head loss not exceeding 300mm at the following rates of flow:-

75mm meter	22.5 cu.m./hr
100mm meter	45 cu.m./hr
150mm meter	90 cu.m./hr

All meters shall be accurate to within $\pm 2\%$ over the range of the meter upwards from the minimum flows given for each size:-

12mm	23 litres/hour
18mm	28 litres/hour
25mm	32 litres/hour
38mm	110 litres/hour
50mm	190 litres/hour
75mm	2.5 cu.m./hr
100mm	2.8 cu.m./hr
150mm	4.5 cu.m./hr

Meters above 150mm diameter should conform to manufacturer's specifications approved by the Engineer.

The 12mm and 18mm sizes shall be guaranteed to register commencing at 5 litres/hour.

The meters shall be tested to a head of not less than 16 bar or as specified.

712. 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.

713. CHECK VALVES (DIRECTIONAL VALVES)

Check valves shall comply with the requirements of SRN 505 with cast iron body and cover, gun metal doors with bronze facing rings and flanged connections in accordance with SRN 207, NP 16.

714. 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.

715. FLANGED JOINTS

All flanges on fittings and pipework where flanged connections are required must comply with the requirements of SRN 207 and drilled to NP 16, unless otherwise specified.

Inspection gaskets for flanged joints shall be rubber reinforced with cotton, 3mm thick and shall be in accordance with SRN 208. Bolts, washers and nuts for flanged joints shall be of mild steel complying with SRN 914.

716. FLEXIBLE JOINTS

All flexible couplings (Viking Johnson or other approved type) shall be supplied complete with rubber gaskets, bolts, nuts and washers. All couplings shall be coated with red oxide primer and bituminous composition suitable for use with potable water.

717. PRESSED STEEL TANKS AND TOWERS

The pressed steel tanks (or similar approved), towers and associated materials and fittings shall comply with SRN 909 and SRN 863.

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

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

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

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

Connections to the tank shall be welded to the outside of the tank plate and drilled and tapped to suit flanges to SRN 207, NP 16 unless otherwise stated.

The cover to the tank shall be of mild steel cambered for external use and adequately supported by rolled steel or pressed steel bearers or trusses.

The tank tower shall be supplied complete with:-

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

The supports to the tank shall consist of steel joints designed to carry imposed load under each transverse joint and the two ends of the tank.

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

Internal surfaces of the tank shall be painted with approved non-toxic primer and non-toxic bituminous paint.

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

718. 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.

719. 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.

720. POLYETHYLENE (PALOTHENE, PEH) PIPES

Polyethylene High Density pipes shall comply with SRN 307 for testing, storage, handling, laying and backfilling. Contractor shall conform to requirement indicated for PVC pipes. Joints shall be required to sustain test pressures similar to which the pipe shall be subjected.

Contractor shall comply with all instructions issued by the manufacturers and shall submit full details of the type, class, dimensions and test pressures of the brass fittings to the Engineer for approval.

721. 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 736 and 419-420. 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 724 and 401-410 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 407.

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 505(C) 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 1/40th of the span. The load shall then be further increased until failure occurs.

If the unit fails to sustain the required load for the prescribed period or if the deflection exceeds the specified amount, the Engineer may order two further tests, and if either of these fail, the batch of units which they represent may be rejected.

722. FILTER MEDIA

The grading of filter media shall be in accordance to the table of gradings shown on drawings.

Filter media must be free from fines which would clog the air spaces, and free from dirt, silt and all foreign matter.

The media shall be delivered in clean vehicles and if stored it shall be placed on a clean and firm surface and if it is liable to be contaminated, protected with sheets. Different sizes of media shall be kept strictly separate.

The uniformity coefficient as indicated in the drawings should be adhered to and Contractor to submit samples and carry out sieve analysis, organic content, friability tests, etc. to the satisfaction of the Engineer. These tests are to be carried out before the media is placed in filters. All costs arising to be borne by the Contractor.

In general, the filter media shall allow the filtration cycle to achieve the following:

- Sedimentation (sieve effect)
- Adsorption

- Absorption;
- Biological action
- Straining.

The filter media shall be suitable for a simultaneous air/water backwash procedure. The filter bed shall be designed and suitable for air/water backwash procedure. The maximum backwash flow rate shall be designed not to exceed 20m/hr to eliminate excessive media loss. The filter control system shall be simple, safe and with reliable controllers and capable of maintaining an adequate head above the media surface. The control system shall incorporate a slow start controller.

The filter area and filter media shall be capable of filtration rate of 7.5m³/m²/hr. The backwash air compressor for the air/water backwash system shall comprise of but not limited to the following:

- Blower main body;
- Inlet muffler (with air filter);
- Public base for motor and blower (including coupling cover);
- Inlet manual butterfly valve;
- Motor;
- Pressure gauge;
- Mounting bolts and connection accessories;
- Check valve;
- Outlet silencer;
- Outlet butterfly valve (manual or electrical);
- Release valve;
- Release silencer;
- Reducer;
- Flexible joint;
- Acoustic enclosure;
- Control cabinet

723. 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.

724. 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 tones 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 Roads, Public Works & Housing or at the Kenya Bureau of Standards or at any other approved laboratory at the rate of one set of tests as shown in SRN 103 for every 200 tonnes, and at monthly intervals thereafter.

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

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

c) Fine Aggregate

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

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

Other properties shall be as set out below:

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

Chlorides soluble in a 10 per cent solution by weight of nitric acid shall not exceed 0.05 per cent by weight expressed as chloride ion when tested as set out in SRN 107, subject also to the further restriction given in the note on total chloride content in sub-clause 724 (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 SO₃, when tested as set out in SRN 601, subject also to the further restriction given in the note on total sulphate content in sub-clause 724 (d).

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

Organic impurities:

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

Test for presence of organic impurities in aggregates:

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

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

d) Coarse aggregate

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

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

Other properties shall be as set out below:-

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

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

• 40mm nominal size and above	2% of dry weight
• 20mm nominal size	5% of dry weight

- 10mm nominal size 15% of dry weight

Chlorides soluble in a 10 per cent solution by weight of nitric acid shall not exceed 0.03 per cent by weight, expressed as chloride ion when tested as set out in SRN 107 but subject also to the further restriction under the note on total chloride content hereunder. Sulphates soluble in a 10 per cent solution by weight of hydrochloric acid shall not exceed 0.4 per cent by weight expressed as SO_3 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 (ASTM), the aggregate shall be non-reactive.

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

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

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

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

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

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

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

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

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

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

NOTE: Total chloride and sulphate content:-

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

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

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

The total sulphate content expressed as SO_3 of all the ingredients in a mix including cement, water and admixtures shall not exceed 0.4 per cent by weight of the aggregate or 4.0 per cent of the weight of cement in the mix, whichever is the lesser.

e) Testing Aggregates

i) Acceptance testing

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

Tests to determine compliance of the aggregates with the requirements of sub-clause 724(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.

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:-

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

725. BUILDING STONE

All building stone shall be capable of withstanding when wet a crushing stress of 3.5 N/sq.mm. The source of stone shall be approved by the Engineer and stone supplied therefrom shall be free from Magadi, overburden, mudstone, cracks, sandholes, veins, laminations or other imperfections.

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

Unless the Engineer allows otherwise the Contractor shall at his own expense provide and dress four 100mm cubes of stone for testing.

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

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

ii) The second criterion of failure shall be amended to allow for a loss of weight of not more than 20% of its original weight.

726. 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%

727. MURRAM

Murram shall be from an approved source quarried so as to exclude vegetable matter, loam, top soil 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.

728. WATER FOR CEMENT TREATED MATERIALS

If water for the works is not available from the Employer's supply the Engineer's approval must be obtained regarding the source of supply and manner of its use. Water to be used with cement or lime shall be free from salt, oil, alkali, organic matter, and other deleterious substances. If the water is required to be tested, this shall be done in accordance with SRN 114 : Tests for Water for Making Concrete, all to the cost of the Contractor.

729. 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.

730. HYDRATED LIME

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

731. CALCIUM CHLORIDE

Calcium chloride shall be of good industrial grade, and shall be obtained from an approved source.

732. 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 729. The constituent materials shall be accurately gauged and mixed in an approved manner.

733. 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 707. 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.

734. 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.

735. 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.

736. REINFORCEMENT FOR CONCRETE

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

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

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

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

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

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

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

Any reinforcement which is likely to remain in storage for a long period shall be protected from the weather 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.

737. 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.

738. 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.

739. PREFORMED JOINT FILLER

Preformed 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.

740. JOINT PRIMER

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

741. JOINT SEALING COMPOUND

Poured joint sealing material shall consist of an approved rubber-bitumen compound, complying with the requirements of SRN 879, or a two component, cold applied compound complying with SRN 879 as stated in the Bill of Quantities. Test Certificates, prepared by an approved testing laboratory, shall be supplied by the Contractor to show that the material does in fact comply in respect of cone penetration, flow and bond with the under-mentioned requirements:

<u>Test Cone Penetration</u>	<u>Hot-poured Materials</u>	<u>Cold-poured Materials</u>
0.15 kg. for 5 secs. at 25° centigrade using standard grease cone	Penetration not to exceed 9mm	Penetration to be not less than 5mm not more than 27.5mm
<u>Flow</u>		
On a plane inclined at 75° to the horizontal, 5 hours at 60° centigrade	Flow not to exceed 5mm	Flow not to exceed 20mm
<u>Bond</u>		
25mm wide joint extended 12mm at rate of 4mm per hour at 18° centigrade. No more than one specimen in three to develop a crack separation or other opening more than 4mm deep	Five cycles of extension and recompression	Three cycles of extension and recompression

Approved hot-poured materials shall also comply with a requirement whereby when heated for a period of 6 hours at a temperature of 80 degrees centigrade above recommended pouring temperature or 30 degrees centigrade below the safe heating temperature whichever is the greater shall still comply with the flow requirements of this clause.

In addition to materials complying with SRN 879, the Engineer may approve the use of alternative materials provided that they meet the requirements of this clause relating to cold-poured joint sealing compounds.

742. CONCRETE PIPES AND SPECIALS

Concrete pipes and specials shall comply with the requirements of SRN 840. They shall carry the relevant Standards Institution registration certification trade mark, or test certificates shall be furnished by the manufacturers.

743. CONCRETE POROUS PIPES

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

744. 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 4.2 using maximum 12mm size aggregates. If required, cube test certificates shall be supplied by the manufacturer.

745. 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 4.2 using maximum 12mm size aggregates. If required, cube test certificates shall be supplied by the manufacturer.

746. AGRICULTURAL TILES AND PIPES

Agricultural tiles and pipes shall be best well-burnt earthenware, true and circular in bore and with an external flat bottom and plain ends suitable for laying with open or butt joints.

747. 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.

748. 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.

749. 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 trade mark, or test certificates shall be furnished by the manufacturer.

750. 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.

751. MANHOLE STEP IRONS

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

752. 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.

753. WATER BARS

Water bars shall be “Dumbell” type and be of natural or synthetic rubber or extruded PVC. They shall be flexible, tough, elastic and durable and of dimensions detailed. They should be unaffected on contact with dilute acids or alkalis. Joints and junctions shall, when possible, be prefabricated by the manufacturer, but if made at site the manufacturer’s instructions including recommended adhesives shall be followed and used. Samples shall be submitted for approval of the Engineer before use of any material.

754. CONCRETE BLOCKS

Solid and hollow concrete blocks for walling shall comply with SRN 904 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.

755. 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 ≥ 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:

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

Diameters: as per EN 12201-2

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

PE 100 (MRS10), $\sigma_{all} = 8.0$ MPa			PN 10.0		PN 16.0	
Outside Diameter (d) (mm)	Tolerance on OD (mm)	Maximum Ovality (mm)	SDR 17 Series 8		SDR 11 Series 5	
			Min. WT (mm)	Tolerance (mm)	Min. WT (mm)	Tolerance (mm)
630.0	3.8	22.1	37.4	3.9	57.2	5.9
710.0	6.4	24.9	42.1	4.4	64.5	6.6
800.0	7.2	28.0	47.4	4.9	72.6	7.4

Performance Characteristics

The pipes shall have the following basic minimum performance characteristics:

Parameter	Unit	Value
Average Density as per ISO 1183	Gm/cm ³	≥ 0.95
Melt Flow Index MFI 190°C / 50N as per ISO 1133	Gm/10 min.	0.4-0.55
Minimum Tensile Strength	N/mm ²	25
Elongation at Break	%	$\geq 600\%$
E-Modulus (Modulus of Elasticity)	N/mm ²	1200
Minimum Radius of Curvature at 20°C		25 x OD
Linear Coefficient of Thermal Expansion (VDE 0304)	°K ⁻¹	1.3×10^{-4}

Marking and Identification

Pipes shall be clearly and indelibly marked to show the following:

- Name of Manufacturer / Brand
- Nominal Diameter x Minimum Wall Thickness
- Material Classification (i.e. PE100)
- Standard Dimension Ratio and Pressure Rating (SDR17 PN10 or SDR11 PN16)
- Reference Standard of Manufacture (e.g. EN 12201)
- Date of Manufacture

Transportation, Storage and Laying of Pipes and Fittings

Before transporting HDPE pressure pipes the loading surface of the vehicle must be cleaned and free from projecting nails, screws or other sharp objects. The bottom layer of all pipes must as far as possible be in contact with the loading surface throughout their entire length and not project beyond it. The pipes must be secured from slipping and shall not be pulled over sharp edges when loading and offloading. Pipes shall not be dragged along the ground.

Pipes, fittings and coils shall be stored in such a way that they are completely protected from direct sunlight. When covered, they must be well ventilated to avoid accumulation of heat and resultant deformation. Transparent coverings shall not be used. The storage location shall be flat and shall, for pipes, support the pipes throughout their length. Stones and sharp objects shall not be present. Pipes shall not be stacked to a height exceeding 1m. The pipes must be

secured at the sides to prevent them from rolling. Contact with harmful materials shall be avoided. As far as possible, coils shall be stored in a horizontal position. The area shall be free of stones and sharp objects. If stored upright they must be secured to avoid tilting.

Prior to laying in trench the bed of the trench must provide support throughout the entire length of the pipe. The pipe shall not be laid directly on cohesive, rocky or stoney soil. Such material shall be over excavated to a depth of not less than 0.1m and shall be removed and replaced by non-cohesive soil or a special pipe support. This shall initially be recompacted and then the surface loosened on the day of and prior to laying.

Pipes supplied in coils and of up to 63mm diameter may be unrolled with the coil in the vertical position. For larger diameters an unwinding device shall be used. A turnstile can be used with the coil laid in a horizontal position on it or with the coil mounted vertically on a slow moving lorry. The pipe shall never be removed from a coil in a spiral manner as this may cause kinking. Should kinking nevertheless occur the Contractor shall cut the pipe on either side of the kink, prepare the ends, and then use an approved joint after laying. All costs of dealing with kinking shall be to the Contractor's expense. A minimum bending 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:** Molded socket fusion fittings are only to be used for joining of HDPE pipe from 1/2 inch to 2" in size. Socket fusion shall be done in accordance with ASTM F 2620 or the fitting manufacturer's recommendations. Socket fusion is the process of fusing pipe to pipe, or pipe to fitting by the use of a male and female end that are heated simultaneously, and pressed together so the outside wall of the male end is fused to the inside wall of the female end. Qualification of the fusion technician shall be demonstrated by evidence of socket fusion training within the past year on the equipment to be utilized on this project. *[Socket fusion is not widely used, and the specifier may decide to prohibit its use]*
- D. Electrofusion:** Electrofusion joining shall be done in accordance with the manufacturers recommended procedure. Other sources of electrofusion joining information are ASTM F 1290. The process of electrofusion requires an electric source, a transformer, commonly called an electrofusion box that has wire leads, a method to read electronically (by laser) or otherwise input the barcode of the fitting, and a fitting that is compatible with the type of electrofusion box used. The electrofusion box must be capable of reading and storing the input parameters and the fusion results for later download to a record file. Qualification of the fusion technician shall be demonstrated

by evidence of electrofusion training within the past year on the equipment to be utilized for this project.

E. Mechanical:

- Mechanical connection of HDPE to auxiliary equipment such as valves, pumps, and fittings shall use mechanical joint adapters and other devices in conformance with AWWA Manual of Practice M55, Chapter 6.
- Mechanical connections on small pipe under 3" are available to connect HDPE pipe to other HDPE pipe, or a fittings, or to a transition to another material. The use of stab-fit style couplings is allowed, along with the use of metallic couplings of brass and other materials. All mechanical and compression fittings shall be recommended by the manufacturer for potable water use. When a compression type or mechanical type of coupling is used, the use of a rigid tubular insert stiffener inside the end of the pipe is recommended.
- Mechanical couplings that wrap around the pipe and act as saddles are made by several manufacturers specifically for HDPE pipe. All such saddles, tapping saddles, couplings, clamps etc. shall be recommended by the manufacturer as being designed for use with HDPE pipe at the pressure class listed in this section.
- Unless specified by the fitting manufacturer, a restraint harness or concrete anchor is recommended with mechanical couplings to prevent pullout.
- Mechanical coupling shall be made by qualified technicians. Qualification of the field technician shall be demonstrated by evidence of mechanical coupling training within the past year. This training shall be on the equipment and pipe components to be utilized for this project.

F. Joint Recording: The critical parameters of each fusion joint, as required by the manufacturer and these specifications, shall be recorded either manually or by an electronic data logging device. All fusion joint data shall be included in the Fusion Technician's joint report.

Testing

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

Cleaning and Disinfecting

- A. Cleaning and disinfecting of potable water systems shall be in accordance with AWWA C651 and AWWA Manual of Practice M55 Chapter 10.
- B. After installation and pressure testing, new water mains should be disinfected according to AWWA C651.

- C. The disinfection chemicals should be limited to less than 12% active chlorine. The duration of the disinfection should not exceed 24 hours.
- D. Upon completion, the system should be thoroughly flushed with fresh water, and retested to verify the disinfectant chlorine level has been reduced to potable drinking water concentrations in all service water tubing and branch lateral pipes.

756. 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 preset for the connection of the electronic controller.

A milling cutter / heating plate support which shall come 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

8. WORKMANSHIP

801. 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.

802. 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.

803. 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.

804. 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.

805. 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.

806. 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.

807. 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 them, 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 809 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 Bench Marks related to the Survey of Kenya Datum shall be provided at such intervals as directed by the Engineer.

808. MAIN LAYING

- a) Mains 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.

809. BACKFILLING OF TRENCH

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

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

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

810. 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.

811. 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.

812. TESTING

- a) The Contractor shall test as long a section of main 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 authorise 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.

813. CLEANING AND STERILISING THE MAIN

- a) When a pipeline is complete and where applicable, has successfully passed the test, it shall be thoroughly washed out, using if possible, an open end. Thereafter it shall be sterilized by being filled with a suitable solution containing not less than 20 ppm of free available chlorine or such other sterilizing agent as the Engineer shall approve. After standing for 24 hours the main shall again be washed out and refilled with mains water prior to the taking of bacteriological samples. The Contractor shall provide all necessary stop-ends, fittings and chemicals for this work.
- b) Emptying and washing out of the pipes shall be done in such a manner as not to damage the trench or cause undue flooding of the vicinity, and the Contractor shall supply and use piping, specials and/or hose as may be necessary to facilitate the flow of water to the nearest drain or watercourse. Water used for washing out and sterilizing may be supplied by the Employer when a suitable supply is available but all expenses should be payable by the Contractor.

Before any section of the main is put into use, 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 tendered 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.

814. 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.

815. TESTING OF WATER RETAINING STRUCTURES

As soon as possible after completion of water retaining structures viz. storage reservoirs etc. they shall be tested for water retention by filling to the normal maximum level with water at a uniform rate of not greater than 2m in 24 hours.

When first filled, the water level should be maintained by adding of further water for a stabilizing period while absorption and antogenous healing take place. This period may be 7 days after which the level of the water surface should be recorded at 24 hour intervals for a test period of 7 days. The structure shall be considered satisfactory if, during this period the total permissible drop in level, after making due allowance for rainfall and evaporation, should not exceed 1/500th of the average water depth of the full tank, 10mm or another specified amount all in accordance with SRN 102. Water used in testing the structures shall be supplied by the Contractor. Sterilization of the structures is to be done as specified by the Engineer and sampling of water carried out similar to Clause 813.

This test shall be carried out before any backfilling has taken place.

In the event of any water retaining structures failing to pass the test, the Contractor shall make good and re-test at his own expense.

816. STERILISATION OF WATER RETAINING STRUCTURES

A strong chlorine solution (about 200 milligrams per litre) shall be sprayed on all interior surfaces of the hydraulic structure. Following this, the structure shall be partially filled with water to a depth of approximately 30 centimetres. During the filling operation, a chlorine water mixture shall be injected by means of a solution feed chlorinating device. The dosage applied to the water shall be sufficient to give a chlorine residual of at least 50 milligrams per litre upon completion of the partial filling operation. Precaution shall be taken to prevent the strong chlorine solution from flowing back into the lines supplying the water. After the partial filling has been completed, sufficient water shall be drained from the lower ends of the appurtenant piping to insure filling the lines with the heavy chlorinated water.

Chlorinated water shall be retained in the hydraulic structure and in the associated piping long enough to destroy all non-spore-forming bacteria and, in any event, for at least 24 hours. After the chlorine-treated water has been retained for the required time, the chlorine residual shall be at least 25 milligrams per litre. All valves shall be operated while the lines are filled with the heavily chlorinated water.

9. TESTING OF MATERIALS AND WORKMANSHIP

901. ENGINEER'S LABORATORY

The Contractor shall provide and maintain for the duration of the contract the Engineer's laboratory as shown in the Book of Drawings and provide all the laboratory equipment and reagents as required by the Engineer. The Contractor shall be paid under appropriate bill items in the Bills of Quantities or as required by the Engineer.

The laboratory shall be sited adjacent to the Resident Engineer's main office and shall revert to the Employer at the end of the contract.

The laboratory shall have piped potable water supply and a continuous electricity supply adequate for lighting and operating the laboratory equipment.

The laboratory shall have a height from floor to ceiling of not less than 2.75 metres and all rooms shall be fitted with electric lighting and power points as instructed by the Engineer's Representative, and each door shall be fitted with a good quality mortise lock and provide with two keys.

Concrete cube curing tanks of adequate size shall also be provided. The concrete cube curing shall have drainage pipes built-in.

The following rooms and facilities shall be provided in the Laboratory: -

(i) Office

This room shall have a total floor area of not less than 9 square metres and a total window area of not less than 2 square meters. The door and windows shall be fitted with fly screens covered with mosquito gauze. The floor shall be of concrete with a float finish. The walls shall be lined and ceiling provided.

A display board of soft board or similar approved material, with a minimum surface area of 3 square metres shall be provided and securely fixed to the wall.

(ii) Main Laboratory

This room shall have a total area of not less than 40 square meters and a total window area of not less than 7 square metres. The external entrance shall be a double door and single doors shall be provided for access to the adjacent offices. The external door and all windows shall be fitted with fly screens covered with mosquito gauze.

The floor shall be of concrete and float finished. Two display boards of soft board or similar approved material, each with minimum area of 3 square metres, shall be securely affixed to the walls as directed by the Engineer's Representative.

The contractor may be directed to pay for stationery or equipment that are foresaid and also pay for servicing and repair of the laboratory equipment being used on the project.

The equipment shall be of approved manufacture, and shall be made available to the Engineer for the Engineer's exclusive use throughout the Contract, not later than three (3)

weeks after the Engineer's order to supply. All equipment shall be ready to use and complete to perform the tests. The equipment shall revert to the Employer on completion of the Contract

Failure by the Contractor to provide or maintain the equipment shall make him responsible to bear all costs that may be incurred as a result of the Engineer's staff using alternative means of testing, including delays in supervision and approval of Works by the Engineer.

Any delays to the Contractor or the Contractor's activities caused by the Engineer being unable to perform laboratory tests due to the contractor's failure to supply and/or maintain the said equipment shall be deemed to have been caused entirely by the Contractor's own actions, and any consequences of such delays shall be interpreted as such.

The payment to comply with this requirement is provided in the Bill of Quantities and ownership of all equipment shall revert to the Employer after the completion of the Works.

902. APPARATUS REQUIRED FOR TESTING ON SITE

Apparatus for testing shall be, if directed by the Engineer, made available on site of the works, for as long a period as required by the Engineer, and regarded as constructional plant. The Contractor to allow for this provision in his rates. The following may be required: -

- a) A set of sieves complying with British Standard 410: Test Sieves, or the following nominal sizes: -

Fine mesh wire cloth 200, 100, 72, 52, 36, 25, 18, 14, 10 and 7.

Medium mesh wire cloth 3mm.

Perforated plate 5mm, 6mm, 9mm, 12mm, 20mm, 38mm, 50mm, 65mm and 75mm.

- b) A suitable balance, a pycnometer and a stove or other approved apparatus for determining the moisture content of the aggregate. The methods of test shall be as described in Part Four of British Standard 812: Sampling and Testing of Mineral Aggregates, Sands and Fillers.

- c) A 200-ml. graduated cylinder in accordance with British Standard 604: Graduate Measuring Cylinders, for the use in the field settling test for clay and fine silt in aggregates.

- d) Two 0.34 kg. graduated clear glass medicine bottles for use in the test of organic impurities in sand.

- e) Apparatus required for testing soils in accordance with British Standard 1377: Methods of Test for Soil Classification and Compaction, and British Standard 1924: Methods of Test for Stabilized Soils.

- f) Apparatus for testing concrete in accordance with British Standard 1881: Methods of Testing Concrete, Parts 1 to 7.

- g) A straight edge 3 metres long and measuring wedge or other approved apparatus for testing the accuracy of surfaces.
- h) Additional testing equipment as stated in the Bill of Quantities or as required by the Engineer.

903. LOAD TESTING OF PIPES

The Engineer may instruct the Contractor to make a Loading Test (Three-Edge Bearing or Sand Bearing) on pipes to be used to construct the sewer. Payment for Load Tests will be entirely in accordance with the General Conditions of Contract.

10. DRAINS, SEWERS AND MANHOLES

1001. 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 authorised 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.

1002. 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.

1003. ROCK CUTTING IN TRENCHES FOR PIPES AND OTHER EXCAVATIONS

Where solid rock is met within trenches and other excavations, 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.

1004. WATER IN TRENCHES FOR PIPELINES AND OTHER EXCAVATIONS

Trenches and other excavations 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.

1005. LAYING AND JOINTING RIGID JOINTED CONCRETE PIPES

Concrete pipes as specified in Clause 742, 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 707 and a fillet of the same worked all round the side. The fillet shall be levelled off and extend for a length of not less than 50mm from the face of the socket.

For 'Ogee' jointed pipes, the joints shall be thoroughly cleaned before laying, and cement mortar, as specified in Clause 707 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 1019.

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

1006. PIPES LAID WITH OPEN JOINTS

O.G. porous concrete pipes as specified in Clause 742 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.

1007. CAST IRON PIPES

Cast iron pipes and special castings, shall be as specified in Clause 703 and 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.

1008. 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.

1009. 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.

1010. 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.

1011. 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 725 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 747 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 749 and Clause 742 shall be laid and bedded in cement mortar 1 to 3 to the required lines and levels, and both sides of the channel pipes shall be benched up with concrete of the appropriate class and finished smooth to the slopes and levels as shown on the drawings or directed by the Engineer. The ends of all pipes shall be neatly built in and finished flush with cement mortar 1 to 3. Where the depth of the invert exceeds 1 metre below the finished surface of the carriageway or the adjacent ground, iron steps as specified in Clause 751 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.

1012. PRECAST CONCRETE MANHOLES

Precast concrete manholes as specified in Clause 749 shall be supplied and laid generally in accordance with Clause 1011 and the drawings.

1013. GULLY CONNECTIONS

Connections from gullies to sewers and surface water drains or ditches shall consist of concrete pipes and fittings as specified in Clause 750 jointed with cement mortar 1 to 3 as specified in Clause 729. All pipes, bends and junctions shall be laid to the lines and levels shown on the drawings or as directed by the Engineer.

1014. 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.

1015. GULLIES

Gullies complete with gratings and with rodding eyes where necessary all as specified in Clause 750 shall be supplied and laid in accordance with the drawings. Where directed by the Engineer, precast concrete gullies shall be laid on and surrounded with 100mm of concrete of the appropriate grade specified in Table 4.2. The concrete surround is to be brought up to the underside of the frame or flush with the top surface as the case may be.

Masonry gullies shall be constructed from 225mm building stone and rendered internally. The rates included in the Bill of Quantities shall include for excavation, provision of all materials, construction, making junctions with connections to main drains, accurate setting of frames to line and level, refilling and disposal of surplus materials. Gullies shall be trapped where leading into foul sewers or into combined foul and surface water sewers.

1016. COMPLETION OF DRAINAGE WORKS

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

1017. 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.

1018. 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 1005 and during the placing of the concrete they shall be adequately supported.

1019. SURROUNDING OR HAUNCHING OF PIPES WITH CONCRETE

Surrounding or haunching of pipes shall be carried out using concrete of the appropriate grade specified in Table 4.2. In carrying out this work the Contractor shall take care to pack the concrete under and around the pipes to ensure even bedding and solidity in the concrete and the concrete shall not be thrown directly on to the pipes. The upper surface of the concrete shall be struck off with a wooden screed or template and neatly finished off. The rates shall include for any formwork that the Contractor requires to use under this item.

1020. INVERT BLOCK AND STONE-PITCHED DRAINS

Precast concrete invert blocks and side slabs shall be formed of concrete of the appropriate grade specified in Table 4.2 to the dimensions shown on the drawings. Each course of side slabs required in the Bill of Quantities shall be interpreted as one complete row of side slabs to one side of the channel concerned. Stone used for channels shall be 225mm x 100mm building stone. Drains should not normally be laid to a radius of curvature less than 10 times the actual width of the drain.

Invert block and stone-pitched drains shall be constructed in the positions and to the levels and dimensions shown on the drawings and laid to true line and even fall. Where underfilling is required it shall be in 100mm maximum thickness layers of compacted murram. 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 murram and be neatly jointed with cement mortar 1 to 3 as the work proceeds. The excavation, murram bedding, providing, laying and jointing invert blocks or stone, backfilling and disposal of surplus shall all be as specified and all in-situ connections shall be in concrete of the appropriate grade specified in Table 4.2.

1021. 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 water-tight.

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.

1022. 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.

1023. 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 1009 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 grove. 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 pen-knife.

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.

1024. WEEP HOLES

Where shown on the Drawings or directed by the Engineer, the Contractor shall cast weep holes into concrete walls. The Contractor shall provide and place plastic pipes of the diameter shown on the Drawings to form weep holes which will be firmly held in position during the placing of the concrete. A 500mm x 500mm square of approved filter fabric shall be placed, central on the weep hole between the concrete wall and backfill material.

1025. DEBRIS SCREENS

Where shown on the Drawings, the Contractor shall fabricate and install debris screens across the full width of the drain channel cross-section. The screens shall be fabricated using galvanised mild steel complying with BS 729. They shall be mounted on R.C. supports and incorporate a safe access platform to facilitate manual clearing of debris as shown on the Drawings.

11. MISCELLANEOUS

1101. GENERAL

The Contractor is referred to the drawings as to the general character of the works and he shall allow in his rates for any extra costs he may consider incurred by reason of the work being in detached positions, in small quantities, difficulty of access or for any other cause. He should also make due allowance for specialist installations taking place during the currency of this contract.

This section of the Specification refers to miscellaneous items. Clauses elsewhere in the Specification shall also be followed where relevant.

1102. BONDING TIES

Bonding ties shall be 75mm wide x 250mm long galvanised 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.

1103. 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.

1104. 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.

1105. 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.

1106. 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%).

1107. 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.

1108. 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%).

1109. 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.

1110. ARCHITRAVES AND STOPS

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

1111. 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.

1112. JOINERY

All exposed joiner's work shall have wrought faces. The prices of all joiner's work shall include for slightly rounded arises.

Where the term 'framing' or 'framed' is made use of, it shall be understood to mean all halvings, dovetails, tenons and hardwood pins and the best-known means of putting the work together.

All framed work shall be put together loosely and stacked under cover where a free current of air can circulate and is not to be wedged and glued until it is required for fixing.

All joinery, when brought on the works, shall be stacked under cover.

The Engineer or his representative, shall have full right of access to the joinery works and power to condemn any work not approved and any approval expressed or implied is not to relieve the Contractor from his responsibility and liability to make good any shrinkage or other defects that may appear after the work is fixed.

All joinery to be painted shall be knotted and primed.

The Contractor shall provide all materials, labour, framing, fixing, etc., nails, screws and everything necessary for the proper execution and completion of the work.

1113. 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 pellating to sub-frames with matching hardwood pellates. Architraves and stops shall be pinned on, heads punched and filled with tinted filler.

1114. 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.

1115. BOLTS AND NUTS

Bolts and nuts shall comply with the relevant requirements of the British Standards as set out below: -

Black Hexagon Bolts, Screws and Nuts	B.S. 4190, Grade 4.6
Metal Washers for General Purpose	B.S. 4320
Black Cup and Countersunk Head Bolts and Screws, with Nuts	B.S. 4993

The items shall preferably have coarse metric threads but items with B.S.W. threads may be used. Bolt lengths shall be sufficient to ensure that nuts are full threaded when tightened in their final position.

1116. 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.

1117. GALVANISED WORK

Iron and steel, where galvanised, 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.

1118. 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 s.
- b) Electric Power Act.
- c) The K.P.&L. Co.'s Bye-Laws.
- d) Relevant current British Standards and Codes of Practice.
- e) All the relevant clauses in this Specification, particularly the clauses in Sections 13 and 14.

PLUMBING INSTALLATION

1119. WATER AUTHORITIES REGULATIONS

The internal plumbing work shall be carried out to the satisfaction of and in accordance with the regulations of the local Water Authority.

1120. RAINWATER INSTALLATIONS

Rainwater installation shall be in grey PVC pipework with 'O' ring joints.

1121. TESTING PLUMBER'S WORK

The plumbing work and sanitary fittings shall be tested at such times as the Engineer's Representative shall direct and to his entire satisfaction. Gutters and rainwater pipes shall be tested with water to satisfy the Engineer's Representative that gutters are to correct falls, pipes are unobstructed and joints are sound.

1122. SETTING OUT

The positions of all pipe runs, including joints and connections, shall be agreed with the Engineer's Representative before work is commenced.

1123. COPPER TUBES AND FITTINGS

Light gauge copper tubes shall comply with B.S. 2871 Part 1, Table X.

Fittings: Fittings and couplings for jointing pipes shall comply with B.S. 864, Part 2 for capillary and compression type A fittings.

Fixing: Tubes shall be fixed clear of walls or soffits with two piece copper spacing clips complying with B.S. 1494 Table 8d, but in metric sizes to suit tubes spaced at not more than 1.2m horizontally and 1.5m vertically for 15mm diameter pipes 2.0m horizontally and 2.5m vertically for 22mm and 28mm diameter pipes.

1124. PLASTIC PIPES, FITTINGS AND ACCESSORIES

uPVC soil and ventilating pipes and fittings shall comply with B.S. 4514. Waste pipes and fittings shall be modified unplasticised polyvinyl chloride (MuPVC). Waste traps shall comply with B.S. 3943. Balloon gratings shall be plastic coated steel wire.

1125. SLEEVES

Where sleeves are required for pipes passing through concrete or blockwork they shall be of galvanised steel heavy gauge tube of sufficient diameter to give a space of 3mm all round the pipe.

1126. PIPEWORK GENERALLY

DOMESTIC MECHANICAL INSTALLATIONS FOR BUILDINGS

Pipes shall be in the maximum lengths possible to avoid unnecessary jointing and fixed to sufficient falls to prevent air locks and to enable the system to be drained down.

i) Pipes

Galvanised Pipes

Galvanised mild steel tubing shall be in accordance with BS EN 10255:2004 as specified in the Bills of Quantities, with screwed and socketed joints.

Fittings for the same shall be galvanised malleable iron to BS EN 10241:2000 joints shall be made with P.T.F.E. tape.

Copper Pipework

Capillary type connectors may be used for copper pipework where installed in continuous runs, and elsewhere approved compression fittings to BS EN 1057:1996 shall be used.

Short right angle bends are to be avoided and normal elbows and bends are to be used where practicable. Sets and bends in copper pipe shall be made by heating and sand filling where necessary. Kinked or flattened bends will be rejected.

PPR Pipework

The pipes and fittings shall comply in all respect with the BS EN 1329 and BS EN 1401 and PPR installation to BS EN 12056 or equivalent DIN 8077 and 8078 and with the Engineer's approval. Pipe jointing shall be by poly-fusion or use of electric coupling at PN 20.

Unplasticized PVC Pipework Above Ground

Unplasticized PVC drainpipes shall comply with BS EN 1329 -1:2000 and bear the BS Kitemark. Jointing of pipes shall be carried out by means of solvent welding or with ring seal expansion joints. The manufacturer's recommended method of joint preparation and fixing shall be followed.

Unplasticized PVC Pipework Below Ground

The pipes and fittings shall comply in all respects with BS 1401:2009 and bear the BS Kitemark. The base of soil and vent stack connection to each of these drains shall be made using a bend with a minimum centre line radius of 150mm.

Black Vulcathene Pipework

The pipes and fittings shall comply in all respects with British Standards (BS EN ISO:9001) and jointing of pipes and fittings shall be carried out in accordance with the manufacturer's instructions and to the approval of the Engineer.

ii) Valves

Valves Generally

- All valves required to be stamped by the appropriate authority.
- Easy clean patterns are to be supplied. Where visible, and where easily accessible, a locking shield type is to be provided.
- Valves should be installed to control each section of the work and as indicated on the Drawings.
- The pattern of all valves to be used must be approved by the Engineer before any orders are placed.
- Stopcocks shall be fitted on all water supplies up to and including 50mm diameter unless otherwise specified. For pipe sizes over 50mm in diameter gate valves shall be installed.
- Drain cocks shall be fitted to all water mains entering the building after the isolating valve, where indicated on the drawings and where necessary for draining of services.
- All must fully conform to the relevant British Standard. Valves of Chinese or Taiwanese origin will not **be considered as acceptable for this Contract**.

a) Stop Cocks

Stopcocks shall comply with BS 1010 and shall be manufactured from bronze or gunmetal.

b) Gate Valves

Bronze-bodied valves shall be cast to BS EN 1982:1999. The bodies shall be of the even thickness throughout, clean and free from scale and flaws.

The gate valves up to and including 80mm shall be as Crane No. D 151 non-rising stem and wedge disc to BS 5154: 1991 with screwed threads to BS 21 taper thread.

Gate valves exceeding 80mm up to 300mm shall be as Glenfield R.S. Gate Valve 3500 series to BS 5163:1986(1991) with flanges to BS 4504:1989 PN 16. The valve is a double flanged cast iron wedge gate valve for water works purposes with Meehanite cast iron body to BS 1561:1997 GR. 14 with rubber covered Meehanite cast iron gate. The stem is to be of forged stainless steel to BS 970 with Meehanite cast iron hand wheel.

c) Drain Cocks

Drain cocks shall be of the packed gland type. Bodies shall be of cast bronze. Plugs shall be tapered and ground into the body to form a tight seal under pressure. Gland flanges shall be bolted to the valve body with steel stud bolts.

Screwed connections shall be BS 21:1985 taper threads; flanged connections shall be BS 10:1962. Cocks shall be suitable for operation by hand switch.

d) Ball Valves

Ball valves supplied for WC Cisterns shall be the plastic diaphragm type with seating to suit the working pressure with plastic float to BS 2456:1990 and suitable for internal overflow unless otherwise specified.

e) Foot Valves

The foot valves shall be as Glenfield check valve no. 5803 to BS 5153: 1974 (1991) incorporating strainer, with flanges to BS 4504:1989 PS 16. The strainer shall be of Meehanite cast iron and the strainer area shall be not less than twice the suction pipe area.

f) Non-Return Valves (Check Valves)

The non-return valves up to and including 80mm diameter shall be as Glenfield no. 5703 conforming to BS 5153: 1974 with flanges to BS 4504:1989 PN 16.

Non -return valves exceeding 80mm diameter and up to 300m diameter shall be as Glenfield no. 5103 conforming to BS 5153:1974 (1991) with flanges to BS 4504:1989 PN 16.

iii) LP G Gas Supplies

General

The gas installation shall be made in accordance with CP 339 and relevant Kenyan Code of Practice and regulations.

a) Pipework and fitting

The gas supply shall be installed in black mild steel pipework to BS 1387. Fittings shall be constructed of a similar material and shall conform to BS 1740.

b) Fittings

Control valves shall be provided where indicated on the Drawings and where required to isolate the gas supplies and shall be manufactured in accordance with BS 1552. Gas governors shall comply with BS EN 88: 1991 and shall be sized to suit the particular items of equipment they are supplying.

c) Testing

The gas pipework and fittings shall be subjected to an air pressure test of twice the working pressure for a period of two hours or for whatever longer time is necessary to complete the section under test. During this time there shall be no fall in pressure.

iv) External Pipe Works, Pipe Laying, Backfilling and Associated Items

Where pipes are laid below ground, the main contractor shall carry out all excavation, back-filling, removal of spoil, and making good as specified and as necessary to complete the installation to the satisfaction of the Engineer.

- The sub-contractor shall include for providing all information and marking out as necessary in good time, so that the main contractor can provide the necessary attendance.
- All pipework shall be installed in a neat and workmanlike manner and be properly aligned throughout.
- Depth of crown of pipe shall not be less than 0.7m and pipes shall be installed with due regard to clearances from other services installed in the area.
- Pipes shall be so arranged as to avoid air pockets, and shall be graded such that the system will vent normally through the installation, or by other approved means.
- Trenches shall be of ample dimensions to permit laying and jointing, and pipes shall be bedded in not less than 75mm of sand or other approved material. Filling of the same material shall be hand packed around the pipe a further 75mm above the crown of the pipe, and the whole shall be well rammed before completion of back-filling, consolidating and making good.

All drainage pipes shall be laid to continuous and even falls and in accordance with the manufacturer's recommendations. The pipe trenches shall not be back-filled before the pipes have been tested and approved by the Architect and the Engineer.

- Following the final back-filling of all trenches, headings and manhole surrounds, the surface of the excavated areas shall be fully reinstated to the approval of the Engineer and Architect.
- All drains below buildings and small roads shall be encased in 150mm thick concrete (1:3:6). On completion, all drains, manholes, etc shall be flushed from end to end with water and left clean and free from obstructions.

v) **Construction of Manholes**

- Manholes shall be watertight and constructed of blockwork 200mm thick on a concrete foundation as shown on the Drawings. Where manholes are likely to receive heavy loads such as roads and access areas, or where they are classed as deep manholes then the blockwork walls shall be reinforced and filled in accordance to the structural engineers Specification. The top of the chamber shall be covered by a reinforced concrete slab with an opening to suit the cover and frame.
- Branch connections to the main drain line shall be made with three-quarter section bends, which will be mounted on top of the half section channel of the main drain line and shall be swept in the direction of the flow.
- The manhole shall be benched up, sloping at 1 in 10 and rendered and trowelled smooth.
- Manhole covers to BS EN 124: 1994 shall be of suitable size to allow complete access, or as indicated on the Drawings.
- Manhole covers should be capable of supporting the traffic indicated by the area in which they are situated, or as shown on Drawings.
- The underside of all foul drainage manhole covers and frames exposed to crude sewage vapours shall be suitably protected at the place of manufacture.
- Keys for the purpose of lifting and locking these covers shall be provided, three sets under this contract.
- Before manhole covers are supplied to site, details of all covers are to be submitted to the Engineer for approval.
- Step irons to BS 1247 shall be provided wherever the depth of the access pit requires, and as shown on Drawings.

- In manholes that may in the future carry liquid containing acid, the trenches/channels shall be formed by uPVC pipe cut in half horizontally and embedded in the manhole benches.
- The neutralising chamber shall be constructed as specified above and as shown on the Drawings full details being agreed.

vi) Gullies

Gullies shall be 100mm PVC trapped type with a 150mm Belfast framed in concrete (1:3:6) of a 100mm minimum thickness, forming a box approximately 300 x 300mm x 100mm above ground. The gullies shall be provided with a light duty cover, to fit in the recess made for this purpose.

vii) Installation of Internal Pipework

All pipework shall be installed in a neat and workmanlike manner, properly supported and aligned throughout.

Prior to erection, all piping, plant and equipment shall be cleaned throughout or blown through with compressed air. Where falls are not shown on the Drawings or stated otherwise in the Specification, pipework shall be installed parallel to the lines of the buildings and as close to the walls, ceilings, columns etc as is practicable. All details shall be approved and shall be clearly indicated on the contractor's detailed Working Drawings.

Before any joint is made, the pipes shall be hung in their supports and adjusted to ensure that the joining faces are parallel and any falls that shall be required achieved without springing the pipe.

All pipes shall be installed with due regard to other services within the ducts, ceiling spaces, or other spaces provided. Branches shall be fitted so as to avoid stresses at the take off point, and to minimise as far as practicable sharp changes in the direction of flow. Pipe ends are to be cut square, be free from burrs and well reamed or filed inside to ensure full bore. The contractor shall ensure that access to all pipework, rodging eyes, etc is readily maintained particularly where such items are installed above false ceilings and similar areas. Full details shall be included in the sub-contractor's detailed Working Drawings.

Screwed piping shall be installed with a sufficient number of unions to facilitate easy removal of valves and fittings and to enable alterations of pipework to be carried out without the need to cut the pipe. It is the sub-contractor duty to suggest the positions and amount of unions to be fitted, but the final decision rests with the Engineer.

Full allowance shall be made for the expansion and contraction of pipework, precautions being taken to ensure that any forces produced by pipe movements are not transmitted to valves, equipment or plant.

The sub-contractor shall pay particular care when supporting all pipework, particularly cast iron pipes, in order to ensure that settlement and building movement do not break the pipe joints.

If nothing else is specified, all pipe supports shall be of robust metal construction galvanised or painted. They shall be so arranged as to permit longitudinal expansion and contraction of the pipework as necessary. Hangers, where used, shall be of the adjustable type, and anchor points shall be installed where necessary. All to be in accordance with

manufacturer's recommendations or where this is not specified then the following maximum spacing will be permitted.

Pipe Nominal Bore (mm)	Horizontal Rums (m)			
	Iron	Copper	uPVC	PPR
15	1.80	1.20	0.30	0.70
20	2.40	1.80	0.35	0.75
32	2.40	1.80	0.38	0.85
40	2.75	2.40	0.43	1.10
50	3.00	2.40	0.45	1.25
65	3.65	3.00	0.65	1.35
80	4.00	3.00	0.67	1.55
100	4.00	3.00	0.75	1.70
150	4.00	3.00	1.00	2.00

The support spacing for vertical runs shall not exceed one and a half times the distances given for the horizontal runs.

Where more than one size of pipe is carried on the same supports, spacing of supports shall be that required for the smallest pipe.

Attachment of supports to masonry shall be by means of approved metal expansion devices. Use of explosive tools will be subject to Site approval by the Architect and Engineer in each case.

Unless otherwise directed, the pipework shall be generally concealed throughout, and no pipework may be exposed without prior approval unless so indicated on the Drawings.

The sub-contractor shall provide all necessary rodding and inspection facilities within the draining system. In positions where stacks pass through the roof, a weather apron shall be provided. The sub-contractor is to fix stacks before roofing is completed, to ensure that stacks do not allow ingress of water to building or duct. Full details shall be agreed with the Architect prior to the commencement of the installation as the Architect must agree details at roof level.

The open end of each stack shall be fitted with a plastic-coated or galvanised steel wire guard.

Where pipes pass through walls and floors, sleeves shall be fitted to allow free axial movement of the pipes. Sleeves shall be of a material compatible with the pipe they protect. Where fitted in visual position the sleeve should be fitted with an end plate, the details to be agreed upon by the Architect and Engineer. In all other cases they shall finish flush with the wall and the open space filled up with approved fire and sound proofed material. Sleeves passing through wetted floors, or walls, and floors below ground shall be of stainless steel and extend 6mm above floor and fitted with approved puddle flanges, or similar type arrangements, to prevent the ingress of moisture. Details shall be agreed.

Note that testing and sterilising of pipework is required as referred to later herein.

viii) Pipe Entry into Buildings

Service pipes shall enter the buildings in the positions shown on the Drawings. Entry shall be by means of sleeves built into the building structure, of ample dimension to permit the installation of the service pipes to move freely. On installation of the pipes, the sleeves shall be sealed both within the building and at the point of entry below ground level for distances of not less than 150mm, to prevent ingress of moisture or vermin. Sealing material shall be by use of bitumen, and the protruding sleeve, must be fitted as specified herein.

ix) Sleeves

Where pipework passes through walls, floors or ceilings a sleeve shall be provided one diameter larger than the diameter of the pipe. The space between is to be packed with mineral wool, to the Engineer's approval.

Where sleeves pass through structural elements (beams, columns structural slabs etc) permission from the structural engineer must be obtained.

All sleeves associated with the same lengths of pipework must align and run true. Particular attention is required on this matter, and failure by the contractor to achieve this will render himself liable to the total costs involved in correcting the position of the sleeves.

x) Floor and Ceiling Plates

Where pipework passes through walls, floors or ceilings, plates shall be secured around the pipe. The plates shall be of stainless steel construction and will serve no other purpose other than to present a neat finish to the exposed installation.

xi) Connections

The sub-contractor shall connect the water supply to all outlets and equipment as scheduled in the Bill of Quantities or shown on the Drawings. Tee's and short radius bends will be permitted in 20mm and 15mm copper where associated with such final connections to equipment and outlets.

Unless otherwise directed, final connections to outlets and sanitary fixtures shall be carried out using copper pipework. Connections to W.C. pans shall be effected by the use of a W.C. connector, gasket and cover, sized to suit pan outlet.

xii) Pipework Lagging

All hot water pipework, except exposed final connections, shall be lagged with an approved mineral or glass fibre sectional insulation. The final lagging thickness shall be commensurate with the pipework and existing installation details.

The required minimum thickness of insulation should be as follows:

<u>Pipe I.D.</u>	<u>Min. Insulation Thickness</u>
15 mm	12.50 mm
20 mm	19.00 mm
25 mm	25.00 mm
32 mm	38.00 mm
40 mm	38.00 mm
50 mm to 150 mm	50.00 mm

All insulation to be covered with aluminium foil, American Cloth and painted with three coats of waterproof paint. Pipework and equipment within boiler house, calorifier room or

external to buildings to be clad with galvanised mild steel or aluminium sheets of minimum 22 gauge thickness.

The insulation shall be fixed to the pipes by means of metal clips at intervals not exceeding 400mm and at bends by continuous binding with copper wire to the extent necessary to provide a neatly formed finish.

xiii) Painting

The sub-contractor shall allow for priming, undercoating, and finishing of all exposed ferrous pipework and equipment to architectural requirements.

Exposed brasswork shall be left polished and all supporting brackets, handles and similar items chromium plated or provided with a permanent bright finish to approval.

xiv) Pressure Tests

a) General

As the installation of pipework proceeds, the various sections shall be tested before they are built in, concealed, or finally connected. The sub-contractor shall advise the Architect and Engineer in writing at least three days in advance of the carrying out of such tests, and such tests shall, if considered necessary by the Engineer, be carried out in his presence.

All tests shall be at the expense of the sub-contractor and it shall be the responsibility of the sub-contractor to make all necessary records of the tests and results and submit these to the Architect and Engineer in the final form agreed.

b) Pressure Pipes

All pipe systems shall be tested hydraulically for a period of one hour to not less than one and a half times the design working pressure.

If preferred, the sub-contractor may test the pipelines in sections. Any such section found to be satisfactory need not be the subject of a further test when the system has been completed, unless specifically requested by the Engineer.

During the test, each branch and joint shall be examined carefully for leaks and any defects revealed shall be made good by the sub-contractor and the section re-tested.

c) Drainage Pipes

A site test shall be carried out on all drainage pipes before concrete haunching or surround is applied. These tests shall be carried out preferably from manhole to manhole.

xv) Sanitary Appliances

The sub-contractor is required supply, install, test and commission the appliances specified elsewhere in accordance with C.P. 305 (1974).

The appliances shall be fixed in the position shown on the drawings or as directed by the Architect or the Engineer.

For all sanitary appliances, the necessary number of supports, brackets, plugs, screws, washers, jointing material, etc shall be provided by the sub-contractor.

Where supports, brackets, etc are screwed to wall or structure rawl-plugs or similar shall be used.

No trap for any appliances whatsoever shall be with less seal than 75 mm.

Fixing shall, if required by the Architect or the Engineer, include for temporarily erecting appliances in the required position of service and discharge pipes, taking down, storing and permanently fixing after completion of wall finishing and connecting to service and discharge pipes.

Care shall be taken at all times, and particularly after fixing, to protect appliances from damage.

Upon completion of the work, all appliances shall be cleaned for plaster, paint, etc and carefully examined for defects.

xvi) Cleaning

The inside of all pipes, valves, tanks and fittings shall be clean, smooth, and free from blisters, loose scale and dirt, when erected.

All lines shall be cleaned after installation and before placing in service.

When pipes are installed all ends shall be suitable plugged until final fixing of fixtures can be carried out. No pieces of cloth or stones will be permitted.

xvii) Sterilisation of Water Supply Systems

All underground water mains and above ground water distribution systems, cisterns, tanks, pumps, etc shall be thoroughly sterilised and flushed out after the completion of all tests and before being fully commissioned for handover.

The sterilisation procedure shall be carried out in accordance with the requirements of BS Code of Practice 310, Clause 409, to the approval of the Architect and Engineer.

xviii) Testing and Commissioning

Before handing over, the sub-contractor shall confirm that the installation has been examined, tested, accepted and approved by the relevant local authorities, is ready for use, that it will operate and can be maintained efficiently.

When handing over, the sub-contractor shall demonstrate to the Employer the methods of operation, limitations, the maintenance requirements and the safety precautions to be observed.

xix) Air Conditioning Installations

The air conditioning units shall be split air-cooled unitary air conditioners comprising outdoor units and indoor units. They indoor units shall mostly be of the cassette type but some floor mounted units, ceiling console units and window type units shall be included.

Each unit shall have centrifugal fans in both the indoor (evaporator) and the outdoor (condensing) units.

Each outdoor unit shall include the compressor, condenser, centrifugal fan and controls. Each indoor unit shall include the evaporator coil, filter and fan. Cassette type indoor units shall include a provision for fresh air intake.

The units shall be capable of inducing a continuous flow of clean fresh air and exhausting stale air at the same time. Other features shall be as follows:

- Efficient draft free cooling and humidity control;
- Whisper quiet in operation;
- Fully automatic microprocessor thermostatic temperature control;
- Robust, protective and corrosion-free construction to ensure long life;
- Finished appearance blending with both internal and external environment;
- Permanent, reliable and cleanable air filter conveniently positioned for easy withdrawal/cleaning;
- Sturdy, reliable controls marked and designed for easy reading and operation.

Each system shall be fully equipped and factory tested and certification shall be produced to this effect. Each of the systems shall be installed as a working unit complete with diffusers/grilles, dampers, silencers, controls and all necessary accessories.

All the air conditioning equipment shall be mounted on suitable anti-vibration mountings with the noise level of the system being kept as low as possible.

The air conditioner shall use a non-ODS refrigerant easily available in the country.

Electrical Works

It shall be the responsibility of others to provide electrical power, including a fused isolator in the vicinity of the air conditioners/fans.

The air conditioning/fan Sub-Contractor shall then be responsible for carrying out all control and electrical wiring between his equipment and in connecting power from the local isolator to his equipment and fittings. The wiring shall be carried out neatly in conduit or trunking to the requirements of IEE regulations.

xx) Fire Hosereel and Portable Extinguishers

The Fire Hose Reels and Portable Fire Extinguishers, shall conform to BS EN 3-10:2009, BS 7863:2009 and BS 5306-8:2001. The Sub-Contractor shall include for all appurtenances and appliances not necessarily called for in this specification or shown on the Contract Drawings, but which are necessary for the successful completion and satisfactory functioning of the equipment.

(i) Water / CO₂ Portable Fire Extinguishers

Portable 9-litre water filled CO₂ cartridge operated portable fire extinguishers shall comply with BS EN 3-7:2007 and BS 7863:2009. Unless manufactured with stainless steel, bodies shall have all internal surfaces completely coated with either lead tin, lead alloy or zinc applied by hot dipping. There shall be no visibly uncoated areas.

The extinguishers shall be clearly marked with the following:

- Method of operation;
- The words 'WATER TYPE' (GAS PRESSURE) in prominent letters;
- Name and address of the manufacturer;
- The nominal charge for the liquid in imperial gallons and litres;
- The liquid level to which the extinguisher is to be charged;
- Instructions for periodical checking;
- The year of manufacture;
- A declaration to the effect that the extinguisher has been tested to a pressure of 350 p.s.i. (24.1 Bar); and
- The number of the British Standard or NFPA/UL-listing/FM-approval;
- The manufacturer's name and identification markings.

(ii) CO2 Gas Portable Fire Extinguishers

Portable carbon dioxide fire extinguishers shall comply with BS EN 3-7:2007 and BS 7863: 2009. The body shall be a seamless steel cylinder manufactured to the latest editions of BS 401, BS 1287 or BS 1288.

The filling ratio shall comply with BS 5355 with valve fittings for compressed gas cylinders to BS 341. Where a hose is fitted, it shall be flexible and have a minimum working pressure of 3000 psi (206.85 bar). The hose is not to be under internal pressure until the extinguisher is operated.

The nozzle shall be manufactured from brass gunmetal, aluminium or stainless steel and may be fitted with a suitable valve for temporarily stopping the discharge if such means are not incorporated in the operating head.

The discharge horn shall be designed and constructed so as to direct the discharge and limit the entrainment of air. It shall be constructed of electrically non-conductive material.

The extinguishers shall be clearly marked with the following:

- Method of operation;
- The words 'CARBON DIOXIDE FIRE EXTINGUISHER' in prominent letters;
- Name and address of the manufacturer;
- The nominal gas content in kg;
- The words 'Recharge immediately after use';
- Instructions for periodical checking;
- The year of manufacture;
- A declaration to the effect that the extinguisher has been tested to a pressure of 350 p.s.i. (24.1 Bar); and
- The number of the British Standard or NFPA/UL-listing/FM-approval;
- The manufacturer's name and identification markings.

(iii) Dry Powder Portable Fire Extinguishers (9kg ABCE Cartridge)

The portable dry powder fire extinguishers shall comply with the latest editions of BS EN 3-7:2007, and BS 7863: 2009. The body shall be constructed of steel not less than the requirements of the latest editions of BS 1446 or Aluminium to BS EN 485, BS EN 515: 1993 BS EN 573, and shall be suitably protected against corrosion.

The dry powder charge shall be non-toxic and retain its free flowing properties under normal storage conditions. Any pressurizing agent used as an expellant shall be in dry state, in particular compressed air.

The discharge tube and gas tube if either is fitted shall be made of steel, brass, copper or other not less suitable materials. Where a hose is provided it shall not exceed 1,060mm and shall be acid and alkali resistant. Provision shall be made for securing the nozzle when not in use.

The extinguishers shall be clearly marked with the following information:

- The words “Dry Powder Fire Extinguishers”;
- Method of operation in prominent letters;
- The working pressure and the weight of the powder charge in kilogram’s;
- Manufacturer’s name or identification mark;
- The words “RECHARGE AFTER USE” if rechargeable type;
- Instructions to regularly check the weight of the pressure container (gas cartridge) or inspect the pressure indicator on stored pressure types when fitted, and remedy any loss indicated by either;
- The year of manufacture;
- The pressure to which the extinguisher was tested;
- The number of the British Standard or NFPA/UL-listed/FM-approval; and
- Appropriate complete instructions for charging the extinguisher shall be clearly marked on the extinguisher or otherwise be supplied with the refill.

(iv) Air Foam Fire Extinguisher

The portable air foam fire extinguishers shall comply with BS 7863:2000, B.S. EN 3-7:2007 and B.S. 381 C .1. The body shall be constructed of steel not less than the requirements of the latest editions of BS 1449 or Aluminium to BS EN 485, BS EN 515: 1993 BS EN 573, and shall be suitably protected against corrosion.

The portable air foam fire extinguishers shall be of 9 litres capacity complete with refills

cartridges and wall fixing brackets.

- The words “Air Foam Fire Extinguishers”;
- Method of operation in prominent letters;
- The working pressure and the weight of the powder charge in kilogram’s;
- Manufacturer’s name or identification mark;
- The words “RECHARGE AFTER USE” if rechargeable type;
- Instructions to regularly check the weight of the pressure container (gas cartridge) or inspect the pressure indicator on stored pressure types when fitted, and remedy any loss indicated by either;
- The year of manufacture;
- The pressure to which the extinguisher was tested;
- The number of the British Standard or NFPA/UL-listed/FM-approval; and
- Appropriate complete instructions for charging the extinguisher shall be clearly marked on the extinguisher or otherwise be supplied with the refill.

(v) Fire Blanket

The fire blanket shall be made from cloth woven with fibreglass or any other fire proof material and to measure 1800 x 1800 mm and shall be fitted with special tapes folded so as to offer instantaneous single action release blanket from storing jacket. It shall be UL/FM approved.

1127. BRASSWORK

Ball Valves: Piston type ball valves shall comply with B.S. 1212, Part 1 for high or low pressure as described. Floats to break feed cisterns shall be copper type complying with B.S. 1968, Class C.

Bib-taps shall comply with B.S. 1010 and shall be of brass with fixed jumpers, chromium plated and colour coded for hot and cold.

Pillar valves shall comply with B.S. 1010 and shall be of brass with fixed jumpers, chromium plated and colour coded for hot and cold.

Stop valves shall comply with B.S. 1010 and shall be of brass with crutch handles.

1128. CISTERNS

Storage cisterns and break feed cisterns shall be galvanised steel cisterns complying with B.S. 417, Grade A.

1129. SANITARY FITTINGS

Sanitary fittings shall be manufactured from glazed vitreous china complying with the requirements of B.S. 3402. They shall be supplied by an approved firm and shall pass the requirements of the local Water Authority.

PLASTERWORK AND OTHER FLOOR, WALL AND CEILING FINISHINGS

1130. GENERAL

All branded materials shall be delivered in the manufacturer's packages bearing the manufacturer's name and the name of the material concerned. Cement, lime, plaster etc., shall be stored separately off the ground in dry conditions. All surfaces shall be properly prepared for plastering, rendering and screeding and brushed or cleaned free from dust and all traces of efflorescence and contamination removed. Concrete surfaces shall be thoroughly cleaned free from all traces of mould oil or other formwork coatings and hacked to provide a key.

Surface to receive plastering, rendering, screeding etc. shall be wetted sufficiently in advance to ensure the correct conditions for adhesion. Undercoats shall be thoroughly scratched to allow for keying and allowed to dry sufficiently before application of further coats. Dubbing out shall be in the same mix as the subsequent coat and shall not exceed 20mm in thickness in one application.

1131. METAL LATHING

Metal lathing shall be light galvanised expanded metal weighing not less than 1.2 kg. per square metre and complying in all other respects with B.S. 1369.

1132. CEMENT

Cement shall be Ordinary Portland Cement and shall comply with KS 02-21. White and/or an equivalent approved coloured cements shall comply with KS 02-21 and shall be obtained from an approved manufacturer.

1133. SANDS

Sand for cement and lime shall comply with B.S. 1199, Table 1 for undercoats and Table 2 for finishing coats. Sand for floor screeds shall comply with B.S. 1199, Table 1.

1134. LIME PUTTY

Lime putty shall be prepared from hydrated lime complying with B.S. 890, Table 2. Hydrated lime shall be added to water, stirred to a creamy consistency and left to mature for at least sixteen hours before use. Alternatively, ready slaked lime may be obtained from an approved manufacturer. The lime putty shall be protected from drying out.

1135. PLASTICISERS

Plasticisers shall be of the resin type and shall be used only with the approval of the Engineer's Representative in accordance with the manufacturer's instructions.

1136. WATER PROOFERS

Water proofers shall be approved integral water proofers and shall be used in accordance with the manufacturer's instructions.

1137. ANGLE AND CASING BEADS AND RENDER STOPS

Galvanised steel angle and casing beads and render stops shall be as manufactured by "Expatmet" or other equal and approved.

TILE WORK

1138. GLAZED CERAMIC WALL TILES

Glazed and eggshell ceramic wall tiles shall comply with B.S. 1218 and shall be of the colours described. Samples of tiles shall be submitted to the Engineer's Representative for approval.

1139. ADHESIVE

Adhesive for fixing wall tiles shall be approved adhesive.

1140. FIXING WALL TILES

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

1141. CERAMIC FLOOR TILES

Ceramic floor tiles shall be fully vitrified clay tiles complying with B.S. 1286 and having a water absorption not exceeding 0.3%.

1142. LAYING FLOOR TILES

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

1143. FIXING METAL LATHING

At junctions of blockwork and concrete where rendering continues over both surfaces a 100mm wide strip of expanded metal lath shall be fixed, centred on the joint.

1144. FINISH

Cement-lime-sand undercoats shall be allowed to dry out thoroughly before a further coat is applied and scratched to provide an adequate key for the next coat. The finishing coat shall be finished with a steel float. A neat cut shall be made with the edge of the trowel through all coats of the wall plaster at junctions with concrete columns and soffits.

1145. INTERNAL RENDERING

The internal rendering on concrete block panels shall be two coat work, total 20mm finished thickness. The undercoat to be 1:1:5 cement, lime putty, sand by volume, 9mm to 12mm thick and scratched for key. The finishing coat to be 1:1:6 cement, lime putty, sand by volume, 6mm to 9mm thick, trowelled smooth. At junctions of panels to concrete columns and beam soffit, finish the rendering with a clean trowel cutting through both coats of rendering.

1146. EXTERNAL RENDERING (TYROLEAN)

The external rendering on concrete blockwork and outer face of in-situ concrete frame shall be two coat work, total 15mm finished thickness. Clean and prepare block and concrete surfaces, shot pin metal lath strip 100mm wide at concrete/blockwork junctions and apply undercoat 10mm finished thickness of 1:1:6 cement, lime putty, sand by volume, floated smooth. The finishing coat shall be approximately 6mm thick off white Culamix Tyrolean open honeycombed texture machine applied to the required thickness by skilled operatives strictly in accordance with the manufacturer's recommendations, manufactured and supplied by Blue Circle Industries Ltd., agents in Kenya, Kencem, P.O. Box 14267, Nairobi, Kenya or other approved alternative. The undercoat surface shall be sound and clean and free from any loose material. All window and door frames shall be protected by suitable masking.

1147. EXPANSION JOINTS

Expansion joints in clay ceramic tile flooring shall be 6mm wide x 50mm deep, unless otherwise described, formed with 6mm wide x 38mm deep butyl rubber or other equal and approved compressible strip pointed with 6mm wide x 12mm deep polysulphide compound to match colour of tiling. All surfaces of concrete or screed in contact with the butyl rubber shall be primed.

Expansion joints shall be formed at perimeters and at not less than 4.5 metre centres both ways in the tiled areas.

1148. PREPARATION

Concrete floors to receive screeds shall be raked where necessary to remove concrete, plaster or mortar droppings and well brushed to remove all loose particles and dirt. Concrete floors shall be well wetted before the screeds are laid.

PAINTING AND DECORATING

1149. PAINT AND PAINTING

All paint, including primers, undercoats and finishings, polish, emulsion etc., to be used shall be obtained ready for use from the manufacturer approved by the Engineer.

The Contractor shall order direct from the manufacturer and only fresh paint will be allowed to be used.

All paints shall be of the qualities, i.e. exterior, interior etc., types and colours scheduled. All coats of paint system shall be obtained from the same manufacturer, shall be ordered for use together and as far as practicable, shall be ordered on one order in sufficient

quantity for the whole of the work, particularly in the case of the finishing colour. Where more than one of the three systems (gloss, semi-gloss or flat) is in use, these paints shall be used in strict accordance with their accompanying printed instructions.

The Contractor shall use only paints delivered to the site in original sealed containers, not exceeding five litre capacity, stamped and bearing the manufacturer's name of mark, the specification number, method of application (e.g. brushing) colour, quantity, batch number and date of manufacture, and expiry.

Contractor's stocks shall not be accepted unless expressly approved by the Engineer's Representative.

The paint, which will be subject to sampling and testing, shall be used exactly as received, after adequate stirring, without the addition of thinners, driers, or adulterating materials of any kind.

All tints and shades (including colours of undercoats) shall be selected and approved by the Engineer's Representative and the Contractor shall allow in his prices for executing the painting work in colour schemes, to be prepared from a wide range of colours.

All paints described as oil paint shall be alkyd paint.

No painting on exterior work shall be carried out in wet weather or upon surfaces which are not thoroughly dry. Painting shall not proceed in dusty conditions. Each coat of paint shall be thoroughly dry and shall be rubbed down with glass paper before a subsequent coat is applied. Adequate care must be taken to protect surfaces of paintwork, still wet.

Lead based priming paints for steelwork shall conform to B.S. 2521 and 2523.

1150. PREPARATION

Copper pipes shall be washed with soap and water, roughened with abrasive paper and washed with white spirit.

Metalwork - remove all scale from unprimed iron and steelwork, degrease using proprietary solution compatible with paint finish, remove all dirt and rust by brushing with a steel wire brush. Clean all steel delivered primed, of dirt and dust and touch up any damage to primed surfaces in transit or erection.

Hardwood - rub down and brush off all dirt and dust, stop any holes or other imperfections with stopping tinted to match pigment finish.

1151. PROTECTIVE DECORATIVE FINISH

The protective decorative finish on hardwood joinery shall be PX65 (Pinotex) and Holdex as manufactured and supplied by Sadolins Paints (E.A.), or other equal and approved finish.

External frames and doors shall be treated with two coats PX65 (Pinotex) Pigmented before fixing and one coat PX65 (Pinotex) Top Coat after fixing.

Internal frames and doors shall be treated with two coats PX65 (Pinotex) Pigmented before fixing and one coat after fixing and finished with two coats of Holdex, Silk Matt Interior Lacquer.

Application shall be strictly in accordance with the manufacturer's recommendations. Not more than three months should separate the initial (before fixing) and final (after fixing) coats.

1152. RENDERED PANELS

The internal rendered blockwork panels shall be painted with two coats Sandtex Matt resin- based surface coating or other equal and approved coating.

Rendered wall surface shall be cleaned down and Sandtex coats laid on by brush or roller in accordance with the manufacturer's recommendations. Spraying wall surfaces will not be allowed.

1153. IRONMONGERY FURNITURE

The rates for painting shall include for taking down and refixing ironmongery furniture, kicking plates etc., as necessary.

ROADS AND FOOTPATHS

1154. PREPARATION OF ROAD FORMATION

After excavation or filling has been completed the road formation shall be shaped to the required contour and compacted with an 8 - 10 tonne roller.

If any soft places develop in the formation during compaction they shall be excavated to such depths as the Engineer may direct, refilled with hardcore or other approved granular material, levelled and re-compacted before the sub-base is laid.

1155. MURRAM SUB-BASE

The murram sub-base will be constructed only in poor soil conditions where directed by the Engineer. The murram shall be from an approved source quarried so as to exclude vegetable matter, loam, topsoil or clay. The California Bearing Ratio (C.B.R.) of the murram, as determined for a sample compacted to maximum density as defined under B.S. 1377 and allowed to soak in water for four days, shall not be less than 30. This C.B.R. is a guide to quality only and the compaction in the work will be judged by density.

The murram sub-base shall be of the thickness as shown on drawings or stated in the Bill of Quantities.

The sub-base shall be evenly spread and compacted using an 8-10 tonne roller for road construction and a 2-4 tonne roller for footpath construction. The Contractor will be required to maintain the selected material at its optimum moisture content to achieve maximum compaction. The roads and footpaths shall be finished to the grades and levels shown on the drawings.

1156. WATER-BOUND MACADAM BASE

The base shall consist of crushed building stone mechanically laid in one or more separate layers, so as to give a total compacted thickness as shown on the drawings, or stated in the

Bill of Quantities. The first layer shall be placed to produce a thickness of 75mm to 150mm after compaction as specified. Where a greater thickness than 150mm of base is specified the material shall be laid in separate layers each not less than 75mm or more than 150mm in thickness after compaction.

The stone shall have the following gradings:-

<u>B.S. Sieve Size</u>	<u>% by Weight Passing</u>
5 in. (125mm) ring	100
3 in. (75mm)	25 - 80
1.5 in. (38mm)	0 - 20
3/4 in. (20mm)	0 - 5

Alternatively, a stone base may be placed by hand. In this case the first stones in each layer, which shall be of a cubical nature, shall be placed to the approximate height of the layer. When an area has been covered in this way a second placing of stones of smaller size shall be positioned by eye in the spaces between these first placed, and wedged home by hammering. A third placing of stones shall follow the second and so on until in the opinion of the Engineer the voids are sufficiently filled to permit compaction.

Thorough watering shall be carried out at all stages of compaction. Initial compaction shall be with a light roller. The surface shall then be blinded with quarry dust so as to fill the interstices completely and again rolled, this time using a heavy roller. The base shall then be well watered and brushed and permitted to dry. Further rolling with a heavy roller, blinding with quarry dust, watering and brushing shall be carried on until the whole presents a homogeneous surface and no movement is visible under the action of the heavy roller. On completion of the base, and before any surfacing is laid, the finishing surface shall be maintained free from potholes, ruts and undulations, irregularities, depressions, loose material or other defects, and shall remain true to cross-section, line and level.

1157. ROLLED ASPHALT HOT PROCESS WEARING COURSE

Rolled asphalt wearing course shall be made and laid in accordance with British Standard 594 : Rolled Asphalt (Hot Process) and the thickness after compaction shall be as shown on the drawings or stated in the Bill of Quantities. Except where impracticable, the rolled asphalt shall be laid using an approved paver.

Where a base course has been used as part of the surfacing, the wearing course shall be laid thereon as soon as practicable, care being taken that the latter is thoroughly clean. In any case the wearing course should be laid within 3 days of the laying of the base course, unless the Engineer allows otherwise, and no construction or other traffic shall be allowed on the base course.

1158. BITUMEN MACADAM WEARING COURSE

Bitumen macadam wearing course shall be made and laid in accordance with British Standard 1621 : Bitumen Macadam with Crushed Rock or Slag Aggregate, using the appropriate Table and Section(s) thereof, other than those for Dense Bitumen Macadam, and nominal size of aggregate all as shown on the drawings or stated in the Bill of Quantities. Except where impracticable the bitumen macadam shall be laid using an approved paver. The maximum mixing temperature for straight run bitumen of penetration 85-100 is 155 degrees centigrade. For other penetration bitumens the mixing temperature shall be as determined by the Engineer.

1159. COMPACTION AND SURFACE FINISH

As soon as rolling can be effected without causing undue displacement of the material, and while the material is above the minimum temperature stated in Table 6.3, it shall be uniformly compacted by an 8-10 tonne roller having a width of roll not less than 18 inches.

1160. PREPARATION OF THE BASE FOR SURFACING OR SURFACE DRESSING

Before any binder or coating material is applied to a base the latter shall have been freed from all extraneous material by brushing with mechanical sweepers or stiff brooms.

Macadam or murram bases shall normally receive a priming coat in accordance with the following clause.

Concrete, bitumen bound or rolled asphalt bases shall normally receive a tack coat in accordance with the following clause.

1161. PRIME COAT AND TACK COAT

When a base is to be sealed before surfacing by means of a prime coat, the surface shall first be prepared in accordance with the preceding clause.

Unless otherwise stated in the Bill of Quantities or ordered by the Engineer, the prime coat material shall be bitumen grade M.C.O. at a rate of application of 1.2-1.5 lit./sq.m. It shall be applied with a mechanical bitumen distributor complying with the requirements of British Standard 1707 : Binder Distributors for Road Surface Dressing.

The prime coat shall be cured for 48 hours. This period may be relaxed at the discretion of the Engineer who shall be informed and shall give his consent before any surfacing works are commenced.

The Contractor shall not permit traffic to run on a prime coat. Where this is unavoidable the Engineer shall order an application of medium sand at a rate of 6 kg./sq.m. which item shall be measured and paid for separately.

Where adhesion on an existing surface is to be improved before surfacing by means of a tack coat, the surface shall first be prepared in accordance with the preceding clause.

Unless otherwise stated in the Bill of Quantities or ordered by the Engineer, the tack coat material shall be approved bitumen emulsion in accordance with British Standard 434 : Bitumen Road Emulsion containing not less than 55% of bitumen. It shall be mechanically applied at a rate of 0.38 - 0.43 lit./sq.m.

The tack coat shall be allowed to cure to a tacky condition and the Engineer's consent obtained before any surfacing works are commenced. Any ponding which has occurred must be brushed out to bring the coverage within the limits specified.

The Contractor shall not permit traffic under any circumstances to run on a tack coat.

1162. ROLLING OF SURFACE MATERIALS

The type and weight of roller to be employed on each course of surfacing shall be approved before hand by the Engineer. Notwithstanding this, the Engineer may call for a certified weighbridge ticket in respect of any roller at any time.

Roller wheels shall always be clean and even. An adequate water tank shall be provided together with a fully operating roller sprinkler system. The roller shall be operated by a person fully trained and experienced in rolling technique.

Rolling shall be generally carried out in a longitudinal direction, working from the edge of the carriageway to the crown or, in the case of a superelevated carriageway, from the low to the high side. The second pass should be precisely on the path of the first, before the roller shifts transversely. Heavy drive wheels should approach the freshly laid material. Reversing should be carried out slowly and smoothly and the reversing points staggered across the carriageway to avoid any wave effect. Rolling should be continued until all rollmarks are eliminated and there is no perceptible movement under the roller wheels.

Idle standing on freshly laid material is not permitted.

If the total surfacing to be compacted exceeds 3,300 sq.m. per day, the Contractor shall provide a second roller.

In confined areas where normal rolling is not possible, mechanical tamping will be permitted. The tampers must be employed systematically to give a smooth "as-rolled" finish.

No traffic will be permitted on a surfacing course until it has been compacted and in the opinion of the Engineer has acquired a sufficient set.

1163. TRAFFIC ON NEWLY CONSTRUCTED ROADS

The Contractor will not be permitted to use a new carriageway at any stage of construction without the written permission of the Engineer's Representative.

Notwithstanding any conditions which the Engineer's Representative may stipulate at the time of giving his permission, the Contractor will be solely responsible for maintaining the new carriageway, keeping the surface clean and for making good at his own expense any damage or wear so caused.

1164. LAYING KERBS, CHANNELS AND EDGING BLOCKS

Kerbs, channels and edging blocks shall be bedded true to line and level in cement mortar on a concrete foundation Grade 15. They shall be haunched with concrete Grade 15. The foundation and haunch shall be laid before the approved sub-base is laid to the dimensions shown on the drawings.

1165. CONCRETE BLOCK PAVINGS

The precast concrete blocks have to be manufactured to the following requirements:-

- i) Depth of block to be 60mm and 80mm.

- ii) The concrete used shall have a maximum aggregate size of 20mm, high workability, and shall be designed to have a 20 day characteristic cube strength of 45 N/sq.mm.
- iii) To ensure that the surface does not polish but retains a micro texture to give good low speed skidding resistance, sands containing more than 25% acid soluble material must not be used.
- iv) To ensure interlock between blocks, they must be manufactured to accurate dimensions, which allows them to be laid with only small spaces between the joints. When laid, the spaces between blocks should not exceed 2 to 3mm.

1166. LAYING OF BLOCKS

The blocks should be laid in such a way so as to develop interlock. The surface course comprises closely fitting paving blocks, the spaces between them being filled with dust and sand particles.

The finished surface level shall be within 5mm of the design level. The maximum deformation within the completed surface measured by a 3m straight edge placed parallel to the centre line of the road in parts of the carriageway where vertical curves necessitate a greater deviation.

The level of any two adjacent blocks should not deviate by more than 2mm.

1167. LAYING COURSE

The laying course shall consist of 40mm sand as specified containing not more than 3% of silt and clay by weight, and, with no more than 10% retained on a 5mm sieve. It is spread to give a thickness when compacted of 40mm. The profile of the uncompacted sand should be similar to that of the final surface. The required thickness of uncompacted sand forming the laying course will depend upon its moisture content grading, and degree of pre-compaction. The laying course sand needs to be spread to a greater depth than the target compacted depth of 40mm. The amount of surcharge will be of the order of 10 to 15mm but the exact value is best determined by trial. To avoid any need to adjust the surcharge during construction, it is helpful to keep the sand grading and moisture content sensibly constant.

Once spread the sand should be screed smooth to level. For roads less than 4.5m wide, the kerbs may be used as screeding guides, but on wide pavements, it is necessary to set temporary screed rails for striking off the laying course. During spreading and screeding, operatives must not stand in the sand, otherwise uneven pre-compaction will occur causing irregularities in the final road surface. To minimise the risk of disturbance, it is advisable to avoid screeding sand long distances in front of the block laying face.

1168. CUTTING BLOCKS

Awkward shapes at edges or obstructions, like gulleys manholes are filled by cutting blocks with a block splitter or by using a bolster chisel and hammer.

1169. VIBRATION

When the laying of concrete blocks has been completed, then blocks should be vibrated with a plate vibrator. The vibrator should have a centrifugal force of 0.35 to 0.50 sq.m. A frequency of 75 to 100 Hz is recommended.

The required number of passes of the plate depends upon a variety of factors and is best determined by site trial. It should be sufficient to provide an even riding surface and prevent vehicles from causing further compaction. Normally two or three passes will suffice. Vibration should not be carried out within about 1m of unrestricted blocks; on the other hand, as little surface course as possible should be left unvibrated overnight.

Finally, sand should be brushed over the surface and two or three further passes of the vibrator made, to complete interlock and fill the joints.

As soon as vibration has been completed, the road can be used.

1170. PREPARATION OF FOOTPATH FORMATION

After the excavation of filling has been completed as specified the footpath formation shall be regulated to an even and uniform surface, and compacted with a roller weighing not less than 2.5 tonnes.

If any soft places develop in the formation during compaction they shall be excavated and backfilled with approved granular material, levelled and re-compacted.

1171. PRECAST CONCRETE PAVING

Precast concrete paving slabs shall be to B.S. 368 : 1971 and shall be laid with 1:3 lime mortar using five pats not less than 150mm diameter for each slab. They shall be laid at a level not exceeding 4mm above the top of the kerb or concrete edging. The joints shall be thoroughly cleaned out and grouted with cement mortar well brushed in and flushed off. No cracked or broken slabs shall be used.

1172. CHASING

Chasing in load-bearing walling for pipes, etc., is to be kept to a minimum size of cut and the positions and runs of chases are to be approved by the Engineer before any cutting is commenced.

1173. DAMP-PROOF COURSES (D.P.C.)

Damp-proof courses shall be 1000 gauge polythene free from tears and holes and be laid with 150mm minimum laps on and including a levelling screed of cement mortar.

1174. BITUMINOUS FELT ROOFING

Bituminous felt roofing shall be carried out complete by an approved Specialist Sub-Contractor.

Felt roofing shall be executed in accordance with British Standard Code of Practice C.P. 114/101 and strictly in accordance with the manufacturer's instructions, laps shall be 100mm minimum and falls 100mm minimum in 3 metres for flat roofs, and the minimum specification shall be as follows (Felt to B.S. 747):-

- a) One layer of asphalt saturated felt (weighing 6.8 kg. per 10 square metres) laid loose to screed or random and lap nailed to the boarding.
- b) One layer of asphalt saturated felt but weighing 9 kg. per 10 square metres and bedded to underlayer with hot bituminous compound.

- c) One layer of white mineral surfaced roofing felt (weighing not less than 23 kg. per 10 square metres) bedded to underlayer with hot bituminous compound.

1175. HACKING, ETC.

The prices for all pavings and plastering, etc., shall include for hacking concrete surfaces and for raking out joints of walls 12mm deep and for cross scoring undercoats to form a proper key.

Plastering on walls generally shall be taken to include flush faces of lintels, beams, etc., in the walls.

1176. SURFACES

All surfaces to be paved or plastered must be brushed clean and well wetted before each coat is applied. All cement pavings and plaster shall be kept continually damp in the interval between application of coats and for seven days after the application of the final coat.

1177. PRICES FOR PAVING

Prices for paving are to include for adequate covering and protection during the progress of the Works to ensure that the floors are handed over in perfect condition on completion.

1178. POLISHED TERRAZZO

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

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

1179. OPERATION AND MAINTAINANCE EQUIPMENT AND LABORATORY INSTRUMENTS

The Contractor will provide the following list of laboratory instruments and equipment for use by the Employer during the operation phase of the project:

LAB EQUIPMENT			
Item	Item Description	Quantity	Unit
1	Portable Multi parameter water Quality Meter	1	No.
2	Analytical Balance (max. cap. 400g)	1	No.
3	Autoclave, Electric	1	No.
4	Industrial Blender, stainless steel	1	No.
5	BOD Incubator Thermostatic cabinet	1	No.
6	BOD Bottles, Amber	12	No.
7	BOD Measurement system 6 place	1	No.
8	COD Photometer	1	No.

9	COD Digester/Thermoreactor	1	No.
10	COD Reagent vials, 0-1,500mg/L Pack	1	No.
11	Colon counter	1	No.
12	Chlorine portable colorimeter	1	No.
13	Lovibond Comparator, complete with cells	2	No.
14	Portable Conductivity meter	1	No.
15	Dissolved oxygen meter	1	No.
16	Digital Thermometer, with stainless steel probe	1	No.
17	Digital weighing balance, 50Kg Capacity	1	No.
18	Floc tester/Jar tester, 6 Paddle	1	No.
19	Hot plate with magnetic stirrer	1	No.
20	Microbiological incubator	1	No.
21	Magnetic rod retrievers	2	No.
22	Stirring rods	10	No.
23	Laboratory Oven	1	No.
24	pH Meter	1	No.
25	Turbidity Meter	1	No.
26	Palintest photometer 7500	1	No.
27	Vacuum diaphragm pump	1	No.
28	Refrigerator, 140L	1	No.
29	Sample cool box, 10L	1	No.
30	VIS Spectrophotometer	1	No.
31	Stop watch, digital	1	No.
32	Laboratory Water bath	1	No.
33	Water Hardness test meter	1	No.
34	Water Still	1	No.
35	First Aid kit complete	1	No.
36	Bench top Fume extractor (Hood)	1	No.

LAB GLASSWARE & ACCESSORIES			
Item	Item Description	Quantity	Unit
1	Evaporating dishes, aluminium	8	No.
2	Autoclave tapes, roll	2	No.
3	Beakers, heat resistant glass, 1L	10	No.
4	Beakers, glass, 500ml	10	No.
5	Beakers, glass, 250ml	10	No.
6	Beakers, glass, 100ml	10	No.
7	Buffer solution PH4.00	1	No.
8	Buffer solution PH7.00	1	No.
9	Buffer solution PH10.00	1	No.
10	Burette, 50ml	5	No.
11	Chlorine disc low range	4	No.
12	Burette clamp, 2 sided	3	No.

13	Conical flask, 50ml	10	No.
14	Conical flask, 100ml	10	No.
15	Conical flask, 250ml	10	No.
16	Conical flask, 500ml	10	No.
17	Macconkey broth, 500g	2	No.
18	Brilliant green, 500g	2	No.
19	Desiccator, with Knob, 12"	1	No.
20	Distiller water, 20L	4	No.
21	DPD No.1 of 500 Tablets per box	20	No.
22	Durham tubes, small size -3cm	200	No.
23	Whitman Filter papers, 185mmØ 100 papers per box	100	No.
24	Ceramic funnel, 125mm	6	No.
25	Gloves, disposable, pk/100	6	No.
26	pH Low Range Disc	2	No.
27	pH High Range Disc	2	No.
28	McCartney Bottles	200	No.
29	Aspirator Bottle, 20L For distilled water	1	No.
30	Industrial Gloves chemical resistant	200	No.
31	100ml Mixing Bottles	12	No.
32	Measuring cylinder, 25ml	6	No.
33	Measuring cylinder, 50ml	6	No.
34	Measuring cylinder, 100ml	6	No.
35	Measuring cylinder, 250ml	6	No.
36	Measuring cylinder, 500ml	2	No.
37	Petri dish, autoclavable, 90mm Pack of 20	1	pack
38	Graduated pipette, 10ml	24	No.
39	Pipette Filler	5	No.
40	Plastic sampling bottles, HDPE, Wide mouth	20	No.
41	Silver nitrate M.W 169.87, 25g	5	Bottles
42	Potassium Chromate M.W 194.19, 500g	1	bottle
43	Ethylenediamine tetraacetic acid disodium salt 99%, 500g	2	bottles
44	Eriochrome black t indicator, 25g	2	bottles
45	Sodium chloride m.w 58-44, 500g	2	bottles
46	Magnesium sulphate m.w 246.47, 500g	2	bottles
47	Ammonium chloride m.w 53.49, 500g	2	bottles
48	Sodium hydroxide pellets 97% extra pure, 500g	2	bottles
49	Murexide (ammonium purpurate m.w 284.19) indicator, 25g	2	bottles
50	Sulphuric acid 65%v/v, 2.5ltr	2	bottles
51	Methyl orange indicator, 500ml	2	bottles
52	Wide range pH indicator solution, 500ml	2	bottles
53	Alkaline Azide, 500ml	2	Bottles
54	Sodium thiosulphate, 500ml	2	bottles

55	Starch solution, 500ml	2	Bottles
56	Mercury sulphate,500ml	1	bottles
57	Silver sulphate, 500g	2	bottles
58	Phenetroline indicator, 500ml	2	bottles
59	Iron (II) sulphate, 500ml	2	bottles
60	Spatula, 6"	5	No.
61	Spatula, 8"	5	No.
62	Burette stand, complete	1	No.
63	Tripod stand	1	No.
64	swivel probe stand with steel base	1	No.
65	Volumetric flasks, 250ml, with stopper	6	No.
66	Volumetric flasks, 500ml, with stopper	6	No.
67	Volumetric flasks, 1000ml, with stopper	2	No.
68	Wash Bottles,500ml	4	No.

1180. ATTENDANCE UPON ENGINEER'S STAFF

The Contractor is to provide the necessary support staff, as and when requested by the Engineer, to assist in some of the duties on site. These staff may include but not be limited to chainmen and other short term staff required for quality control monitoring. An allowance for these is made in the Bill of Quantities.

12. ELECTRICAL INSTALLATION

PART I: GENERAL SPECIFICATIONS

1201. CONTRACTOR'S LICENCE

The complete electrical installation shall be carried out by a Registered Electrical Contractor with the valid Class 'A' Electrician's License issued by the Ministry of Energy & Regional Development of the Republic of Kenya.

1202. REGULATIONS AND STANDARDS

The complete electrical installation shall be carried out as per the Specifications and complying with the following documents: -

- a) Regulations for the Electrical Equipment of Buildings (17th Edition) issued by the Institution of Electrical Engineers of Great Britain.
- b) Electric Power Act and the Rules made thereunder.
- c) The Kenya Power & Lighting Co. Ltd.'s Bye-Laws.
- d) Relevant current British Standards, European Norms (EN), International Standards Organisation and Kenya Standard Specifications and Codes of Practice.
- e) Government Electrical Specification GES 1 and 2, which can be seen at the office of Chief Electrical of Ministry of Public Works.

Regulations of 17th Edition of I.E.E. The Regulations are to be observed in conjunction with other related local Bye-Laws and Acts.

1203. EXTENT OF ELECTRICAL WORK WITHIN CONTRACT

The electrical works in the proposed development are required to be complete in all respects as specified herein and shall include all items of equipment, materials, accessories, switchgear, lighting fittings, cables, labour, etc., necessary whether such items are specifically referred in the Contract or not. The Contractor shall be deemed to have included in his Tender, price for all items necessary such that the installations are complete in all respects and left in a satisfactory working order.

The Contractor will be responsible for liaison with the Kenya Power & Lighting Company Limited and the Telkom Kenya Ltd. to suit the incoming power and telephone requirements.

The Contractor shall include for all Civil Works, Structures, Foundations, Builder's Works and associated requirements for the mounting, housing and support of all items of plant and equipment supplied and installed under this Contract. The concrete foundation will be to approved manufacturer's details and instructions.

All work and materials are to be of the best quality approved by the Engineer and strictly in accordance with the Specification.

In the event of any portion of the work or materials failing to pass the tests specified herein, or set forth in the Maker's list for that particular item, the Engineer may at his discretion, reject that portion of the work or material entirely.

1204. MATERIALS

All materials used in the Contract shall comply with the appropriate Standard Specification where such applies. Where materials of a particular manufacturer are called for in the Specification and Drawings, they must be offered. However, the Contractor may alternatively suggest and quote other brands of equal quality approved by the Engineer.

Conduit fittings shall be the same metal as the conduit to which they are connected except that Zinc-alloy OR Aluminium-alloy fittings may be used with steel conduits.

Conduit fittings and accessories shall conform to the appropriate Standard. Conduits shall be mechanically and electrically continuous.

All bends and sets shall be made cold without altering the section of the conduit. The inner radius of the bend shall not be less than two and a half times the outside diameter of the conduit. Not more than two right angle bends will be permitted without the inter-position of the draw-in box. Where straight runs are installed draw-in boxes shall be provided at distance not exceeding 12m. Tees, elbows or sleeves of either inspection or solid type will not be permitted.

Conduits which terminate in fuse gear, distribution boards, adaptable boxes, non-spout switches, trunking, etc., shall be connected thereto by means of screwed sockets and smooth bore brass male bushes.

Where conduits are installed flush in floor slabs or in chases in walls, they shall be held firmly in position by means of substantial pipe hooks driven into wooden plugs. Where conduits are installed on surface they shall be fixed with spacerbar saddles at a distance not exceeding one metre. Conduits shall be installed entirely separate and at least 150mm clear of the hot water and steam pipes and at least 75mm clear of cold water and other services.

The Electrical Contractor shall be responsible to ascertain from site details of reinforced concrete and structural steel work and to check from the Main Contractor's drawings the positions of walls, structural concrete and steel work finishes, etc. No reinforced concrete or steelwork shall be drilled without obtaining permission from the Structural .

The entire circular conduit boxes shall be of a malleable iron conforming to SRN 052 with 50mm fixing centres fitted with H.G. lids where required. They shall be long spouts internally threaded. Deep boxes or extension rings on standard circular boxes shall be used where necessary in order to bring the front face of each box flush with the ceiling or wall.

Conduit boxes installed externally shall be galvanised and where subjected to direct weather conditions they shall be compound filled.

Where the words or other approved or equal are used, they shall mean any make of equal quality but the written approval of the Engineer for the use of such alternative shall be obtained prior to their use in the installation. In the absence of any such request, the Engineer is entitled to suppose that materials used are specified.

1205. WORKMANSHIP

The whole of the work shall be carried out in the straight forward manner by competent workmen under skilled supervision. The Engineer shall have the authority to have portion of the work taken down, removed or undone, which is executed in an unworkmanlike manner or with improper materials. Where required, the Electrical Contractor shall submit to the Engineer literature, technical brochures and samples of materials he proposes to install for test and approval before installation. For major equipment they shall be approved / inspected by the engineer and the Client representative at the place of manufacture / source prior shipment to site for installation.

In the event of the portions of the work or materials failing to pass the specified tests, or the approval of the Engineer, the Electrical Contractor shall be required at his own expense to put right such defects.

1206. INSTRUCTIONS ON SITE

The Contractor shall be required to maintain on site, at all times, during the progress of the Contract and English-speaking Supervisor, to the satisfaction of the Engineer who shall have a full knowledge of the installation and to whom the instructions can be given on site.

1207. WORKING DRAWINGS

The Contractor shall prepare working drawings as necessary and shall submit to the Engineer for approval.

Working drawings in triplicate shall include, but not be restricted to the following: -

1. Shop floor drawing or Switchboard and Control Panels.

Approval by the Engineer of the working drawings shall not relieve the Contractor of his obligations under this Contract nor relieve him from correcting any error found subsequently in the approved working drawings.

Drawings, and, where relevant, calculations in respect of the following shall be prepared by the Contractor and submitted to the Engineer for his approval commencing within ten (10) days from acceptance of the tender.

- (a) Cabling and external cable routes;
- (b) Details of all conduit and trunking runs in respect of different services;
- (c) Details of lighting and power circuits, routes etc;
- (d) Details of sub-main switchgear and distribution boards;
- (e) Fire alarm layouts and all circuit diagrams;
- (f) Lightning and surge protection details;
- (g) Technical literature for all the services;
- (h) Layouts of all ducts, chases, holes, trenches and all other services throughout the whole of the building and associated external works.

All drawings shall be to scale and fully detailed with all the important dimensions shown and the construction of key components indicated.

During progress of the building works, the Contractor shall make all necessary checks on site to ascertain that the various services can be installed as specified and shown on the approved Drawings.

Where such works cannot be so installed, this must be immediately brought to the notice of the Engineer prior to the progress of such works.

The Engineer, in conjunction with the Employer, will check and return the Drawings submitted for approval within a reasonable period, but in any case not exceeding fourteen (14) days from receipt of the Drawings.

The layouts of plant and equipment are for general guidance only. The Contractor shall assess the requirements and prepare a plant layout for approval within twenty one (21) days, the required liaison being maintained with other specialists, such that an agreed layout is submitted for approval.

1208. RECORD DRAWINGS

The Contractor shall keep on site at all times a complete set of the drawings relative to this Contract, and as the Contract works are proceeded with, indicate in red colour on such drawings, any variations to the Contract works as executed from those shown on the Contract Drawings. The 'As Built' drawings shall be submitted to the Engineer on completion of works or when demanded in writing. A minimum of three sets of 'As Built' drawings shall be provided.

1209. TESTING

On completion of the electrical installation work the installation shall be subject to the following test as laid down in the I.E.E. Regulations and Electric Power Act in the presence of the Engineer or his representative.

- a) Insulation Test
- b) Polarity Test
- c) Earth Loop Impedance Test
- d) Earth Electrode Test

Any other test which may be required by the Engineer. The results of all the tests shall be recorded on a Test Certificate to be signed by the Contractor and submitted to the Client for record. The original of the Test Certificate shall be submitted to the Kenya Power & Lighting Co. Ltd. together with a Completion Certificate.

The Contract works shall not be considered complete until all testing has been completed to the satisfaction of the Engineer and the Record Drawings have been approved as installed and all specified spares have been provided.

1210. MAINTENANCE MANUALS

At the start of the defects liability period, the Contractor shall hand over to the Engineer, four sets of maintenance and operations manuals for each plant and equipment installed. These manuals shall be in English and shall be fully illustrated.

1211. BUILDER'S WORK AND CIVIL WORKS

Builder's Work and Civil Works that are incidental to this section of the Contract such as cutting of holes in walls and floors, provisions of foundations for the plant and machinery, shall

be the responsibility of the Main Contractor. The Contractor shall be fully responsible for the preparation of all such details that relate to such works, the details being subject to approval by the Architect and Engineer prior to submission to the Main Contractor for action. Other items such as fixing of brackets, cables and ductwork and trenching, making good etc. shall be carried out by the Contractor to suit the installation of all the services.

It is the Contractor's sole responsibility to ensure that all holes and chases are in the required position and that any additional ducts, holes and chases necessary for erection of the installations in situ concrete walls, floor slabs etc., are included in the early stages of construction as appropriate.

The Contractor shall furnish the Engineer, Architect and Main Contractor with all the necessary information including position of foundations, brackets and fixings and shall ensure that such works are performed in accordance with available information.

The Contractor shall include in his tender all supports, fixings, plugging of holes in walls, ceilings and floors to facilitate the fixing of the pipe work, accessories, and all other portions of installations. Any purpose-made fixing brackets shall also be provided and installed by the Contractor, including escutcheon plates and the like.

The Contractor shall supply and install approved pipe work support brackets and hangers. It shall be deemed that prices include for any special requirements and that the Contractor has visited the site during the tender period to ascertain all details.

The Contractor shall pay particular attention to the fixing and alignment of items. All items shall be installed square, true and perpendicular to floors i.e. as shown on Drawings and as may be required at site to the Engineers approval.

1212. COMMISSIONING OF THE ELECTRICAL INSTALLATION

The Contractor shall instruct the Employer's Maintenance Engineer or his representative on the operation and maintenance of the various components forming the electrical installation and shall provide drawings, diagrams and manuals to ensure the Maintenance Engineer or his representative is completely conversant with such installations.

The Contractor shall ensure that the services installations are left in complete safe working order and operating to the satisfaction of the Engineer.

1213. SITE PERFORMANCE AND ACCEPTANCE TESTS

The Contractor shall give notice of the date of the specified tests to be performed on completion of installation. The notice shall be made in writing to the Engineer at least five days to the date of the specified tests. Unless otherwise agreed the tests shall take place within seven days of the stated date or on such day or days as the Engineer shall in writing notify the Contractor in writing. The tests shall be carried out under normal working conditions to the satisfaction of the Engineer and shall extend over such continuous periods as he may direct.

All skilled labour, supervision, apparatus, fuel and instruments required for carrying out the tests will be the responsibility and at the expense of the Contractor. The accuracy of the

instruments shall be demonstrated if required. The Contractor shall ensure that test instruments are in good working condition and have been calibrated by an authorised agent.

If any part of the plant or equipment fails to pass the specified tests, further tests of the said part shall, if required by the Engineer, be repeated. The Contractor shall, without delay, put in hand such modifications as found necessary so as to meet the requirements of the Contract and any expense which the Client may have incurred by reason of such further tests shall be deducted from the Contractor's Contract price.

Each completed system within the installation shall be tested as a whole under operating conditions to ensure that each component functions correctly in conjunction with the rest of the system.

1214. PAINTING AND FINISHING

All mechanical and electrical plant and equipment installed under this Contract shall be painted or otherwise finished to approval in accordance with appropriate international code for standard colours to be furnished by the Contractor prior to the shipment or manufacture of the plant or equipment including all pipe work, ductwork, etc. Such finish shall be entirely compatible with the conditions of heat, humidity, exposure to the weather, and other relevant factors arising from the materials, location and condition of operation of the equipment.

Paintwork will be measured in the builder's work in connection with the Engineering Element. Any additional work will be measured in accordance with the conditions of the Contract.

The Engineer may request samples of paint finishes, the cost of which shall be deemed to have been included within the tendered prices for all works.

All final painting of equipment, fixtures, and accessories shall be carried out by the Contractor, except where it is the usual practice of the manufacturer of items of plant and equipment to apply a high standard of protective finishing paintwork in the shop before despatch. This will be acceptable provided the Contractor at his own costs makes good any damage to paintwork, occurring in shipment, transportation and installation.

The interiors of electrical switchboards control panels, and similar items, shall be finished in an approved enamel colour and shall comply with the appropriate international standards for enamel finish which shall be furnished by the Contractor prior to shipment or manufacture of the plant or equipment. The exteriors of such panels and enclosures shall be of international standards specification colour as specified by the Engineer.

1215. LABELS

All items of electrical plant, Sub-main distribution boards, etc. shall be neatly and clearly labelled externally with identification marks corresponding with those on Drawings or in Technical Specifications. Final details shall be agreed upon by the Contractor and the Engineer.

Identification labels shall be of laminated plastic material engraved, white on black or white on blue, with no less than 6mm "Lino" style letters and shall be fixed on or adjacent to all items by means of at least two brass screws or to the approval of the Engineer. Self-adhesive labels shall not be permitted.

All main switches, circuit breakers, isolators, valves, motors, switch-fuse, consumer service units, and distribution boards etc. shall be neatly and clearly labelled externally with identification marks corresponding with those on the Drawings or Technical Specifications. Final details shall be agreed upon by the Contractor and the Engineer. All labels / plates shall be in English.

1216. SPECIALIST MANUFACTURERS

Where specialists are not nominated by the Employer, the Contractor shall appoint specialist manufacturers and suitable specialists for any sections of the Works described herein in which he is not himself an experienced, recognized and approved specialist.

The Tenderer shall, on submission of his tender, indicate the names of all proposed specialist manufacturers and specialists, together with the precise sections of the Works for which each will be responsible. The Contractor may be required to seek alternative manufacturers or Contractors or to accept specialists nominated by the Employer; it shall be deemed that the prices entered in the tender include for this requirement. For plant and equipment supplied by suppliers other than the Contractor, the Contractor will be required to furnish an agreement between himself and the supplier stating that he is authorised by the supplier to deal in the plant and equipment and that he is authorised to stock the necessary spare parts or that the Employer will be authorised to revert to the supplier in the event of breakdown of the plant or equipment.

The Contractor shall allow in his prices for phasing his work to meet the requirements of the other specialists, and for varying his programme or otherwise, to comply with the erection programme of such specialist. No additional costs will be allowed to the Contractor for any disruptions to his programme, or otherwise, in his compliance with the above requirements.

1217. SUNDRIES

The necessary holding down bolts, supporting brackets and templates, guards and screens, locks, piping, conduits, lamps and other requisite sundries whether specified in detail or not shall be provided, under the Contract and it shall be deemed that the Contractor's prices, rates and the like include for all such items.

PART II: PARTICULAR SPECIFICATIONS

1218. EXTENT OF INSTALLATION

The Contractor shall carry out all the necessary works for successful installation of the electrical services as described and set out in this section of the Technical Specification, Bills of Quantities and accompanying Drawings in accordance with the General Electrical Specification herewith.

The Works, the major elements of which are scheduled below, includes the supply of all labour, material, equipment, plant and components necessary for complete installation and setting out work in respect of the entire electrical services requirements within the proposed development and rendering it in complete working condition in respect of but not limited to the following installations:

- (i) Low voltages switchboard;
- (ii) Electrical distribution system;
- (iii) Lighting and power installations;
- (iv) Fire detection and alarm system;
- (v) IT structured cabling system;
- (vi) Grounding / earthing, lightning protection and transient over-voltage protection;
- (vii) External and streets lighting.

In general the installations shall be concealed in conduits except in areas where surface installation is necessary. In such cases, installation will be carried out in trunking, conduit or cable tray as indicated on the Drawings.

1219. L.V. SWITCHBOARD

A new LV Switchboard shall be supplied, installed, tested and commissioned by a specialist switchboard manufacturer complete with MCCB (moulded case circuit breakers), instruments etc and all relays, metering, and items necessary for the complete installation and setting to work.

The LV Switchboard shall be of the industrial / enclosed cubicle type, constructed and installed as described below.

The LV switchboard, suitable for floor mounting, comprising of a sheet steel cubicle with front access, complete with interior busbars, incoming main switch, VT's, CT's programmable digital meter, surge protector units, LED's lamp indicators, fuse switches, MCCB's etc. The switchgear shall be heavy duty, cast metal, enclosed type, dust proof to IP 44 Form – 4B type tested, and capable of operating on load at the rated current. Contacts shall be heavy duty silver surfaced type. The MCCB's shall have short circuit capacity of not less than 35 kA unless otherwise stated.

The cubicles shall be rigidly constructed and shall be provided with an angle iron or heavy gauge folded steel framework, panelled in zinc anneal or galvanneal of not less than 1.6 mm gauge.

The doors shall be of similar rigid construction free from twists and warps. The hinges and locks or latches shall be brass, and attached by brass screws. The locks shall be spring types, provided with two keys, and unless otherwise specified, all locks on the installation shall have identical keys.

The exposed unpainted metal shall be chrome plated, and removable panels where used, shall be attached by chrome plated captive milled headed brass screws and felt washers.

The Contractor should ensure that entry of cables, ducts, and conduits shall be neatly made and head boxes provided as required. All entries and openings shall be vermin-proof.

The floor mounted panel shall be erected on a 150 mm raised built-in base treated to be impervious to corrosion by rust.

All mounting brackets and additional items shall be supplied and installed to suitably support the switchboard in the position in which it is to be erected. In general mounting height to the top shall be 2000 mm.

Adequate ventilation shall be provided as necessary, and bronze mesh and suitable trim fitted to prevent entry of insects.

Dust tight enclosures shall have ample volume to dissipate heat, which may be generated in service, and doors shall be provided with a neoprene seal fitted with a channel and closing against a suitable folded edge or ridge. Moulded sealing strips may be submitted as alternative.

All bolts, nuts, screws, hinges, handles, etc. shall be corrosion resistant.

Enclosures shall be type tested according to IEC 60439-1 / BS EN 60439 – 4 and comply with IEC publication 144 IP 44 for indoor equipment and IP 54 for outdoor equipment. The busbars and connections shall be completely screened within the switchboard and the bus bar shall comply to BS EN 13601. The LV switchgear and control gear shall comply to BS EN 60947 and BS EN 60439 or any other approved equivalent standards.

All cables and piping entries shall be made through glands in a plate covering the base of the cubicle.

Cases shall be rubbed down, undercoat with suitable primer and finished in not less than 2 coats of hard enamel, oven baked where practicable.

1219.1 Moulded Case Circuit Breakers

(a) General

Moulded Case Circuit Breakers (MCCB's) shall as a minimum requirement comply with BS EN 60947 – 2 / IEC 60947 - 2 or any other approved equivalent Standard.

The breaking capacities of the circuit breakers shall be at least equal to the prospective fault level at the point of the distribution system where the breakers are installed.

All MCCB's shall be designed for horizontal or upright mounting without any adverse effect on electrical performance.

(b) Construction

Operating mechanism shall be of the quick make quick break type, with the speed of operation independent of the operator, and mechanically trip free from the operating handle so as to prevent the contacts from being held closed against short-circuit and overload conditions. The operating mechanisms shall be constructed to operate all poles in a multi-pole breaker simultaneously during opening, closing and tripped conditions.

The breakers shall be operated by a toggle, which shall clearly indicate the three fundamental positions ON, OFF and TRIPPED. If required, rotary handles shall be supplied.

The breaking and extinction of the electrical arc shall be achieved by means of non-welding contacts and an arc chute surrounding these contacts.

The current limiting MCCB's with very high capacity shall be made of two parts:

- (a) A standard circuit breaker for small and medium fault current;
- (b) A current limiter block to break and limit large short-circuit current.

The current limiter blocks shall be of fuse free type and the one opening mechanism type and factory fitted to the standard breakers.

All accessories and electrical auxiliaries such as shunt trip or under-voltage release auxiliary contact or motor mechanism shall be manufactured in such a way that they can be easily adapted on the installation premises.

(c) Operation

Each pole of the MCCB is provided with bimetallic thermal element for inverse time delay protection and magnetic element short-circuit protection. The thermal releases shall be of the adjustable type and could be equipped with sealing facility. Above 250 Amps the trip unit could be of the solid state energised by internally mounted current transformer.

It shall not require any external power supply to operate the tripping mechanism. All MCCB's shall be provided with interchangeable trip unit.

Current discrimination tables showing overload and short-circuit discrimination shall be provided for each rating.

1219.2 Busbar

The busbars shall be copper on insulated supports rated as shown on the drawings and capable of withstanding the fault level on the system at that point.

The busbar shall not be exposed when any access doors or plates other than those provided for busbar access of the panel shall be removed for maintenance or other work. The bus bar shall comply with BS EN 13601 or any other approved equivalent Standard.

1219.3 Under Voltage and Over Voltage Protection

To safeguard against voltage spikes suitable under voltage and over voltage protection relays shall be supplied and installed under this quotation. The relay units shall be of adjustable type and are suitable for operation under all voltage conditions anticipated. The unit shall be housed in the LV switchboard in the switch room.

The Contractor shall include for one under-voltage protection relay unit of -15% and over voltage protection relay unit +15%. Details shall be submitted with the tender and are fully discussed and agreed by all parties prior to placing the order.

1219.4 Phase Failure Relays

An alarm system, to indicate when there has been a loss of one or more phases on the incoming supply and the automatic tripping of the main circuit breaker, under these fault conditions shall be supplied and installed under this contract. The indicator shall be of LED's type installed in front face of the switchboard.

1219.5 LV Switchboard Wiring

Ample wiring space shall be provided within the LV switchboard.

Internal power connections shall be by means of copper bus bars of ample current rating and not less than 3.0 mm thick, and incoming and outgoing cables are attached to terminals by means of approved cable lugs. All live copper parts shall be insulated by PVC tape except at terminals, which may need to be disconnected.

No live metal shall be exposed except by removal of normally fixed panels.

Internal control wiring shall be through PVC insulated stranded conductors not smaller than 10 amp rating. Conductors shall be neatly laid and fixed in cable trays, or bunched to approval. No loose wiring shall be accepted.

All wiring shall be terminated using approved cable lugs. The ends of each wire shall be labelled with engraved numbered or lettered plastic ferrules, matching the identification used in the wiring diagrams.

Colour coding of the separate phases, neutral and earth, shall be provided and maintained throughout the installation. Where necessary, further identification of wiring shall be provided to the extent necessary to permit any conductor to be located and traced. All colour coding of the control and local control wiring shall be provided and their voltages of control system shall be stated clearly.

1219.6 Instruments and Relays

All wiring, space and connections and other items shall be provided for digital programmable meter, ammeter, voltmeter, selector switches and the like as applicable. Meters shall be supplied and installed and shall be of the appropriate range, and complete with CT's where required. In case of voltage selector switches shall give phase to phase, phase to neutral readings. Ammeter selector switches shall provide readings in all three phases and an off position. The accuracy of all meters VT's and CT's shall be class 1 or class 0.5. These

measuring instruments shall comply to BS EN 60044 or any other approved equivalent Standard

Ammeters and voltmeters shall be moving iron, self-contained instruments complying with BS 89 or BS EN 60051-2 and IEC 60051-2 to Class 1 or better.

Instruments and relays shall be removed from the switchboard for delivery and shall be packed in cases and delivered with the associated switchboard.

All current operated instruments and relays shall be suitable for operating on 5 amp secondary windings of current transformers.

1219.7 Labels

All switchgear shall be individually labelled showing the circuits controlled by means of laminated Formica labels and showing white letters on a black background. Wiring diagram of the LV switchboard shall be printed on the approved type of paper, size A3 and shall be folded and inserted in a suitably designed slot inside the switchgear door.

1219.8 Earthing

The Contractor shall provide earthing terminal block within the LV switchboard in accordance with the KENYA POWER / IEE Regulations. The earth terminal block shall have provision for connections to other equipment such as the transformer, PABX cabinets, UPS earth terminal block and to metal ducts steel works, building steel work, metal cable ladders and galvanised sheet steel cable trays.

1219.9 Interlocks

Provision shall be made in the LV Switchboard to make it possible in future for inter-locking the incoming supply from a diesel generator such that paralleling cannot take place under any circumstances.

Interlocks of a substantial mechanical type shall be provided on each cubicle between the door and the circuit breaker such that the door cannot be opened unless the circuit breaker is in the 'OFF' position, and all live parts, which can be accidentally touched have been disconnected.

When the door is open it shall not be possible to readily turn the circuit breaker to the 'ON' position.

1219.10 Switchboard Equipment Rupturing Capacity

All switchboard equipment shall be entirely suited to the application and adequate space shall be provided for all items as required.

Switchboards shall be capable of withstanding the maximum fault level which may occur in the installation and shall have a short circuit rating of not less than 35 kA and capable of sustaining the maximum short circuit for a period of three seconds.

1219.11 Layout of LV Switchboard

The general layout of the LV Switchboard is to be submitted by the contractor to the Engineer before commencing the manufacture of the new LV Switchboard. The final layout of the switchboard is to suit the proposed loads and mode of operation.

1220. CONDUIT SYSTEM

a) Metallic Conduits and Accessories

Metallic conduits shall be of heavy gauge solid drawn or welded steel to SRN 052. No conduit shall be less than 20mm diameter. Conduits installed within the buildings shall be black enamel finish. Where installed externally or on surface in basement areas, conduits shall be galvanised.

b) Non-Metallic Conduits and Accessories

These shall be rigid PVC super high impact heavy gauge Class 'A' conduit to SRN 054. No conduit shall be smaller than 20mm diameter. Joints shall be made by using an approved cement.

Tube and fittings shall be perfectly clean and free from greases. The cement shall be applied to both surfaces and the tube shall be rotated within the accessory to ensure complete coverage.

In cases of screwed joints, tubes shall be screwed with standard stocks and dies and shall be used with threaded accessories. PVC conduits shall be used only in situation where ambient temperature is between 70 degrees centigrade (153 degrees Fahrenheit) - 60 degrees centigrade (140 degrees Fahrenheit).

Expansion couplers shall be used in straight runs exceeding 6 metre with flexible type joint. These couplers shall be extended in length, the one end of which shall be bored standard depth and the other end shall be provided with a sliding entrance over a longer distance allowing the tube to slide up and down as it expands or contracts.

For a watertight joint, adhesive shall be used for the sliding end. All PVC conduit boxes shall be circular pattern of Rigid PVC with push fit or screwed spout conformed to SRN 054, and circular looping boxes to SRN 054.

1221. GENERAL WIRING

The wiring throughout shall be in looping cables from point to point and no tee or other joints shall be permitted. Conductors of the same circuit shall be contained in the same conduit or trunking. At distribution boards, the neutral conductors shall be connected to the neutral bar in the same sequence as the line conductors connected to fuses or circuit breakers so that they can be readily identified.

a) PVC Cables in Conduits

PVC cables in conduits unless otherwise specified shall conform to SRN 055, 600/1000 volts grade, single core PVC insulated. No cable smaller than 1.5mm² shall be used in the installation.

b) Flexible Cords

Flexible cords shall be of 300 volts grade, V.R.I. OR PVC insulated conforming to SRN 056. No flexible cord shall be smaller than 0.72mm² (24/0.20mm).

c) PVC

These cables shall be 600/1000 volt grade, conforming to SRN 024 having standard copper conductors with PVC insulation, cores laid up circular, PVC sheath beading, single wire armour and PVC sheath. The cables shall be terminated on distribution boards, switchboards, trunking or adaptable box with compression type brass gland with locknuts and shroud.

d) PVC Armoured Cables (with Aluminium Conductors)

These cables shall be 600/1000 volt grade, conforming to SRN 063 having cores of solid Aluminium conductors, insulated with PVC, armoured with aluminium strip or steel wire with PVC sheath overall.

e) M.I.C.C. Cables

These cables shall be 440 or 660 volt grade consisting of high conductivity copper conductors embedded in pure and dense, magnesium oxide insulation, contained in a robust yet ductile, seamless, solid drawn copper sheath conforming to SRN 057. Where installed in corrosive situations, they shall be sheathed with PVC sleeving. Terminations of cables shall be provided with sleeves having a temperature rating similar to that of the seals. Terminations shall be made by means of cold screw on pot type seals and in conjunction with ring type universal glands. The greatest care shall be exercised at all times when terminating M.I.C.C. cables and insulation after. All cables shall give infinity test when tested on 1000 volt megger.

Where single core M.I.C.C. cables are used, all necessary precautions shall be taken to prevent Hysteresis. Ferrous plates or structure through which the cables pass shall be slotted and brass glands and sockets shall be used.

f) Wiring System

System A - Cables enclosed in concealed steel screwed conduit or trunking

The wiring shall be carried out in PVC insulated cables installed in steel screwed conduit or trunking concealed in floor slabs, walls of buildings, installed in roof space or concealed in structural beams and columns.

System B - Cables enclosed in steel screwed conduits or trunking fixed to the surface of walls and ceiling

The wiring shall be carried out in PVC insulated cables installed in steel screwed conduit or trunking installed on the surface of the walls and ceiling or in false ceiling spaces.

Conduits shall be screwed in position by means of space bar saddles using brass round head screws fixed with rawlplugs. Where two or more conduits are installed in

parallel, multiple saddles which are screwed between each way shall be used. Conduits shall be installed horizontally on the walls and vertically to switches or outlets.

System C - Cables enclosed in concealed non-metallic conduits

The wiring shall be carried out in PVC insulated cables installed in rigid, PVC super high impact heavy gauge conduit concealed in floor slabs, walls of buildings in ceiling space or concealed in structural beams and columns. Each continuity conductor shall be installed throughout the length of the conduit.

System D - Cables enclosed in non-metallic conduits fixed to the surface of walls and ceilings

The wiring shall be carried out in PVC insulated cables installed in rigid PVC super high impact heavy gauge conduit installed on surface of the walls and ceiling or in false ceiling spaces. Where straight run of conduit in excess of 6m are installed on the surface and approved expansion coupling must be installed at every 6m distance. Switch boxes and lighting point boxes shall be fitted with purpose made earthing connectors. Lighting point outlet boxes shall be fitted with steel insert clips to prevent distortion under load.

System E - M.I.C.C. cables installed on surface of the walls and ceilings in the roof space or concealed in walls and floors

M.I.C.C. cables shall be secured with copper saddles fixed at 375mm centres on vertical runs and 525mm centres on horizontal runs. Termination shall be made by means of cold screw on pot type seals and conjunctions with ring type universal glands. Insulation test shall be taken as described in Clause 1209 above.

System F - cables clipped to the roof members and run in steel conduit or rigid PVC conduit drops concealed in walls

The wiring shall be in PVC insulated and sheathed cables securely fixed to the roof member by means of buckle clips and then to switches and outlets through conduit drop (steel conduit or rigid conduit). Earth continuity conductor shall be run throughout, if PVC single insulated and sheathed cables are used or PVC twin with earth shall be used.

System G - PVC insulated and sheathed cables clipped to the surface of the wall and roof members or to the ceiling

The wiring shall be in PVC insulated and sheathed cables fixed to the roof member, surface of the walls and ceiling only when there is no reasonable access from above. They shall be fixed by means of buckle clips. Where cables pass through holes they shall be bushed.

System H - PVC insulated single wire armoured, PVC sheathed cables laid in ducts or saddled to walls

All the PVC insulated single wire armoured PVC cables laid direct in the ground shall be laid at minimum depth of 600mm, on 75mm bed of sand. Cables shall be

suspended on purpose made frames and hangers, drawn through ducts or laid in trenches. Cables suspended on multiple hangers shall be so arranged that one can be removed without disturbing the other. Frames and hangers shall be galvanised or of non-ferrous material and shall not be fixed in contact with which they are liable to set up electrolytic action. All spacing of cable hangers and supports shall not exceed those laid down for the relevant size and type of cables in the I.E.E. regulations. PVC SWA cables laid direct in ground shall be provided with concrete cable tiles marked "Danger", "Hatari", throughout. Cables shall be terminated using brass compression glands and cable lugs of appropriate size.

1222. LIGHTING SWITCHES

Flush Switches

These shall be flush type contained in steel or alloy boxes of the ratings and gangs as specified on the drawings, complete with overlapping ivory or BMA or Matt Chrome coverplates and switch dolies. They shall be as manufactured by "M.K. Electric Limited", gridswitch range or other equal and approved to SRN 058.

Ceiling Switches

These shall be of the semi-recessed ivory pattern for fixing to, standard conduit boxes as "M.K. Electric Limited" list to 3121 or other equal and approved. Surface ceiling switches shall be ivory pattern as "M.K. Electric Limited" list 3121 or other equal and approved to SRN 058.

Surface Wall Switches

These shall be contained in a steel box with steel cover plate with rating and gangs as specified on the drawings and as manufactured by "M.K. Electric Limited" either dolly-operated or Rocker-operated or any other equal and approved to SRN 058.

1223. SOCKETS AND SWITCH SOCKETS

These shall be 13 amps, flush pattern in steel box complete with overlapping ivory or BMA or Matt Chrome coverplates.

They shall be 13 amps, 3 pins, shuttered, switched or unswitched as specified on the drawings and as manufactured by "M.K. Electric Limited" or any other equal and approved and as per SRN 059. All sockets or switch sockets shall be with fused plugtop containing a fuse whose rating shall be suitable for the load connected to it. The plugtop shall be as manufactured by "M.K. Electric Limited" or other equal and approved and as per SRN 059.

The surface type sockets or switch sockets or switch sockets shall be in a steel box with metalclad steel coverplates or ivory insulated with ivory mounting block and backplate as manufactured by "M.K. Electric Limited" or other equal and approved and to the SRN 059.

1224. FUSED CONNECTION UNIT

These shall be flush, D.P. switched or unswitched in a steel box with ivory or BMA or Matt Chrome overlapping coverplate with or without pilot light as manufactured by "M.K. Electric Limited" or other equal and approved and as per SRN 059.

Surface fused spurboxes shall be in a steel box, D.P. switched or unswitched with metalclad steel coverplates as manufactured by "M.K. Electric Limited" or other equal and approved and as per SRN 060.

1225. TELEPHONE OUTLETS

These shall consist of 75 x 75 x 50mm deep steel box with single or double outlet telephone cord-outlet plate, ivory or MBA or Matt Chrome as manufactured by "M.K. Electric Limited" or other equal and approved. A 25mm diameter conduit shall be provided between the telephone outlet plate and the outside / to of the building. Where the conduit is taken to the top of the building, the conduit end shall be bent to prevent ingress of rain water. Conduits shall be left with draw-wires.

1226. TIME SWITCHES

These shall be 30 Amps., A.C. 200/250 volts 50 C/S with 9 hours spring reserve, "Venner" type TJDISP or other equal and approved.

1227. M.C.B. DISTRIBUTION BOARDS AND CONSUMER UNITS

These shall be surface or flush pattern complete with hinged cover incorporating single pole or three pole circuit breakers as indicated on the drawings. The M.C.B. distribution boards and consumer units shall be as manufactured by CRABTREE OR equivalent. The MCB units shall have a short circuit rating as specified on the drawings or as appropriate to its location in the distribution network. The boards shall be complete with 100 Amps. D.P. or T.P. switches as specified.

1228. WATER-TIGHT SWITCHES

These shall be of the rating specified 5 ampere OR 15 ampere single pole as manufactured by 'THORN' Cat. No. PD 145. The Protection class shall be IP65, or other approved equivalent.

1229. RADIO / T.V. AERIAL OUTLETS

These shall be flush type, ivory, with steel box as manufactured by "M.K. Electric Limited" List No. 3523 WHI/890 OR equivalent. A 25mm diameter conduit shall be provided between the outlet and the top of the building with the top conduit end suitably bent to prevent ingress of rain water. Conduit shall be left with draw-wire.

1230. BELL PUSHES

These shall be flush type, ivory, with steel box as manufactured by "M.K. Electric Limited" List No. 4850 WHI/890 OR equivalent. The wiring for bell circuits shall be carried out through 2406V step down transformer.

1231. COOKER CONTROL UNIT

These shall be white flush type with pilot lamp, installed in an aluminium stove enamelled box with earth terminals as manufactured by "M.K. Electric Limited" List No. 5011/5120. The Electrical Contractor shall supply and install flush connector box for Cooker underneath the cooker control unit 300mm above floor level, complete with wiring in 6mm² PVC cables in 25mm conduit and with terminal block and moulded with cover plate as manufactured by "M.K. Electric Limited" List No. 5045 OR equivalent. The wiring between the connector box and the cooker terminals shall be carried out in 6mm² PVC twin with earth cable.

1232. WATER HEATER SWITCH & CONNECTION TO WATER HEATER

The Contractor shall wire the water heater switch from 15 Amp., S.P. & N., M.C.B. in the distribution board of consumer unit. The wiring from water heater switch to the water heater shall be in 70 / 0076 x 3 core asbestos flexible cable. The water heater switch shall be 20 Amp., D.P. ivory flush type, with pilot lamp and flex-outlet installed in a box as manufactured by "M.K. Electric Limited" List No. 5523 WHI/890 OR other equal and approved by the Engineer.

1233. FIRE DETECTION AND ALARM SYSTEM

1233.1 Scope of work

The Contractor shall be responsible for supplying, installing, wiring and commissioning the Addressable Fire detection and alarm system. The system shall consist of manual call points (break-glass), electronic bells, smoke detectors, heat detectors and indicator panels. All items shall be installed in the positions shown on the Drawings and as finally recommended by the fire alarm specialist. The Employer shall require entering into a longer term maintenance contract for the fire detection and alarm system and in this respect the electrical Contractor shall therefore consider the use of a fire alarm specialist to supply all equipment and carry out the complete installation.

1233.2 Operation

The fire detection and alarm system shall operate in the event of a signal being initiated from any of the break-glass units, heat detectors or smoke detectors.

The signal representing the zone in which the alarm has been initiated will be indicated on the main indicator panel such that staff can easily and clearly see the affected area. All electronic bells shall continue to ring until they are manually reset at the indicator panel. On silencing the bells the supervising buzzer within the indicator shall remain operational until such time that the glass for the break-glass contact has been replaced or the smoke/heat detector de-energised and returned to its normal operational or monitoring condition.

1233.3 Fire Detection and Alarm Equipment

The fire detection and alarm equipment shall be of the addressable type and latest version and to final approval of the Employer or the Engineer. The unit shall be manufactured by a renowned company and installation shall be carried out in conjunction with a fire alarm specialist.

All equipment provided and installed under this section of the Specification shall comply with BS 5445, BS 5839-1 / BS EN 54-2 and BS EN 54-23 or approved equivalent standard and relevant local by-laws. The fire detection and alarm system to be provided shall be category L where the sensors are installed throughout the building.

The fire alarm indicator panel shall be installed in the location shown on the Drawings. The alarm indicator panel shall be of modular construction housed in one or more enclosures of sheet steel with scratch resistant baked enamel finish. Panel doors shall be provided with

piano type hinges with key operated locks. The Fire detection and alarm System shall operate on 24 volts DC supply and the main alarm panel shall house complete the integral charger and sealed maintenance-free batteries. Solid state components shall be utilised wherever possible. All relays shall be of the plug-in sealed type. Terminal strips and enclosures shall be provided and coded to match the zone input and output functions. Fuses shall be provided for each alarm input and output circuit. Blown fuses shall operate a "fault" signal lamp, which shall be labelled "Replace Fuse". The failure of any one circuit shall not interfere with the proper operation of other circuits. The alarm device circuit wiring shall be supervised for open circuit, shorts and earth faults on each side of the line.

Due account shall be taken of voltage drops when sizing the cables, details of sizes, types of cable etc. shall be provided for approval.

The wiring shall be carried out in PVC cables enclosed in surface heavy gauge PVC conduit. A separate and independent conduit system shall be used for wiring to fire alarm equipment.

Manual alarm points and fire detectors shall be connected to the various zone points as shown on the drawings.

Manual contacts shall be of the break-glass type. Breaking the glass shall release a spring-loaded switch that breaks the electrical monitoring circuit and results in an alarm being indicated on the fire alarm control.

Fire detectors shall consist of the heat or photocell smoke type. Detectors circuit design shall be suitable for the type and number of detectors to be installed and shall limit detector circuit current to not more than the current ratings of the detectors and associated relays.

1234. STRUCTURED CABLING FOR VOICE AND DATA SYSTEMS

1234.1 Scope of Work

The tenderer shall include in his tender for the shop design, supply, installation, testing and commissioning of multi- outlet points for the telephone and data systems including the related structured cabling. The telephone block wiring and data networks wiring shall be carried out by licensed block wiring sub-contractors. Proof of such licence issued by Authority Communication of Kenya (ACK) Regulatory Body is mandatory. The supply and installation of the telephone switchboard, subscriber and terminal equipment as well as data server and computer equipment are not part of this tender. The contractor shall submit his designs and working drawings for the telephone and data network installations to the Engineer for approval before commencement of site works.

1234.2 Working Drawings

The provisional telephone and data outlet positions have been indicated on the drawings. These may be adjusted, increased or decreased to suit Employer's and final design requirements.

The Contractor shall liaise with the Engineer, ISP provide and Communication regulatory body and produce working drawings showing all external data and voice distribution and outlet points, conduit / trunking and structured cabling layouts and submit for approval by the Engineer and Employer.

1234.3 Telephone and Data Outlets

Flush telephone and data outlets shall be provided where shown on the drawings and complete with white finish plate with PVC sleeve cord with internal diameter of 5mm complete with steel clamp to retain sleeve cord on underside.

1234.4 Structured Cabling for Data and Telephone Network

This section of the Specification includes the inspection, delivery to site, unloading, complete installation, putting into commission and handing over in the approved working order, the whole of the data and telephone cables and wiring as detailed herein and in the tender.

The work includes the supply, delivery and erection of all data switches and hubs, termination blocks, fibre optic cable and its accessories, unshielded twisted pair (UTP) cable CAT 6 (multi-core), terminal outlets, racks, cable cleats, Unistrut and fittings required for the support and accommodation of the cables and wiring, grouting of rag bolts for the fixing of cable racks, supports, and setting to work. The work includes the installation of the data and telephone cables and related wiring within the ducts, conduit, trunking and the proper protection, marking and terminations of all such data and telephone cables.

Under this project short distances will be covered. In this case only complete stretches of UTP cables, optic fibre cable etc will be used and jointing will not be permitted. However, where joints are permitted by the Engineer for any reason they shall be of an approved type and manufacture. The data and telephone cabling network installation shall be as manufactured

installed and tested in accordance with the international standards following and in particular the ones described herein shall apply:

- (d) *Fibre optic cables provided shall comply with BS 7718 (Code for practice for installation of fibre optic cabling) or approved equivalent standard and relevant local by-laws;*
- (e) *Unshielded twisted pair (UTP) cables CAT 6 shall comply to BS EN 50173 (Information technology generic cabling), BS EN 50174-1 (Specification and quality assurance) and BS EN 50174-2, (installation planning and practices inside buildings), or approved equivalent standard;*
- (f) *The data network accessories shall comply with IEE 802-3 and EN 50081/82-2 or approved equivalent standard;*
- (g) *All cables and accessories shall be delivered to site in the same coils and packing as despatched from the manufacturer and the labels showing size, type and length and shall be unpacked only in the presence of the Engineer or his representative and handed to him;*
- (h) *The Contractor shall agree with the Engineer and the Employer route of all cables, conduit and cable trunking and shall not install such trunking or conduits until agreement and approval has been given.*

The power supply shall be extended from the LV switchboard position in the service areas. It will be necessary for the Contractor to liaise with the Engineer when finalising the cable routes.

3.1.2 Fibre Optic cable

The fibre optic cable shall be of the multimode type and with top quality ceramic connectors and to final approval of the Employer or the Engineer. The fibre optic cable shall be manufactured by a renowned company and installation shall be carried out by authorised specialist only.

All fibre optic cable and the related accessories provided and installed under this section of the Specification shall comply with BS EN 6701 or approved equivalent standard.

The fibre optic cable supplied shall be multimode type, 4-core and have a maximum attenuation of 3 dB / Km at 850 nanometre (nm) and maximum of 0.7 dB / Km at 1300 nm, Bandwidth 200 MHz / Km at 850 nm and 500 MHz / Km at 1300 nm, cable size (3 x 6.1 mm), core diameter 62.5 μ m, minimum bending radius 75 mm, minimum proof test of 100 kpsi AND numerical aperture of 0.275 ± 0.015 . The fibre optic cable shall also have the following environmental characteristics:

- (a) *Temperature dependence (- 60 to +85C) - 0.2 dB / Km;*
- (b) *Temperature and humidity cycling (- 10 to +85C, 4 to 90% RH) – 0.2 dB / Km.*

3.1.3 Unshielded Twisted Pair

The Unshielded Twisted Pair (UTP) cables CAT 6 shall meet all standards and have snag-free boots prevent cable kinks and bent pins when removing from patch panels and they reduce cross talk and shall be subject to final approval of the Employer or the Engineer. The

Unshielded Twisted Pair (UTP) cables CAT 6 shall be manufactured by a renowned company and installation shall be carried out by authorised specialist only.

All Unshielded Twisted Pair (UTP) cables CAT 6 and the related accessories provided and installed under this section of the Specification shall comply with BS EN 50173 (Information technology generic cabling), BS EN 50174-1 (Specification and quality assurance) and BS EN 50174-2, (installation planning and practices inside buildings), ISO / IEC 11801 Category 6 Patch or approved equivalent standard.

The Unshielded Twisted Pair (UTP) cables CAT 6 supplied shall be 23 AWG, 4 pair stranded, tinned copper, PVC sheathed, and have a maximum attenuation of -29.2 dB / 100m up to 200 MHz frequency, impedance $100 \pm 15 \Omega$ mutual capacitance 46 pF / m and resistance of 20 ohms / 300m and RJ- 45 connectors.

1235. COMPLETION AND INSPECTION CERTIFICATES

On completion of the Electrical Works, the Contractor shall submit to the Engineer Completion and Inspection Certificates as required by Section E of I.E.E. regulations.

ELECTRICAL INSTALLATION - SPECIFICATION OF WORK

1236. SCOPE OF WORK

Scope of work shall include the following: -

a) **Various Buildings**

Complete installation of lighting, power, voice and data points, lighting fittings, distribution board, meter board, etc. in all buildings constructed.

b) **Security Lighting**

Complete installation of security lighting with columns, cables, lanterns, distribution board, etc.

c) Supply and Installation of generator in the generator / switchroom.

13. MECHANICAL WORKS

1301. GENERAL

All materials and equipment shall be obtained from reputable manufacturers, who have well established agent(s) in Kenya. The local agent(s) shall be able to provide an efficient service for the equipment and shall have ample stocks of all expendable items such as packings, impellers, fuses, etc.

The Engineer reserves the right to reject manufacturer(s) or agent(s) not fulfilling the above requirements.

It is the responsibility of the Contractor to provide evidence that the equipment is in compliance with the Bills of Quantities, Specifications herein, and as shown on the drawings, and that the equipment will operate satisfactorily under the conditions under which it is installed. The work shall comprise complete installation such as anchor bolts, base plates, gaskets, painting, etc., all to the satisfaction of the Engineer.

1302. TRADE NAMES

Where trade names or manufacturers' catalogue numbers are mentioned in the Specification herein or shown on the drawings, the references are intended as a guide to the type of equipment or quality of materials required. The Contractor may propose any equipment or materials in type or quality to those described herein or shown on the drawings subject to prior approval of the Engineer and at his absolute discretion. The Contractor shall guarantee that the quality of the equipment he proposes are equal to or higher than that indicated herein or as shown on the drawings.

1303. SPARE PARTS

The Contractor shall supply sufficient amount of spare parts to properly operate and maintain all the equipment furnished and installed under this Contract for over three (3) years period. The Contractor shall, as recommended by the manufacturer supply the quantities of such spare parts, the list of which must be submitted with the Tender, and costs thereof shall be covered by the Contractor's rates.

1304. STORAGE OF MATERIALS

The Contractor shall provide weather-proof lock-up sheds for safe storage and custody of materials for the works. The sheds shall be removed upon completion of the works, and the site shall be restored to the original conditions to the satisfaction of the Engineer.

1305. TESTS ON MATERIALS / EQUIPMENT

The Engineer reserves the right to inspect, examine and test materials and workmanship, from time to time during the period of manufacturing, all equipment to be supplied under the Contract at manufacturer's factories. Such inspections and testing, however, will not in any way relieve the Contractor from any obligation under the Contract.

The Contractor shall carry out any tests on the quality of materials and workmanship of equipment as directed by the Engineer. Performance tests shall be carried out by the Contractor for all mechanical equipment to ensure that the equipment complies with the requirements of the Specification.

All tests shall be carried out in the presence of the Engineer or such personnel as appointed by the Engineer for this purpose.

The Contractor shall provide all necessary labour and instruments for carrying out these tests, and he shall be responsible for the use and discharge of any water and chemicals during these tests.

The Contractor shall give to the Engineer, a written notice of the date after which he will be ready to conduct the tests as required in the Contract. Unless otherwise agreed, the test shall take place within 14 days after the said date on such day or days as the Engineer shall notify the Contractor.

If the Engineer fails to appoint a time after having been asked to do so, or does not attend at the time and place appointed, the Contractor shall be entitled to proceed with the tests in his absence. The tests shall then be deemed to have been made in the presence of the Engineer and the results of the tests shall be accepted as accurate. The Engineer shall give the Contractor 7 days notice in writing of his intention to attend the tests.

1306. DRAWINGS

The works as shown on the drawings are prepared for tendering purposes only, and it is the Contractor's responsibility to provide promptly, detailed shop drawings of the equipment he proposes to use. It is also the Contractor's responsibility to see that all openings, recesses, channels, conduits, etc., in structures are so located and installed as to fit and function properly with mechanical and electrical works.

The Contractor shall prepare all necessary detailed or workshop drawings required for manufacturing and erecting the equipment. Such drawings shall be submitted to the Engineer for approval prior to the commencement of manufacture and installation of the equipment. Upon completion of the works, the Contractor shall prepare and submit information on as-built drawings to the Engineer for his retention.

The Contractor shall be responsible for any discrepancies, errors, or omissions in the Contractor's drawings unless they are due to incorrect drawings or other written information supplied by the Employer or the Engineer. Approval by the Engineer of the Contractor's drawings shall not relieve the Contractor from any responsibility under this section.

1307. DESCRIPTION OF SERVICES

The Contractor shall supply, transport, deliver, install, connect, commission and hand over all equipment and materials specified in the Specifications, Drawings, Bills of Quantities, in a clean complete and in every detail working condition. He shall carry out all tests specified herein to Kenyan or other International Standards together with any tests which might be requested by the Engineer with respect to the use of these materials or equipment.

All costs accruing due to preparation of the above drawings, manuals, tests and other obligations including all necessary labour, overheads and profits, duties, sales taxes, etc., shall be deemed to be included in the Contract Price.

1308. MAINTENANCE

The Contractor shall be liable for all defects and shall maintain all Mechanical and Electrical Equipment for a period of twelve (12) calendar months from the date the works are taken over by the Employer. All such expendable items necessary for the maintenance of the works as gaskets, filters, fuses, indicator lamps, relays, coils, switches, oils, etc., are to be supplied by the Contractor.

In case permanent power supply is not made available in time for testing equipment, the Contractor, if he intends to clear out of the site, shall make his own arrangement for testing equipment and again return to the site for final testing when permanent power supply is made available. No extra payment will be made for such arrangement.

The Contractor shall be responsible for making good any defect in or damage to any part of the works which may appear or occur during the Defects Liability Period. The Defects Liability Period for the works shall not end until all defects which occurred or appeared during the period have been satisfactorily rectified.

The Defects Liability Period for the works shall be extended by a period equal to the period during which the works cannot be used by reason of a defect or damage of equipment. If only part of the works is affected the Defects Liability Period shall be extended only for that part.

1309. INITIAL DEFECTS LIABILITY PERIOD

During the twelve months Defects Liability Period, the Contractor shall carry out all necessary adjustments and repairs, cleaning and lubricating, etc., required for maintaining the equipment in good working condition. A report of any work executed with respect to such maintenance shall be submitted to the Engineer and incorporated in Maintenance Records.

The Contractor shall inform the Employer his schedule of any routine maintenance inspection work before the work commences. Any items of materials found to be defective shall be replaced by the Contractor within seven (7) days after the receipt of such notice by the Employer or his representative. If the defect or damage is such that repairs cannot be expeditiously carried out on the site, the Contractor may with the consent of the Engineer remove from the site for the purposes of repair any part of the works which is defective or damaged.

The Contractor shall bear all the costs required for maintenance and inspection services of the equipment and provide for all labour, tools, instruments and plant, and the transportation thereof, as required for the satisfactory execution of these obligations and for the provision, use and installation of all materials such as fuses, expendable items, oils, greases, etc., and such parts which are periodically renewed as relay contacts or parts which are faulty for any reason.

1310. MAINTENANCE AND SERVICES AFTER COMPLETION OF INITIAL DEFECTS LIABILITY PERIOD

The Contractor shall, if required by the Employer, enter into a Maintenance and Service Agreement with the Employer for a period of up to five (5) years from the last day of the Initial Defects Liability Period. Such an Agreement shall offer the same services as specified under "Initial Defects Liability Period". The Contractor shall be entitled to be paid the cost for such additional maintenance and services which will be determined by negotiation between the Employer and the Contractor.

1311. MANUFACTURER'S MAINTENANCE MANUALS

Upon completion of the works, the Contractor shall furnish to the Engineer six (6) copies of Manufacturer's Maintenance Manuals for the equipment installed in A-4 size loose leaf type binding containing information on the following items:

- a) Description of Equipment
- b) Full Operation and Maintenance Instructions
- c) Valve Operations
- d) Fault-finding Charts
- e) Emergency Procedures
- f) Maintenance and Service Periods
- g) Lubricating Instructions
- h) Colour Code Legend
- i) Spares List
- j) Record Drawings in size A-4 / A-3
- k) Any other relevant information.

The Manual shall be specifically written for this Contract and not be the manufacturer's standard manual unless otherwise approved by the Engineer.

All instructions in the Manual shall be written with reference to the drawings. All valves, terminals and controls in the plant and other sites be labeled to correspond with the Operation and Maintenance Manual.

The Works will not be considered completed for the purpose of taking over until such Manual containing instructions and the drawings have been supplied to the Employer.

1312. PRESSURE GAUGES

Pressure gauges shall be wall mounted, in metric units complete with connection to delivery side of pumps, and copper pipe from pipe to gauge supplied with isolating cock. If proposed and instructed, the gauges can be directly mounted on the delivery pipework.

1313. PUMPS

General

The pumps shall be designed and constructed so as to be suitable for the particular liquid to be pumped. All pumps shall comply with the requirements of ISO 9905, Technical Specification for Centrifugal Pumps - Class I.

The pumps shall be designed to give the specified output against all losses including those relating to the pump. The Contractor shall match his pump characteristics to achieve the highest pump efficiency, reliability and low life cycle costs.

The pumps shall have a non-overloading characteristic over the complete range of head and quantity delivered and the drive shall be capable of starting centrifugal pumps against maximum run out conditions.

Each set must be capable of running satisfactorily in parallel with other sets in the system without throttling and by itself, without cavitation or overload under all operating conditions within the system characteristics given.

The whole pumping unit shall be capable of withstanding without detriment, reverse rotation to a speed that would occur if the pump were to stop when the differential head was at a maximum and the delivery and/or non-return valve failed to close.

The head/flow characteristic of any pump shall be stable under all possible operating conditions including parallel operation and with maximum surcharge.

The design of the influent path to the sump and the configuration of the sump shall avoid risk of ingesting entrapped air or other condition likely to result in cavitation. The NPSH of the installation has to be calculated by the Contractor. It must suit the required NPSH from the pumps constructor.

Velocities in the suction and delivery branches shall be sufficiently low to prevent hydraulic turbulence and cavitation within the pump and the pipe-work and sufficiently high to prevent settlement of any suspended solids.

The pump and its drive motor shall be suitably rated and the characteristic curve selected as appropriate to allow for any increased head, due to sliming, etc., of the rising main, without unacceptable loss of delivery during the lifetime of the pump.

The centrifugal pumps switchgear and control gear quality shall be as defined by IEC 60947 for electronics applications encompassing all electrical components and devices that are used to activate, deactivate, and protect electrical consumers and include switches, contactors, residual current devices and motor protection devices. Pump control units shall safeguard proper operation of the connected pumps.

The application-specific switching and control functions include the following:

- Equal distribution of operating hours;
- Automatic pump changeover after a specified number of operating hours has been reached or after every start;
- Pump starting and stopping in response to service demand;
- Pump changeover in the case of a pump fault;
- Functional check run via battery-backed real-time clock (as a function of fluid level);
- Sequenced soft start / stop if pumps have to be started or stopped, to prevent pressure surges and minimize starting currents;
- Freely selectable automatic re-start after a fault;
- Adjustable after-run time;
- Variable stop delays to prevent deposits in the tank

Pumps monitoring functions shall include:

- High water alert;
- Operational availability;
- Mains-independent alarm;
- Programmable general fault / "in operation" message;
- Phase monitoring;
- Voltage monitoring and display;
- Overload detection per pump;
- Thermal monitoring of pump motors.

Impellers

Impellers and guide vanes (if any) shall be of stainless steel, accurately machined and smoothly finished to minimise hydraulic losses. The rotating elements shall be balanced to

achieve minimum vibration and shall be statically and dynamically balanced before final assembly.

The impeller shall be readily withdrawable from the pump casing without the need to disconnect pipe-work. The impeller shall be provided with means of preventing abrasive matter getting to the glands. Clearance at the eye rings and wear plates shall be kept to a minimum and where it is found necessary to cut back the impeller, this is to be done on the vanes only.

Where specified the impeller shall have renewable wear rings. Clearance at eye rings and wearing plates shall be kept to a minimum and, where it is found necessary to cut back the impeller, this shall be done on the vanes only. Eye rings and wear rings shall be bronze or other compatible materials and shall be replaceable without machining.

Impellers, as far as practicable, shall be hydraulically balanced to reduce end thrust on the bearings to the minimum possible. Machining of holes in the impeller shall not be used to balance hydraulic forces.

The suction arrangements shall be such as will avoid pre-rotation in the suction pipe-work and present a good flow pattern at the entrance to the impeller.

Pump Shafts

The pump shaft shall be of high tensile stainless steel adequately sized, with good fatigue, shock load and corrosion resistance. The duty speed range shall be well below the first critical speed of the shaft.

Bearings

All bearings shall be liberally rated to ensure cool running and meet the load factors specified. For vertically mounted pumps, the top bearing shall be a combined thrust and journal type, designed to prevent any thrust loads being imposed upon the drive motor.

A label made of non-deteriorating material shall be attached to each pump and motor in a place where it can be easily read and shall show the following information:

- a) Manufacturers, serial numbers and types of both pump and motor
- b) Nominal flow in m^3/h (Q_{opt})
- c) Manometric head in m (H_{man opt})
- d) Efficiency eta opt in %
- e) Net positive suction head (NPSH req opt) in m
- f) Power consumption, voltage, start-up mode in kW, V
- g) Speed of rotation 1/min

Pumps shall withstand continuous operation at full load (8000 hours/year).

1314. Motors

Characteristics

The motors will be continuous duty of squirrel cage type, designed with continuous duty. Motors will be equipped with PT 100 in the winding and the bearings. The speed of the motors shall be 1450rpm.

The motors will have “F” insulation class, “B” temperature rise class and IP54 protection degree.

Conditions of operation

The supply voltage of the motors may vary by plus or minus five percent.

Nominal motor capacity in continuous operation at a frequency of 50 Hz and with an effective ambient temperature of 55 °C will be at least 10 % greater than the maximum power intake of the pump throughout the range of lift height.

The service factor of the motors shall be 1.15.

Motors will be designed for at least six starts per hour.

Each set will be fitted with an hour-meter and an operation meter with no zero resetting devices in order to check the values above.

Name Plates on Motors

Manufacturer's name plates on electric motors shall contain at least the following information:

- a) Manufacturer
- b) Type, serial number
- c) Year of manufacture
- d) Rated power (kW)
- e) Power factor
- f) Efficiency (%)
- g) Voltage (V), type of starting
- h) No. of Phases
- i) Degree of protection
- j) Frequency (HZ)
- k) Synchronous speed (rpm)
- l) Rated current insulation class
- m) Rated current
- n) Insulation Class

STANDARD REFERENCE NUMBERS

1. Introduction

The Engineer has agreed to use a method of modifying the text of 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 ing.

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

Where Standard Specifications are referred to in the Text of the Specifications this is done by reference to a Standard Specification Reference Number (SRN). A table of comparison is annexed to this Specification where the SRN is cross-referenced to Standard Specifications issued by the International Standards Organization (ISO) and to National Standard Specification that will be accepted in their English version by the Engineer as providing for the quality of workmanship etc. required.

The Bidder shall at his discretion base his Bid on one or other of the National Standard Specifications indicated in that table save that where a relevant Standard Specification issued by the ISO exists at the date of Bid, such an International Standard should as a minimum be compiled with. As the National Standards referred to in the table of comparison may expand on or strengthen further the requirements of ISO, Bidders choosing not to comply with one of the National Standards indicated may either indicate an alternative National Standard with which they shall comply or provide with their Bid a full and detailed description of the Standards they propose to attain.

Where a Bidder offers a particular item to a National Standard not specified in the table of comparison he shall comply with the requirements of the Instructions to Bidders in this respect and shall enclose a copy in English of the alternative National Standard offered with his Bid. Alternative National Standards or Bid'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 (exclu. In-situ Concrete)
900-999	EMiscellaneous

3.1 CONCRETE

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
100	METHOD FOR SPECIFYING CONCRETE	1045	TBL. 1	5328	TBL. 3	KS 02-594	
101	STANDARD OF MATERIAL & WORK - GENERAL	See	VOB	8110		VOB 2	
102	STANDARDS OF MATERIAL, WATER RETAINING STRUCTURES		SUB. NO.	8007			
103	ORDINARY PORTLAND CEMENT	1164	1	12		KS 02-1262 & KS 02-1263	
104	SULPHATE RESISTANT CEMENT	1164	1:CL. 4	4027			
105	MORTAR CUBES - COMPRESSIVE STRENGTH	1164	1:CL. 4-4	12	METHOD 2 CL.7.3	ISO 3893	
106	CEMENT - TEST FOR SOUNDNESS		6, EN.112	12	CL.9		
107	SAMPLING AND TESTING OF AGGREGATES	4226	1-4	812	1, 2, 3	BS EN 1097-3 BS EN 932-1	BS 812 Part 1 Replaced by BS 882 Part 2 Replaced by BS EN 1097-3 Part 102 Replaced by BS EN 932-1 but remains current
107	SAMPLING AND TESTING OF AGGREGATES (CONT.)	1045		812	101-119		
108	FINE AGGREGATE FOR CONCRETE - GENERAL	4226	1-4	882	CL.4.1		
108	FINE AGGREGATE FOR CONCRETE - GENERAL (CONT.)	1045					
109	FINE AGGREGATE FOR CONCRETE - GRADING	4226	1-4	882	TBL.2		
110	COARSE AGGREGATES FOR CONCRETE - GENERAL	4226		882	CL.4.1		
110	COARSE AGGREGATES FOR CONCRETE - GENERAL (CONT.)	1045					
111	COARSE AGGREGATES FOR CONCRETE - GRADING	4226		882	TBL.2		
111	COARSE AGGREGATES FOR CONCRETE - GRADING (CONT.)	1045					
112	COARSE AGGREGATES FOR CONCRETE - SHRINKAGE & ABSORPTION	4226		812	2	ISO 6783 BS EN 1367	BS 812 Part 120 Replaced by BS EN 1367 but remains current
112	COARSE AGGREGATES FOR CONCRETE - SHRINKAGE & ABSORPTION (CONT.)	1045					
113	COARSE AGGREGATES FOR CONCRETE - FLAKINESS	4226		812	105.1		
113	COARSE AGGREGATES FOR CONCRETE - FLAKINESS (CONT.)	1045					
114	WATER FOR MAKING CONCRETE	4226		3148			
114	WATER FOR MAKING CONCRETE (CONT. 1)	4030					
114	WATER FOR MAKING CONCRETE (CONT. 2)						
115	CONCRETE MIX DESIGN - GENERAL			5328			
115	CONCRETE MIX DESIGN - GENERAL (CONT.)	1084	1				
116	TRIAL MIXES - CUBES	1048		1881	108		
117	SAMPLING & TESTING OF CONCRETE	1048		1881	5, 114, 121, 122	ISO 1920, 4012, 4108, 4013	
118	CONCRETE BATCH MIXER			1305			BS 1305 Obsolescent
119	CONCRETE BATCH TYPE MIXERS	459		3963			BS 3963 Obsolescent
120	STRUCTURAL USE OF R/C IN BUILDING	1045		8110	1		
121	CONCRETE TRUCK-MOUNTED MIXERS	1084	3	4251	Withdrawn		BS 4251 Withdrawn
122	BITUMEN RUBBER JOINT SEALING COMPOUND			2499	TYPE A1		
123	POLYSULPHIDE JOINT SEALING COMPOUND			4254			BS 4254 Obsolescent
124	WATERPROOF BUILDING PAPERS			1521	(CLASS B)		
125	IMPACT TESTING OF MILD STEEL	488	3	7613 7668	Grade NDI, CL.B		BS 4360 Withdrawn. Replaced by BS 7613, BS 7668, BS EN 10029 Parts 1 to 3 of BS EN 10113, BS EN 10155, BS EN 10210-1
126	STEEL R/F HOT-ROLLED STEEL BARS	488	1-3	4449			
127	STEEL R/F COLD TWISTED	488	1-3	4449			
128	STEEL R/F STEEL FABRIC	488	4-5	4483			
129	BAR REINFORCEMENT AND BENDING			4466			
130	SAND FOR INTERNAL PLASTERING	4226		1199			
131	PLYWOOD SHUTTERING	68791		6566	1-8		BS 6566 Withdrawn. Replaced by various BS EN standards on the same subject
131	PLYWOOD SHUTTERING (CONT.)	68792					
132	CONCRETE COMPACTION	4235	1,2				
133	CONCRETE - SITE QUALITY CONTROL	1084	1				
134	DESIGN OF CONCRETE MIXES	52171		See HMSO		HMSO RD NOTE 4	
135	SAND FOR MORTAR	4226		1200			
136	SAND FOR RENDERING	4226		1199			
137	HOT APPLIED JOINT SEALER			2499			
138	WATER STOPS AND WATER BARS	7865	1, 2	8007			

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
139	TESTING CONCRETE STATIC MODULES (COMPARISON ELASTICITY)			1881	121		
140	TESTING CONCRETE - WATER ABSORPTION			1881	122		
141	TESTING CON-SAMPLING, TESTING FRESH CONCRETE, ETC.	1048		1881	101-110 & 113	KS 02-595 : 1-8	
142	PRECAST CONCRETE COMPONENTS (COPING UNITS)			5642/2	2		
143	STRUCTURAL USE OF CONCRETE DESIGN & CONSTRUCTION			8110	1		
144	STRUCTURAL USE OF CONCRETE - SPECIAL CIRC.						
145	IN-SITU CONCRETE DIAPHRAGM WALLS	4126					
146	TEST SIEVES FOR AGGREGATES			410			
147	LIGHT WEIGHT AGGREGATES FOR CONCRETE	4226	2, 3	3797	2		BS 3797 Partly Replaced by BS EN 1744-1: 1998
148	SUPERSULPHATED CEMENT			4248 (4550)			BS 4248 Partly Replaced by Parts and Section of BS 4550
149	CONCRETE ADMIXTURES			5075			
150	GRADUATE MEASURING CYLINDER			604		ISO 4788	
151	COLD REDUCED STEEL WIRE FOR THE REINFORCEMENT OF CONCRETE			4482			
152	FUSION BONDED EPOXY COATED CARBON STEEL BARS FOR THE REINFORCEMENT OF CONCRETE			7295	1 & 2		Part 1: Coated bars Part 2: Coatings

3.2 METALLIC PIPES AND FITTINGS

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
200	GREYCAST IRON PRESSURE PIPES AND FITTINGS			1211		ISO 13; ISO 49	BS 1211 Obsolescent Partially replaced by BS 4772
200	GREY IRON PIPES AND FITTINGS (CONT)			4622		ISO 13	BS 4622 Obsolescent
201	CAST IRON FLANGED PIPES & FITTINGS			2035		ASME/ANSI B16.1 - 1998	BS 2035 Obsolescent Partially replaced by BS 4772
202	DUCTILE IRON PIPES & FITTINGS (WATER)					ISO 2531, EN 545	
202	DUCTILE IRON PIPES & FITTINGS (SEWERAGE)					EN 598	
202	DUCTILE IRON PIPES & FITTINGS (GAS)					EN 969	
203	STEEL TUBES WITH PLAIN OR THREADED ENDS			1387		ISO 65	
203	STEEL TUBES WITH THREADED ENDS (CONT)	2440					
203	STEEL TUBES WITH THREADED ENDS (CONT)	2441					
203	STEEL TUBES WITH THREADED ENDS (CONT)	2442					
203	STEEL TUBES WITH THREADED ENDS-THREADS	76	2	21		ISO 7/1:1982; ISO 7/2:1982	
204	WROUGHT STEEL PIPE FITTINGS TO SSRN 203			1740	1	ISO 4145	
204	TH. STEEL PIPE FITTINGS TO SSRN 203	2980					
204	TH. STEEL PIPE FITTINGS TO SSRN 203-LONG THREAD	2981					
204	TH. STEEL PIPE FITTINGS TO SSRN 203-NIPPLES	2982					
204	TH. STEEL PIPE FITTINGS TO SSRN 203-BENDS	2983					
204	TH. STEEL PIPE FITTINGS TO SSRN 203-TEES ETC.	2987	1, 2				
204	W. STEEL PIPE FITT. TO SSRN 203-BUSHINGS	2990					
204	W. STEEL PIPE FITT. TO SSRN 203-PLUGS & CAPS	2991					
204	TH. STEEL PIPE FITTINGS TO SSRN 203-SOCKETS	2986				ISO 7-2:1982	
204	W. STEEL PIPE FITT. TO SSRN 203-RED'NG SOCKETS	2988					
205	COPPER TUBES FOR WATER					EN 1057, ISO 8493 (TESTS)	
205	COPPER TUBES FOR WATER (CONT)	1754	3				
205	COPPER TUBES FOR WATER (CONT)	1755	3				
206	COPPER TUBES - GENERAL PURPOSE			2871	2	ISO 196:1978	
206	COPPER TUBES - GENERAL PURPOSE (CONT)	1754	1, 2				
206	COPPER TUBES - GENERAL PURPOSE (CONT)	1755	1, 2				
207	FLANGES FOR FERROUS PIPES - STEEL BY PN	2500		4504	3-3.1	ISO 7005-1:1992	BS 4504 Part 3: Sections 3.2 (1989) Withdrawn. Replaced by BS EN 1092-2 (1997)
207	FLANGES FOR FERROUS PIPES - STEEL BY CLASS	2501	1	1560	3-3.1	ISO 7005:1988; ANSI B 16.5	
207	FLANGES FOR FERROUS PIPES - C.I. BY CLASS	2519	1	1560	3-3.2	ISO 7005-2	
207	FLANGES FOR FERROUS PIPES - C.I. BY PN				2	EN 1092, ISO 2531:1991; ISO 7005-2:1988	
207	FLANGES FOR FERROUS PIPES-SLIP ON FOR WELDING	2576					
207	FLANGES FOR FERROUS PIPES-WELDING NECK	2627-38					
207	FLANGES FOR FERROUS PIPES-SCREWED	2566					
207	FLANGES FOR FERROUS PIPES-LAPPED-PLAIN COLLAR	2655-56					
207	FLANGES FOR FERROUS PIPES-LOOSE-WELDING NECK	2673					
207	FLANGES FOR FERROUS PIPES-CONTACT SURFACE	2526					
207	FLANGES FOR FERROUS PIPES-BLANK	2527					
SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS

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 JIS G 3460-88	
210	STEEL PIPES & FITTINGS - DESIGN	2413	1, 2	8010 2.1		AWWA M11	
210	STEEL PIPES & FITTINGS - WELDING JOINTS	2559	1, 2, 3	8010 2.1		AWWA M11 ASTM A333/A333M-99	
211	CEMENT MORTAR LINING - D.I. PIPES			EN 545		EN 545, AWWA C.104A, C602-95	
211	CEMENT MORTAR LINING - D.I. PIPES	2614				DVGW W343 ISO 4179:1985, ISO 6600:1980,	
211	CEMENT MORTAR LINING - D.I. PIPES (CONT)						
212	CEMENT MORTAR LINING - STEEL PIPES	2614		534		AWWA C 205, NFA 49-701DVGW-W343/W346	
212	CEMENT MORTAR LINING - STEEL PIPES (CONT)	2614				AWWA C 602-95 ISO / DIS 8324	
213	S. PIPES & TUBES-MATERIAL, PROP., TESTS	1629		3600		AWWA C200-97	
213	CARBON STEEL PIPES AND TUBES			3601		ISO 2604/2 /3 /6	
213	STEEL PIPES AND TUBES-SPECIAL REQUIREMENTS	1626					
213	STEEL PIPES AND TUBES-SEAMLESS	2448					
213	STEEL PIPES AND TUBES-WELDED	2458					
214	BITUMEN PROTECTION TO IRON AND STEEL - HOT			4147		(BS 4147 type I, grade 'd')	
214	BITUMEN PROTECTION TO IRON AND STEEL- COLD			3416		(BS 3416 type II)	
214	BITUMEN PROTECTION TO STEEL PIPES ETC	30673	Type E4				
214	BITUMEN PROTECTION TO DUCTILE IRON PIPES	30674	4				
215	EXT. PROTECTION - IRON & STEEL-EPOXY C.			none		AWWA C210-97	
216	STEEL FITTINGS - REINFORCING			none		AWWA C208-59 AWWA M11	
216	STEEL FITTINGS - DIMENSIONS			534		AWWA C208-59 AWWA M11	
217	D.I. PIPES & FITT.-SCREWED GLAND JOINTS					See SSRN 219	
218	D.I. PIPES & FITT.-BOLTED GLAND JOINTS					See SSRN 219	
219	D.I. PIPES & FITT.-S & S JOINTS			8010	2-2.1		
219	D.I. PIPES & FITT.-S & S JOINTS (CONT)					EN 545	
219	D.I. PIPES & FITT.-S & S JOINTS (CONT)	28603					
219	PIPELINES ON LAND; DESIGN, CONSTRUCTION AND INSTALLATION: STEEL FOR OIL AND GAS			8010	2.8		
220	D.I. PIPES-ZINC COATING & PROT. SHEATHS	30674	3	none			
221	IRON AND STEEL PIPES-ENAMEL-HOT APPLIED			7873		AWWA C203-97	
221	STEEL FLANGED PIPES & FITTINGS-ENAMELLED	2873					
222	ELASTOMERIC JOINTS RINGS- REQUIREMENTS			2494		Partly replaced by BS 7874 and BS EN 681-1	
222	ELASTOMERIC JOINTS RINGS- VULCANISED RUBBER				1	EN 681	
222	ELASTOMERIC JOINTS RINGS-DRAINS & SEWERS	4060					
223	PIPE THREADS-TUBES & FITT. (WATERTIGHT	See ISO DIN		21		ISO 7/1:1982; ISO 7/2:1982	

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 Obsolete, Partially replaced by BS 4772
225	STEEL PIPES-HOT DIP GALVANISING					EN 10240	
226	CARBON STEEL FITTINGS - BUTT-WELDING-GENERAL	2609		1965	1		BS 1965 Part 2 Withdrawn
226	STEEL FITTINGS - BUTT-WELDING-TEES	2615	1, 2				
226	STEEL FITTINGS - BUTT-WELDING-REDUCERS	2616	1, 2				
226	STEEL FITTINGS - BUTT-WELDING-CAPS	2617					
227	POLYTHENE SLEEVING FOR STEEL PIPES & FITTINGS	none		none		ISO 8180:1985	
227	POLYTHENE SLEEVING FOR D. I. PIPES	30674	5				
228	ST. PIPES-DIMENSION & MASSES-PRESS. PURPOSE	2413	1, 2	3600			
228	S. PIPES-DIMENSION & MASSES-PRESS. (CONT)	2460					
229	STAINLESS STEEL TUBES AND WIRES			1554			
229	STAINLESS STEEL TUBES AND WIRES (CONT)			4825	1	ISO 2037:1980	
229	STAINLESS STEEL TUBES AND WIRES (CONT)			6362		ISO 7598	
229	STAINLESS STEEL TUBES AND WIRES (CONT)	17457					
229	STAINLESS STEEL TUBES AND WIRES (CONT)	17440					
230	STEEL PIPES FOR WATER FLEXIBLE SOCKET & SPIGOT JOINTS	2460		CP2010-2		EN 10224, ISO 559	
230	STEEL PIPES FOR WATER FLEXIBLE SOCKET & SPIGOT JOINTS	2460		CP2010-2		EN 10224, AWWA C200-97	
231	FERROUS P. DEFINITION OF NOMINAL PRESSURE			none		ISO 7268:1983	
232	STEEL PIPELINES - TAPE COATING SYSTEMS	30672	1	none		AWWA C214-95	
233	BURSTING DISCS & DEVICES			2915		ISO 6718:1991	
234	STEEL PIPES FOR PETROLEUM AND GAS INDUSTRY	17172				EN 10208-2, API 5L	
235	FITTINGS TO STAINLESS STEEL TUBES			4825	2	ISO 2851:1973	
235	FITTINGS TO STAINLESS STEEL TUBES (CONT)			4825	3	ISO 2852:1974	
235	FITTINGS TO STAINLESS STEEL TUBES (CONT)			4825	4	ISO 2853:1976	
235	FITTINGS TO STAINLESS STEEL TUBES (CONT)			4825	5		
236	FITTINGS TO BRASS TUBES			2051	1		
237	RUBBER GASKET MATERIAL JOINTS FOR PIPELINES			2494		ISO 4633; ISO 6447; ISO 6448	
238	STORAGE OF VULCANISED RUBBER			none		ISO 2230:1973	
239	BITUMINOUS VARNISH TO DUCTILE IRON PIPES			none		ISO 8179-2:1995	
240	FOUNDRY - SPHEROIDAL GRAPHITE CAST IRON					EN 1563	
240	FOUNDRY - AUSTEMPERED DUCTILE IRON CASTINGS					EN 1564	
241	FUSION BONDED EPOXY COATINGS FOR STEEL PIPES	30671		none		EN 10309, AWWA C213, NFA 49-706	
241	FUSION BONDED EPOXY LININGS FOR STEEL PIPES					AWWA C213	
242	FLEXIBLE BOLTED SLEEVE COUPLINGS			534		AWWA C219	
243	FLEXIBLE GROOVED AND SHOULDERED COUPLINGS					AWWA C606	
244	SPHERICAL JOINTS FOR WELDING, STEEL PIPES			534		UNI 6363	
245	BIT. SEAL COATGS ON D.I. PIPE CEM. MOR. LINING			7892			
246	POLYMERIC FILM PROT. SLEEVG FOR IRON PIPES	30674	5	6076		EN 534	
247	HOT ENAMEL COATING TO IRON & STEEL PIPES			7873			
248	EXTERNAL ZINC COATINGS ON DI PIPES	2444		none		ISO 8179-1:1995	
249	BOLTS & NUTS FOR PIPELINES	2507		none			
250	STEEL PIPELINES - THERMOSET PLASTIC COATINGS	30671		BGC/CW6		AWWA C213, NFA 49-706	

251	STEEL PIPES - POLYPROPYLENE COATING	30678		none		EN 10286, NFA 49-711	
252	STEEL TUBES - ELECTROMAGNETIC TESTING - LEAKS				1	EN 10246	
253	TWO & THREE LAYER POLYTHENE COATINGS FOR STEEL PIPES	30670		534		AWWA C215, NFA 49-704, NFA 49-710	
254	LIQUID EPOXY COATINGS FOR STEEL PIPES					AWWA C210	
255	LIQUID EPOXY LININGS FOR STEEL PIPES					AWWA C210, NFA 49-709	
256	LIQUID POLYURETHANE COATINGS FOR STEEL PIPES	30671				AWWA C222	
257	LIQUID POLYURETHANE LININGS FOR STEEL PIPES					AWWA C222, NFA 49-709	
258	EXTRUDED POLYTHENE COATINGS FOR D.I. PIPES	30674	1	EN 545		EN 545	
259	CEMENT MORTAR COATINGS FOR D.I. PIPES	30674	2				
260	LIQUID EPOXY COATINGS FOR D.I. PIPES			EN 545		EN 545	
261	FUSION BONDED EPOXY COATINGS & LININGS FOR D.I. FITTINGS					AWWA C116	
262	LIQUID POLYURETHANE COATINGS FOR D.I. PIPES			EN 545		EN 545	
263	LIQUID POLYURETHANE LININGS FOR D.I. PIPES			EN 545		EN 545	
264	TWO LAYER EPOXY-NYLON COATINGS & LININGS FOR STEEL PIPES					EN 10310, AWWA C224	

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 (CONT. 2)					ISO 161/1	
300	uPVC PIPES FOR COLD WATER (CONT. 3)					KEBS 06-149:2	
301	JOINTS AND FITTINGS FOR uPVC PRESSURE PIPES	8063	1, 12	4346	1-3	ISO 2035, 2044	
301	JOINTS AND FITTINGS FOR uPVC PRESSURE PIPES (CONT. 1)	16450				ISO 2045, 2048, 2536	
301	JOINTS AND FITTINGS FOR uPVC PRESSURE PIPES (CONT. 2)	16451					
302	uPVC PIPELINES - LAYING AND JOINTING	16928		See CP		CP 312	
303	uPVC PIPELINES - PRESSURE TESTING	4279	1, 7				
304	uPVC PIPELINES - ADHESIVES FOR JOINTING	16970					
305	uPVC PIPES - GENERAL	8061		3505			
305	uPVC PIPES - GENERAL (CONT. 1)	8062		3506			
305	uPVC PIPES - GENERAL (CONT. 2)	19532					
306	uPVC PIPES - PRESSURE TESTS TO DESTRUCTION			4728		ISO 1167	Obsolescent (but still remains current) Replaced by BS EN 921 and partially replaced by BS EN 2782 Part II method 1127P - 1997 but remains current
307	HDPE PIPES, JOINTS, FITTINGS	16963	1-3	3284 (6572) (6730)			Obsolescent - Partially replaced by BS 6572, BS 6730
308	RUBBER RINGS FOR MECHANICAL JOINTS			2494			
309	uPVC UNDERGROUND DRAIN PIPES & FITTINGS			4660			Partially replaced by BS EN 1401-1
310	uPVC PIPES IMPACT TEST 20 DEGREES CENTIGRADE			3505		ISO 3127	
311	uPVC PIPES SHORT TERM HYDROSTATIC TEST			3505			
312	uPVC PIPES LONG TERM HYDROSTATIC TEST			3505			
313	uPVC PIPES INTERNAL PRESSURE ENDURANCE TEST	8061					
314	uPVC WATER ABSORPTION TEST	8061				ISO 2508	
315	uPVC PIPES - VARIOUS OTHER TESTS					ISO 2505, 3114, 3472, 3473, 3474	
316	PIPES - RATE OF LEAKAGE			8010:2			
317	G.R.P. PIPES			6464			
318	PLASTICS PIPES AND FITTINGS FOR USE AS SUB SOIL FIELD DRAINS			4962			
318	POLYPROPYLENE WASTE PIPE AND FITTINGS (EXTERNAL DIAMETER 34.6MM, 41.0MM AND 54.1MM)			5254			
319	THERMOPLASTICS WASTE PIPE AND FITTINGS			5255			
320	GLASS REINFORCED PLASTICS (GRP) PIPES, JOINTS AND FITTINGS FOR USE FOR WATER SUPPLY OR SEWERAGE			5480			
321	UNPLASTICIZED PVC PIPE AND FITTINGS FOR GRAVITY SEWERS			5481			
322	PLASTICS PIPEWORK (THERMOPLASTICS MATERIALS)			5955	6		Part 6: Installation of unplasticized PVC pipework for gravity drains and sewers
323	BLUE POLYETHYLENE PIPES UP TO NOMINAL SIZE 63 FOR BELOW GROUND USE FOR POTABLE WATER			6572			
324	BLACK POLYETHYLENE PIPES UP TO NOMINAL SIZE 63 FOR ABOVE GROUND USE FOR COLD POTABLE WATER			6730			

3.4 **OTHER PIPES AND FITTINGS**

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
401	ASBESTOS CEMENT (A/C) PRESSURE PIPES	19800	1-3	486		ISO 160 BS EN 512	BS 486 Withdrawn Replaced by BS EN 512
401	ASBESTOS CEMENT (A/C) PRESSURE PIPES (CONT.)			4624			
402	A/C SEWER PIPES, JOINTS, FITTINGS			3656		ISO 881 BS EN 588-1	BS 3656 Withdrawn Replaced by BS EN 588-1
402	A/C SEWER PIPES, JOINTS, FITTINGS (CONT. 1)						
402	A/C SEWER PIPES, JOINTS, FITTINGS (CONT. 2)	19850	1, 2				
403	A/C PIPES FOR THRUST BORING					ISO 4488	
404	A/C PIPES - GUIDE FOR LAYING			5927		ISO 4482	
405	A/C PIPES - FIELD PRESSURE TESTING	4279	1, 6, 9, 10	5886		ISO 4483	
406	PIPE SUPPORTS	See DVGW		3974	1	DVGW 310 PT. 2	
407	UNREINFORCED CONCRETE PIPES (OGEE)	4032		5911	3		
408	PRESTRESSED CONCRETE PRESSURE PIPES	4035		4625			
409	PRECAST CONCRETE PIPES - DRAINS & SEWERS	4032		5911	1, 3		
409	PRECAST CONCRETE PIPES - DRAINS & SEWERS (CONT.)	4035					
410	CONCRETE POROUS PIPES - UNDER DRAINS			5911	114		
411	NON-PRESSURE DUCTILE IRON PIPES ETC.					ISO 7186	
412	RUBBER AND PLASTIC HOSES AND ASSEMBLIES					ISO 7751	
413	CONCRETE CYLINDRICAL PIPES & FITTINGS METRIC			5911	1-3	AWWA C602-83	BS 5911 Part I: 1981 Withdrawn Replaced by BS 5911 Part 100: 1988 BS 5911 Part 200: 1989 BS 5911 Part 200: 1994
414	CLAY PIPES (SEWERAGE)			65			
415	TESTING OF JOINTED PIPES AND MANHOLES			2005			BS 2005 - Obsolescent
416	CONCRETE PRESSURE PIPES INCLUDING JOINTS AND FITTINGS						BS EN 639

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 (CONT.)	3352	1, 4				
503	C.I. (PARALLEL SLIDE) GATE VALVES - GENERAL			5151			
504	C.I. GLOBE VALVES - GENERAL	3356	1-5	5152			
505	C.I. CHECK VALVES - GENERAL	3202		5153		AWWA C508-82	
505	C.I. CHECK VALVES - GENERAL (CONT.)	See DVGW		6282	1, 4	DVGW-W376	
506	C.I. AND STEEL BUTTERFLY VALVES - GENERAL	3354	1-4	5155		BS EN 593: 1998	BS 5155 Withdrawn Replaced by BS EN 593.: 1998
507	BOURDON TYPE PRESSURE GAUGES			1780		BS EN 837: 1998	BS 1780 Withdrawn Replaced by BS EN 837-1: 1998
508	FLOAT OPERATED VALVES N.D. 500MM			1212	1, 2, 3		
509	FIRE HYDRANTS	3221	1, 2	750			
510	WATER METERS	19648	1-3	5728	1, 2	ISO 4064-1	BS 5728 Part 1 Withdrawn Replaced by BS 5728: Part 7
510	WATER METERS (CONT.)					KS 06-248 1, 2	
511	COPPER ALLOY GATE, CHECK, ETC. VALVES	3352	11				
511	COPPER ALLOY GATE, CHECK, ETC. VALVES (CONT.)			5154			
512	FIRE HOSE COUPLINGS & EQUIPMENT	14244		336			
513	SURFACE BOXES			5834	2, 3		
513	SURFACE BOXES (CONT. 1)						
513	SURFACE BOXES (CONT. 2)						
513	SURFACE BOXES (CONT. 3)						
513	SURFACE BOXES (CONT. 4)						
514	METALLIC BALL VALVES	3357	1-7				DIN 3357 Part 6, 7 Withdrawn
515	uPVC VALVES	3441	2				
517	FIRE HYDRANT SYSTEMS FOR BUILDINGS			5041	1-5		
518	BUTTERFLY VALVES			5155			
519	DIAPHRAGM VALVES			5156			
520	CAST IRON PLUG VALVES			5158			
521	UNDERGROUND STOPVALVES FOR WATER SERVICES			5433			

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 ING PURPOSE - TEST METHODS	18196		1377			
602	TESTING OF PIPELINE FOR WATER (INTERNAL PRESSURE)	4279	1-7, 9, 10				
603	TESTING OF CEMENT	See EDIN		4550	1, 2, 3	BS EN 196-7 EDIN EN75, 112, 114, 15 ISO 404, EURONORM 21 ISO 4064/3	BS 4550 Part 1 & Part 2 Withdrawn Replaced by BS EN 196-7: 1992
604	MATERIAL TESTING - DOCUMENTATION						
605	MEASUREMENT OF WATER FLOW (WATER METERS)						
606	DRINKING WATER QUALITY - TESTING					KS 05-459.5	
607	RECOMMENDATIONS AND CLASSIFICATION FOR TOPSOIL			3882			
608	METHODS OF TESTING MORTARS, SCREEDS AND PLASTERS			4551			
609	STRUCTURAL FIXINGS IN CONCRETE AND MASONRY			5080	1 & 2		Part 1: Method of test for tensile loading Part 2: Method for determination of resistance to loading in shear
610	SIZE OF HARDWOODS AND METHODS OF MEASUREMENT			5450			
611	RECOMMENDATIONS FOR TESTING OF AGGREGATES			5835	1		Part 1: Compacity 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 Part 3
657	USE OF STRUCTURAL STEEL IN BUILDING	18203	1, 2	449 BS 5950	2	GB 7101-91 SABS 1431	BS 449 Parts 1 and 2 Withdrawn Part 2: Addendum No. 1 (1975) Replaced by BS 5950 Part 5 (1987)
658	SEWERAGE			8005		BS EN 1610	
659	SMALL SEWAGE TREATMENT WORKS AND CESSPOOLS			6297			
660	TEST PUMPING OF WATER WELLS			6316			
661	METHODS OF MEASUREMENT OF LIQUID FLOW IN OPEN CHANNEL			3680	1-10	BS ISO 748 BS ISO 1100-2 ISO TR 8363	BS 3680 Part 3A Withdrawn Replaced by BS ISO 748: 1997 BS 3680 Part 3C Withdrawn Replaced by BS ISO 1100-2 BS 3680 Part 3G Withdrawn Replaced by ISO TR 8363 BS 3680 Parts 3J, 8F, 8G Withdrawn
662	MEASUREMENT OF FLOW IN CLOSED CONDUITS (BY CURRENT METERS OR PITOT STATIC TUBES)					ISO 7194	
663	CONSTRUCTION AND DEMOLITION OF CONCRETE AND MASONRY					ANSI A10, 9-1983	
664	DRAINAGE OF ROOFS AND PAVED AREAS			6367			
665	FOUNDATIONS			8004		CP 2004	CP 2004 Withdrawn Replaced by BS 8004
666	STRUCTURAL USE OF TIMBER			5268		CP 112, 2	CP 112, 2 Withdrawn Replaced by BS 5268 Part 2 BS 5268 Part 3
667	RETAINING WALLS	4085					
668	WATERPROOFING OF BUILDINGS & STRUCTURES	18195	1-4				
669	WATER QUALITY - SAMPLING					ISO 5667/2/3	
670	WELDING PROCEDURES - APPROVAL TESTING			4870	1	BS EN 288-3 BS EN 288-4	BS 4870 Part 1 Withdrawn Replaced by BS EN 288-3 BS 4870 Part 2 Withdrawn Replaced by BS EN 288-4
671	WELDING - APPROVAL TESTING			4871	1	BS EN 287-1 BS EN 287-2	BS 4871 Part 1 Withdrawn Replaced by BS EN 287-1 BS 4871 Part 2 Withdrawn Replaced by BS EN 287-2
672	LOGGING OF ROCK CORES					LOGGING OF ROCK CORES FOR ING PURPOSES, GEOL. SOC. OF LONDON	
673	TEST FOR STABILISED SOILS			1924			
674	DRAIN AND SEWER SYSTEMS OUTSIDE BUILDINGS				1, 2 & 3	BS EN 752	Part 1: Generalities and definitions Part 2: Performance requirements Part 3: Planning
675	CONSTRUCTION AND TESTING OF DRAINS AND SEWERS					BS EN 1610	
676	IDENTIFICATION OF PIPELINES AND SERVICES			1710			
677	WELDING OF STEEL PIPELINES ON LAND AND OFFSHORE			4515			
678	PERFORMANCE REQUIREMENTS FOR JOINTS AND COMPRESSION FITTINGS FOR USE WITH POLYETHYLENE PIPES			5114			
679	STRUCTURAL USE OF TIMBER			5268	2, 3 & 5		Part 2: Permissible stress design, materials and workmanship Part 3: Trussed rafter roof Part 5: Preservative treatment of structural timber
680	STAIRS, LADDERS AND WALKWAYS			5395	1, 2 & 3		Part 1: Design of straight stairs Part 2: Design of helical and spiral stairs

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
							Part 3: Design of industrial type stairs, permanent ladder and walkways
681	INTERNAL PLASTERING			5492			
682	GUIDE TO ACCURACY IN BUILDING			5606			
683	SAFE USE OF EXPLOSIVES IN THE CONSTRUCTION INDUSTRY			5607			
683	USE OF MASONRY			5628	3		Part 3: Materials and components, design and workmanship
684	EARTHWORKS			6031			
685	PAINTING OF BUILDINGS			6150			
686	LOADING FOR BUILDINGS			6399	1		Part 1: Dead and imposed loads
687	GUIDE TO INSTALLATION AND USE OF VALVES			6683			
688	DESIGN, INSTALLATION, TESTING AND MAINTENANCE OF SERVICES SUPPLYING WATER FOR DOMESTIC USE WITHIN BUILDINGS AND THEIR CURTILAGES			6700			
689	GUIDE FOR STRUCTURAL DESIGN OF PAVEMENTS CONSTRUCTED WITH CLAY OR CONCRETE BLOCK PAVER			7533			
690	SEWERAGE			8005	1		Part 1: Guide to new sewerage construction
691	PROTECTION OF STRUCTURES AGAINST WATER FROM THE GROUND			8102			
692	DESIGN AND INSTALLATION OF DAMP-PROOF COURSES IN THE MASONRY CONSTRUCTION			8215			
693	CODE OF PRACTICE FOR BUILT-UP FELT ROOFING			8217			

3.8 **DRAWING PRACTICE, STANDARD SYMBOLS ETC.**

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
700	IDENTIFICATION OF PIPELINE ACCORDING TO FLUID CONVEYED	2403					
701	GRAPHICAL SYMBOLS FOR GENERAL ING - PIPING SYSTEMS	2406		1553	1		
701	GRAPHICAL SYMBOLS FOR GENERAL ENGINEERING - PIPING SYSTEMS (CONT.)	2429	1				
702	PROJECT NETWORK TECHNIQUES			4335			
703	DRAWING OFFICE PRACTICE - ARCHITECTS AND BUILDERS			1192	1-4		BS 1192 Part 2 Obsolescent
704	CONSTRUCTION DRAWING PRACTICE			1192	1-4		BS 1192 Part 2 Obsolescent
705	ING DRAWING PRACTICE			308	1	ISO 128, 2162, 2203	
706	DRAWING PRACTICE FOR ING DRAWINGS			5070	1-3	BS EN 61082	BS 5070 Part 1 Partially Replaced by BS EN 61082-1 BS 5070 Part 2 Withdrawn Replaced by BS EN 61082-2
707	BUILDING AND CIVIL ING 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 Respectively but remain current
803	DAMP-PROOF COURSE (BITUMINOUS FELT)			743 (6398: BS 6398, BS 6515 and BS 8215)			BS 743 Partially Replaced by
804	CONCRETE BLOCKS			6398		KENYA M.O.W. ST. SPEC.	
804	CONCRETE BLOCKS (CONT.)			6073	1, 2		BS 6073 Partially Replaced by BS EN 772-2
805	HOLLOW CLAY PARTITION BLOCKS	278		3921			BS 3921 Partially Replaced by BS EN 772-3 & 7
806	BRICK WALLING	105	1-5	3921			BS Partially Replaced by BS EN 772-3 & 7
806	BRICK WALLING (CONT.)	106	1, 2	690	3, 4		
807	ASBESTOS ROOF SLATES AND SHEETING						BS 690 Part 3 & 4 Withdrawn Replaced by BS EN 494 and 492 respectively
808	FIXING BOLTS & SCREENS FOR ROOFING						
809	INSULATION BOARD AND HARD BOARD			1142	1, 2, 3	ISO 766/7/9, 818/19, 2695, 3340, 3546, 3729	BS 1142 Partially Replaced by BS EN 120, 310, 316-323, 324: 1 & 2, 325, 382-1 and BS EN 622: 1-5
809	INSULATION BOARD AND HARD BOARD (CONT.)						
810	BLOCKBOARD	68705	1, 3	3444		ISO 1096, 97, 98, 2074, 2426-30	DIN 68705 Part 1 Withdrawn
811	PLYWOOD (TROPICAL HARDWOOD)	4078		6566	1-8	ISO 1096, 1097	BS 6566 Replaced by various BS EN Standards on the same subject
811	PLYWOOD (TROPICAL HARDWOOD) (CONT.)	68705	1, 5			ISO 1098	DIN 68705 Part 1 Withdrawn
812	SEALING OF EXT. WALL JOINTS	18540	SH. 1, 2, 3				
813	CHIPBOARD	68761	4	5669			BS 5669 Part 1 Partially Replaced by BS EN 120, 309, 310, 311, 312, Parts 1-6 and 317 BS 5669 Part 4 Partially Replaced by BS EN 634-2 & BS EN 1328 BS 5669 Part 5 Withdrawn Replaced by BS 7916
813	CHIPBOARD (CONT. 1)	68763					
813	CHIPBOARD (CONT. 2)	68764					
814	LAMINATED PLASTIC SHEETING	16922		3794		BS EN 438	BS 3794 Withdrawn Replaced by BS EN 438 Parts 1 & 2
814	LAMINATED PLASTIC SHEETING (CONT. 1)						
814	LAMINATED PLASTIC SHEETING (CONT. 2)						
815	WOOD WOOL SLABS	1101		1105			BS 1105 Obsolescent
815	WOOD WOOL SLABS (CONT. 1)	1102					
816	QUALITY OF TIMBER - WORKMANSHIP	68141		1186	2		
817	MATERIAL FOR FLUSH DOORS	68706		459			BS 459 Part 3 Withdrawn
817	MATERIAL FOR FLUSH DOORS (CONT. 1)	18101					
817	MATERIAL FOR FLUSH DOORS (CONT. 2)						
818	WATERPROOF ADHESIVE	53255		1203	TYPE MR		
819	STRUCTURAL STEEL & METALWORK			4360 7316 7668		ISO 630, 6891 BS EN 10029: 1-3 BS EN 10113 BS EN 10155 BS EN 10210-1	BS 4360 Withdrawn - Replaced by BS 7316, BS 7668, BS EN 10029 Parts 1 to 3 BS EN 10113, BS EN 10155 and BS EN 10210-1
819	STRUCTURAL STEEL & METALWORK (CONT. 1)					JIS G30101-87	
820	SPLIT RING TIMBER CONNECTORS			1579			
821	METAL WINDOWS			6510			
822	GLASS FOR GLAZING	1249	1	952	1		
822	GLASS FOR GLAZING (CONT.)	18301					
823	GALVANISED M.S. TUBING (MILD STEEL)	2440		1387		ISO 65, 7/1, 7/2	
823	GALVANISED M.S. TUBING (MILD STEEL) (CONT. 1)	2441		21			
823	GALVANISED M.S. TUBING (MILD STEEL) (CONT. 2)	2442					
823	GALVANISED M.S. TUBING (MILD STEEL) (CONT. 3)	2999	1				
824	FITTINGS TO M.S. TUBING MILD STEEL	2460		1256, 143			
824	FITTINGS TO M.S. TUBING MILD STEEL (CONT. 1)			143		BS EN 10242	
824	FITTINGS TO M.S. TUBING MILD STEEL (CONT. 2)			1740	1		

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
825	POLYTHENE TUBING FOR COLD WATER SERVICES	19533		2782		ISO 161-1 BS ISO 4065 BS ISO 11922-1	
825	POLYTHENE TUBING FOR COLD WATER SERVICES (CONT. 1)	8072		6572 6730			
825	POLYTHENE TUBING FOR COLD WATER SERVICES (CONT. 2)	8073					
825	POLYTHENE TUBING FOR COLD WATER SERVICES (CONT. 3)	8075					
825	POLYTHENE TUBING FOR COLD WATER SERVICES (CONT. 4)	8074					
826	BRASSWORK & FITTINGS FOR TAPS & STOP VALVES			1010	2		
827	BALL VALVES FOR CISTERNS			1212	3		
828	PLASTIC FLOATS FOR BALL VALVES			2456			
829	CAST IRON SOIL, WASTE & VENT PIPES			416			
829	CAST IRON SOIL, WASTE & VENT PIPES (CONT. 1)						
829	CAST IRON SOIL, WASTE & VENT PIPES (CONT. 2)						
829	CAST IRON SOIL, WASTE & VENT PIPES (CONT. 3)	19522	1, 2				
830	GALVANISED MILD STEEL COLD WATER TANKS			417	2 CLA		
831	ENAMELLED CAST IRON BATH			1189			
831	ENAMELLED CAST IRON BATH (CONT. 1)						
831	ENAMELLED CAST IRON BATH (CONT. 2)	4774					
832	PILLAR TAPS	7572		1010	2		
833	GLAZED VITREOUS CHINA W.C. PAN	1387		5503			
833	GLAZED VITREOUS CHINA W.C. PAN (CONT.)	1381					
834	HINGED PLASTIC SEAT TO W.C. PAN			1254			
835	GLAZED VITREOUS CHINA LAVATORY BASIN	4462		1188			
835	GLAZED VITREOUS CHINA LAVATORY BASIN (CONT.)			5506	2		
836	STAINLESS STEEL SINK	4465		1244	2		
837	BRASS "S" AND "P" TRAPS			1184			
839	A/C DRAIN PIPES AND FITTINGS	19831		3656		BS EN 588-1	BS 1184 Obsolescent BS 3656 Withdrawn Replaced by BS EN 588-1
839	A/C DRAIN PIPES AND FITTINGS (CONT. 1)	19841					
839	A/C DRAIN PIPES AND FITTINGS (CONT. 2)	19850	1, 2				
840	CONCRETE DRAIN PIPES	See 409		2870			
841	PITCH FIBRE DRAIN PIPES			2760			BS 2760 Withdrawn
842	CAST IRON DRAIN PIPES	19500		437		ISO 6594	
842	CAST IRON DRAIN PIPES (CONT. 1)	19501					
842	CAST IRON DRAIN PIPES (CONT. 2)	19502					
842	CAST IRON DRAIN PIPES (CONT. 3)	19503					
842	CAST IRON DRAIN PIPES (CONT. 4)	19504					
842	CAST IRON DRAIN PIPES (CONT. 5)	19505					
842	CAST IRON DRAIN PIPES (CONT. 6)	19506					
842	CAST IRON DRAIN PIPES (CONT. 7)	19507					
842	CAST IRON DRAIN PIPES (CONT. 8)	19508					
842	CAST IRON DRAIN PIPES (CONT. 9)	19509					
842	CAST IRON DRAIN PIPES (CONT. 10)	195010					
842	CAST IRON DRAIN PIPES (CONT. 11)	195011					
842	CAST IRON DRAIN PIPES (CONT. 12)	195014					
842	CAST IRON DRAIN PIPES (CONT. 13)	195019					
842	CAST IRON DRAIN PIPES (CONT. 14)	19521					
843	JOINTING COMPOUND FOR C.I. DRAIN PIPES			BS 6956	1, 5, 6, 7		
844	C.I. S & S FITTINGS FOR DRAINS	19519		437			
845	STEP-IRONS TO MANHOLES & SEPTIC TANKS	1211	1	1247			
845	STEP-IRONS TO MANHOLES & SEPTIC TANKS (CONT. 1)	1212	1				
845	STEP-IRONS TO MANHOLES & SEPTIC TANKS (CONT. 2)	1213					
845	STEP-IRONS TO MANHOLES & SEPTIC TANKS (CONT. 3)	4281					
846	C.I. MANHOLE COVERS AND FRAMES	1229		497	1	BS EN 124	BS 497 Withdrawn Replaced by BS EN 124
846	C.I. MANHOLE COVERS AND FRAMES (CONT. 1)	4271	1, 3				
846	C.I. MANHOLE COVERS AND FRAMES (CONT. 2)	19593	1, 2, 3				
846	C.I. MANHOLE COVERS AND FRAMES (CONT. 3)	19594	1, 2				
846	C.I. MANHOLE COVERS AND FRAMES (CONT. 4)	19596					

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
846	C.I. MANHOLE COVERS AND FRAMES (CONT. 5)	19597					
847	STEEL LADDERS FOR PERMANENT ACCESS	3620		4211			
848	HANDRAILING	24533		6180			
849	GALVANISED CHAIN LINK FENCING	11991		1722	1		
850	OPEN MESH STEEL FLOORING			4592	1		
851	MASTIC ASPHALT FOR ROOFING			6925			
852	ALUMINIUM FOR LOUVRE WINDOWS			1470		BS EN 485 BS EN 515 BS EN 573	BS 1470 Withdrawn Replaced by BS EN 485 Parts 1-4, BS EN 515, BS EN 573 Parts 1-4
853	FIXING ACCESSORIES FOR BUILDING PURPOSES			1494	1		BS 1494 Part 2 Withdrawn
854	PRECAST CONCRETE MANHOLES	4034		5911	2, 3		BS 5911 Part 1 Withdrawn Replaced by BS 5911 Part 100 (1988) BS 5911 Part 200 (1989) and BS 5911 Part 200 (1994)
855	PRECAST CONCRETE KERBS & CHANNELS	483		7263	1		
856	WATERPROOF BUILDING PAPERS	4122		1521			
856	WATERPROOF BUILDING PAPERS (CONT. 1)	52126					
856	WATERPROOF BUILDING PAPERS (CONT. 2)	52127					
856	WATERPROOF BUILDING PAPERS (CONT. 3)	52128					
856	WATERPROOF BUILDING PAPERS (CONT. 4)	52129					
856	WATERPROOF BUILDING PAPERS (CONT. 5)	52130					
857	METAL TIES FOR CAVITY WALL			1243			
858	A/C BUILDING PRODUCTS (TESTS FOR SHEETS)	274	1-4	4624			
859	PRECAST CONCRETE FLAGSTONES	485		7263	1		
860	ASBESTOS CEMENT RAIN WATER GOODS	19831	1-9	569			
860	ASBESTOS CEMENT RAIN WATER GOODS (CONT. 1)	19841	1-6				
860	ASBESTOS CEMENT RAIN WATER GOODS (CONT. 2)	19850	1				
861	LINTELS - PREFABRICATED			5977	2		
862	uPVC SOIL AND VENT PIPES, FITTINGS, ETC.	1187		4514			
863	STRUCTURAL STEEL IN BUILDINGS			449 (5950)	2		BS 449 Part 2 Withdrawn Replaced by BS 5950 Part 5
864	PROTECTIVE BARRIERS IN AND ABOUT BUILDINGS			6180			
866	BITUMENS FOR BUILDING & CIVIL ING			3690	1, 3		
867	SOLAR WATER HEATERS			6263	2		AS 2813-85
868	FLOORING - INITIAL TREATMENT MAINTENANCE						
869	RIGID FLAT SHEET BUILDING MATERIALS						
870	BUILDING STONE			1438			
871	CAST STONE			1217			
872	WOOD PRESERVATIVES - CREOSOTE			144			
873	WASTE TRAPS - PLASTIC			3943			
874	COPPER FLOATS FOR FLOAT OPERATED VALVES			1968			
875	VITREOUS CHINA SANITARY FITTINGS			3402			
876	PAINTS - LEAD BASED			2523 (5082, 5358)			BS 2523 Obsolescent, Partially Replaced by BS 5082 and BS 5358
877	READY MIXED OIL-BASED PRIMING PAINTS			2521/4 (See 2523)			
878	READY MIXED OIL-BASED UNDERCOATING AND FINISHING PAINTS						
879	COLD POURED SEALING MATEIALS FOR CONCRETE PAVEMENTS			5212			
880	GULLY TOPS AND MANHOLE TOPS FOR VEHICULAR PEDESTRIAN AREAS. DESIGN REQUIREMENTS, TYPE TESTING, MARKING QUALITY CONTROL						BS EN 124
881	STRUCTURAL TIMBER. STRENGTH CLASSES			338			
882	CLAY ROOFING TILES AND FITTINGS			402	1		Part 1: Specification for plain tiles and fittings
883	BITUMEN ROAD EMULSIONS (ANIONIC AND CATIONIC)			434	1		Part 1: Bitumen road emulsions
884	DRESSED NATURAL STONE KERBS, CHANNELS, QUADRANTS AND SETTS			435			
885	CONCRETE ROOFING TILES AND FITTINGS. PRODUCT SPECIFICATION						BS EN 490
886	AIR BRICKS AND GRATINGS FOR WALL			493			

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
	VENTILATION						
887	EAVES GUTTERS AND FITTINGS MADE OF PVC-C					BS EN 607	
888	EAVES GUTTERS AND RAINWATER DOWN-PIPES OF METAL SHEET					BS EN 612	
889	PLYWOOD					BS EN 635	
890	TIMBER IN JOINERY					BS EN 942	
891	PRESSED STEEL GUTTERS, RAINWATER PIPES, FITTINGS AND ACCESSORIES			1091			
892	WC FLUSHING CISTERNS (INCLUDING DUAL FLUSH CISTERNS AND FLUSH PIPES)			1125			
893	NAILS			1202	1, 2 & 3		Part 1: Steel nails Part 2: Copper nails Part 3: Aluminium nails
893	FIXING ACCESSORIES FOR BUILDING PURPOSES			1494	1		Part 1 Fixings for sheet, roof and wall coverings
894	AUTOMATIC FLUSHING CISTERNS FOR URINALS			1876			
895	WASTES (EXCLUDING SKELETON SINK WASTES) AND BATH OVERFLOWS			3380			
896	LIGHTWEIGHT AGGREGATES FOR MASONRY UNITS AND STRUCTURAL CONCRETE			3797			
897	TERRAZO TILES			4131			
898	WELDABLE STRUCTURAL STEELS			4360			
899.1	UNPLASTICIZED POLYVINYL 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 plastics open bar gratings
899.3	READY-MIX BUILDING MORTARS			4721			
899.4	INTERNAL AND EXTERNAL WOOD DOORSETS, DOOR LEAVES AND FRAMES			4787	1		Part 1: Dimensional requirements
899.5	HOT-ROLLED STRUCTURAL STEEL SECTIONS			4848	2 & 4		Part 2: Hot-finished hollow sections Part 4: Equal and unequal angles
899.6	URINALS			4880	1		Part 1: Stainless steel slab urinals
899.7	MORTAR ADMIXTURES			4887	1 & 2		Part 1: Air-entraining (plasticizing) admixtures Part 2: Set retarding admixtures
899.8	SOFTWOOD GRADES FOR STRUCTURAL USE			4978			
899.9	COATED MACADAM FOR ROADS AND OTHER PAVED AREAS			4987	1 & 2		Part 1: Constituent materials and mixtures Part 2: Transport, laying and compaction
899.10	WATER-BORNE PRIMING PAINTS FOR WOODWORK			5082			
899.11	MASONRY CEMENT			5224			
899.12	EXTERNAL RENDERINGS			5262			
899.13	SOLVENT-BORNE PRIMING PAINTS FOR WOODWORK			5358			
899.14	WALL AND FLOOR TILING			5385	1, 2, 3, 4 & 5		Part 1: Design and installation of internal ceramic wall tiling and mosaics in normal conditions Part 2: Design and installation of external ceramic wall tiling and mosaics (including terra cotta and faience tiles) Part 3: Design and installation of ceramic floor tiles and mosaics Part 4: Tiling and mosaics in specific conditions Part 5: Design and installation of terrazzo tile and slab, natural stone and composition block floorings
899.15	STONE MASONRY			5390			
899.16	SPECIFICATION FOR LOW-RESISTANCE SINGLE TAPS AND COMBINATION TAP ASSEMBLIES (NOMINAL SIZE 1/2 AND 3/4) 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 dimensions

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
899.1 8	VITREOUS CHINA BOWL URINALS (RIMLESS TYPE)			5520			
899.1 9	PRESERVATION OF TIMBER			5589			
899.2 0	PLASTIC CONNECTORS FOR USE WITH HORIZONTAL OUTLET VITREOUS CHINA WC PANS			5627			
899.2 1	STILES, BRIDLE GATES AND KISSING GATES			5709			
899.2 2	GLAZING FOR BUILDINGS			6262			
899.2 3	MANUFACTURE OF GLUED STRUCTURAL COMPONENTS FOR TIMBER AND WOOD BASED PANEL PRODUCTS			6446			
899.2 4	POLYETHYLENE DAMP-PROOF COURSES FOR MASONRY			6515			
899.2 5	INSTALLATION OF CHMICAL DAMP- PROOF COURSES			6576			
899.2 6	PORTLAND PULVERIZED-FUEL ASH CEMENTS			6588			
899.2 7	PRECAST CONCRETE PAVING BLOCKS			6717	1		Part 1: Paving blocks
899.2 8	EXTERIOR WOOD COATING SYSTEMS			6952	1		Part 1: Guide to classification and selection
899.2 9	PRECAST CONCRETE FLAGS, KERBS, CHANNELS, EDGINGS AND QUADRANTS			7263	1 & 2		Part 1: Specification Part 2: Code of practice for laying
899.3 0	IN-SITU FLOORINGS			8204	2		Part 2: Concrete wearing surfaces

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 and BS IEC 1008-2-2
007	FUSE SWITCHES (AIR BREAK)			5419		IEC 408	BS 5419 Withdrawn Replaced by BS EN 60947-3
008	MOTOR STARTERS AND CONTROLLERS	46062		587			BS 587 Withdrawn Replaced by BS EN 60947-4-1 and BS 5856-1
009	MOTOR STARTERS ABOVE 1000 V.A.C.			5856	1	IEC 60632-1	
010	ELECTRIC MOTOR DIMENSIONS	42673	BL. 1-4	4999	10	IEC 60072, 72A	
011	INDUCTION MOTORS FOR GENERAL PURPOSE	42673	BL. 1-4	5000	10	IEC 60072	
012	ENCLOSURE PROTECTION SWITCH / CONTROL GEAR	40050	BL. 2, 6, 9, 10	5420		IEC 60144 (IP32)	BS 5420 Withdrawn Replaced by BS EN 60947-1
013	MOTOR STARTERS NOT EXC. 1000 V.A.C.	46062		4941	1, 3, 4	IEC 292, 1, 2, 3, 4	BS 4941 Withdrawn Replaced by BS EN 60947-4-1
014	ELECTRICITY METERS			37	1, 5, 8		BS 37 Withdrawn Replaced by Parts 1-4 of BS 5685
015	WATT-HOUR METERS			5685		IEC 521	BS 5685 Part 1 (1979) and Parts 2, 3 & 4 (1986) all Obsolescent
016	ACCEPTANCE TESTS FOR PUMPS (CLASS C)	4325		5316	1	ISO 2548 IEC 198	
017	ACCEPTANCE TESTS FOR PUMPS (CLASS B)	4325		5316	2	ISO 3555 IEC 198	
018	CODE OF PRACTICE, ELECTRICAL WIRING					IEE W. REGS (15 th ED)	
019	ELECTRICAL PROTECTIVE RELAYS			142			BS 142 Part 1 Section 1.5 Sub-Section 1.5.1 - 1.5.3 all renumbered as BS 60255-21-1, 2, 3 respectively
020	FACTORY BUILT SWITCHGEAR ASSEMBLIES	57670	TL. 6	5486	1, 2, 3, 13	IEC 439-2	BS 5486 Part 1 Withdrawn Replaced by BS EN 60439-1
021	RECIPROCATING INT/COMB. ENGINES			5514	1, 2	ISO 3046, PT. 1, 2	BS 5541 Part 2 (1988) 'Test Methods' Withdrawn - Replaced by BS 5514 Part 1 (1996)
022	MACHINES FOR MISCELLANEOUS APPLICATIONS			5000	99		
023	INSULATING MATERIALS FOR ELECTRICAL MACHINES			2757		IEC 85	
024	PVC INSULATED CABLES NOT EXCEEDING 1900 V.A.C.	57207	4, 5	6346			
025	ROTATING ELECTRICAL MACHINES - GENERAL			4999	1, 2, 3	IEC 34-1, 34-8, 72, 72A	Renumbered as EN 60034-4
026	CONCRETE CABLE COVERS			2484			BS 2484 Obsolescent
027	ELECTRIC POWER SWITCHGEAR (LOW VOL. N.E. 1kV)	57660		5486 5727 7354			
028	SAFETY ISOLATING TRANSFORMERS			3535			
029	ROTATING ELECTRICAL MACHINES - RATING PLATES	42961		4999	4	IEC 60034-1	
030	ROTATING ELECTRICAL MACHINES - ENCLOSURES	40050		4999	20	IEC 60035-5	
031	ROTATING ELECTRICAL MACHINES - CONDITIONS			4999	31	IEC 60034-1	
032	ROTATING ELECTRICAL MACHINES - TEMPERATURE LIMITS	See E DIN		4999	32	IEC 60034-1 E DIN	
033	ROTATING ELECTRICAL MACHINES - VIBRATION	See DIN ISO		4999	50	ISO 2373	
034	ROTATING ELECTRICAL MACHINES - TESTS			4999	60	IEC 60034-1	
035	GENERATORS DRIVEN BY I/C ENGINES	See VDMA		5000	3	VDMA 6280	
036	MACHINES WITH FLAMEPROOF ENCLOSURES	22418		5000	17		
037	MAINTENANCE OF ELECTRICAL SWITCHGEAR (V.N.E. 14 kV)			6626			
038	PROTECTION PROVIDED BY ENCLOSURES (CLASS N OF DEG.)			5490		IEC 600529, BS EN 60529	BS 5490 Withdrawn Replaced by BS EN 60529
039	ELECTRICAL EQUIPMENT OF INDUSTRIAL MACHINES			2771		EN 60204, Part 1	BS 2771 Part 1 Replaced by EN 60204-1 (1993) but remains current for use as a reference standard for BS EN 60204-3-1: 1992
040	SWITCHGEAR AND CONTROL GEAR UPTO 1000V			4752		IEC 600157-1, 600157-1A	BS 4752 Withdrawn Replaced by BS EN 60947-2
041	PVC INSULATED CABLES FOR SWITCHES AND CONTROL GEAR			6231			

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
042	BASIC ENVIRONMENTAL TESTING PROCEDURES			2011	1.1	IEC 60068-1	BS 2011 Parts Withdrawn and Replaced by Parts of BS EN 60068
043	DEFINITIONS AND GENERAL REQUIREMENTS					IEC 60051-1	
044	PANEL MOUNTED INSTRUMENTS - DIMENSIONS					IEC 600473	
045	CELLULOSIC PAPERS FOR ELECTRICAL PURPOSES			5626	1, 2, 3	IEC 600554	
046	COMMISSIONING, OPERATION AND MAINTENANCE OF STORAGE PUMPS					IEC 600805	
047	RUBBER INSULATED CABLES					IEC 600245	
048	VOLTAGE FLUCTUATION LIMITS - GUIDE					IEC 600827	
049	ELECTRIC CABLES - ARMOURING - WIRE FOR					KS 04-290	
050	ROTATING ELECTRICAL MACHINES FOR HAZARDOUS AREAS ("N")			5000	16		
051	POWER TRANSFORMERS - GENERAL					BS EN 60076-1	
052	ELECTRIC CONDUIT - STEEL			4568	2		
053	BUS BARS			159			
054	NON-METALLIC CONDUITS			4607 (6099)	2		Partially Replaced by BS 6099 Part 1 and BS 6099 Section 2.2
055	PVC CABLES IN CONDUITS			6004			
056	INSULATED FLEXIBLE CORD			6500			
057	M.I.C.C. CABLES			4782	1		
058	FLUSH SWITCHES			3676			
059	ELECTRIC SOCKETS			1363			Part 3: 1989 Replaced by BS 1363 Part 3 (1995) but remains current
060	FUSED SPUR BOXES			1362			
061	CONTACTORS			775			Part 1 (1969) Withdrawn Replaced by BS 5424: Part 1 1977
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 BS EN ISO 12944
901	METALLIC ZINC RICH PRIMER			4652			
902	COLOUR OF FINISH (BUILDING MATERIALS)	See VOB		4800		VOB pt. C	
903	HOT DIP GALVANIZING ON IRON & STEEL			729		ISO 1459	
903	HOT DIP GALVANIZING ON IRON & STEEL (CONT.)			5493		ISO 1461 BS EN ISO 12944	BS 5493 Proposed for Obsolescence Partially Replaced by Parts 1-8 of BS EN ISO 12944
904	BLACK BITUMEN SOLUTION (COLD APP.) FOR WATER TANKS		See DVGW	3416	TYPE II	DVGW-GWS	
905	WELDABLE STRUCTURAL STEELS	1025	1-5	4360		ISO 630	BS 4360 Withdrawn - Replaced by BS 7613, BS 7668, BS EN 10113, BS EN 10155 & BS EN 10210
906	CLASSIFICATION OF GREY CAST IRON			1452		ISO 185	BS 1452 Withdrawn Replaced by BS EN 1561
907	BEARING DESIGN LIFE						
908	BITUMEN - HOT APPLIED - COATINGS FOR IRON AND STEEL	30673		4147			
908	BITUMEN - HOT APPLIED - COATINGS FOR IRON AND STEEL (CONT.)			5493			
909	PRESSED STEEL RECTANGULAR TANKS			1564			
910	GREY IRON CASTINGS FOR MANHOLE COVERS			1452	GRADE 10		
911	MALLEABLE CAST IRON			6681		ISO 5922	BS 6681 Withdrawn - Replaced by BS EN 1562
911	MALLEABLE CAST IRON (CONT.)					ASTM A 47-77	
912	ROLLED STEEL			4360		ISO 630	BS 4360 Withdrawn - Replaced by BS 7613, BS 7668, BS EN 10113, BS EN 10155 & BS EN 10210
912	ROLLED STEEL (CONT.)						
913	STRUCTURAL STEEL SECTIONS	1025	1-5	4	1		BS 4 Part 2 (1969) Withdrawn Replaced by BS 4848 Part 2
914	ISO METRIC BLACK HEXAGONAL BOLTS, SCREWS AND NUTS	267	1, 2	4190		ISO 272, 4759-1, 3	BS 4160 Obsolescent
914	ISO METRIC BLACK HEXAGONAL BOLTS, SCREWS AND NUTS (CONT 1)					ISO 885, 888	
914	ISO METRIC BLACK HEXAGONAL BOLTS, SCREWS AND NUTS (CONT 2)					ISO 898/2, 898/1	
915	SIZES FOR FERROUS & NON-FERROUS BARS			6722			
916	MECHANITE IRON, GRADE E					ASTM A48, No. 308	
917	CORROSION PROTECTION OF STEEL STRUCTURES - GENERAL	55928	1-9	5493		BS EN ISO 12944	BS 5493 Proposed for Obsolescence Partially Replaced by Parts 1-8 of BS EN ISO 12944
918	INGOT ZINC			3436		ISO 752 BS EN 1179 (1996)	BS 3436 Withdrawn Replaced by BS EN 1179 (1996)
919	WELDING OF STEELS (METAL ARC)	8528	1-2	5135	1		BS 5135 Partially Replaced by BS EN 1011-1 (1998)
919	WELDING OF STEELS (METAL ARC) (CONT 1)	8553		499	1		BS 499 Part Obsolescent / Withdrawn
919	WELDING OF STEELS (METAL ARC) (CONT 2)	8558	1				
919	WELDING OF STEELS (METAL ARC) (CONT 3)	50120	1				
920	STEEL PLATE, SHEET AND STRIP			1449	1 (Withdrawn)	ISO 3573	BS 1499 Parts Withdrawn Replaced by BS EN 10111, 10209, BS EN 10149-2 & 3, 10051, 10131, 10139, 10149-2 & 3, 10048, 10140, 10029, 10258 & 10259
920	STEEL PLATE, SHEET AND STRIP (CONT 1)					ISO 3574	
920	STEEL PLATE, SHEET AND STRIP (CONT 2)						
920	STEEL PLATE, SHEET AND STRIP (CONT 3)						
920	STEEL PLATE, SHEET AND STRIP (CONT 4)						
920	STEEL PLATE, SHEET AND STRIP (CONT 5)						
920	STEEL PLATE, SHEET AND STRIP (CONT 6)	1614					
920	STEEL PLATE, SHEET AND STRIP (CONT 7)	1632	2				
920	STEEL PLATE, SHEET AND STRIP	1624					

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
	(CONT 8)						
921	ELECTROPLATED COATINGS ON THREADS - STANDARD			3382	1-6		
922	ELECTROPLATED COATINGS ON THREADS - THICKENED			3382	7	ISO-DIS 4042	
923	ISO METRIC SCREW THREADS			3643	1-2	ISO 68, 261, 724, 965/1, 965/3, 262	
923	ISO METRIC SCREW THREADS (CONT)					ISO 1106-3, 7438	
924	ISO METRIC PRECISION HEXAGON BOLTS, SCREWS AND NUTS			3692		ISO 887	BS 3692 Obsolescent
925	METAL WASHERS FOR GENERAL ING			4320		ASS 2602: 83 2603: 83 - ISO/12 887	
926	STEEL STRUCTURES - PAINTS FOR POLYURETHANE						
927	SHEAR TEST FOR METALS	50141				APS 650	
928	WELDED STEEL TANKS FOR OIL STORAGE						
929	LIFTING APPLIANCES - OVERHEAD TRAVELLING CRANES					ISO 7752/5	
930	HIGH STRENGTH FRICTION GRIP BOLTS			4325			
931	ELECTRODES FOR MANUAL ARC WELDING			639		BS EN 499	BS 639 Withdrawn Replaced by BS EN 499
932	BLACK CUP COUNTERSUNK BOLTS, SCREWS WITH NUTS			4933			BS 4933 Obsolescent
933	METAL LATHING			1369			
934	ROLLED ASPHALT HOT PROCESS FOR ROADS			594			
935	BINDER DIST. FOR ROAD SURFACE DRESSING			1707			
936	BITUMINOUS ROOFING FELT			747		CP 114: 3	CP 114:3 Withdrawn
937	GAS WELDING			2640			
938	METALLIC COATINGS. HOT DIP GALVANISED COATINGS ON FERROUS MATERIALS					BS EN 1460	
939	METHOD FOR SPECIFYING ELECTROPLATED COATINGS OF ZINC AND CADMIUM ON IRON AND STEEL			1706			
940	DIMENSIONS OF GASKETS FOR PIPE FLANGES TO BS 4504			4865	1		Part 1: Non-metallic flat gaskets (including gaskets for flanges to BS 4722)
941	BONDING AGENTS FOR USE WITH GYPSUM PLASTERS AND CEMENT			5270	1		Part 1: Polyvinyl acetate (PVAC) emulsion bonding agents for indoor use with gypsum building plasters
942	FALSEWORK			5975			
943	TUBULAR POLYETHYLENE FILM FOR USE AS A PROTECTIVE SLEEVING FOR BURIED IRON PIPES AND FITTINGS			6076			
944	FLEXIBLE JOINTS FOR GREY OR DUCTILE CAST IRON DRAINPIPES AND FITTINGS (BS 437) AND FOR DISCHARGE AND VENTILATING PIPES AND FITTINGS (BS 416)			6087			
945	HOT ROLLED PRODUCTS OF NON-ALLOY STRUCTURAL STEELS			10025			
946	STAINLESS STEELS			10088	2		Part 2: Technical delivery conditions for 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 TH 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		

3. ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MONITORING PLAN (ESMMP)

ENVIRONMENTAL & SOCIAL MITIGATION AND MANAGEMENT PLAN (ESMMP)

SCHEDULE A- CONTRACTOR'S RESPONSIBILITIES

Environmental/ Social Impact	Mitigation Action Plan	Responsibility	Phase
Loss of flora and fauna	<ul style="list-style-type: none"> ▪ Site clearance should be limited to the minimum area required for the execution of the works. ▪ The contractor to obtain permits for cutting down of trees within and around the site. ▪ Top soil should be stockpiled separately from the subsoil. After completion of works, the subsoil should be backfilled first then top soil should be restored on top to facilitate natural regeneration of those areas, particularly at the borrow sites/ Rehabilitation and restoration of quarries and borrow pits ▪ 	Contractor Project Resident Engineer/ Supervisor KFS KWS	Construction Phase
Flooding, Siltation and failure of the pressure filters	<ul style="list-style-type: none"> ▪ Planting of trees in the upstream to control any sources of erosion and siltation to the Dam by human activities ▪ Undertake monitoring of the upstream to control siltation and erosion ▪ Take necessary engineering measures to sustain the pressure projected ▪ Mitigate any impacts related to climate change from an engineering perspective. 	Contractor Project Resident Engineer/ Supervisor KFS KWS	Pre- construction Phase Construction Phase
Quarries and borrow pits	<ul style="list-style-type: none"> ▪ Contractor to obtain a separate ESIA license for quarries, his campsites, and borrow pits ▪ Comply with the NEMA Integrated National Land Use Guidelines (<i>Guidelines for Mining and Quarrying</i>), 2011 	Contractor Project Resident Engineer/ Supervisor KFS/ KWS	Construction Phase

Air pollution, Noise and Dust	<ul style="list-style-type: none"> ▪ Comply with NEMA Air and Noise pollution control regulations ▪ Vehicles and other equipment emissions would be kept to a minimum by servicing and maintaining the equipment to manufacturer's specification. ▪ Use protective clothing like helmets and dust masks by construction crew and any other required Personal Protective Equipment (PPEs) ▪ Avoid night time construction when noise is loudest. ▪ Avoid night-time construction using heavy machinery ▪ Construction sites and transportation routes will be water-sprayed on dry and windy days up to three times a day, especially if these sites are near sensitive receptors, such as ecological sites, local villages, or institutions, especially during transportation of materials to the project site. 	Contractor Project Resident Engineer/ Supervisor	Construction Phase
Generation of solid and liquid waste	<ul style="list-style-type: none"> ▪ Compliance to NEMA Waste Management Regulations 2006 ▪ Provide adequate waste disposal facilities. Ensure collection of all solid waste from generation points, safe transportation to a central point where they are sorted out and safely disposed according to type to protect the environmental resources. ▪ Put in place adequate and efficient sanitary facilities for handling liquid waste especially waste water to protect the river from pollution. ▪ Wastewater from residential quarters and offices to be directed to constructed septic tanks for safe handling. ▪ Pit latrines can be used in areas where the other services are not available or feasible 	Contractor Project Resident Engineer/ Supervisor	Construction Phase
Pollution of water resources	<ul style="list-style-type: none"> ▪ Ensure proper measures are in place for collection and disposal of spilled oils and lubricants. ▪ Rehabilitation and restoration/ 	Contractor Project Resident Engineer/ Supervisor	Construction Phase Decommission

	Decommissioning Plans for quarries and borrow pits	Supervisor	ning phase
Health and safety	<ul style="list-style-type: none"> ▪ Full compliance with OSHA, 2007/ comply with operating occupational health and safety law requirements ▪ Provision of Personal Protective Equipment (ear muffs, gloves, dust masks and helmets) for the construction crew ▪ Employ a qualified (graduate level) Environment, Health and Safety officer on site. ▪ Provide First aid kit and appropriate procedures and safety measures ▪ Ensure that all construction machines and equipment are in good working conditions to prevent occupational hazards. ▪ Provide information, education and communication about safe uses of drinking water. ▪ Isolate construction sites from the general public through hoarding and other suitable methods ▪ Provide workers training on safety procedures and emergency response such as fire, oil and chemical spills, pipe bursts and other serious water loss risks. ▪ Develop and implement an HIV/ AIDS sensitization and awareness creation program. Sensitize workers and the surrounding communities on awareness, prevention and management of HIV/AIDS through staff training, quarterly awareness campaigns ▪ Provide condom dispensers at appropriate locations coupled with awareness campaigns to workers and surrounding communities on HIV/AIDS throughout the construction period ▪ Provide enough toilets and other sanitary facilities within the camp ▪ Work to minimize or altogether eliminate mosquito breeding sites. 	Contractor Project Resident Engineer/ Supervisor	Construction Phase

Traffic Accidents and Management	<ul style="list-style-type: none"> ▪ Develop and implement a Traffic Management Plan in the Park ▪ Provide temporary road signs or notices to indicate ongoing works ▪ Strictly follow KWS Park traffic rules ▪ All transport staff (especially drivers) to undergo induction and abide to the traffic rules within the Park ▪ Provide appropriate signage to warn motorists and other road users of the construction activities, diversion routes to ward off traffic accidents. ▪ Communicate any intended disruption of the services to enable the people to prepare, e.g. Power disruptions ▪ In the event that delivery trucks damage parts of the road, repair the spots in consultation with the local authorities. 	Contractor Project Resident Engineer/ Supervisor KWS	Construction Phase
Gender balance and Mainstreaming	<ul style="list-style-type: none"> ▪ Ensure equitable distribution of employment opportunities between men and women ▪ Provide toilets and bathrooms for both male and female workers on site 	Contractor Project Resident Engineer/ Supervisor	<p>Pre-Construction Phase</p> <p>Construction Phase</p>
Increased spread of Sexually Transmitted Diseases (STD) and HIV/AIDs	<ul style="list-style-type: none"> ▪ Develop and implement an STDs, HIV/ AIDs program throughout the project period to protect the workers and local communities from infections from migrant workers ▪ Contractor to create partnership with the County HIV/AIDs control department 	Contractor Project Resident Engineer/ Supervisor	Construction Phase

SCHEDULE B- EMPLOYER'S RESPONSIBILITIES

Environmental / Social Impact	Mitigation Action Plan	Responsibility	Phase
Low river flows during the dry season	<ul style="list-style-type: none"> ▪ Set minimum abstraction rates for dry and wet months (based on hydrological studies) to avoid drying up of the Yamo River downstream especially during the dry seasons 	NWWDA	Construction Phase
Flooding, Siltation and failure of the pressure filters	<ul style="list-style-type: none"> ▪ Mitigate any impacts related to climate change from an engineering perspective. 	NWWDA	Pre-Construction Phase Construction Phase
Quarries and borrow pits	<ul style="list-style-type: none"> ▪ Comply to the NEMA Integrated National Land Use Guidelines (<i>Guidelines for Mining and Quarrying</i>), 2011 	NWWDA	Construction Phase
Gender balance	<ul style="list-style-type: none"> ▪ Ensure equitable distribution of employment opportunities between men and women 	NWWDA	Pre-Construction Phase Construction Phase
Increased spread of Sexually Transmitted Diseases (STD) and HIV/AIDs	<ul style="list-style-type: none"> ▪ Develop an STDs, HIV/ AIDS program throughout the project period to protect the workers and local communities from infections from migrant workers 	NWWDA	Pre-Construction Phase Pre-Construction Phase