

**REPUBLIC OF UGANDA**

**MINISTRY OF WATER AND ENVIRONEMT**

**INTEGRATED WATER MANAGEMENT AND DEVELOPMENT PROJECT**

**PROJECT ID NO: P163782**

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| **EMPLOYER** | **MINISTRY OF WATER AND ENVIRONMENT** |
| **PROJECT** | **NYAMUGASANI WATER SUPPLY SYSTEM** |
| **CONTRACT TITLE** | **CONSTRUCTION OF THE NYAMUGASANI WATER SUPPLY AND SANITATION SYSTEM PHASE 1**  **Lot 1: Nyamuruseghe Intake, Water Treatment Plant, Kyarumba - Kisinga Supply Area** |
| **COUNTRY** | **UGANDA** |
| **LOAN NO.** | **P163782** |
| **RFB NO** | **MWE/WRKS/22-23/00009/1** |

**BIDDING DOCUMENT**

**VOLUME 3 OF 5 – SPECIFICATIONS**

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**CONTENTS**

**SECTION 1: GENERAL AND SPECIFIC SPECIFICATIONS**

**SECTION 2: STANDARD REFERENCE NUMBER**

**SECTION 1**

**GENERAL AND SPECIFIC SPECIFICATIONS**

**GENERAL AND PARTICULAR SPECIFICATIONS**

**TABLE OF CONTENTS**

SECTION 1: GENERAL AND PARTICULAR SPECIFICATIONS i

1. GENERAL 1-1

101. OFFICES FOR THE RESIDENT ENGINEER 1-1

101.(a) PROVISIONS AND CONSUMABLES FOR THE RESIDENT ENGINEER’S OFFICES 1-2

101.(b) STAFF FOR THE RESIDENT ENGINEER’S OFFICES 1-3

101.(c) SURVEY EQUIPMENT 1-3

101.(d) ACCOMMODATION 1-4

102. OFFICE FOR CONTRACTOR 1-4

103. CLIMATE CONDITIONS 1-4

104. LEVEL DATUM 1-4

105. SETTING OUT OF THE WORKS 1-4

106. SOIL TREATMENT 1-5

107. CONTROL OF TRAFFIC 1-5

108. TEMPORARY DIVERSION OF TRAFFIC 1-5

109. TEMPORARY TRAFFIC SIGNS 1-6

110. PROTECTION OF WORKS 1-6

111. SURVEY BEACONS 1-6

112. DAMAGE TO LAND 1-6

113. RIVERS AND DRAINS 1-7

114. REINSTATEMENT OF ROADS AND FOOTWAYS FOR WATER MAINS AND SEWER CROSSINGS 1-7

115. TEMPORARY WORKS 1-7

116. LIGHTING AND GUARDING OF OBSTRUCTIONS 1-7

117. EXISTING SERVICES 1-8

118. CONNECTIONS TO EXISTING PIPES AND EQUIPMENT 1-8

119. PRIVATELY OWNED OR PUBLIC SERVICES 1-9

120. WATER SUPPLY 1-9

121. ADDITIONAL LAND 1-9

122. USE OF HEAVY PLANT 1-9

123. PROVISION OF INSTRUMENTS AND LABOUR 1-9

124. ACCESS TO SITES 1-9

125. POLLUTION 1-10

126. TREE PROTECTION 1-10

127. GEOLOGICAL DATA 1-10

128. WATCHING, FENCING, AND LIGHTING 1-10

129. TIPS 1-10

130. TOPICALIZATION 1-10

131. MONTHLY SITE MEETINGS 1-10

132. INSPECTION BY ENGINEER DURING DEFECTS LIABILITY PERIOD 1-11

133. SUBMISSION OF SAMPLES 1-11

134. RESPONSIBILITY FOR ORDERING MATERIALS AND MANUFACTURED ARTICLES AND SAMPLES FOR TESTING 1-11

135. TESTS OF MATERIALS AND MANUFACTURED ARTICLES BEFORE USE 1-11

136. REJECTED MATERIALS 1-12

137. QUALITY OF MATERIALS AND WORKMANSHIP 1-12

138. TEST RUNNING OF THE SCHEME 1-12

139. EQUIPMENT FOR THE RESIDENT ENGINEER 1-12

140. OPERATION AND MAINTENANCE MANUALS 1-12

141. CONSTRUCTION PROGRAMME 1-13

142. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN 1-14

143. HEALTH AND SAFETY MANAGEMENT PLAN 1-16

144. PROGRESS REPORTS 1-17

145. DAILY LOGS 1-18

146. TEST FORMS 1-18

147. CONTRACT DOCUMENTS 1-18

148. AS-BUILT AND RECORDED DRAWINGS 1-18

2. CLEARING SITE 2-1

201. CLEARING SITE 2-1

202. VEGETATION 2-1

203. BUSHES AND SMALL TREES 2-1

204. HEDGES 2-1

205. FELLING TREES 2-1

206. GRUBBING-UP ROOTS 2-2

207. WEED CONTROL 2-2

3. EXCAVATION 3-1

301. DEFINITION AND CLASSIFICATION OF EXCAVATED MATERIALS 3-1

302. STORAGE AND HANDLING OF EXPLOSIVES AND BLASTING 3-1

303. EXCAVATION FOR FILL 3-2

304. COMPACTION OF FILL 3-2

305. EMBANKMENTS OVER SEWERS 3-3

306. STONE REVETMENTS (STONE PITCHING) 3-3

307. TIPPED REFUSE ON SITE 3-3

308. REMOVAL OF INDUSTRIAL WASTE, ETC. 3-3

309. LAND SLIPS 3-4

310. CLASSIFICATION OF MATERIAL FROM SLIPS 3-4

311. BORROW PITS 3-4

312. STREAMS, WATERCOURSES, AND DITCHES 3-4

313. FILLING OLD WATERCOURSES 3-4

314. OPEN DITCHES 3-4

315. CLEARING EXISTING DITCHES 3-4

316. EXCAVATION FOR FOUNDATIONS BELOW OPEN WATER 3-4

317. TRENCHES OF GREATER WIDTH AND DEPTH THAN NECESSARY 3-5

318. SUPPORTS FOR TRENCHES 3-5

319. PROVISION OF SPOIL HEAPS 3-5

320. USE OF VIBRATORY COMPACTION PLANT 3-5

321. WATER IN EXCAVATIONS 3-5

4. PIPELINE CONSTRUCTION WORKS 4-1

401. HANDLING OF PIPES AND FITTINGS 4-1

402. LOADING AND UNLOADING 4-1

403. STORAGE 4-1

404. TRANSPORT 4-1

405. EXAMINATION OF PIPES AND FITTINGS 4-1

406. INTERFERENCE WITH FENCES, DRAINS AND OTHER SERVICES 4-1

407. METHOD OF EXCAVATION 4-1

408. PIPE LAYING 4-3

409. BACKFILLING OF TRENCH 4-4

410. ANCHOR BLOCKS AND SUPPORTS 4-5

411. CHAMBERS AND SURFACE BOXES 4-5

412. PRESSURE TESTING OF PIPELINES 4-5

413. CLEANING AND STERILISING OF PIPELINES 4-6

414. CLEARANCE OF SITE 4-6

5. PIPES, FITTINGS, VALVES AND METERS 5-1

501. GENERAL 5-1

502. UNPLASTICISED PVC (uPVC) PIPES 5-2

503. HIGH DENSITY POLYETHYLENE (HDPE) PIPES 5-3

504. POLYPROPYLENE PIPES 5-8

505. STEEL PIPES AND SPECIALS 5-8

506. G.R.P. PIPES AND SPECIALS 5-9

507. GALVANISED PIPES AND SPECIALS 5-9

508. DUCTILE IRON AND CAST IRON PIPES AND SPECIALS 5-9

509. CONCRETE PIPES AND SPECIALS 5-10

510. CONCRETE POROUS PIPES 5-10

511. FLANGED JOINTS 5-10

512. FLEXIBLE JOINTS 5-10

513. GATE VALVES 5-11

514. AIR VALVES 5-12

515. CHECK VALVES (DIRECTIONAL VALVES) 5-12

516. CONSUMER WATER METERS 5-13

517. ELECTROMAGNETIC FLOW METERS AND TELEMETRY SYSTEM 5-17

518. ELECTRO-FUSION JOINTING MACHINE 5-21

519. BUTT-WELDED FUSION JOINTING MACHINE 5-21

6. DRAINS, SEWERS AND MANHOLES 6-1

601. EXCAVATION FOR DRAINS, SEWERS AND MANHOLES 6-1

602. SUPPORTS FOR PITS, TRENCHES AND OTHER EXCAVATIONS 6-1

603. ROCK CUTTING IN TRENCHES FOR PIPES 6-1

604. WATER IN TRENCHES FOR PIPELINES 6-1

605. LAYING AND JOINTING RIGID JOINTED CONCRETE PIPES 6-2

606. PIPES LAID WITH OPEN JOINTS 6-2

607. CAST IRON PIPES 6-3

608. DRAINS TO BE LEFT CLEAN ON COMPLETION 6-3

609. REFILLING TRENCHES 6-3

610. CONNECTIONS OF EXISTING SEWERS AND DRAINS 6-3

611. MANHOLES AND INSPECTION CHAMBERS 6-3

612. PRECAST CONCRETE MANHOLES 6-4

613. GULLY CONNECTIONS 6-4

614. SURFACE BOXES, COVERS ETC. 6-4

615. GULLIES 6-4

616. COMPLETION OF DRAINAGE WORKS 6-5

617. TEMPORARY STOPPERS 6-5

618. PROVISION FOR FUTURE CONNECTION TO MANHOLES 6-5

619. SURROUNDING OR HAUNCHING OF PIPES WITH CONCRETE 6-5

620. INVERT BLOCK AND STONE-PITCHED DRAINS 6-5

621. TESTING OF JOINTED PIPES AND MANHOLES 6-5

622. PIPES WITH RUBBER RING JOINTS 6-6

623. LAYING, JOINTING AND BACKFILLING FOR FLEXIBLE JOINTED PIPES 6-6

7. CONCRETE 7-1

701. THE DESIGN OF CONCRETE MIXES 7-1

702. MIXING CONCRETE 7-7

703. HAND-MIXED CONCRETE 7-9

704. TRANSPORT OF CONCRETE 7-9

705. PLACING OF CONCRETE 7-9

706. COMPACTION OF CONCRETE 7-13

707. CURING OF CONCRETE 7-13

708. PROTECTION OF FRESH CONCRETE 7-15

709. CONCRETING IN HOT WEATHER 7-15

710. FINISHES ON UNFORMED SURFACES 7-16

711. MORTAR 7-17

712. CONCRETE FOR SECONDARY PURPOSES 7-18

713. RECORDS OF CONCRETE PLACING 7-18

714. CONSTRUCTION JOINTS 7-18

715. EXPANSION AND CONTRACTION JOINTS 7-20

716. WATERSTOPS 7-20

717. GROUTING OF POCKETS AND HOLES AND UNDERPINNING OF BASEPLATES 7-21

718. REMEDIAL WORK TO DEFECTIVE SURFACES 7-21

719. BENDING REINFORCEMENT 7-22

720. FIXING REINFORCEMENT 7-22

721. MATERIALS FOR CONCRETE 7-23

8. FORMWORK 8-1

801. FORMWORK FOR CONCRETE 8-1

802. CONSTRUCTION OF FORMWORK AND FALSEWORK 8-1

803. PREPARATION OF FORMWORK 8-2

804. REMOVAL OF FORMWORK 8-3

805. SURFACE FINISHES ON FORMED SURFACES 8-4

806. TOLERANCES 8-5

9. MASONRY 9-1

901. GENERAL 9-1

902. WORKMANSHIP 9-1

903. CAST STONEWORK 9-1

10. MISCELLANEOUS ITEMS AND MATERIALS 10-1

1001. GENERAL 10-1

1002. SUBMISSION OF SAMPLES 10-2

1003. ARCHITRAVES AND STOPS 10-2

1004. BLOCKWORK 10-2

1005. BOLTS AND NUTS 10-3

1006. BONDING TIES 10-3

1007. BUILDING STONE 10-3

1008. CAST STONE 10-3

1009. CEMENT GROUT 10-4

1010. CEMENT MORTAR 10-4

1011. CEMENT-LIME MORTAR 10-4

1012. CONCRETE BLOCKS 10-4

1013. CONCRETE DRAIN INVERT BLOCKS 10-4

1014. CONCRETE SLABS FOR OPEN DRAINS 10-5

1015. DAMP-PROOF COURSE (D.P.C.) 10-5

1016. DOORS 10-5

1017. ELECTRICAL INSTALLATION 10-5

1018. FIRE HYDRANTS 10-5

1019. FIXING IRONMONGERY 10-6

1020. FIXING JOINERY 10-6

1021. FRAMES AND LININGS 10-6

1022. GABIONS 10-6

1023. GALVANISED WORK 10-7

1024. GULLY GRATINGS AND FRAMES 10-7

1025. HARDWOOD 10-7

1026. HYDRATED LIME 10-7

1027. IRONMONGERY 10-8

1028. JOINERY 10-8

1029. JOINT PRIMER 10-8

1030. JOINT SEALING COMPOUND 10-8

1031. LIME MORTAR 10-9

1032. MANHOLE COVERS AND FRAMES 10-9

1033. MANHOLE STEP IRONS 10-9

1034. MARKER AND INDICATOR POSTS 10-9

1035. MURRAM 10-10

1036. PAINTS 10-10

1037. PENSTOCKS 10-10

1038. PLYWOOD 10-10

1039. PRECAST CONCRETE GULLIES 10-10

1040. PRECAST CONCRETE MANHOLES AND INSPECTION CHAMBERS 10-10

1041. PRECAST CONCRETE UNITS 10-11

1042. PRECAST LINTELS 10-13

1043. PREFORMED JOINT FILLER 10-13

1044. STONE DUST 10-14

1045. STOP VALVES 10-14

1046. STRUCTURAL STEEL FOR WELDED WORK 10-14

1047. STRUCTURAL STEELWORK 10-14

1048. TIMBER 10-14

1049. WATER BARS 10-15

1050. WATERPROOF UNDERLAY 10-15

11. PROJECT SPECIFIC INFORMATION AND CONTRACTOR’S GENERAL RESPONSIBILITY 11-16

1101. PROJECT LOCATION 11-16

1102. SCOPE OF WORKS 11-16

1103. WATER TREATMENT UNITS 11-17

1104. ADDITIONAL CONTRACTOR’S RESPONSIBILITIES 11-21

1105. CONDITIONS OF CONTRACT 11-22

1106. CONSTRUCTION PERIOD 11-22

1107. SITE AND OTHER DATA 11-22

1108. WAYLEAVE / EASEMENT FOR PIPELINE WORKS 11-22

1109. RESTRICTIONS ON USE OF ROADS 11-23

1110. PREVAILING CONDITIONS 11-23

1111. PROGRAM OF WORKS 11-24

1112. METHOD STATEMENTS 11-25

1113. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN 11-26

1114. HEALTH AND SAFETY MANAGEMENT PLAN 11-26

1115. PROGRESS REPORTS 11-26

1116. DAILY LOGS 11-26

1117. TEST FORMS 11-26

1118. MISCELLANEOUS FORMS 11-26

1119. CERTIFICATES OF COMPLETION 11-27

1120. VERIFICATION BY CONTRACTOR 11-27

1121. INTERFACE WITH ONGOING WORKS OR EXISTING NETWORKS 11-27

12. ELECTRICAL AND MECHANICAL WORKS. 29

1201. SUB SECTION 1: COMMON REQUIREMENTS 29

1202. SCOPE OF CONTRACT 29

1203. DEFINITIONS 29

1204. REGULATION, STANDARDS, MATERIALS AND WORKMANSHIP 30

1205. DESIGN AND STANDARDIZATION 31

1206. PACKING TRANSPORT AND STORAGE OF MATERIALS AND PLANT 32

1207. CONTRACT PERIOD AND PROGRAMME 32

1208. TENDER DRAWINGS 33

1209. WORKING DRAWINGS 34

1210. CONTRACT DRAWINGS 35

1211. RECORD DRAWINGS (AS-BUILT DRAWINGS) 35

1212. AMBIENT CONDITIONS 36

1213. SCHEDULES OF TECHNICAL INFORMATION 36

1214. COPIES OF ORDERS 36

1215. STANDARDIZATION 36

1216. FOUNDATIONS AND BUILDING WORKS 36

1217. INSPECTION AND TESTS AT MANUFACTURER'S WORKS 36

1218. ERECTION AND CHECKING OF WORK 37

1219. SUPERVISION AND LABOUR 38

1220. SPECIALIST SUBCONTRACTORS 38

1221. SPECIAL TOOLS 38

1222. INSTALLATION, OPERATING AND MAINTENANCE MANUALS 38

1223. SPARE PARTS 40

1224. LABELS AND PLATES 40

1225. DUST, INSECT AND VERMIN PROOFING 41

1226. ALTERNATIVES 41

1227. TESTING AND COMMISSIONING 42

1228. INSTRUCTIONS AND TRAINING OF LOCAL STAFF 47

1229. WORKS EXECUTED BY THE EMPLOYER OR BY OTHER CONTRACTORS 48

1230. SEQUENCE OF OPERATIONS AND DELAYS TO OTHER CONTRACTORS 48

1231. CONTRACTOR'S SITE OFFICES, WORKSHOPS, STORAGE AND WORKING AREAS 48

1232. USE OF SITE 48

1233. POSSESSION OF SITE 49

1234. INTERFERENCE WITH THE WORKS 49

1235. REJECTED MATERIALS AND DEFECTIVE WORK 49

1236. EXISTING WORKS AND SERVICES 49

1237. OVERHEAD POWER LINES 51

1238. EXISTING ACCESS 51

1239. EXCAVATION ACROSS ROADS AND TRACKS 51

1240. LIAISON WITH POLICE AND OTHER OFFICIALS 51

1241. PRESERVATION OF TREES 51

1242. PROTECTION FROM WATER 51

1243. PROTECTION AGAINST FIRES 51

1244. WATCHING, FENCING AND LIGHTING 52

1245. WATER AND POWER FOR USE ON THE WORKS 52

1246. FUEL SUPPLIES 52

1247. TELEPHONE AND COMMUNICATIONS 52

1248. SANITATION 53

1249. FIRST AID AND MEDICAL SERVICES 53

1250. INSPECTION BY ENGINEER DURING DEFECTS LIABILITY PERIOD 53

1251. REFERENCE DOCUMENTS 53

1252. SUB-SECTION 2 - MECHANICAL REQUIREMENTS GENERAL 65

1253. INTRODUCTION 65

1254. MATERIALS AND WORKMANSHIP 65

1255. DESIGN LIFE 66

1256. WELDING 66

1257. FORGINGS 67

1258. FIXINGS 68

1259. ALLOWANCE FOR WASTAGE 68

1260. LUBRICATION 68

1261. MACHINERY, LIFTING, DISMANTLING, GUARDS, NOISE AND VIBRATION 70

1262. GEAR BOXES 71

1263. BEARINGS 71

1264. PUMPS 72

1265. PIPEWORK 79

1266. VALVES AND PENSTOCKS 89

1267. INSTRUMENTS AND ANCILLARIES 98

1268. PAINTING AND PROTECTIVE COATINGS 102

1269. STANDBY POWER GENERATING PLANT 115

1270. SUB-SECTION 3 - ELECTRICAL REQUIREMENTS GENERAL 12-1

1271. INTRODUCTION 12-1

1272. VOLTAGE AND SUPPLY SYSTEM 12-1

1273. CABLES 12-1

1274. CABLE INSTALLATION 12-4

1275. CABLE TERMINATIONS, JOINTS, AND IDENTIFICATION 12-13

1276. SWITCHGEAR AND CONTROL EQUIPMENT 12-16

1277. MEDIUM VOLTAGE CIRCUIT BREAKER SWITCHGEAR (GAS-INSULATED, VACUUM) 12-24

1278. MOTOR STARTERS 12-37

1279. SWITCHBOARD AND CONTROL PANEL COMPONENTS 12-43

1280. SWITCHBOARD AND PANEL WIRING 12-50

1281. ELECTRIC MOTORS 12-52

1282. GENERAL SERVICES 12-60

1283. EARTHING 12-63

1284. SMALL POWER AND LIGHTING DISTRIBUTION SYSTEM 12-67

1285. ROAD LIGHTING 12-73

1286. CONTROL AND MONITORING SYSTEMS 12-74

1287. CIVIL WORKS ASSOCIATED WITH INSTALLATION OF SERVICES 12-76

1288. SCHEDULE OF TEST 12-76

13. SURVEYOR’S SPECIFICATION 13-81

1301. INTAKE WEIR 13-81

1302. WATER TREATMENT PLANT 13-81

1303. INTAKES,TRANSMISSION, AND DISTRIBUTION MAINS 13-81

1304. ASSIGNMENT FOR TOPOGRAPHIC SURVEYOR 13-82

14. ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MONITORING PLAN (ESMMP) 14-83

1501. MANAGEMENT PLAN PRINCIPLES 14-83

1502. SPECIFIC MANAGEMENT ISSUES 14-84

SECTION 2: STANDARD REFERENCE NUMBERS 14-1

# SECTION 1: GENERAL AND PARTICULAR SPECIFICATIONS

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

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

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

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

## OFFICES FOR THE RESIDENT ENGINEER

For Supervision of the Works, 1Nr. A rented office will be established in Kasese District. The Contractor to provide the rented office from the date of Commencement of Work. The Office including location shall be to the Resident Engineer’s approval.

The Office shall be of a design and construction approved by the Engineer and shall be constructed of strong, durable, and weatherproof materials with walls, ceilings, and floors adequately insulated against heat and cold.

The Office shall have a floor area of at least 120 square meters and shall be provided with equipment and furniture detailed under the following clauses. The Office shall have burglar proofing to all windows and external doors.

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

The Contractor shall arrange for the provision of telephones (and if necessary extensions) with suitable privacy for conversation for the exclusive use of the Resident Engineer and his Staff employing a separate connection to the Telephone Exchange. Provision shall also be made by the Contractor for all necessary gas, electricity, kerosene, water, light, attendance, and stationery required in connection with the execution of the Contract.

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

### PROVISIONS AND CONSUMABLES FOR THE RESIDENT ENGINEER’S OFFICES

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

| **Stationery** | **Quantity for Office** |
| --- | --- |
| Photocopy paper A4 | 4 Reams |
| A3 paper | 2 Ream |
| Biro pens blue/black | ½ Doz. |
| Clutch Pencils | ½ Doz. |
| Box files | 6 Nr |
| Spring Files | 6 Nr |
| Document Wallets | 6 Nr |
| Spirals (various sizes of Reports) | 2 Doz. |
| Embossed (hardback cover) | 2 Doz. |
| Perspex covers | 2 Doz. |
| 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. |
| CD-RW (Pack of 12) | 1 Pac. |
| Highlighters (set of all colors) | 2 Sets |
| A6 hardcover notebooks | 2 Nr |
| Soft Pencil Erasers (Staedtler or equivalent) | 3 Nr |
| Envelopes (all sizes) | 3 Doz. |
| Batteries for flashlights | 3 Sets |
| Black ink cartridge/ toner for the A4/A3 printer | 1 Set |
| Colour cartridges/toner for the A4/A3 printer | 1 Set |

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

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

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

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

### STAFF FOR THE RESIDENT ENGINEER’S OFFICES

The Contractor shall provide a Secretary for the exclusive use of the Resident Engineer for the duration of the Contract. The secretary shall be English speaking, with a minimum of 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 before 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.

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

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

### 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 is to revert to the Contractor after all Works.

| **Equipment** | **Quantity** |
| --- | --- |
| Total Station including tripods, complete with reflectors, poles, brackets, and carrying case (Wild or similar) | 5 Nr |
| Automatic Level (Wild or Similar) with legs and metric staff, complete with carrying case | 3 Nr |
| Metric extending leveling staffs with vertical bubble | 5Nr |
| 30m (enameled or otherwise protected) steel bands | 5 Nr |
| 3-meter ranging rods | 10 Nr |
| Survey umbrellas with stand | 5 Nr |
| Work boots | 10 sets |
| Rain Gear (trousers and jacket type, complete with rain hat) | 10sets |
| Hard hats | 12 sets |
| 5-meter retractable pocket steel tapes | 10 Nr |
| 30 meter metal tapes | 5 Nr |
| 100 meter metal tapes | 3Nr |
| Builders spirit levels 1000mm long | 5 Nr |
| Hammers 3 kg each | 5 Nr |

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

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

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

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

### ACCOMMODATION

The Contractor to make provision for accommodation for the Resident Engineer (RE), Assistant Resident Engineer (ARE), and Inspectors of Works. The furnished rented houses shall be to the approval of the Resident Engineer and shall comply with all his requirements. All costs in connection with the rental of house, supply, consumption, and maintenance of water supply, electrical power, house help, etc., shall be borne by the Contractor. Provisions of full-time security guards shall be made for the houses for day and night security. The provision for this is made under the relevant item in Bill No. 1 – Preliminaries & General.

## OFFICE FOR CONTRACTOR

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

## CLIMATE CONDITIONS

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

## LEVEL DATUM

Before the commencement of Construction Work, the Contractor shall establish, in a position to the approval of the Engineer, a benchmark comprising of steel datum pegs which shall be securely concreted in. The level of these pegs shall be established and agreed upon with the Engineer and all levels used in the construction of the Works shall be referred to as 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 Uganda. The Contractor shall be responsible for obtaining the location and values of the permanent benchmarks. In cases where such benchmarks do not exist, the site datum shall be agreed upon with the Engineer.

## SETTING OUT OF THE WORKS

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

The Site Layout Drawings show indicative Site Layouts. Before commencing construction, the Engineer will agree with the Contractor on the basic information supplementary to that shown on the Drawings such as the position of manholes, chambers, center lines, and baselines 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 following the indicative alignments shown on the drawings taking into account physical features on the ground, any existing services, any requirements of relevant Authorities and any changes deemed necessary by the Engineer, confirming the locations of all valves, air valves, washouts, hydrants, bends, manholes, etc.

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

The Contractor shall also be required to carry out a Site / Engineering Survey of demarcated land where permanent structures/appurtenances will be constructed as directed by the Engineer after initial clearance of sites. The Contractor shall prepare an updated layout plan with contours at 1.0m intervals. The contours shall be generated from a 10x10m grid topo survey.

## SOIL TREATMENT

The contractor shall carry out pre- construction soil treatment to create a horizontal barrier for termites. The termiticide will be sprayed under and around the concrete base during the pre-construction phase before the concrete slabs are laid on the ground for the reservoir and water treatment plant sites. The contractor shall use termiticide that is approved by the Engineer before application.

## CONTROL OF TRAFFIC

In the event of single-way traffic becoming necessary on any particular section of the Works, or the approaches to the Works, the Contractor shall, in maintaining through traffic routes, provide a width of at least 3 meters 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 following Clause 108. Signal lights are to be operated by competent operators provided by the Contractor, if and when required by the Engineer. Manually operated “Stop-Go” signs will only be permitted if approved by the Engineer and shall be of the size, color and type authorized. The Contractor shall be responsible for liaison with Police.

## 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, and 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 required to use it. It shall be constructed in advance of the taking up of the existing way and regularly maintained for so long as required in a satisfactory condition all to the approval of the Engineer.

## 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 reflectors or adequately illuminated at night by approved means.

## PROTECTION OF WORKS

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

## SURVEY BEACONS

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

Should any beacon be damaged or destroyed, the Contractor shall forthwith report the damage to the Engineer and the Director of Surveys and shall be held liable for the cost of reinstatement thereof.

## DAMAGE TO LAND

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

Except where specified for the proper execution of the Works, the Contractor shall not interfere with any fence, hedge, tree, land, or crops within, upon, or forming the boundary of the site or elsewhere. In the event of such interference, the Contractor shall make good to the satisfaction of the owner and the Engineer and shall pay to the owner such damages as the Engineer may determine.

The Contractor shall not enter upon or occupy with men, tools, equipment, or materials any land other than the site without the written consent of the owner of such land.

On the occupation of the Site or other land, the Contractor shall provide such fencing, as required.

## RIVERS AND DRAINS

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

## REINSTATEMENT OF ROADS AND FOOTWAYS FOR WATER MAINS AND SEWER CROSSINGS

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

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

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

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

## 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 carrying 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.

## LIGHTING AND GUARDING OF OBSTRUCTIONS

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

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

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

**Signing**

A warning sign at least 1.22m x 0.92m in size and 70 meters 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 a particular danger point, a 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 meters intervals in the direction of traffic flow and 0.9 meters 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 meters 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 meters intervals.

## EXISTING SERVICES

Before commencing Works which include excavation or ground leveling by manual or mechanical excavation the Contractor shall at his expenses ascertain in writing from Uganda Electricity Distribution Company Limited, Data Cables Companies, the Water Services Provider, and all other Public Bodies, Companies, and persons who may be affected, the position and depth of their respective ducts, cables, mains, pipes, or other appurtenances. He shall thereupon search for and locate such services.

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

Except that such services as require to be removed or altered under the layout of the permanent work and not how the work is carried out, shall be so removed or altered at the direction and 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.

## 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.

## 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.

## 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.

## ADDITIONAL LAND

The Contractor shall select and arrange at his 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.

## 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.

## PROVISION OF INSTRUMENTS AND LABOUR

The Contractor shall provide at his expense 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 labor 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.

## 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.

## POLLUTION

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

## TREE PROTECTION

Trees within the permanent and temporary easement are the property of the owners. Specific trees will be identified by the Engineer, before 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 in the original locations and backfilled carefully with selected soft soil which can support vegetation.

## GEOLOGICAL DATA

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

## 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.

## TIPS

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

## TOPICALIZATION

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.

## MONTHLY SITE MEETINGS

Throughout the project period, site meetings will be held at the Resident Engineer’s Office once every calendar month to discuss the progress of the work, scheduled for the ensuing month, methods of construction, procurement, transportation, labor, etc. These meetings can be called at any other time intervals at the request of the Contractor or as directed by the Engineer. The meetings will be attended by representatives of the Client, Supervision Team, and the Contractor. Costs of holding the meetings shall be deemed to be covered under the Contractor’s rates.

## INSPECTION BY ENGINEER DURING DEFECTS LIABILITY PERIOD

The Engineer will give the Contractor notice of his intention to inspect 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.

## SUBMISSION OF SAMPLES

Before incorporating in the finished work any materials or articles which he supplies under the terms of the contract, the Contractor shall submit to the Resident Engineer for approval a sample of each respective material or article, and such samples shall be delivered to and kept at his office for reference. All the respective kinds of materials and articles used in and upon the Works shall be at least equal in quality to the approved samples. Every sample shall be a fair average of the bulk material or of the article which it represents. The Resident Engineer may decide the method by which each sample to be taken from the bulk material shall be obtained. Any costs related to adhering to the above will be deemed to be covered in Bidder’s Rates.

## 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.

Concerning 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.

## 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 labor, materials, plant, and apparatus for sampling and for carrying out tests on the site on all such materials and manufactured articles shall be supplied by the Contractor at his expense. For all goods to be supplied including pipes, fittings valves, meters, etc., factory and site acceptance inspections and Tests will be carried out. In addition, 3rd party independent inspection and testing will be carried out as directed by the Engineer. The cost of this has been allowed for in the Preliminary and General Bill.

## REJECTED MATERIALS

Should any material or manufactured articles be brought on to the site of the Works which are in the judgment 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.

## 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.

## TEST RUNNING OF THE SCHEME

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

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

## EQUIPMENT FOR THE RESIDENT ENGINEER

The Contractor shall provide 2 Nr Digital Cameras, Sony or approved equivalent, suitable for Construction Sites with splash and shock proof casing for the exclusive use of the Resident Engineer and his staff to take record photographs of the progress of the Works. The Cameras should have a picture capture resolution of 7.1 megapixels or more, both optical and digital zoom capabilities, a storage capacity of 128 MB, downloading facility using the USB port, neck strap, and hard cover pouch. The Contractor shall further provide 1 Nr suitable photo printer with necessary photo paper and color ink cartridges for prints production for Monthly, Quarterly Progress Reports as directed by the Resident Engineer. The cost for this service is deemed to be covered by the Contractor in his rates in the Bills of Quantities.

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

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

## OPERATION AND MAINTENANCE MANUALS

Draft Operation and Maintenance Manuals will be compiled before substantial completion and Handing Over of the Works.

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

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

## 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 all activities and their 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 following 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 their 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 completion above the “Time for Completion” stated in the Form of Bid.

(4) The Programme once approved by the Engineer shall hereafter be referred to as the Contractual Programme. The Engineer’s approval of such program 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 following 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 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.

## ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

Within 42 days of Commencement, the Contractor shall submit a Project Specific Environmental and Social Management Plan (ESMP) for approval of the Engineer. The Contractor must carry out all works following Uganda Environmental Laws and Regulations, and the requirements of this document.

It is also a contractual obligation for the Contractor to take full cognizance of the environmental and social concerns and requirements as stipulated in the Employer's Environmental and Social Management Plan (ESMP) prepared for this Project and which is given in Chapter 12. The full Environmental and Social Impact Assessment (ESIA) Report will also be issued to the Contractor on Award.

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

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

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

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

1. Executive Summary
2. Introduction
3. Project Description
   * Focus on impact-generating activities (e.g. demand for water and permanent materials, earth movement, etc.);
   * Environmental liabilities: identify and include a photographic registry of pre-existing environmental liabilities (e.g. gully erosion areas, abandoned borrow pits, unauthorized dumping sites, etc.) that are not attributed to the implementation of the Project.
4. Potential Impacts during Mobilisation, Construction, and Demobilisation
   * Apply a simple rating of significance;
   * Quantity/quality impacts (e.g. surface and type of vegetation to be removed, amount and type of wastes to be generated, noise levels, etc.);
   * Identify places where specific impacts will manifest
5. Mitigation Plan
   * Specify the detailed measures to mitigate the identified impacts (also by location)
   * Include designs for measures requiring structural solutions (e.g. gabions, etc.);
   * Include the schedule of implementation of mitigation measures concerning the general construction schedule;
   * Health and Safety Plan (detailed);
   * Waste Management Plan (detailed) including decommissioning of the Existing Asbestos Cement (AC) Mains;
   * Traffic Management Plan (detailed);
   * Training Program (detailed);
   * Accident and Emergency Response Plan (detailed);
   * HIV/AIDS Awareness and Prevention Program (include only a reference to this program to be prepared by an NGO);
   * Community Relations Program;
   * Location and technical specifications for installation and operation of campsites, including workshops, garages, laboratories, offices, communal kitchenette/dining facilities, sanitary installations, etc.;
   * Location, and technical specifications for operation of quarries and borrow pits, and procedures for negotiation with and compensation of land owners where they are located;
   * Location and technical specifications for installation and operation of concrete batching, stone crushing, cement mixing, and asphalt plants;
   * Location and technical specifications for installation and operation of temporary and permanent dump sites.
6. Inspection Plan
   * Inspection function: specify frequency, locations, and instruments (e.g. checklists, site reports, photo registry, etc.) to conduct site inspections;
   * Permitting: required environmental permits and schedule to obtain them;
   * Specific actions and responsibilities: what, who, where, when, how, and why
7. Monitoring Plan
   * Specify, for each variable: frequency of measurement, locations, methods/equipment, units/measures, quality standards, and reporting requirements and periodicity, including the establishment of trends.
   * Specific actions and responsibilities: what, who, where, when, how, and why.
8. Organization and Management
   * Specify organizational structure, personnel, resource and equipment requirements, reporting requirements and periodicity, and inter-institutional communication and coordination mechanisms.
   * Specific actions and responsibilities: what, who, where, when, how, and why
9. Annexes
   * If the Contractor wishes to incorporate information beyond the indicated above, such as the policy, institutional and regulatory framework for environmental management in Uganda, biophysical and socio-economic characteristics of the area of influence of the Project, etc., that information should be included as an annex and not in the body of the site-specific ESMP. Preferably, such information should not be attached and, further, if necessary, the pertinent chapter of the ESIA should be referenced.
   * Annexes should be used, if necessary, to include detailed information on the specific topics of the ESMP (e.g. inspection forms or checklists, design of structural mitigation measures, photographic registry of environmental liabilities, etc.).

## HEALTH AND SAFETY MANAGEMENT PLAN

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

The Contractor must at all times comply with the National and Local Government laws and Regulations during the Construction and Commissioning Phases of the Project.

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

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

1. Introduction (including objectives of the HSMP)
2. Hazard Prevention and Control
   * 1. Risk assessment (including a description of the risk assessment method used);
     2. Prevention, protection, and control measures (based on the risk assessment performed):

a) Personal protective equipment and clothing: safety goggles, ear plugs, work boots, dusk masks, protective clothing, etc.;

b) H&S and sanitary facilities, equipment, materials, and personnel: first-aid kits and stations, health personnel, safe drinking water, sanitary facilities, accommodation, washing facilities, domestic waste disposal, etc.;

c) On-site safety measures and procedures to protect workers against accidents and health risks in the performance of construction-related activities:

- Site security: access, the safety of visitors, separation of work and rest areas, signage, etc.

- Handling of raw materials: earthwork, gravel, crushed rock, sand, etc.

- Handling of other materials causing dust development, such as cement;

- Handling of hydrated lime and other activators and additives;

- Handling of asphalt;

- Hazardous materials management

- Handling of inflammable materials;

- Maintenance of vehicles and machinery;

- Deep Excavation and trenching;

- Emergency prevention, preparedness, and response.

* + 1. Contractor's participation in Health and Safety Training Program
    2. Contractor's participation in HIV/AIDS Awareness and Prevention Program
    3. Provide specifics of training and instruction: topics, frequency, modalities, target audiences, instructors, training materials, etc.
    4. Potential Topics:
* Occupational safety risks and prevention
* Health risks and prevention
* Use of personal protective equipment
* Safe work procedures: general and specific.
* Organization and Management
  + 1. Organizational structure, personnel, equipment, communication and reporting requirements, accident and incident reports, and procedures and tools to verify and ensure compliance with occupational health and safety requirements.
    2. Annexes should be used, if necessary, to include detailed information on the specific topics of the HSMP, such as (illustrative list):
* Accident Report forms.
* Dangerous Occurrence forms (near misses).
* Safety Audit Forms.
* Safety Check List.
* Safety Rules.
* List of hospitals, emergency evacuation strategy, and other arrangements to treat seriously injured staff.
* List of personnel trained in first aid and their places of deployment.
* List of first aid kits and locations where these will be held.

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

## PROGRESS REPORTS

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

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

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

## DAILY LOGS

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

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

In addition, the log sheet shall have a space designated for comments by the Engineer.

The Engineer may, at his discretion, instruct the Contractor to provide daily labor and plant returns. Alternatively, the Engineer may request to review such information.

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

## TEST FORMS

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

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

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

## CONTRACT DOCUMENTS

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

## AS-BUILT AND RECORDED 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 this specification. Two copies shall be submitted to the Resident Engineer before the commencement of the Tests on Completion of Works.

In addition, the Contractor shall prepare and submit to the Resident Engineer “as- built-drawings” of the works, showing all works as executed. The drawings shall be prepared as the works proceed, and shall be submitted to the Resident Engineer for his inspection. The Contractor shall obtain the consent of the Resident Engineer as to their format, size, the reference system, and other pertinent details such as compatibility with the Water Service Provider’s GIS application.

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

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

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

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

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

# CLEARING SITE

## CLEARING SITE

The Contractor shall demolish, break up and remove buildings, walls, gates, fences, advertisements, and other structures and obstructions, grub up and remove trees, hedges, bushes, and shrubs and clear the site of the works at such time and to the extent required by the Engineer but not otherwise, subject to the provisions of Clause 15 of the Conditions of Contract: the materials so obtained shall so far as suitable be reserved and stacked for further use; all rubbish and materials for use shall be destroyed or removed from the site, as directed by the Engineer.

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

Underground structures and chambers were required to be demolished and 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.

## 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.

## BUSHES AND SMALL TREES

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

## HEDGES

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

## 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 cutting down, removing branches and foliage, cutting useful timber into suitable lengths, loading, and transporting not more than 1 km. and stacking or disposing of off all as directed by the Engineer.

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

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

## WEED CONTROL

The Contractor shall take all necessary precautions against the growth on the site of weeds and remove them as necessary throughout 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 liters per square meter. After this application, the footways shall receive at least two further waterings before the surface is sealed.

# EXCAVATION

## DEFINITION AND CLASSIFICATION OF EXCAVATED MATERIALS

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

1) Common Excavation

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

2) Rock

The decision of the Engineer in classifying rock shall be final and binding. Rock in the Bills of Quantities will be itemized 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 labor 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 blackstrap or lava. A boulder or outcrop of hard rock 1.5 cubic meters or less and grey or green building stone in a formation that is massive and geologically homogeneous, will be deemed to be Class ‘B’ rock.

Class ‘C’

Phonolite in a formation that is massive and geologically homogeneous shall be known as Class ‘C’ rock.

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

## STORAGE AND HANDLING OF EXPLOSIVES AND BLASTING

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

In the Bill of Quantities hard material is classified as a 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 the manner and quantities to be approved; he shall also be responsible for the prevention of any unauthorized issue or improper use of any explosives brought on the works and shall employ only licensed and responsible men to handle explosives for the 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 any finished work or is being carried out recklessly, he may prohibit it, and order the rock to be excavated by other means and payment will be made at the rate for rock for excavation where blasting is permitted. The use of explosives by the Contractor in large blasts, as in seams, drifts, pits, or large holes, is prohibited unless authorized in writing by the Engineer. In the event of wasting of rock through any such blasting, the Contractor shall if required by the Engineer, furnish an equivalent amount of approved materials for fill, 1 cubic meter of rock in-situ being taken to equal 1.5 cubic meters of material in an embankment.

## EXCAVATION FOR FILL

Where excavation reveals a combination of suitable and unsuitable materials, the Contractor shall, wherever the Engineer considers it practicable, excavate 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 sources.

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

## COMPACTION OF FILL

All materials used in fill shall be compacted to specification by the plant approved by the Engineer for that purpose. The 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 percent 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 a 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 percent 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 the excavation is too wet for satisfactory compaction and the Engineer orders the moisture content to be lowered or raised, such work shall be treated as included in the rates. All adjustments of moisture content shall be carried out in such a way that the specified moisture content remains uniform throughout compaction.

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

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

## 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 following 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.

## 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 a 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 the depth of 0.05 cubic meter in volume. The stones shall be laid to break the bond and shall be well bedded onto 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.

## TIPPED REFUSE ON SITE

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

## REMOVAL OF INDUSTRIAL WASTE, ETC.

Artificial deposits of industrial waste or shale found on the site shall be removed and disposed of 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.

## LAND SLIPS

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

## CLASSIFICATION OF MATERIAL FROM SLIPS

The classification of material from slips or slides will be following its condition at the time of removal, regardless of a 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.

## 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.

## 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 excavated materials and all pumping, timbering works, and materials necessary for dealing with the flow of water.

## 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.

## OPEN DITCHES

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

## 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 maintaining and keeping clean until and up to the maintenance period.

## EXCAVATION FOR FOUNDATIONS BELOW OPEN WATER

The rates for excavation for foundations below the water level shall include 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.

## 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.

## 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.

## 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.

## USE OF VIBRATORY COMPACTION PLANT

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

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

## WATER IN EXCAVATIONS

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

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

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

# PIPELINE CONSTRUCTION WORKS

## 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.

## 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.

## 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.

## 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.

## 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.

## 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.

## METHOD OF EXCAVATION

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

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

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

Nominated trench width for:

75mm main 0.5m

100mm main 0.6m

150mm main 0.6m

200mm main 0.6m

225mm main 0.6m

250mm main 0.6m

300mm main 0.7m

400mm main 0.8m

500mm main 0.9m

600mm main 1.0m

700mm main 1.1m

800mm main 1.2m

900mm main 1.4 m

1200mm main 1.6m

1400mm main 1.8m

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

c) Where the trench passes through grassland, arable land or gardens, whether enclosed or otherwise, the turf, if any, shall be carefully pared off and stacked, and the productive soil shall be carefully removed for a width of 600mm greater than the nominated trench width, or equal to the overall width of track of excavating machine, whichever is greater, and laid aside to be subsequently used in reinstating the surface of the ground after the trench has been refilled.

d) The bottom of the trench shall be properly trimmed off, and all low places or irregularities shall be levelled up with fine material. Where rock or large stones are encountered, they shall be cut down to a depth of at least 100mm below the level at which the bottoms of the barrel of the pipes or flanges are to be laid, and covered to a like depth with fine material, so as to form a fine and even bed for the pipes. The bottom of trenches to accommodate uPVC piping shall be hardened by tamping in gravel or broken stone in all soft spots. The bedding shall consist of soil which can be properly compacted to provide support for the pipe and to comply with Clause 409 b).

e) Joint holes shall be excavated to suit minimum dimensions as will allow the joints to be well and properly jointed.

f) The pipe trench shall be kept clear of water at all times as per Clause 321 of this

Specification.

g) The Contractor shall, wherever necessary, by means of timbering or otherwise, support the sides of the trench so as to make them thoroughly secure, and afford adequate support to adjoining roads, land, buildings and property, during the whole time the trench remains open and shall remove such timbering when the trench has been backfilled. The cost of such timbering or other work shall be deemed to be included in the rates for excavation. In case the Contractor is instructed by the Engineer to leave any portion of such timber in position after backfilling the trench, he will be paid for it accordingly.

h) The clear width inside the timbering shall be at least 150mm in excess of the external diameter of the pipe being laid, in order to allow it to be freely lowered into position, in the trench without damage to the external protection.

i) Should the excavation be taken out to a greater depth than is specified the bottom shall be made good to the correct level with 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 Uganda Datum shall be provided at such intervals as directed by the Engineer.

## PIPE LAYING

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

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

The pipes and specials shall be checked for flaws before they are lowered into the trench. After the pipes or specials have been checked they shall be cleaned and set to proper gradient and line so that there is a continuous rise from each washout to air valve.

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

b) Large diameter curves to mains shall wherever possible be formed by allowing for deflection at flexible joints, not exceeding 3 degrees, or as specified by the manufacturers.

c) In jointing of the pipes and specials the Contractor shall comply with the standards adopted for the various types of joints as specified.

d) In laying pipes and specials with flanged joints, flanges shall be brought together and bolted with the faces absolutely parallel. A rubber jointing gasket ring 3mm thick shall be used in each flange joint and one washer with and not provided for each bolt.

The bolts shall be tightened up gradually and equally in the customary manner in order to distribute the stress evenly over the flange. If it is found necessary to deviate slightly from the normal run of the flanged piping, the deflection shall be obtained by means of a bevelled gun metal ring washer between the flanges.

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

f) The Contractor shall, subject to approval of the Engineer, cut pipes to such lengths as directed. Pipes should be cut off clean and square with the axis. Cuts should be made with an approved cutting device dependant on the type of pipe specified. Ends of pipes should be tapered by means approved by the Engineer if mechanical joints are to be used.

g) Equipment for tapping off the mains under pressure may be employed in the making of service or branch connections. The Contractor is required to choose a suitable method for fixing of the ferrule to the type of pipe specified, to the Engineer’s approval.

## 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.

## 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.

## 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.

## PRESSURE TESTING OF PIPELINES

a) The Contractor shall test a section of main as long as possible subject to the maximum length of open trench approved by the Engineer. The test shall be carried out within 12 working days of the completion of such section of the main.

b) The pipeline shall be adequately anchored during the test at stop ends or valves to prevent movement under the test pressures.

c) The test section shall be filled with water and great care should be taken to drive out all air through air valves, ferrules etc. The test pressure is to be at least 1.5 times the nominal working pressure for the class of pipe being tested and is to be applied for at least 2 hours.

d) The leakage from the mains and connections from each section tested shall be according to SRN 316, i.e. not exceeding 0.02 litres per millimetre of nominal bore per kilometre of pipeline per 24 hour per bar of applied pressure head.

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

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

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

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

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

The Engineer shall be the sole judge of water tightness.

## CLEANING AND STERILISING OF PIPELINES

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

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

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

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

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

## 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.

# PIPES, FITTINGS, VALVES AND METERS

## GENERAL

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

1. All items shall be suitable for water works purposes and for use with cold water installation and operation being in a tropical climate.
2. All items hereinafter specified shall be to such other Standard or Specification which in the opinion of the Consultant provides for a quality of material and workmanship. The Standard or Specification must be submitted to the Consultant for approval before commencement of work.
3. All ferrous pipes and fittings shall be coated with a protective paint suitable for use in and transport through a tropical climate.
4. The Supplier shall supply to the Purchaser a certificate stating that each item supplied has been subjected to the tests hereinafter laid down and conforms in all respects to the said Specification.
5. The Supplier shall provide adequate protection to all piping, flanged items and valves so as to guard effectively against damage in transit and storage and ingress of foreign matter inside the valves.
6. All pipework and fittings shall be subjected to a works hydrostatic test pressure which shall be not less than twice the maximum operating pressure.
7. The Supplier should exercise diligence to provide the best material.
8. Where applicable, the manufacturer’s Specification should accompany all offers. The name of the manufacturer must in every case be stated.
9. Where necessary the Supplier shall provide rubber gaskets to comply with EN 1514, DIN 2693 or DIN 2697 and all other bolts, nuts, washers, etc. to undertake jointing at fittings etc.
10. Any articles required under this Contract which are found to be faulty due to a crack, flaw or any other reason or is not in accordance with the Specification stipulated will not be accepted nor will the Purchaser be liable for any charges in respect of such an article. Where any such rejected article can, in the opinion of the Consultant, be rendered usable, the Supplier may deal with it accordingly and include it in the Contract at a price to be mutually agreed. Straight pipes which have been cut will be accepted at the discretion of the Consultant, provided the length is not less than 4 metres or two thirds of the standard length whichever is the lesser and will be priced pro-rata.
11. Wherever possible, samples of pipes and fittings shall be submitted for approval of the Consultant prior to the Supplier obtaining the total requirements.

## UNPLASTICISED PVC (uPVC) PIPES

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

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

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

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

The joint shall sustain the end thrust to which the pipe shall be subjected. The Supplier shall supply sufficient quantity of the cleaner and adhesive which shall be required to make the joints with the pipes.

The pipes of 50mm diameter and over shall consist of a grooved socket at one end of the pipe. The socket shall be designed to give a clearance fit on the outside diameter of the parent pipe. The sealing medium which shall seat in the groove shall be a rubber ring.

If the formation of the socket and groove results in the thinning of the original wall thickness of the pipe, it shall be compensated for by shrinking on to the outside of the socket area a reinforcing sleeve of the same material as the pipe. The socket and groove shall incorporate no sharp angles where the stress points are created.

The joint shall take 10% deformation of the spigot at the point where it enters the socket without leakage from the pipe when subjected to the test pressure specified for the pipe. Thermal expansion of the pipe shall be accommodated in the joint. The joint shall be capable of linear deflection up to 3 degrees.

The sealing ring shall be of first grade natural rubber and the physical properties of the mix shall meet the requirements of DIN 4060, BS2494 or EN 681.

The Supplier shall supply sufficient quantity of any lubricant or other material which shall be needed to make the joint which shall be assembled by hand.

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

The fittings shall have the same type of joint as for the pipes to be used. The Supplier shall submit full details of the materials dimensions and test pressures of the fittings offered.

Precautions shall be taken to avoid damage to the pipes and fittings.

In handling and storing the pipes and fittings, every care shall be taken to avoid distortion, flattening, scoring or other damage. The pipes and fittings shall not be allowed to drop or strike objects. Pipe lifting and lowering shall be carried out by approved equipment only.

Special care shall be taken in transit, handling and storage to avoid any damage to the ends.

Pipes and fittings shall be marked at not greater than one metre intervals showing their class and diameter.

## 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: Colour: | Polyethylene PE100 (MRS100), density ≥0.95 kg/dm³  **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 ≥0.95 kg/dm³ |
|  | 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), σall = 8.0 MPa** | | | **PN 10.0** | | **PN 16.0** | |
| --- | --- | --- | --- | --- | --- | --- |
| **Outside Diameter (d)**  **(mm)** | **Tolerance on OD**  **(mm)** | **Maximum**  **Ovality**  **(mm)** | **SDR 17**  **Series 8** | | **SDR 11**  **Series 5** | |
| **Min. WT**  **(mm)** | **Tolerance**  **(mm)** | **Min. WT**  **(mm)** | **Tolerance**  **(mm)** |
| **16.0** | 0.3 | 1.2 | **-** | - | **-** | - |
| **20.0** | 0.3 | 1.2 | **-** | - | **2.0** | 0.3 |
| **25.0** | 0.3 | 1.2 | **-** | - | **2.3** | 0.4 |
| **32.0** | 0.3 | 1.3 | **2.0** | 0.3 | **3.0** | 0.4 |
| **40.0** | 0.4 | 1.4 | **2.4** | 0.4 | **3.7** | 0.5 |
| **50.0** | 0.4 | 1.4 | **3.0** | 0.4 | **4.6** | 0.6 |
| **63.0** | 0.4 | 1.5 | **3.8** | 0.5 | **5.8** | 0.7 |
| **75.0** | 0.5 | 1.6 | **4.5** | 0.6 | **6.8** | 0.8 |
| **90.0** | 0.6 | 1.8 | **5.4** | 0.7 | **8.2** | 1.0 |
| **110.0** | 0.7 | 2.2 | **6.6** | 0.8 | **10.0** | 1.1 |
| **125.0** | 0.8 | 2.5 | **7.4** | 0.9 | **11.4** | 1.3 |
| **140.0** | 0.9 | 2.8 | **8.3** | 1.0 | **12.7** | 1.4 |
| **160.0** | 1.0 | 3.2 | **9.5** | 1.1 | **14.6** | 1.6 |
| **180.0** | 1.1 | 3.6 | **10.7** | 1.2 | **16.4** | 1.8 |
| **200.0** | 1.2 | 4.0 | **11.9** | 1.3 | **18.2** | 2.0 |
| **225.0** | 1.4 | 4.5 | **13.4** | 1.5 | **20.5** | 2.2 |
| **250.0** | 1.5 | 5.0 | **14.8** | 1.6 | **22.7** | 2.4 |
| **280.0** | 1.7 | 9.8 | **16.6** | 1.8 | **25.4** | 2.7 |
| **315.0** | 1.9 | 11.1 | **18.7** | 2.0 | **28.6** | 3.0 |
| **355.0** | 2.2 | 12.5 | **21.1** | 2.3 | **32.2** | 3.4 |
| **400.0** | 2.4 | 14.0 | **23.7** | 2.5 | **36.3** | 3.8 |
| **450.0** | 2.7 | 15.6 | **26.7** | 2.8 | **40.9** | 4.2 |
| **500.0** | 3.0 | 17.5 | **29.7** | 3.1 | **45.4** | 4.7 |
| **560.0** | 3.4 | 19.6 | **33.2** | 3.5 | **50.8** | 5.2 |
| **630.0** | 3.8 | 22.1 | **37.4** | 3.9 | **57.2** | 5.9 |
| **710.0** | 6.4 | 24.9 | **42.1** | 4.4 | **64.5** | 6.6 |
| **800.0** | 7.2 | 28.0 | **47.4** | 4.9 | **72.6** | 7.4 |

**Performance Characteristics**

The pipes shall have the following basic minimum performance characteristics:

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Unit** | **Value** |
| Average Density as per ISO 1183 | Gm/cm3 | ≥ 0.95 |
| Melt Flow Index MFI 190°C / 50N as per ISO 1133 | Gm/10 min. | 0.4-0.55 |
| Minimum Tensile Strength | N/mm2 | 25 |
| Elongation at Break | % | ≥ 600% |
| E-Modulus (Modulus of Elasticity) | N/mm2 | 1200 |
| Minimum Radius of Curvature at 20°C |  | 25 x OD |
| Linear Coefficient of Thermal Expansion (VDE 0304) | °K-1 | 1.3 x 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 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**

* + - * 1. Hydrostatic leakage testing is recommended and shall comply with ASTM F 2164, ASTM F 1412, AWWA Manual of Practice M55 Chapter 9.
        2. 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.
        3. Pneumatic (compressed air) leakage testing of HDPE pressure piping is prohibited for safety reasons.

**Cleaning and Disinfecting**

* + - * 1. Cleaning and disinfecting of potable water systems shall be in accordance with AWWA C651 and AWWA Manual of Practice M55 Chapter 10.
        2. After installation and pressure testing, new water mains should be disinfected according to AWWA C651.
        3. The disinfection chemicals should be limited to less than 12% active chlorine. The duration of the disinfection should not exceed 24 hours.
        4. 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.

## POLYPROPYLENE PIPES

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

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

## STEEL PIPES AND SPECIALS

All piping shall be plain ended unless otherwise specified and suitable for use with flexible mechanical couplings. The grade of steel used shall comply with the requirements of BS EN 14164.

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

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

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

All fittings and specials shall be of such dimensions as will conform / fit with the piping supplied.

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

The spigot ends of all Tees shall be suitable for connection to the pipework supplied using the aforementioned flexible mechanical joints.

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

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

## G.R.P. PIPES AND SPECIALS

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

## 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. Screw down 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.

## 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.

## 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.

## CONCRETE POROUS PIPES

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

## FLANGED JOINTS

Where specifically called for or deemed appropriate, flanged joints shall be utilised. They shall conform to DIN Standards 2500, 2501, 2519, 2576, 2627, 2566, 2655-56, 2673, 2526, 2527, BS EN 1092, BS 1560 or ISO 7005: 1988., drilled to NP10 except where otherwise indicated in Price Schedules, with gaskets made of reinforced elastomer rubber to DIN Standards 2693, 2697 or EN 1514 and minimum thickness of 3mm.

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

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

## FLEXIBLE JOINTS

All flexible couplings (Viking Johnson or other approved type) shall be supplied and shall be coated with fusion bonded epoxy layer 350 microns thick, complete with rubber gaskets, bolts, nuts and washers. All couplings shall be coated with red oxide primer and bituminous composition suitable for use with potable water.

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

## GATE VALVES

Gate valves shall comply with the requirements of BS 5163, AWWA C203-78, DIN 3230 Part 1-3, DIN 3352 Part 1-4.

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

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

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

Spindles of the gate valves shall be provided with cast iron caps conforming to the requirements as specified under “Valve Caps” in DIN 3230, DIN 3352, BS 5163 or AWWA C203-78, or handwheels if so specified.

Unless otherwise specified the face to face dimensions of gate valves with integral flanged ends shall be in accordance with BS 5155 basic series 14 (short) or basic series 15 (long) as indicated in the Price Schedules.

Where specified, valves for replacement washouts shall be in accordance with specification Clause 202except that the valve bodies shall be of epoxy coated ductile iron and the flanges shall be undrilled. Face to face dimensions for these valves shall be to BS 5155 basic series 14 (short).

The spindles of the gate valves shall be of the non-rising type, except where specifically indicated otherwise and screwed so as to close the valves when rotated in a clockwise direction. The direction of closing shall be clearly cast on the valve cap or hand-wheel. Where specified, valves for replacement washouts shall be in accordance with specification Clause 202 except that the valve bodies shall be of epoxy coated ductile iron and the flanges shall be undrilled. Face to face dimensions for these valves shall be to BS 5155 basic series 14 (short).

The gate valves shall be subject to “Closed End Tests” in accordance with the procedure set out in BS 5163, AWWA C203-78, DIN 3230 Part 1-3, DIN 3352 Part 1-4.

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

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

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

## AIR VALVES

The Supplier shall provide air valves to suit the site on which the main is located and the maximum water pressure specified. The body and cover of air valves shall comply with BS EN 1074.

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

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

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

The double orifice type of air valve shall comprise a small and large orifice unit with common connection to the main and screw-down isolating valve to permit inspection of the valve. The spindle of the isolating valve shall be screwed so as to close the valve when rotated in a clockwise direction and be provided with a Spindle Cap to dimensions as specified in DIN 3230, DIN 3352, BS 5163 or AWWA C203-78.

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.

## CHECK VALVES (DIRECTIONAL VALVES)

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

The body and cover material of the valves shall be made of carbon steel conforming to ASTM A216, Grade WCB. The hinge pin material shall conform to ASTM A479, the disc carrier material shall conform to ASTM A217, the seat material shall conform to ASTM A106 and the disc material shall conform to ASTM A216.

## CONSUMER WATER METERS

**General**

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

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

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

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

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

**Performance**

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

The nominal flowrate (Qn) is equal to half the maximum flowrate, Qmax. It is expressed in cubic metres per hour and is issued to designate the meter.

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

The minimum flowrate (Qmin) is the flowrate above which the meter must not exceed the maximum permissible errors (+/-5%), and is fixed as a function of Qn.

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Performance Parameter** | | **Nominal Diameter (mm)** | | | |
| 15 | 20 | 25 | 40 |
| Nominal Flow Rate - Qn | m³/h | 1.5 | 2.5 | 3.5 | 10 |
| Maximum Flow Rate...........Qmax | m³/h | 3 | 5 | 7 | 20 |
| Minimum Flow Rate.............Qmin | l/h | 15 | 25 | 35 | 100 |
| Transitional Flow Rate.....……Qt | l/h | 22.5 | 37.5 | 52.5 | 150 |

**Meteorological Classes**

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

|  |  |  |
| --- | --- | --- |
| **Class** | **Qn=Lessthan15m³/h** | **Qn=15m³/hormore** |
| Class C  Value of: Qmin  Value of: Qt | 0.01Qn  0.015Qn | 0.006Qn  0.015Qn |

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

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

**Sizes**

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

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

**Tightness, Pressure and Temperature Resistance**

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

**Headloss**

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

**Materials**

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

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

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

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

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

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

**Counter**

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

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

Type 1 By a row of inline consecutive digits in one or more apertures (drum counters); or

Type 2 A combination of drum counters for whole units of cubic meters and pointers on circular scales for fractions of cubic meters.

Drum counters shall be black for indication of a cubic metre and its multiples shall be red for indication of fractions of a cubic metre. Visible movements of the digits shall be upwards and the actual or apparent height of the digits on the drums shall be not less than 4 mm. The advance of a digital unit shall be completed while the next lower valued digit is within the last tenth of its travel. The drums showing digits of lowest value shall move continuously in Type 1, and may move continuously in Type 2. Indicators with pointers (Type 2) shall rotate in a clockwise direction. The value of each division on the scales shall be expressed in multiples or sub-multiples of ten. Each scale shall be graduated in cubic meters or accompanied by a multiplying factor (x0.01, x0.1, x10, x100) according to the value of the scale. The symbol m³ shall appear on the dial. The gear unit and the counter shall be combined and completely sealed.

The number drums shall be contained in a non-toxic fluid for lubrication and protection. The counter shall be placed in a window in the meter body and be placed so as to allow for ease of meter reading. Counter window shall be of minimum 7mm thickness. Black numbers on white shall denote cubic metres and white numbers on red shall denote litres. The counter shall reset to zero at a reading of not less than 10,000 m³.

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

|  |  |  |
| --- | --- | --- |
| **Size of Meter(DN)** | **Minimum Registration**  **(m³)** | **Maximum Registration Before Se l**  **Re- Set (m³)** |
| 15mm  20mm to 40mm | 0.001  0.001 | 10,000  100,000 |

**Protection**

A suitable in-built strainer (0.75 mm aperture and 2.844 mm2 mesh area) shall protect the measuring mechanism and an in-built non return valve shall prevent meter reversal.

**Marking**

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

* Direction of flow of water on both sides of the meter
* Maximum flow rate (3m³/hr)
* Individual Serial number (engraved)
* Manufacturer’s name
* Country of Origin
* Year of manufacture
* WSP’s name (max 10 letters)

**Sealing**

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

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

Tenderer’s shall provide details of the sealing wire type with proof of corrosive resistant and method proposed.

**Pre-Shipment Testing**

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

**Packing**

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

**Workmanship**

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

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

## ELECTROMAGNETIC FLOW METERS AND TELEMETRY SYSTEM

**Power, communications and installation requirements.**

**Power Supply**

long-life battery minimum 5 years.

**Pressure and flow data logger**

high resolution flow and pressure data logger with GSM modem, transmitter and receiver with required ancillaries and soft ware.IP68 Flow and Pressure Data Logger, Software compatible with (Latest Windows Compatible) ,Adaptor Cable PC to Logger (Commissioning), USB-Serial Adaptor Cable with Drive Software, PC Host Modem, Laptop for External installation and commissioning, Laptop for Office - Data Receiving and operations, 750W Inverter System with 1 x 120AH 12V Battery (Power supply), System Set Up and Training, Installation and commissioning

**Wireless communication via optional built in GSM modem**

Supply all materials including demonstration and training of operation staff on how to install, configure for use, download data and acquire data remotely and manually. These will be by either the following methods

Remote access to logger data over quad-band GSM network by SMS text message

Diagnostics and configuration, via standard GSM mobile phone

Automated metering data reporting via SMS text

**IP68 electronic package**

zero water ingress, even during flood conditions

military specification IP68 plug and socket connections

sealed-for-life – maintenance free

**Battery power for remote locations**

Up to 5-year battery life

Manganese alkaline battery pack

Site-replaceable battery pack

The battery can be replaced without loss of logger contents enabling smooth switchover

**Installation requirements**

Installation requirement of zero pipe diameters (OD) upstream and downstream

**Specification – Flow meter**

Battery- or renewable energy-powered reduced-bore meters (FER) – flow specifications

**Minimum flow requirements**

****

**Screw-end meters**

Brass and stainless steel 316L and super-austenitic steel

**Flanged meters**

Electrodes – stainless steel 316L

**Pressure limitations**

As flange rating

PN40 Max Process Temp 50 °C (122 °F)

PN40 Max Process Temp 40 °C (104 °F)

OIML / MID Approved Meters 40 bar

**Pressure equipment directive 97/23/EC**

This product should be applicable in networks for the supply, distribution and discharge of water and associated equipment and is therefore exempt.

**Environmental protection**

Rating:

IP68 (NEMA 6P) to 10 m (33 ft.)

Buriable (sensor only) to 5 m (16 ft.)

**Temperature limitations**

**Ambient temperature**

* Remote transmitter
  + –20 to 70 ° C (–4 to 158 °F)
* Close-coupled transmitter
  + –20 to 60 ° C (–4 to 140 °F)

**Process temperature**

* OIML R49 T50 approval
  + 0.1 to 50 ° C (32 to 122 °F)

**Conductivity**

>50 μS/cm

**End connections**

**40 to 300 mm (1.5 to 12 in.) flanged (FER)**

EN1092-1 / ISO 7005 – PN10, PN16

ANSI B16.5 Class 150

AS 2129 Tables C, D, E and F

AS 4087 PN14, PN16, PN21

JIS to BS2210, 10k

**Pipe conditions**



**Specification – Transmitter**

**Mounting**

Directly on sensor (close-coupled)

or

Remote up to 200 m (650 ft)

**Housing**

IP68 (NEMA 6P), <2 m (6 ft.),Stainless steel housing in a thermoplastic outer cover with

window, encapsulated with polyurethane-based resin.

**Electrical connections**

IP68 plug and socket, mains cable

**Sensor cable**

ABB cable supplied as standard or equivalent

**External battery pack**

IP68 (NEMA 6P)

Lithium Battery or Manganese alkaline battery life: 0 to 45 °C (32 to 113 °F) typically 5 years, Battery life is shorter to be used once per day for SMS automated reporting of data logged at 15 minute intervals, the allowable life of a battery pack to be reduced by not more than 20 %.

**Backup power time**

Approximately 1 minute

**Pulse and alarm outputs**

Three, bidirectional, solid-state switches with common isolation ±35 V DC 50mA, Output 1 – forward only or forward plus reverse pulses, Output 2 – reverse pulses or direction indicator, Output 3 – alarm indicates any problem with measurement or with power, Pulse output – 50 Hz maximum, 50 % nominal duty cycle

**Communications options**

Serial data communications, Local Port RS232, RS485 MODBUS, MODBUS RTU slave, Baud rates: 1200, 2400, 4800, 9600 or 19200, RS485:2-wire + ground signalling, Low power shut-off mode after 10 s of inactivity

**Telemetry applications**

**GSM / SMS modem**

Mounting: Internal ,Frequency bands: Quad band: 850 / 900 / 1800 / 1900 MHz Functions: SMS auto report of flow and optionally, pressure logger data ( 1 s or 1 min. average) SMS report frequency: typically daily , SMS alarm reporting at time of event, for example power loss, limited to 1 per day SMS flow meter configuration, SMS flow meter diagnosis , SMS total / tariff auto report

**Response time (programmable)**

Minimum15 s (battery-powered + external renewable energy)

**Device languages**

English, Pressure system – external transducer, Pressure range not less than 16 bar Abs.Connection

Standard quick-fit male probe connector via an adapter cable Operating temperature range –20 (ambient) to 70 °C (–4 to 158 °F), Protect the sample and transducer from freezing. Accuracy (typical) ±0.4 % of range Thermal error band (typically 100 °C [212 °F]) ±1.5 % span , Cable length , 5 or 10 m (16 or 33 ft)

## ELECTRO-FUSION JOINTING MACHINE

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

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

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

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

## 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 (±1°C) with digital display and regulating buttons. This system shall include Led indicators to check if the machine is working normally (live tension and working temperature), contingent probe’s failures and/or temperature anomalies.

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

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

# DRAINS, SEWERS AND MANHOLES

## EXCAVATION FOR DRAINS, SEWERS AND MANHOLES

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

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

## 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.

## ROCK CUTTING IN TRENCHES FOR PIPES

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

## WATER IN TRENCHES FOR PIPELINES

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

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

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

## LAYING AND JOINTING RIGID JOINTED CONCRETE PIPES

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

For spigot and socket joints, the spigot of each pipe shall be placed home in the socket of the one previously laid, and the pipe then adjusted and fixed in its correct position with the spigot of the pipe accurately centred in the socket. A ring of tarred rope yarn shall next be inserted in the socket of each pipe previously laid and driven home with a wooden caulking tool and wooden mallet, such yarn when in position shall be 25mm in depth. The socket shall then be completely filled with cement mortar 1 to 2 as specified in Clause 1010 and a fillet of the same worked all round the side. The fillet shall be levelled off and extend for a length of not less than 50mm from the face of the socket.

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

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

Where shown on the drawings or directed by the Engineer, concrete pipes shall be bedded and haunched or surrounded with concrete as specified in Clause 619.

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

## PIPES LAID WITH OPEN JOINTS

Concrete porous pipes shall be laid unjointed with a space of 12mm between the spigot and the inner end of the socket.

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

## CAST IRON PIPES

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

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

## 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.

## 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.

## 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.

## MANHOLES AND INSPECTION CHAMBERS

Manholes and inspection chambers shall be constructed in accordance with the drawings and in the position shown on the drawings or directed by the Engineer. Foundation slabs shall consist of concrete of the appropriate classes as specified on drawings. The side walls shall consist of similar concrete or building stone as specified in Clause 1007 in accordance with the drawings.

The side walls shall be fair faced or rendered internally as specified on drawings. They shall be brought up vertically to receive a precast slab formed of concrete of the appropriate classes specified and reinforced all as shown on the drawings. Cast iron manhole covers and frames as specified in Clause 1032 shall be provided and frames shall be bedded in cement mortar 1 to 3 and so set that the tops of the covers shall be flush at all points with surrounding surface of the footway, verge or carriageway, as the case may be. Any slight adjustment of the slab level which may be necessary to accomplish this shall be effected by topping the side walls with concrete integral with the slab.

If required, half channel pipes, bends and junctions as specified in Clause 1040 shall be laid and bedded in cement mortar 1 to 3 to the required lines and levels, and both sides of the channel pipes shall be benched up with concrete of the appropriate class and finished smooth to the slopes and levels as shown on the drawings or directed by the Engineer. The ends of all pipes shall be neatly built in and finished flush with cement mortar 1 to 3. Where the depth of the invert exceeds 1 metre below the finished surface of the carriageway or the adjacent ground, step irons as specified in Clause 1033 shall be built in with alternate steps in line vertically and with such additional hand irons as the Engineer may direct.

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

## PRECAST CONCRETE MANHOLES

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

## GULLY CONNECTIONS

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

## 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.

## GULLIES

Gullies complete with gratings and with rodding eyes where necessary all as specified in Clause 1024 shall be supplied and laid in accordance with the drawings. Where directed by the Engineer, precast concrete gullies shall be laid on and surrounded with 100mm of concrete of the appropriate grade. The concrete surround is to be brought up to the underside of the frame or flush with the top surface as the case may be. Masonry gullies shall be constructed from 225mm building stone and rendered internally. The rates included in the Bill of Quantities shall include for excavation, provision of all materials, construction, making junctions with connections to main drains, accurate setting of frames to line and level, refilling and disposal of surplus materials. Gullies shall be trapped where leading into foul sewers or into combined foul and surface water sewers.

## COMPLETION OF DRAINAGE WORKS

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

## 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.

## PROVISION FOR FUTURE CONNECTION TO MANHOLES

Inlet pipes of the required diameters shall be built into the walls of manholes and elsewhere for future use and shall be of the diameters shown on the drawings. The external ends of all such connections shall be sealed off with temporary stoppers, approved by the Engineer. The pipes shall be laid and jointed as specified in Clause 611 and during the placing of the concrete they shall be adequately supported.

## SURROUNDING OR HAUNCHING OF PIPES WITH CONCRETE

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

## INVERT BLOCK AND STONE-PITCHED DRAINS

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

Invert block and stone-pitched drains shall be constructed in the positions and to the levels and dimensions shown on the drawings and laid to true line and even fall. Where under- filling is required it shall be in 100mm maximum thickness layers of compacted 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.

## 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.

## 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.

## LAYING, JOINTING AND BACKFILLING FOR FLEXIBLE JOINTED PIPES

The Contractor shall ensure that any hard spots and loose stones are removed from the formation prior to laying of bedding materials. The Contractor shall lay a bed of thickness

100mm consisting of granular material i.e. sand, gravel, or approved soil of friable nature.

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

After completion of this operation the Contractor shall lay the bedding material on top of the pipe in 150mm layers to a thickness of 300mm. The material is to be compacted by tamping. However, precautions are to be taken to avoid excessive tamping on top of the pipe. The remaining trench excavation is to be backfilled to comply with Clause 609 of specification.

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

**Flexible Rubber Ring Joints**

The Contractor shall ensure that the spigot end is free from grit, dust or dirt and sealing rings should be seated evenly in the socket 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.

# 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.

## THE DESIGN OF CONCRETE MIXES

1. **Cement**

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

183

1. **Classes of Concrete**

The classes of structural concrete to be used in the works shall be those shown on the Drawings and designated in Table 7.1, in which the class designation includes two figures. The first figure is the nominal strength at 28 days expressed in N/mm2 and the second figure is the maximum nominal size of aggregate in the mix expressed in millimetres.

1. **Design of Proposed Mixes**

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

**Table 7.1 - Concrete Classes and Strengths**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Class of**  **Concrete** | **Nominal**  **Strength** | **Maximum**  **Nominal Size** | **Maximum Water / Cement Ratio** | | **Trial Mixes**  **Target Mean** | **Early Works Test Cubes**  **(Clause 401 d)** | |
|  | **N/mm2** | **of Aggregate** |  |  | **Strength** | **Any one** | **Average of** |
|  |  | **mm** | **A** | **B** | **(Clause 401 c) N/mm2** | **Cube**  **N/mm2** | **any Group**  **of 4 Cubes**  **N/mm2** |
| 10/75 | 10 | 75 | 0.60 | 0.55 | 13.5 | 8.5 | 13.3 |
| 15/75 | 15 | 75 | 0.60 | 0.50 | 21.5 | 12.8 | 20.0 |
| 15/40 | 15 | 40 | 0.60 | 0.50 | 21.5 | 12.8 | 20.0 |
| 15/20 | 15 | 20 | 0.57 | 0.50 | 21.5 | 12.8 | 20.0 |
| 20/40 | 20 | 40 | 0.55 | 0.48 | 31.5 | 17.0 | 27.5 |
| 20/20 | 20 | 20 | 0.53 | 0.48 | 31.5 | 17.0 | 27.5 |
| 20/10 | 20 | 10 | 0.50 | 0.48 | 31.5 | 17.0 | 27.5 |
| 25/40 | 25 | 40 | 0.52 | 0.46 | 36.5 | 21.3 | 32.5 |
| 25/20 | 25 | 20 | 0.50 | 0.46 | 36.5 | 21.3 | 32.5 |
| 25/10 | 25 | 10 | 0.48 | 0.46 | 36.5 | 21.3 | 32.5 |
| 30/40 | 30 | 40 | 0.50 | 0.45 | 41.5 | 25.5 | 37.5 |
| 30/20 | 30 | 20 | 0.48 | 0.45 | 41.5 | 25.5 | 37.5 |
| 30/10 | 30 | 10 | 0.47 | 0.45 | 41.5 | 25.5 | 37.5 |
| 40/20 | 40 | 20 | 0.46 | 0.43 | 51.5 | 34.0 | 47.5 |
| 40/10 | 40 | 10 | 0.45 | 0.43 | 51.5 | 34.0 | 47.5 |

**NOTES**: 1. Under water/cement ratio, column A applies to moderate and intermediate exposure, and column B applies to severe exposure. See NOTE after Table 7.2.

2. In case of concrete having a maximum aggregate size of 40mm or less, 150mm cubes should be used.

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

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

ii) The cement content shall be such as to achieve the strengths called for in Table 7.1 but in any case not less than the minimum necessary for impermeability and durability shown in Table 7.2.

iii) The workability shall be consistent with ease of placing and proper compaction having regard to the presence of reinforcement and other obstructions.

iv) The water/cement ratio shall be the minimum consistent with adequate workability but in any case not greater that that shown in Table 7.1 taking due account of any water contained in the aggregates. The Contractor shall take into account that this requirement may in certain cases require the inclusion of a workability agent in the mix.

v) The drying shrinkage determined in accordance with BS 1881 shall not be greater than 0.05 percent.

**Table 7.2 - Minimum Cement Content**

|  |  |  |  |
| --- | --- | --- | --- |
| **Minimum Cement Content - kg/m3 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 drying Surface exposed to driving rain; alternate wetting exposure and drying; exposure traffic; corrosive fumes; heavy condensation

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

**d)** **Trial Mixes**

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

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

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

* 1. The slump of the concrete shall be determined.
  2. 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.
  3. Three cubes from each batch shall be tested for compressive strength at seven days and the remaining three at 28 days.
  4. The density of all the cubes shall be determined before the strength tests are carried out.

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

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

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

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

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

**e) Quality Control of Concrete Production**

i) Sampling

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

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

Each sample shall be taken from one batch selected at random and at intervals such that each sample represents not more than 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 5) below, the compressive strength of the concrete at 28 days shall be such that no single result is less than the value shown in Table 7.1 under the heading early works test cubes’ and also that the average value of any four consecutive results is not less than the value shown in Table 7.1 under the same heading.

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

5) When test cube results are available for at least 20 consecutive batches of any class of concrete mixed in any one plant, the average of any four consecutive results at 28 days shall exceed the nominal strength by not less than half the current margin (Table 7.3) and each individual result shall not be less than 85 per cent of the nominal strength.

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

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

**Table 7.3 - Minimum Current Margin For Test Cubes**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Minimum Current Margin for** | | |
| **10N/mm2** | **15N/mm2 &**  **above** | **20N/mm2** |
| After 20 batches  After 50 batches | 3.3  1.7 | 5  2.5 | 7.5  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 Specification, and the Contractor shall immediately adjust the mix design subject to the agreement of the Engineer to restore compliance with the Specification. After adjustment of the mix design the Contractor will again be required to comply with sub- clauses 701(b) and 701(c) of this Section of the Specification.

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

i) Increasing the frequency of sampling until control is again established.

ii) Cutting test cores from the concrete and testing in accordance with SRN 117.

iii) Carrying out strengthening or other remedial work to the concrete where possible or appropriate.

iv) Carrying out non-destructive testing such as load tests on beams.

v) Removing the concrete.

## MIXING CONCRETE

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

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

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

and

b) adequate control is exercised during mixing.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

## 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.

## TRANSPORT OF CONCRETE

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

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

## 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 714. Before deposition of further concrete they shall be clean, hard and sound and shall be wet but without any free-standing water.

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

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

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

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

**c) Chutes**

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

**d) Concrete Pump or Placer**

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

Delivery pipes shall be so installed as to permit easy removal. Before starting the pump or placer operation, about one cubic metre of mortar with the same proportion of water, admixture, cement and fine aggregate as designated for the regular concrete mix shall be passed through the pipe. The pipe shall be set as straight and horizontally as possible to prevent clogging of the concrete mix in the pipe. The supports of the 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 706. All work on the concrete shall be completed while it is still plastic and it shall not thereafter be disturbed until it is hard enough to resist damage. Plant and materials to comply with this requirement shall be readily available at all times during concrete placing.

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

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

**g) Dimensions of Pours**

Unless otherwise agreed by the Engineer, pours shall not be more than two metres high and shall as far as possible have a uniform thickness over the plan area of the pour. Concrete shall be placed to the full planned height of all pours except in the circumstances described in sub-clause 705(d).

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

**h) Placing Sequence**

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

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

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

## 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.

## CURING OF CONCRETE

**a) General**

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

Curing shall be continued for as long as may be necessary to achieve the above objectives but in any case for at least seven days or until the concrete is covered by later construction whichever is the shorter period.

The above objectives are dealt with in sub-clause 707(b) and (c) but nothing shall prevent both objectives being achieved by a single method where circumstances permit.

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

Details of the Contractor’s proposals for curing concrete shall be submitted to the

Engineer before the placing of concrete commences in the Works.

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

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

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

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

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

**b) Loss of Moisture**

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

If for some reason it is not possible to use impermeable sheeting, the Contractor shall keep the exposed surfaces continuously wet by means of a water spray or by covering with a water absorbent material which is kept wet, unless this method conflicts with sub-clause 707(c).

Water used for curing shall be of the same quality as that used for concrete mixing as stated in Clause 702.

**c) Limitation of Temperature Differential**

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

1. limiting concrete temperatures at placing as set out in sub-clause 709(b);
2. use of low heat cement, subject to the agreement of the Engineer;
3. insulation of exposed concrete surface by insulating blankets. Such blankets shall have an insulation value at least equivalent to 50mm of dry mineral wool;
4. leaving formwork in place during the curing period. Steel forms shall be suitably insulated on the outside;
5. preventing rapid dissipation of heat from surfaces by shielding from wind;
6. avoiding the use of water sprays when such use would cause rapid cooling of the surface.

## PROTECTION OF FRESH CONCRETE

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

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

Concrete placed in the Works shall not be subjected to any loading until it has attained at least its nominal strength as defined in Clause 701.

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

## 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 loose any moisture during transporting and placing.

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

* + 1. Shielding aggregates from direct sunshine.
    2. Use of a mist water spray on aggregates
    3. Sun shields on mixing plants and transporting equipment.
    4. 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.
    5. 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.

## FINISHES ON UNFORMED SURFACES

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

**UF 1 Finish**

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

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

**UF 2 Finish**

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

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

**UF 3 Finish**

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

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

**Table 7.4 - Surface Tolerances**

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

**Notes**:

1. Col. A is the maximum allowable value of any sudden change of level in the surface.

2. Col. B is the maximum allowable value of any gradual irregularity of the surface, as indicated by the gap between the surface and a three metre long straight edge or correctly shaped template placed on the surface.

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

Where dimensional tolerances are given on the drawings or in this Special Specification they shall take precedence over those given in Table 7.4.

## MORTAR

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

Mortar shall be composed of fine aggregate complying with Clause 721 c) and ordinary Portland cement complying with SRN 103. The mix proportions shall be as stated on the drawings or elsewhere in this Specification or if not stated shall be one part of cement to two parts of fine aggregate by weight.

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

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

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

## 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.

## 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 preceeding 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.

## 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 scrabbled by mechanical means or wet sand blasted and then washed with clean water. The indentations produced by scrabbling shall be not less than 10mm deep and shall not extend closer than 40mm to a finished face.

If instructed by the Engineer the surface of the concrete shall be thoroughly brushed with a thin layer of mortar composed of one part of cement to two parts of sand by weight and complying with Clause 711 all as set out in sub-clause 705(b) immediately prior to the deposition of fresh concrete. The mortar shall be kept just ahead of the fresh concrete being placed and the fresh layer of concrete shall be thoroughly and systematically vibrated to full depth to ensure complete bond with the adjacent layer.

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

## 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.

## 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.

## 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.

## REMEDIAL WORK TO DEFECTIVE SURFACES

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

Defective surfaces shall not be made good by plastering. Areas of honey combing (of a mild nature) which the Engineer agrees may be repaired shall be cut back to sound concrete or to 75mm whichever is the greater distance. In the case of reinforced concrete the area shall be cut back to at least 25mm clear distance behind the reinforcement or to 75mm, whichever is the greater distance. The cavity shall have sides at right angles to the face of the concrete. After cleaning out with water and compressed air, a thin layer of cement grout shall be brushed on to the concrete surface in the cavity and it shall then be filled immediately with concrete of the same class as the main body but with aggregate larger than 20mm nominal size removed. A form shall be used against the cavity, provided with a lip to enable concrete to be placed. The form shall be filled to a point above the top edge of the cavity.

After seven days the lip of concrete shall be broken off and the surface ground smooth. Surface irregularities which are outside the limits of tolerance set out in Clause 710 shall

be ground down in the manner and to the extent instructed by the Engineer.

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

## 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.

## 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.

## 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 Uganda 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 Transport & Communications or at the Uganda National Bureau of Standards or at any other approved laboratory at the rate of one set of tests as shown in SRN 103 for every 200 tonnes, and at monthly intervals thereafter.

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

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

**c) Fine Aggregate**

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

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

Other properties shall be as set out below:

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

Chlorides soluble in a 10 per cent solution by weight of nitric acid shall not exceed 0.05 per cent by weight expressed as chloride ion when tested as set out in SRN 107, subject also to the further restriction given in the note on total chloride content in Clause 721 (d).

Sulphates soluble in a 10 per cent solution by weight of hydrochloric acid shall not exceed 0.4 per cent by weight expressed as SO3, when tested as set out in SRN 601, subject also to the further restriction given in the note on total sulphate content in Clause 721 (d).

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

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

Test for presence of organic impurities in aggregates:

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

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

**d) Coarse Aggregate**

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

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

Other properties shall be as set out below:-

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

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

The total content of aggregate shall not be more than the following:

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

Chlorides soluble in a 10 per cent solution by weight of nitric acid shall not exceed 0.03 per cent by weight, expressed as chloride ion when tested as set out in SRN 107 but subject also to the further restriction under the note on total chloride content hereunder. Sulphates soluble in a 10 per cent solution by weight of hydrochloric acid shall not exceed 0.4 per cent by weight expressed as SO3 when tested as set out in SRN 601 subject also to the further restriction given in the note on total sulphate content hereunder.

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

When tested in accordance with test C289 of the American Society for Testing of

Materials, the aggregate shall be non-reactive.

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

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

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

Impact value: Not more than 45 percent when tested in accordance with SRN 107. Ten percent fines value: Not less than 50kN when tested in accordance with SRN 107.

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

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

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

Aggregate Crushing Value (ACV): Not more than 35 percent. Los Angeles Abrasion (LAA): Not more than 50 per cent.

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

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

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

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

The total sulphate content expressed as SO3 of all the ingredients in a mix including cement, water and admixtures shall not exceed 0.4 per cent by weight of the aggregate or 4.0 percent of the weight of cement in the mix, whichever is the lesser.

**e) Testing Aggregates**

**i) Acceptance Testing**

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

Tests to determine compliance of the aggregates with the requirements of Clause 721(c) and (d) shall be carried out by the Contractor in a laboratory acceptable to the Engineer. If the tested materials fail to comply with the Specification, further tests shall be made in the presence of the Contractor and the Engineer and acceptance of the material shall be based on such tests.

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

**ii) Compliance Testing**

The Contractor shall carry out routine testing of aggregates for compliance with the Specification during the period that concrete is being produced for the Works. The tests set out below shall be performed on aggregates from each separate source on the basis of one set of tests for each day on which aggregates are delivered to site provided that no set of tests shall represent more than 250 tonnes of fine aggregate nor more than 500 tonnes of coarse aggregate, and provided also that the aggregates are of uniform quality. If the aggregate from any source is variable, the frequency of testing shall be increased as instructed by the Engineer.

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

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

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

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

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

**f) Delivery and Storage of Aggregates**

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

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

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

**g) Water for Concrete and Mortar**

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

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

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

If water for the works is not available from the Employer’s supply the Engineer’s approval must be obtained regarding the source of supply and manner of its use. Water to be used with cement or lime shall be free from salt, oil, alkali, organic matter, and other deleterious substances.

**h) Admixtures**

**i) General**

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

In all cases the Contractor shall submit to the Engineer full details of the admixture he proposes to use and the manner in which he proposes to add it to the mix.

The information provided shall include but not be limited to:-

* + 1. The typical dosage, the method of dosing and the detrimental effects of an excess or deficiency in the dosage.
    2. The chemical names of the main active ingredients in the admixture.
    3. Whether or not the admixture contains chlorides, and if so the chloride ion content expressed as a percentage by weight of admixture.
    4. 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.
    5. Details of previous uses of the admixture in Uganda.

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

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

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

**ii) Workability Agents**

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

**i) Reinforcement Steel**

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

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

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

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

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

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

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

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

**Dowel Bars**

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

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

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

i) It shall not retard or in any other way affect the setting of concrete.

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

# FORMWORK

## 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.

## CONSTRUCTION OF FORMWORK AND FALSEWORK

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

Formwork and falsework shall be so constructed that they will support the loads imposed on them by the fresh concrete together with additional stresses imposed by vibrating equipment and by construction traffic, so that after the concrete has hardened the formed faces shall be in the positions shown on the drawings within the tolerances set out in Clause 806.

Ground supports shall be properly founded on footings designed to prevent settlement. Joints in formwork for exposed faces shall, unless otherwise specified, be evenly spaced

and horizontal or vertical and shall be continuous or form a regular pattern.

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

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

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

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

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

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

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

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

Formwork shall not be re-used after it has suffered damage which in the opinion of the

Engineer is sufficient to impair the finished surfaces of the concrete.

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

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

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

## 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.

## REMOVAL OF FORMWORK

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

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

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

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

**Table 8.1 - Minimum Periods for Formwork Removal**

|  |  |  |
| --- | --- | --- |
| **Position of Formwork** | **Min. Period for temp over 10 Degrees Centigrade** | **Strength to be attained** |
| Vertical or near vertical faces of mass concrete | 24 hours | 0.2 C |
| Vertical or near vertical faces of reinforced walls, beams and columns | 48 hours | 0.3 C |
| Underside of arches, beams and slabs  (formwork only) | 4 days | 0.5 C |
| Supports to underside of arches, beams and slabs | 14 days | C |
| Arched linings in tunnels and underground works | 24 hours | 4 N/mm2 |

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

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

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

## SURFACE FINISHES ON FORMED SURFACES

**Classes of Finish**

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

**a) Class F1 Finish**

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

**b) Class F2 Finish**

This finish is for surfaces which are permanently exposed to view but where the highest standard of finish is not required. Forms to provide a Class F2 finish shall be faced with wrought 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 discoloration and other minor defects shall be remedied by methods agreed by the Engineer.

**c) Class F3 Finish**

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

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

**d) Curved Surfaces**

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

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

## TOLERANCES

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

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

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

**Table 8.2 - Tolerances**

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

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

1. Column A is an abrupt irregularity in the surface due to misaligned formwork or defects in the face of the formwork.

2. Column B is a gradual deviation from a plane surface as indicated by a straight edge 3m long. In the case of curved surfaces the straight edge shall be replaced by a correctly shaped template.

3. Column C is the amount by which the whole or part of a concrete face is displaced from the correct position shown on the drawings.

# MASONRY

## GENERAL

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

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

## WORKMANSHIP

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

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

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

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

## CAST STONEWORK

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

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

# MISCELLANEOUS ITEMS AND MATERIALS

## GENERAL

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

a) All items shall be suitable for water works purposes and for use with cold water installation and operation being in a tropical climate.

b) All items hereinafter specified shall be to such other Standard or Specification which in the opinion of the Engineer provides for a quality of material and workmanship not inferior to the Standard Reference Number (SRN) quoted. The Standard or Specification must be submitted to the Engineer for approval before commencement of work.

c) All ferrous pipes and fittings shall be coated with a protective paint suitable for use in and transport through a tropical climate.

d) The Contractor shall supply to the Employer a certificate stating that each item supplied has been subjected to the tests hereinafter laid down and conforms in all respects to the said Specification.

e) The Contractor shall provide adequate protection to all piping, flanged items and valves so as to guard effectively against damage in transit and storage and ingress of foreign matter inside the valves.

f) All pipework and fittings shall be subjected to a works hydrostatic test pressure which shall be not less than twice the maximum operating pressure.

g) The Contractor should exercise diligence to provide the best material.

h) Where applicable the manufacturer’s Specification should accompany all offers. The name of the manufacturer must in every case be stated.

j) Where necessary the Contractor shall provide rubber gaskets to comply with

SRN 208 and all other bolts, nuts, washers, etc. to undertake jointing at fittings etc.

k) Any articles required under this Contract which are found to be faulty due to a crack, flaw or any other reason or is not in accordance with the Specification stipulated will not be accepted nor will the Employer be liable for any charges in respect of such an article. Where any such rejected article can, in the opinion of the Engineer, be rendered usable, the Contractor may deal with it accordingly and include it in the Contract at a price to be mutually agreed. Straight pipes which have been cut will be accepted at the discretion of the Engineer, provided the length is not less than 4 metres or two thirds of the standard length whichever is the lesser and will be priced pro-rata.

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

## 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.

## ARCHITRAVES AND STOPS

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

## 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.

## BOLTS AND NUTS

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

Black Hexagon Bolts, Screws and Nuts B.S. 4190, Grade 4.6

Metal Washers for General Purpose B.S. 4320

Black Cup and Countersunk Head Bolts B.S. 4993

and Screws, with Nuts

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

## BONDING TIES

Bonding ties shall be 75mm wide x 250mm long galvanized bitumen-coated expanded metal strip, cast 100mm into concrete surfaces in contact with block work. The bonding tie used shall be approved by the Engineer’s Representative.

## 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:-

1. The treatment shall be repeated for 10 cycles only; and
2. The second criterion of failure shall be amended to allow for a loss of weight of not more than 20% of its original weight.

## 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.

## 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.

## 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.

## CEMENT-LIME MORTAR

Cement-lime mortar shall consist of Portland Cement, hydrated lime and natural sand or crushed natural stone or a combination of both, as specified for cement mortar in Clause 712. The constituent materials shall be accurately gauged and mixed by volume in an approved manner in the proportions specified.

Cement-lime mortar shall be made only in small quantities as and when required. Any mortar which has begun to set or which has been mixed for a period of more than two hours shall be rejected.

## CONCRETE BLOCKS

Solid and hollow concrete blocks for walling shall comply with SRN 804 in every respect.

All solid and hollow concrete blocks used in the walling must be capable of withstanding a crushing pressure of not less than 0.35 kg per square millimetre after 28 days. The blocks shall be cast in Metric sizes.

## CONCRETE DRAIN INVERT BLOCKS

Precast concrete invert blocks shall be manufactured to the detail drawings supplied from concrete Class 20/10 as specified in Table 7.2 using maximum 12mm size aggregates. If required, cube test certificates shall be supplied by the manufacturer.

## CONCRETE SLABS FOR OPEN DRAINS

Precast concrete slabs for lining open drains shall be manufactured to the detail drawings supplied from concrete Class 20/10 as specified in Table 7.2 using maximum 12mm size aggregates. If required, cube test certificates shall be supplied by the manufacturer.

## 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.

## 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%).

## ELECTRICAL INSTALLATION

The electrical installations will be carried out by Licensed Electrician and complying with the following: -

a) Regulations for Electrical Equipment of Buildings issued by the Institution of

Electrical Engineers.

b) Electric Power Act.

c) The Uganda Electricity Distribution Company Limited, Bye-Laws.

d) Relevant current British Standards and Codes of Practice.

e) All the relevant clauses in this Specification.

## FIRE HYDRANTS

Fire hydrants shall be in accordance with SRN 509. They shall be for installation underground and shall be in accordance with SRN 509.

The spindle shall be provided with a universal cast iron cap conforming to SRN 501.

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

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

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

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

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

## 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.

## 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.

## 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.

## GABIONS

Gabions shall be of the hexagonal wire mesh type, with mesh dimensions of 80 mm x 100 mm. The minimum dimension shall not exceed 83 mm. Wire shall be galvanised prior to weaving the mesh to resist corrosion from water.

All wire used in the fabrication of the gabion and in the wiring operation during construction shall be in accordance with BS 1052/1980 Mild Steel wire appended having a tensile strength of 38-50 kg/mm2

All wire shall be galvanised to BS 443: 1982 'Zinc coatings on steel wire' with the minimum weight of Zinc coating in accordance with Table below.

|  |  |  |
| --- | --- | --- |
|  | **Diameter (mm)** | **Minimum Weight of Coating (g/m2)** |
| Mesh wire | 2.7 | 260 |
| Binding and connecting wire | 2.2 | 240 |
| Selvedge wire | 3.4 | 275 |

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

Gabions shall be of the following standard sizes:

2m x 1m x 0.5m

2m x 1m x 1m

6m x 2m x 0.3m

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

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

Gabions shall be as manufactured by Maccaferri, or equivalent. Alternative materials shall be subject to the approval of the Engineer.

Rockfill for gabions shall consist of hardcore i.e. sound hard stone or broken rock. The maximum size shall be 220mm, and the minimum size shall be 120mm; however, up to 10% of some smaller blinding material (min. 75mm) to fill the internal voids between the bigger rocks will be allowed.

Gabions shall be placed in their final positions prior to filling with rock, and shall then be tied together and filled with rock. After filling with rock, the tops shall be closed and securely tied with connecting wire. The larger rocks shall be placed on the upper face of the gabion in order to present a reasonably closed surface. All assembly, erection, stretching, filling with rock and final filing shall be in accordance with the instructions as issued by the manufacturer.

## GALVANISED WORK

Iron and steel, where galvanized, shall comply with B.S. 729, entirely coated with zinc after fabrication by complete immersion in a zinc bath in one operation and all excess carefully removed. The finished surface shall be clean and uniform.

## 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.

## 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%).

## HYDRATED LIME

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

## 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.

## 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.

## JOINT PRIMER

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

## JOINT SEALING COMPOUND

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

|  |  |  |
| --- | --- | --- |
| Test Cone Penetration  0.15 kg. for 5 secs. at 25o centigrade using standard grease cone | Hot-poured Materials  Penetration not to exceed 9mm | Cold-poured Materials  Penetration to be not less than 5mm not more than 27.5mm |
| Flow  On a plane inclined at 75o to the horizontal, 5 hours at 60o centigrade | Flow not to exceed  5mm | Flow not to exceed 20mm |
| Bond  25mm wide joint extended 12mm at rate of 4mm per hour at 18o 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.

## LIME MORTAR

Lime mortar shall consist of proportions by volume as specified of hydrated lime and naturals and/or crushed natural stone or a combination of both as specified for cement mortar in Clause 1010. The constituent materials shall be accurately gauged and mixed in an approved manner.

## 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.

## MANHOLE STEP IRONS

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

Step Irons.

## 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.

## 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.

## 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.

## 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.

## 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.

## 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.

## 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.

## PRECAST CONCRETE UNITS

Precast concrete covers to be precast units for use in the works, whether instructed under the Contract or proposed by the Contractor.

**a) Formwork for Precast Units**

Moulds shall be so constructed that they do not suffer distortion or dimensional changes during use and are tight against loss of cement grout or fines from the concrete.

Moulds shall be set up on firm foundations so that no settlement occurs under the weight of the fresh concrete.

Moulds shall be constructed so that units may be removed from them without sustaining any damage.

Release agents used for demoulding shall not stain the concrete or affect its properties in any way.

**b) Reinforcement for Precast Units**

Reinforcement in precast units shall comply with the requirement of Clauses 721 i) and 719-720. When preformed cages are used the cages shall be made up on jigs to ensure dimensional accuracy and shall be carefully supported within the could in such a way that they cannot move when concrete is placed. Reinforcement complying with SRN 126 may be tack welded where bars cross to provide rigidity in the cage but reinforcement complying with SRN 127 shall not be welded.

Cover to main reinforcement shall be as shown on the drawings, or if not shown shall be not less than 25mm or the diameter of the bar, whichever is the greater. Cover on distribution steel shall not be less than 15mm or the diameter of the bar whichever is the greater.

Bars shall be spaced so that the minimum clear distance between them is the maximum nominal aggregate size plus five millimetres but in any case not less than the diameter of the bars.

Bars may be placed in pairs provided that there are no laps in the paired lengths.

**c) Casting of Units**

Concrete for precast units shall comply with Clauses 1039/1040 and 701-710 using the class of concrete specified on the drawings.

If lightweight aggregates are specified, they shall comply with SRN 147.

The area in which units are cast shall be adequately protected from the weather so that the process is not affected by rain, sun or drying winds.

**d) Curing Precast Units**

Requirements for curing shall be generally as set out in Clause 707.

The Contractor shall ensure that units do not suffer any loss of moisture or sudden changes of temperature for at least four days after casting. If a water spray is used for curing, the water shall be at a temperature within 5 degrees centigrade of the temperature of the unit being cured.

If Contractor proposes curing at elevated temperatures, the method shall be subject to the agreement of the Engineer and shall include means whereby units are heated and subsequently cooled evenly without sudden changes of temperature.

**e) Dimensional Tolerances of Precast Units**

Units shall be accurately formed to the dimensions shown on the drawings unless closer tolerances are called for by the Engineer.

**f) Surface Finish of Precast Units**

The formed faces of precast units shall be finished to Class F3 as set out in Clause

805c) unless another class of finish is specified on the drawings.

Free faces shall be finished to Class UF2 unless another class of finish is specified on the drawings

In cases where a special finish is required a trial panel shall be constructed by the Contractor which after approval by the Engineer shall be kept available for inspection at the place of casting and production units shall thereafter match the approved pattern.

Those parts of the unit which are to be joined to other units or to in-situ concrete shall be brushed with a stiff brush before the concrete has fully hardened. Alternatively, if the concrete has been allowed to harden, the surfaces shall be roughened by sand blasting or by the use of a needle gun.

**g) Handling and Storage of Precast Units**

Precast units shall be handled in a manner which will not cause damage of any kind and shall be stored on a hard impermeable base.

Prestressed units and large precast normally reinforced units shall be handled and stored so that no stresses shall be induced in excess of those which they will incur in their final positions in the Works unless they have been designed to resist such stresses.

Units shall be provided with adequate lifting holes or loops, placed in the locations shown on the drawings or agreed by the Engineer and they shall be lifted only by such holes or loops. Where it is not possible to provide holes or loops, suitable sling positions shall be indicated in paint on the units.

Units shall be marked indelibly with the reference number and date of casting and shall be stacked on suitable packers which will not damage the concrete or stain the surfaces. Not more than two packers shall be placed under each unit and these shall be located either at the positions of the permanent support points or in positions such that the induced stresses in the unit will be a minimum.

**h) Testing Precast Units**

Precast units shall be capable of safely sustaining the loads which they have been designed to carry. The Contractor shall subject units selected by the Engineer to load tests simulating the working conditions. Details of such tests shall be agreed between the Engineer and the Contractor.

In the case of units subject to bending loads the test piece shall be supported at full span and a loading equivalent to 1.25 times the sum of the live and dead loads which were assumed in the design shall be maintained for one hour without the appearance of any signs of distress. The recovery one hour after the removal of load shall be not less than 75 per cent of the full load deflection.

If the unit fails to meet the above requirements, further tests shall be carried out on two more units. If either of these fail the whole batch of units will be rejected.

If the Engineer so requires, a test to destruction shall also be carried out which on units subject to bending shall be as follows:-

The units shall be supported at full span and a load applied in increments instructed by the Engineer up to 95 per cent of the designed ultimate load. This load shall be held for 15 minutes without failure of the unit. The deflection at the end of this period shall be not more than 1/40th 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.

## 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.

## 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.

## 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%

## 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.

## 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.

## 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.

## 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.

## 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.

## 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.

# PROJECT SPECIFIC INFORMATION AND CONTRACTOR’S GENERAL RESPONSIBILITY

## PROJECT LOCATION

The Nyamugasani Water Supply and Sanitation project area is located in Kasese District between latitudes 00 12’ 21” S and 00 19’ 05” N and longitudes 290 41’ 56” E and 300 15’ 51” E in Western Uganda. It is accessible by approximately 390km of tarmac road from Kampala via Fort Portal town. The proposed supply area is 1,723km2 and includes seven Sub Counties namely Kyondo, Muhokya, Munkunyu, Kisinga, Kyarumba, Lake Katwe and Nyakatonzi.

## SCOPE OF WORKS

Phase I is intended to cover the Nyamuruseghe intake, Raw water main and water treatment plant as well as transmission, and distribution to Kyarumba, Lake Katwe, Kahokya and Muhokya sub counties including Kyarumba and Muhokya Town Councils.

**Lot 1** is intended to cover Nyamuruseghe intake, Raw Water main, Water treatment plant, transmission and distribution pipeline from Kyarumba to Kyondo and Kisinga Sub Counties including Kyarumba, and Kisinga Town Councils.

The scope of construction work is described below

1. Intake works: Construction of one raw water intake weir and chamber across River Nyamurushege of 19,000m3/h design discharge capacity.
2. Laying of a Raw water gravity main steel/iron pipe DN 250 mm PN 25, 1.045 km length to the water treatment plant
3. Water Treatment Works of 5,588m3/day Design capacity comprising of reinforced concrete units including:
4. 4 No. Stair step cascade aerator unit
5. 2No. Flocculation tank
6. 2No. Sedimentation tank
7. 2No.Rapid Sand Filters
8. 2No. Automatic Valveless Gravity Filter (AVGF) each of 120m3/h capacity
9. Chlorine House
10. 2875.49 m3 Clear water Tank
11. 4No: Sludge drying beds
12. 200m3 hot pressed steel section panel backwash tank elevated 12m above ground level on structural steel support tower
13. Pump House
14. Generator House
15. Staff camp manager House
16. Staff camp Operator House
17. Guard House
18. Administration building
19. Septic tank
20. Site drainage works
21. External works including:

* Access road and parking
* Landscaping
* Chain-link fencing on concrete posts,
* Metallic frame gate and guard house
* Walkways paved with 80mm thick pre-cast concrete pavers laid on well compacted
* Gravel earth material and sand base material.

1. Transmission Pipelines - Laying of 12.56 km of high pressure rated gravity transmission steel pipe network from Kyarumba to Kisinga including one (01) break pressure tank as follows;

|  |  |
| --- | --- |
| DN 300mm Steel | 9,969m |
| DN 200mm Steel | 992m |
| DN 80mm Steel | 18m |
| DN 50mm Steel | 1,600m |

1. Distribution Pipelines- Laying of 22Km of uPVC pipes and 81Km of HDPE pipes distribution network as follows including 13No. break pressure tanks.;

|  |  |
| --- | --- |
| UPVC OD 250mm | 974m |
| UPVC OD 200mm | 1,740m |
| UPVC OD 160mm | 6,660m |
| UPVC OD 125mm | 6,135m |
| UPVC OD 110mm | 6,504m |
| HDPE OD 90mm | 6,429m |
| HDPE OD 75mm | 7,120m |
| HDPE OD 63mm | 1,610m |
| HDPE OD 32mm | 1,500m |
| HDPE OD 25mm | 6,000m |
| HDPE OD 20mm | 60,000m |

1. Reservoir Tanks – Construction of 5No ground water pressed steel storage tanks of the following capacities

|  |  |  |  |
| --- | --- | --- | --- |
| **Tank Position/Name** | **Tank Capacity (m3)** | **QTY** | **Type** |
| Lower Kisinga | 800 | 1No | Steel on Dwarf Walls |
| Kyarumba | 275 | 1No | Steel on Dwarf Walls |
| Kaberere | 125 | 1No | Steel on Dwarf Walls |
| Upper Kisinga | 50 | 1No | Steel Elevated Tank |
| Kasokero | 50 | 1No | Steel Elevated Tank |

1. Service Connections - Installation of 1,500No consumer service connections.
2. Sanitation – Construction of 16No. VIP toilets in Schools and 1No. Water borne toilets at public places, health facilities and government offices at the locations detailed below.

|  |  |  |  |
| --- | --- | --- | --- |
| Location | Type of Facility | Number of | |
| Facilities | Stances |
| Kyarumba HC III | WBT | 1 | 13 |
| Kyarumba PS in Kyarumba SC | VIP | 2 | 5 each |
| Musasa PS in Kyarumba SC | VIP | 2 | 5 each |
| Kinyabisikyi PS in Kyondo SC | VIP | 2 | 5 each |
| Uganda Martyrs PS in Kyondo SC | VIP | 2 | 5 each |
| Kalikyikalikyi PS in Kisinga SC | VIP | 2 | 5 each |
| Kisinga PS in Kisinga TC | VIP | 2 | 5 each |
| Kisinga SDA PS in Kisinga TC | VIP | 2 | 5 each |
| Kisinga Vocational in Kisinga SC | VIP | 2 | 5 each |

## WATER TREATMENT UNITS

All the works at the water treatment plant shall be able to handle a flow of 5588 m3/day and achieve the drinking water standards of the government of Uganda. The system components are as follows:

1. **Cascade Aerators**

The cascade aerators having 4 number steps, 800mm treads and 300mm risers will be constructed and will have a thin rectangular weir plate located at the outlet chamber having the following dimensions 1.5m length, 1.5 breadth, and 1m depth as shown in drawing 5116042-DWS-NYA-02102.

1. **Flocculation Tank**

As shown in drawing 5116042-DWG-02103 two flocculation tanks shall be constructed having the following internal dimensions 12.2m length, 10m width, and 1m depth for each tank. Water shall enter through a 500mm distribution channel into the flocculation tank having 18 baffle walls, that are 150mm thick at a spacing of 500mm each. A sluice gate shall be used to close off the flow to either of the basins when required. The whole structure shall be finished completely watertight and shall pass the water tightness tests.

1. **Sedimentation - Horizontal Flow Tanks**

The contractor shall construct two sedimentation tanks with the following internal dimensions 19.5m length, 6.5m width, and 3.75m depth, and shall have a sludge collection hopper for each tank as shown in drawing 5116042-DWG-02104. Water shall flow through a 500mm distribution channel, into 150mm diameter holes then into the sedimentation tank. A sluice gate shall be used to close off the flow to either of the basins when required. Water shall exit from the sedimentation tank through V-notch weirs into a collection channel. The whole structure shall be finished completely watertight and shall be provided with the safety fittings like handrails and access ladders.

1. **Rapid Sand Filters**

The contractor shall construct two rapid sand filters with the following internal dimensions 3.6m length, 6.5m width, and 3.55m depth as shown in drawing 5116042-DWG-02105. The whole structure shall be finished completely watertight and shall pass the water tightness tests. The following shall be provided:

* **Filter Media**

Filter media shall be of hard grain quartz having no constituents in any way friable or susceptible to mechanical damage when subjected to pressure. The filter sand shall contain no carbonaceous matter, clay, or silt and the loss on acid washing and ignition shall not exceed 2% by weight in either case. The specific gravity shall be not less than 2.4, and the grain size shall be 0.8mm - 0.9mm. The designed filter bed thickness is 1.55m containing 1 m of homogeneous filter sand and 550mm of the gravel filter support. Before commissioning each filter shall be backwashed and the media skimmed, if necessary, such that the proportion of fines in the top 150 mm does not exceed 5%. The depth of media lost by skimming and any media lost during commissioning shall be replaced by the Contractor at his own expense.

* **Filter Inlet**

The filter inlet shall be an open channel, and the inlet into each filter shall have a 1m depth and 0.5m width provided with a penstock.

* **Underdrainage**

The filter under drainage shall be of proprietary manufacture and shall be made from non-corrodible and preferably non-metallic materials, and designed for water wash. The under-drainage shall be even and shall ensure a uniform distribution of water both during filtration and backwash. It shall be strong enough to withstand the load on it, as well as any surges resulting from the backwash operations. The Contractor shall provide the details of the under drainage he intends to use for the Engineer’s approval.

* **Filter outlet**

The filter outlet shall be a DN350mm pipe connecting to a 500mm wide and 900 mm deep manifold channel before discharge into the clear water tank. It shall be in ductile iron or similar materials suitably provided with valves as shown in the drawings. Provision shall be made for a sampling point on the filter manifold.

* **Filter Backwashing**

Filter washing shall be achieved by air scour followed by water washing. The washing conditions should be so designed that the sand filters can be effectively cleaned. The rate of backwashing and air supply shall be adequate for cleaning the bed and removing material but shall not dislodge the media layers or disturb the consistency of the bed. Facilities shall be provided for the following minimum air-scour and wash water rates:

* Air Scour - 46.567 m3/min
* Wash Water - 0.32 m3/sec

The wash water outlet penstock shall be of such design as to allow complete closure without leaking even when sand grains occasionally wash out of the filter lodge into the frame or gate seat.

* **Air Scour Blowers**

The Contractor shall supply a duty and standby air scour blowers and have a design flow adequate for effectively cleaning the filters. Each shall be rated to deliver a minimum airflow of 46.567 m3/min. A manually operated air dump valve and orifice plate-type flow meter with local indication shall be installed in the air scour discharge pipework. The air blower, silencers, pipework, and flexible connections shall be welded in accordance with BS 4870. The contractor shall ensure that the air scour is evenly distributed over the whole filter area.

* **Wash Water Outlet**

The wash water shall flow into the wash water gutter and channeled into DN 450mm washout pipe. The penstock shall be provided with an extended spindle for operation from the filter control deck.

* **Wash Water System**

The backwash water is delivered from a backwash tank. The backwash water main shall be DN 350 and shall be provided with a bulk flow meter, an electromagnetic flow meter, transmitting the flow to a panel in the filter control room and a flow control butterfly valve. The contractor shall ensure that the water scour is evenly distributed over the whole filter area.

1. **The Automatic Valveless Gravity Filter (AVGF)**

The AVGF Technical Specifications are as follows;

|  |  |  |
| --- | --- | --- |
| **A** | **General** | |
|  | Model: | STPL–AVGF–120 |
|  | Type: | Automatic Valve less Gravity Filter (Vertical) |
|  | Fluid: | Water |
|  | Quantity: | 2 Nos. |
|  | Capacity of Each Filter: | 120 m3/hr |
|  | Surface loading rate: | 10.6 m3/m2/h |
|  | Filter dimension: | Diameter 3.8 m x 4.5 m Shell Height |
|  | Filter media details: | Quartz Sand |
|  | Inlet TSS: | Up to 50 ppm |
|  | Outlet TSS: | Less than 2 ppm or 10% of inlet TSS |
|  | Degree of Filtration: | 30 Micron |
|  | Frequency of backwash: | At least once in 24 hours of operation |
|  | Backwash duration: | 120 sec to 300 sec |
|  | Design Pressure: | Full of water |
|  | Operating Temperature: | 45 deg C |
|  | Design Temperature: | 60 deg C |
|  | Pressure Drop in clean condition: | 1.2 MWC – 1.5 MWC |
|  | Pressure Drop in dirty condition /just before Backwash | 2.1 MWC – 2.4 MWC |
|  | Corrosion Allowance | 1.5 mm |
| **B** | **MOC** | |
|  | Plate: | IS2062 GrE250 BR/BO |
|  | Pipe: | Up to 150 NB – IS1239 Hvy  Above 150 NB up to 400 NB –IS3589, 6 mm thick |
|  | Flanges: | IS 2062 |
|  | Strainers: | Polypropylene (PP) |
|  | Gasket: | Neoprene Rubber |
| **C** | **Construction Details** | |
|  | Shell thickness: | 8 mm |
|  | Bottom plate thickness: | 8 mm |
|  | Overhead tank and loop tank thickness | 8 mm |
|  | Inlet Distributor type: | Deflected Vortex Type |
|  | Underdrain Collection System: | Underdrain Collection System: |
|  | Air Scouring: | Not Required |
| **D** | **Surface Preparation** | Weld Seams Ground Smooth to facilitate painting.  All the Welds and Surfaces in Descaled and clean condition free from dirt, oil & grease by wire brushing mechanical cleaning. |
|  |  |  |
| **E** | **Painting:** | Rust primer coat with Epoxy paint |
|  |  |  |
| **F** | **Accessories** | 1 No Rota meter, 1 No. DP Gauge, 2 Nos. Sampling cock at inlet & outlet |
| **G** | **Others** | * One Lot of Sand Media per filter. * Butterfly valves for Inlet, manual back wash & ball valve for sampling points * 1 No. Rotameter (Flow Measurement) and 1 Nos. DP Gauges for each filter * One set of Internal Piping per filter as per proprietary drawings * Ladders and Handrails: One set per filter |

1. **Clear Water Tank**

The Contractor shall construct a clear water tank as detailed in the drawings and 5116042-DWG-02122. The clear water tank shall be reinforced concrete. The chlorine contact tank shall be provided with internal baffle walls to eliminate short-circuiting. The tank serves as a suction reservoir for backwash water pumping and suction reservoir for treated water to gravitate to the distribution system. The whole structure shall be finished completely watertight and shall pass the water tightness tests.

The tank shall be provided with internal access ladders for each of the compartments. These shall be galvanized to protect them from rusting. Roof vents of diameter DN 100 shall be provided as shown in the drawings. These shall be vermin proofed, and fitted with corrosion resistant mosquito proof fabric. They shall be of such design as not to allow surface run-off to gain access to the tank. A roof mounted level indicator shall be provided for each tank compartment, and shall have metric graduations. All the components of the level indicator shall be rust proof, and be made from durable materials. Access covers shall be provided at roof level for the tank compartments as shown in the drawings. These shall be raised against the general level of the roof to stop roof run-off from entering the tank. Control electrodes shall be installed in the tank to control the operation of the water pump.

1. **Sludge Drying Beds**

As shown in drawings 5116042-DWG-02122 and 5116042-DWG-02124 The contractor shall construct four sludge drying bed of the following dimension 20m length, 4m width and a 1m height to handle process wastes. The sludge drying beds will be located in the lowest part of the site so as to receive wastes from the whole site.

1. **Pump Station**

As shown in drawings 5116042-DWG-02183 there is one pump house to be constructed by the contractor. The pump house shall be used to pump backwash water to from the clear water tank to the elevated tank. The backwash pump shall use Solar energy. The pump house shall have the following:

* 2 No Surface centrifugal pumps with motor Q=40L/s, H=20m
* 2 No air scour blowers
* Switchgear and controls
* Solar power system with a capacity of 15KW
* All associated pipe works

The machine plinths shall be in concrete and shall have independent foundations from the pump house floor. The plinth construction shall ensure no ground water leakage into the pump house. All works to ensure this shall be deemed to have been included in the cost of the plinths.

1. **Chemical Dosing Units**

As shown in drawings 5116042-DWG-02115, the contractor shall construct a chemical storage and mixing building. The building shall have two dosing units of Aluminium Sulphate(alum), two dosing units of soda ash and an area for Alum storage. The units will have hand regulated gravity dosers, dosing flow meters and mixing spades (Hand Agitators). From each dosing unit a pipe leads to the open raw water channel. All accessories, valves, etc. have to be included.

1. **Chlorine Units**

As shown in drawings 5116042-DWG-02120, the contractor shall construct a chlorination building. The building shall have two dosing units of chlorine and a chlorine storage room. The units will have hand regulated gravity dosers, dosing flow meters and mixing spades (Hand Agitators). The system will operate without electricity or any power source other than water flow. It will be self-priming and continuously adjustable to flow. All piping connections to this equipment, and all concreting for foundation bases shall be done under the respective sections for such work.

## ADDITIONAL CONTRACTOR’S RESPONSIBILITIES

The Pipelines are to be laid within a rural setting.

Briefly, the Contractor’s Additional Responsibilities will include:

* Setting out and verification survey of pipeline routes;
* Preparation of “As-Built” drawings and O&M manuals for the whole Project;
* Compliance with the project specific Environmental and Social Management Plan, all according to NEMA Conditions. This shall include issues such as disposal of wastes, health and safety of workers, safety of public, access and avoid nuisance to the public and property owners, confirm to emissions requirements, drainage and excessive erosion, among others;
* Maintaining the works for a pre-determined period (12 months) following hand-over, to ensure that the materials and workmanship are performing as intended.
* The Client has no land available for Contractor’s Camp or Camps. The Contractor will procure / rent adequate land for his camps including offices, workshops, stores, labour camp and other facilities within the vicinity of the Project Site. The Contractor will submit probable camp site(s) location details with the Bid.
* The Client has no land available for Storage of Materials including Pipes, Valves, Fittings, etc. The Contractor will procure / rent adequate land for proper storage and protection of all pipes, valves, fittings, etc. The Contractor will submit probable storage site(s) location details with the Bid.
* The Contractor shall be responsible for locating and protecting existing utilities and services, including existing bulk water supply trunk mains, electrical power cable routes (Uganda Electricity Distribution Company Limited), telephone (Uganda Telecom) and other service providers), water and sewerage pipes (the water company), roads and drains (Uganda National Roads Authority). In this respect, the Contractor shall be responsible for obtaining all Permits and Approvals, and in general complying with the requirements of the individual utilities and agencies.
* The new works will be connected to the existing, operational water distribution systems. The Contractor will be required to liaise closely with the Water Company when executing the works activities. Further, strict “rules” will apply to all such tie-in works since, in general, they may require for some time, a partial shut-down of the supply system and affected consumers to be informed well in advance.
* The pipelines traverse along roads and rural, residential areas. Working in these areas will require provision of safety barriers, warning signs and lighting, temporary accesses to properties, etc. The Contractor should indicate the cost of these works under Bill No. 1, Item 6 – Other Works, Obligations, Method Related Charges. If this item is not priced or inadequately priced, the Contractor’s rates for Other Works will be deemed to cover this requirement.
* The Contractor shall be responsible for identifying and paying all Government Levies and Statutory costs such as training levy, licencing fee, etc. The costs of these are deemed to be covered in the Contractor’s rates for the Works.

## CONDITIONS OF CONTRACT

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

## CONSTRUCTION PERIOD

The proposed construction period will be **16 months**. Potential Contractors will note that multiple teams will be required to comply with this requirement, and will provide documentation to demonstrate adequacy of resources in this respect. Additionally, potential Contractors to note that some disruptions to scheduled work may be expected to occur during the rainy seasons. This to be allowed for in their programme of implementation.

## SITE AND OTHER DATA

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

## WAYLEAVE / EASEMENT FOR PIPELINE WORKS

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

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

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

## RESTRICTIONS ON USE OF ROADS

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

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

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

## PREVAILING CONDITIONS

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

1. Climatic Conditions

The climatic conditions in Kasese district vary ranging from temperate, tropical, and alpine to semiarid plains and a bi-modal rainfall pattern. The district receives bimodal rainfall in March, May, October and November averaging between 800 and 2,000 mm. The annual rainfall distribution is greatly influenced by altitude. In terms of total annual rainfall, the extreme southern to south-eastern part of the district receives slightly less than 800 mm. Temperatures in Kasese district normally range between 23.9ºC and 30ºC.

1. Access

The works are to be executed along roads and in a rural area. Bidders to visit the Project Areas and familiarize themselves with the specific conditions in each area.

1. Services

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

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

1. Local Materials

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

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

1. Laws and Regulations

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

1. Local Labour

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

1. Ground Conditions

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

The Geotechnical Investigation was carried out and the information is available along the pipelines routes. Approximate rock excavation quantities have been appropriately provided for in the Bills of Quantities. These quantities are re-measurable.

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

## PROGRAM OF WORKS

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

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

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

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

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

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

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

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

## METHOD STATEMENTS

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

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

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

## ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

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

## HEALTH AND SAFETY MANAGEMENT PLAN

***[Refer to Clause 142 in Chapter 1]***

## PROGRESS REPORTS

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

If the Engineer considers it necessary, the frequency of reporting may be increased. Alternatively, the Contractor may be instructed to provide a special progress report for a particular section of works (that is significantly delayed for example), on a more frequent basis (e.g. weekly, or even daily).

## DAILY LOGS

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

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

The Engineer may, at his discretion, instruct the Contractor to provide daily labour and plant returns. Alternatively, the Engineer may request to review such information.

In addition, the Contractor shall provide the Engineer with copies of all delivery notes of plant and materials delivered to site.

## TEST FORMS

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

All test forms shall be completed, signed and dated by the appropriate persons conducting the tests. The original copy of all test forms shall be submitted to the Engineer.

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

## MISCELLANEOUS FORMS

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

1. Site Instruction Form;
2. Request for Information / Inspection / Approval Form;
3. Materials Supply Form;
4. Setting Out Works Form;
5. Pipeline Final Excavation Level Form;
6. Pipeline Laying Form;
7. Pipeline Backfilling Form;
8. Pipeline Testing Form;
9. Dayworks Form; and
10. Concrete Pour Form; etc.

## CERTIFICATES OF COMPLETION

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

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

## VERIFICATION BY CONTRACTOR

**Survey and Dimensional Checking**

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

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

## INTERFACE WITH ONGOING WORKS OR EXISTING NETWORKS

**Responsibility Matrix Probable Interface of Works with ongoing Works in Project Areas**

In cases where there may be ongoing distribution networks construction or upgrade and there will be interactions/interface with the works under this contract, the interface management shall follow the below criteria.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Responsibility** | **Supervising**  **Engineer** | **Nominated**  **Sub-Contractor** | **WSP** | **Main Contractor** | **Remarks** |
| Review detailed design of primary & secondary distribution network | A |  | input | X | Quantities and Costs included under Works Contract |
| Review of design of network configuration, diameter & appurtenances of tertiary mains, based on base/topography/areal maps | A |  | input | X | Quantities and Costs included under Works Contract |
| Locating existing connections (on existing secondary & tertiary mains) along water mains being replaced. | A |  | Input/A | X | Quantities and Costs included under Works Contract |
| Status verified and reconciliation of utility network fittings locations |  |  | Input/A | X | Quantities and Costs included under Works Contract |
| Locating existing secondary & tertiary mains |  |  | input | X | Quantities and Costs included under Works Contract |
| Assessment of connection needs of new secondary mains constructed and tested, based on bulk transmission reviewed detailed designs |  |  | input | X | Quantities and Costs included under Works Contract |
| Replacement of destroyed existing tertiary mains | A |  |  | X | Quantities and Costs included under Works Contract |
| Indicate all abandoned existing mains on as-built drawings/GIS |  |  | input | X | Quantities and Costs included under Works Contract |
| Plan for reinstatement and commissioning of repaired damaged secondary & tertiary mains. |  |  | A | X | Quantities and Costs included under Works Contract |
| Plan for reconnecting of disconnected consumer lines that were cut-off by contractor |  |  | A | X | Quantities and Costs included under Works Contract |
| Reconnection of existing customers pipelines. Geo-referencing of connection and entered in GIS-file |  | X | A |  | Quantities and Costs included under Works Contract |

*x = action A= Approval*

# ELECTRICAL AND MECHANICAL WORKS.

## SUB SECTION 1: COMMON REQUIREMENTS

## SCOPE OF CONTRACT

The Contract shall include the design, manufacture, inspection and works testing, supply and delivery, unloading, supervision of erection, complete installation, commissioning, tests on completion, training of local operators, production of record drawings, installation, operating and maintenance manuals, setting to work of, electric motor driven pumping plant, water treatment plant and all associated equipment, pipe work and fittings, electrical equipment and cabling at the Site, finishing, painting and remedying of defects for a period of one year.

The Contractor shall provide sufficient tools and lifting equipment to enable all installation work to be undertaken for completion of the Contract. These said tools should not be used as part of the supply of Special Tools specified elsewhere.

The Contract shall also include the supply of spare parts necessary for undertaking normal maintenance for a period of three years.

The Plant is required to be complete in all respects as specified herein and shall include all items of plant, machinery, fittings, etc., necessary whether such items are specifically referred to in the Contract or not.

The Contractor shall prepare and submit to the Engineer, in addition to the specified Working Drawings, all details, drawings and technical data required by the Engineer to enable him to ascertain the foundation requirements, supports and fixings to be built into the Civil Works.

The Contractor shall give all facilities to the Engineer for inspection and testing, during manufacturing and installation of mechanical and electrical Plant.

The altitude range for the works is between 700 to 1,200 m.a.s.l, .and the temperature ranges between 17 degrees Celsius to 38 degrees Celsius.

## DEFINITIONS

In construing the Conditions and the Specification relating to the Plant, the following words and expressions shall have the meanings herein assigned to them unless there is something in the subject matter or context inconsistent with such construction:

**"BS" and "BSCP"** shall mean the Edition of the relevant British Standard Specification and British Standard Code of Practice respectively current twenty-eight days prior to the date set for the submission of Tenders.

**"C.E.E."** shall mean the International Commission of Rules for the approval of Electrical Equipment

**"IEC"** shall mean the International Electro Technical Commission

**"ISO"** shall mean the International Organization for Standardization

**"BPC"** shall mean Botswana Power Company

**"IEE"** shall mean the Institution of Electrical Engineers (British)

**"Tender Drawing"** shall mean a drawing prepared by the Engineer for Tendering purpose only

**"Working Drawing"** shall mean a working drawing submitted by the Contractor to the Engineer for approval, all as specified in the Conditions of Contract

**"Contract Drawing"** shall mean a drawing, which has been approval by the Engineer and issued as part of the Contact

**"Certified Manufacturer's Drawing"** shall mean a drawing, which is prepared by the manufacturer, and certified by the manufacturer as showing the exact dimensions and details of the equipment as it will be supplied for the Contract

**"Special Tools"** shall mean both special tools and appliances necessary for the duties specified

## REGULATION, STANDARDS, MATERIALS AND WORKMANSHIP

All work carried out under this Contract shall comply with the latest requirement of any duly constituted authorities having authority over the work.

All materials shall comply with the appropriate ISO, British Standard Specification, C.E.E Standards, Ugandan Standard and the recommendations of the IEC as specified. Where an alternative specification to those from such standards and recommendation are to be used, these will be specifically referred to hereinafter and the Contractor must seek the approval of the Engineer or show confirmation that they are equal or more stringent to the quoted standard.

All references to such standards shall be to the latest edition or revision thereof unless otherwise stated. Where a specific ISO, British or other Standard is referred to in this Specification, other Standard will be acceptable if they ensure an equal or higher quality of material and workmanship than the Standard referred to at no extra cost to the Employer. If the Contractor intends to use such alternative Standard, he shall notify the Engineer thereof, submitting with his notice two copies (in English), of the proposed Standard and shall not order any material or perform any work unless and until he has obtained the Engineer's approval of such Standard.

All materials and equipment incorporated in the Works shall be to the approval of the Engineer.

The names of the manufacturers of materials and equipment proposed for incorporation in the Works together with performance, capacities, certified test reports and other significant information pertaining to the same, submitted for approval to the Engineer, who shall have power to reject any parts which in his opinion are unsatisfactory or not in compliance with the Specification. Parts so rejected shall be replaced by the Contractor at no extra cost to the Employer.

All materials and equipment shall be the most suitable for the purpose specified and shall be new and of first class quality, free from imperfections and selected for long life and minimum maintenance.

No second-hand materials whatsoever will be acceptable. The Contractor may be required to produce certified invoices.

All articles and materials specified to conform to ISO, British or other standards shall be clearly and indelibly marked with the appropriate standard number specified, except where marking is impractical when the relevant advice/delivery notes shall include the ISO, British or other standard number with which they are to comply.

All set, fixing and wood screws, studs and the like used through the whole of the electrical installations shall be brass or serialized or other material resistant to corrosion.

## DESIGN AND STANDARDIZATION

The Contractor shall be responsible for the design and submission of calculation of all Mechanical and Electrical works specified in respect of capacity, hydraulic consideration, strength, voltage drop, fault levels, protection and discrimination. The Contractor's design shall be subject to the approval of the Engineer, which approval shall not in any way relieve the Contractor of his obligations under the Contractor.

The Works in the Contract shall be designed to facilitate inspection, cleaning, and repairs, where continuity of operation is the first consideration. All Plant supplied shall be designed to ensure satisfactory operation under working conditions. All plant containing rotating parts shall be capable of operating at speeds up to the maximum duty specified without vibration or excessive noise.

The plant shall be designed on the basis that all butt welds are made at the manufacturer′s work site. Welding shall only be used for fillet welding of loose flanges to make up pipe lengthen.

All motors, fluorescent lighting and other electrical plants shall have a power factor of not less than 0.92 lagging after correction and minimum 0.8 before correction.

Corresponding parts throughout the contract works shall be submitted to the Engineer to prove inter changeability who may require they are actually changed to prove their interchangeability.

Suitable provisions by means of eyebolts or other means are to be provided to facilitate handling of all items with a mass greater than 70kg.

## PACKING TRANSPORT AND STORAGE OF MATERIALS AND PLANT

Before dispatch from the manufacturer's works, the plant and equipment shall be thoroughly cleaned, protected against damage, deterioration, corrosion and ingress of dirt. The packing shall be suitable for transport by sea and shall withstand prolonged exposure to a hot atmosphere and storage on site.

All packages shall be clearly and conspicuously marked with the contractor's identification mark and the Employer's reference mark. And should be consigned to the Employer c/o the Contractor.

All separate component parts of the Plant shall be identified by metal tags tied by wire and referenced to drawings, installation instructions, packing lists, etc. Details of the referencing system shall be submitted to the Engineer for approval.

All items shall be adequately protected from damage and deterioration always, including the period of storage and erection at the Site.

All wooden cases and support timbers within cases shall be proofed with suitable anti-termite solution. Straw or similar organic materials shall not be used for packing.

## CONTRACT PERIOD AND PROGRAMME

As required by the Conditions of Contract, the Contractor shall provide within the agreed days of the Commencement Date, a fully detailed programme for the completion of the Works. This programme shall be based on Data Schedule, and shall indicate the programmed dates for the commencement and completion of the following:

* Submission of foundation drawings for approval
* Submission of Working Drawings for approval
* Placing orders with Subcontractors for materials, plant and equipment
* Receipt by the Contractor from Subcontractors of ordered plant, materials, and equipment.
* Inspection and Testing by the Engineer at the manufacturer’s works
* Delivery to Site
* Erection on Site
* Tests on Completion
* Instruction Period
* Defects and liability period

The above activities shall be scheduled for each individual plant installation. The programme shall also the planned rate of progress for each month.

The programmed dates shall be coordinated with the civil works contractor and the power supply authorities, and shall be subject to approval by the Engineer.

## TENDER DRAWINGS

The Contractor shall refer to and examine all Tender Drawings appropriate to any part of the Contract, and to provide and co-ordinate all work accordingly.

Positions of Plant, pipe work, cables, columns, outlets, and other items as shown on the Drawings are approximate and the Contractor shall allow for minor adjustments to final positions as may become necessary during installation. It shall be the responsibility of the Contractor to verify dimensions.

Drawings shall, in general, not be scaled off. However, where the Contractor is measuring cable lengths or similar items, he shall determine the appropriate scale of the drawings and measure to suit his own requirements. The lengths, sizes and ratings of all cables shall be submitted for approval.

The Contractor is not at liberty to modify or alter the disposition of items supplied by others from that shown on Tender Drawings. Apart from this reservation, the drawings are issued only to give general guidance and any proposed modifications will only be considered providing the general principles are followed.

The Engineer may supply to the contractor such further drawings as may be necessary for the manufacture, erection, completion and maintenance of the plant and the contractor shall execute. obey and be bound by the same and shall not be entitled to any extra payment in respect of any work shown or directed to be done by such further drawings unless the Engineer shall have given written instructions for the same.

## WORKING DRAWINGS

The Contractor shall prepare fully dimensioned scale drawings of builder's work arising from the installation of mechanical and /or electrical plants, for approval of the Engineer.

The Contractor shall give to the Engineer full particulars of loading, including moments, details of any anti-vibration measures; and dimensions and positions of foundations and plinths and /or fixings necessary for the support and accommodation of all such plant, so that adequate provision may be ensured.

The Contractor must prepare full working drawings of all plant and services for the complete installation, including cable layouts, diesel plant drawings, and electrical layouts within buildings, road-lighting and floodlighting column locations. All drawings shall be submitted to the Engineer for approval before any works are commenced. Where possible service reserves shall be established such that a regular approved layout is achieved for all services, these being dimensioned from fixed points within each compound.

Where the items of Plant offered by the Contractor vary in size and/or configuration from that shown on the Tender Drawings, the Contractor shall submit for approval, the proposed layout for his particular Plant. In this regard, the Contractor is not at liberty to effect major alterations to structures, nor major relocations of Plant, but will be expected to arrange his installation within the space provided. All dimensions affecting accommodation of the Plant supplied under this Contract, and points at which services other than those covered under this Contract are required, shall be clearly indicated on drawings to be submitted to the Engineer by the Contractor. These drawings shall show such other details of Plant, not given in the Tender or Tender Drawings, as the Engineer may require for the purpose of preparing detailed drawings for installation of the Plant and for the purpose of making any necessary modifications to the Works being provided under other contracts.

Any proposed deviations from the arrangements shown on the Drawings shall be clearly stated in the Tender and will only be considered if the above principles are followed. The information under this Clause is required within 8 weeks of the award of the Contract.

The Contractor shall also, in accordance with his approved programme submitted with his Tender, commence to submit before proceeding with manufacturer's working drawings large scale Plant room layouts, ductwork detailed drawings, pipe work and pipe work support and expansion details "certified" fully dimensioned and detailed manufacturer's drawings of Plant including all necessary wiring diagrams detailing connections, current loading in cables and external wiring requirements, schematic diagrams of the electrical control systems etc. These drawings shall show leading dimensions and design sizes of all Plant.

All these drawings shall either be cleared for general acceptance or commented on by the Engineer for amendment until finally accepted. The accepted drawings shall constitute Contract Drawings and the Plant shall be manufactured to these Contract Drawings in every particular case. The acceptance by the Engineer of any drawing does not relieve the Contractor of his responsibility under the Contract and will not commit the Engineer or make the Engineer liable for any mistake of the manufacturer or deficiencies in strength of any part or in the capacity or efficiency of the Plant for carrying out, in accordance with this Specification, the work for which it is designed.

The Contractor shall supply to the Engineer two copies of all drawings in English, including associated electrical wiring diagrams for comment and four further copies of all accepted Contract Drawings.

## CONTRACT DRAWINGS

Following approval of the Contractor's Drawings by the Engineer they shall constitute Contract Drawings and the Plant shall be manufactured in accordance with the approved drawings. The acceptance by the Engineer of any such drawings shall not relieve the Contractor of his responsibility under the Contract and shall not commit the Engineer nor make the Engineer liable for any mistakes or the manufacturer's deficiencies in strength or efficiency in operation of any part or item for its specified purpose.

The Engineer reserves the right to amend or add to the Contract Drawings as may be necessary or expedient as stated.

The Contractor shall keep available on site copies of all drawings on which he shall periodically update the details to facilitate the production of the Record (As Built Drawings) at the completion of the whole of the works.

Two sets of negatives and of paper prints shall be provided by the Contractor after approval of the drawings and supporting information.

## RECORD DRAWINGS (AS-BUILT DRAWINGS)

Record drawings in A1 size shall be prepared and compiled by the Contractor after the Works have been completed and handed over and shall constitute a permanent record of the whole of the Works as finally built and installed. Five copies shall be produced in the form of black lines on a durable translucent film from which paper prints can be taken by others as required (the drawings could be made using acceptable latest technology).

A print of the appropriate wiring connection diagram shall be fixed to the inside of the hinged front of each control cabinet, switchboard panel or distribution switchboard. Nonflammable transparent material shall protect the print. Where insufficient space is available, the print shall be reduced in size. A copy of the print shall also be provided with the Record Drawings and inserted in the Operating and Maintenance Instructions. In addition, block diagrams of the panel components shall also be fixed to the inside front covers so that operators and maintenance personnel are made aware of the function of each component.

## AMBIENT CONDITIONS

All Plant, materials and installation techniques shall be suitable for the climate conditions and altitude prevailing at the Site as mentioned in Section 1.1.

## SCHEDULES OF TECHNICAL INFORMATION

The Contractor shall complete all the Data Schedules of technical information contained in the Tender Documents particularly any departure or deviations from the Specification and names of manufacturers of supply of the Plant, should he fail to do so, then the Tender may not receive full consideration, and may be liable to rejection.

## COPIES OF ORDERS

Copies of all orders for all major Plant items, materials and subcontract works placed with suppliers and subcontractors shall be provided in triplicate to the Engineer. The orders shall give or shall be accompanied by full details of the material, Plant or work ordered.

Copies of all orders shall be provided in the English language or with an English translation where the actual order is placed in any other language.

## STANDARDIZATION

Corresponding parts and units shall be interchangeable wherever possible. Where required by the Engineer, the contractor shall demonstrate the parts can actually be interchanged.

## FOUNDATIONS AND BUILDING WORKS

In general, all building, structures and foundation upon which plant will be erected will be constructed by the contractor. The Contractor shall plan his work accordingly by:

* Submitting all his foundation requirements within the specified times, and
* Arranging for the supply of all foundation bolts, trench covers kerbs and other cast in components in advance of the delivery of Plant.

## INSPECTION AND TESTS AT MANUFACTURER'S WORKS

The Employers representative, Engineers and his duly authorized representative shall have access to the Contractor's premises at all reasonable times to inspect and examine the material and workmanship of the mechanical and electrical components. If part of the Plant is being manufactured on other premises, the Contractor shall obtain permission for the Engineer or his duly authorized representative, to inspect as if the Plant was manufactured on the Contractor's own premises. Such inspection, examination, or testing, if made, shall not relieve the Contractor from any obligation under the Contract.

Where the Plant is a composite unit of several individual pieces manufactured in different places, it shall be assembled and tested as one complete working unit, at the manufacturer’s works, to the relevant British or other approved, equal standard where applicable.

The Contractor shall submit his proposed programme of tests for the Engineer's approval three weeks before the commencement of testing.

The Contractor shall give the Engineer a three weeks’ notice in writing of the date on any the place at which any Plant will be ready for testing as provided in the Contract and the Engineer shall thereupon at his discretion notify the Contractor of his intention to inspect such part of the Plant and shall then, on giving twenty four hours’ notice in writing to the Contractor, attend at the place so named within seven days of the date by which the Contractor has stated in his notice the said Plant will be ready for testing. The Contractor shall forward to the Engineer six duly certified copies of the test readings and characteristic performance curves for items such as pumps, fans, etc.

Whether at the premises of the Contractor, or of any subcontractor, the Contractor, except where otherwise specified, shall provide, free of charge, such labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonable demanded, to carry out efficiently such tests of the Plant, in accordance with the Contract, and shall give facilities to the Engineer, or to his authorized representative, to accomplish such testing. Where inspection or testing is to be carried out for subcontractors’ works, a representative of the Contractor shall be present.

Works tests shall also be carried out such that due consideration is given to the site conditions under which the Plant is required to function. The test certificates shall give all details under which the tests were done.

As and when any Plant shall have passed the tests referred to in this clause, the Engineer shall issue to the Contractor a notification to that effect.

The Contractor shall not pack for shipment any part of the Plant until he has obtained from the Engineer his written approval to the release of such part for shipment after tests required by the Engineer in terms of this clause have been completed to his satisfaction.

## ERECTION AND CHECKING OF WORK

The Contractor shall be solely responsible for transport to the Site, handling and transport about the Site and the erection of the Plant. As each part of the Plant is erected, it shall be subject to approval by the Engineer.

All parts shall be tested on Site as required, notwithstanding the tests carried, by the Engineer to prove compliance with the Contract irrespective of any tests, which may have been carried out at the manufacturer's works.

## SUPERVISION AND LABOUR

The Contractor shall provide all skilled and unskilled labour for the completion of the works. The Contractor is required to maintain a competent supervising Engineer and staff on site throughout the erection and instruction periods, and thereafter as may be required during the defects liability period.

## SPECIALIST SUBCONTRACTORS

Where Subcontractors are not nominated, the Contractor shall appoint specialist Subcontractors for any sections of the Works in which he himself has no experience, recognised and approved operator.

## SPECIAL TOOLS

The Contractor is to provide one complete set of any special tools and appliances necessary for the operation, testing, maintenance and dismantling of the various sections of the Plant whether of a mechanical or electrical nature.

Tools for each different type of equipment shall be new and unused and kept in a wall-mounted strongbox or boxes each fitted with a suitable lock and two keys. Such tools shall be provided for each and every separate location of the Works and shall not be used by the Contractor during the erection of the Plant. The cost of these tools shall be included in the Contractor's Tender. The strongbox is to be clearly marked or labelled with its description. Each tool shall be identified and a list of tools shall be affixed inside the box lid. Racks shall be provided as necessary to separate the various items.

A provision has been made for the Contractor to provide schedule such tools and appliances in the Data Schedules and for him to price for such tools and appliances as allowed for in the Schedule of Prices.

## INSTALLATION, OPERATING AND MAINTENANCE MANUALS

The Contractor shall supply to the Engineer illustrated operating and maintenance manuals. The manuals shall be in one or more volumes in order to separate literature from drawings, etc., as necessary.

The manuals shall be in English. They shall include the following information for the operating personnel:

1. Description of all systems installed, including electric lighting and power installation, electronic installations, mechanical installation, air systems, automatic controls systems, etc. An identification system should be established and shown on drawings and in the manuals.
2. Description of all Plant supplied including manufacturers' leaflets, which are to be scheduled for easy of reference.
3. Schedule of all Plant supplied, giving duties, electrical loads, etc.,
4. Schedule of all equipment suppliers (and their local agents) including names, addresses, telephone, telex and Fax numbers.
5. Fully detailed instructions for the installation testing and commissioning of all plant, which will be undertaken by the contractor including detailed schedules of checks to be carried out prior to putting the equipment into operation.
6. The Start-Up Operation and shut down instructions for all equipment and systems,
7. Full maintenance instructions for all equipment including planned maintenance schedules or charts giving daily, weekly, monthly, quarterly, half yearly and annual maintenance instruction, together with recommended lubricants and spares. This should also include details of routine maintenance work that will be within the competence of the normal maintenance staff, and notification of maintenance work that will have to be done the manufacturer, his agent or other specialist operator.
8. Spare parts list.
9. Fault finding charts.
10. Record drawings of all systems installed including general arrangements, conduit and wiring trunking systems, Plant rooms details, air and water systems flow sheets, wiring diagrams, control schematics and valve charts, etc., to a reduced scale.
11. Certified supplier's drawings of all equipment supplied, which are to be scheduled for easy reference.
12. Copies of performance curves.
13. Copies of all test certificates (carried at manufacturer’s works and at the site).

A copy of each manual, at least in draft form shall be submitted four weeks before shipping the equipment to which it refers. The draft manual submitted shall include details of all items of plant and equipment unless separate submission of details of particular items is already approved by the Engineer.

Six copies of each set of manuals shall be issued to the Engineer before the Plant is shipped.

The final version, modified as necessary to accommodate any changes on site and all test results and certificates as specified, shall be presented as soon as possible thereafter.

Each manual shall be durable and permanently bound within a stiff binder. The cover of each binder shall be finished with a black waterproof and greaseproof material and the title printed in gold block lettering on the front and on the spine.

## SPARE PARTS

The Tender shall submit with his Tender the completed relevant Data Schedule, listing the recommended spare parts and their prices which are considered necessary for the maintenance of the Plant for two years’ normal operation. When considering the proposed list, he must bear in mind the availability of such Plant in Uganda.

A Provisional Sum has been allowed in the Schedule of Prices for the supply of spare parts. The Engineer shall decide on which of the recommended spare parts shall be supplied. The prices of the spare parts shall be valid for two years from the award of contract, and the Engineer will give instructions on which spares shall be provided within this period.

The spare parts shall at least include the following items;

* Complete set of spare fuses or MCB's as required
* Spare coils and contactors for starters
* Recommended spares for control systems
* Bearing for pumps, motors, etc.
* Spare overloads and contacts for starters
* Recommended spares for generator sets and control panels
* Any other spares recommended by manufacturers of specialized equipment

All spare parts shall be new, unused and strictly interchangeable with the parts for which they are intended to be replacements and shall be treated and packed for long storage under the climatic conditions prevailing at the Site. Each spare part shall be clearly marked or labelled on the outside of its packing with its description and purpose, and when more than one spare is packed in a single case or other container, general description of its containers and other packages shall be marked and numbered in an approved manner for purposes of identification.

All cases, containers or other packages are liable to be opened for such examination as the Engineer may require and packing shall be designed to facilitate opening and subsequent repacking.

## LABELS AND PLATES

Identification labels of "Traffolyts" or similar approved material engraved black on white unless otherwise agreed, with not less than 5 mm "lino" style letters shall be fixed on or adjacent to all equipment, valves, controls switches and distribution gear, by means of at least two brass screws or rivets or other approved means.

Danger or warning tables shall be engraved white on red.

Glue, as the only means of attachment is unacceptable.

All labels shall be in English.

The labels shall bear the identification shown on the drawings, such as indication, designation function and, where necessary, phase voltage, current, pressure and temperature.

Plastic adhesive strip labels or adhesive die stamped tapes will not be permitted.

## DUST, INSECT AND VERMIN PROOFING

All Plant, which is affected by ingress of dust, shall be effectively dust proofed.

All Plant shall be vermin proofed, where no protection is afforded in its normal manufactured form, to ensure that no mechanical breakdown shall occur due to interference or damage by vermin. All materials used in construction or for connections shall be resistant to attacks by insects, microbiological life or other local fauna and such materials shall be to the approval of the Engineer.

Where cables are laid in trenches, the trenches shall be treated with an approved additive to prevent termite activity, or a termite barrier provided.

Where panels or components are sealed, adequate provision shall be made to dissipate heat so those electrical components are not subject to any form of de-rating resulting from unacceptable temperature rises.

## ALTERNATIVES

The Contractor's main Tender shall comply fully with the Specifications.

The Contractor is however at liberty to include alternative items of Plant, subject to approval by the Engineer, which do not completely comply with the requirements of the Specifications provided that the requirements of the following two paragraphs are fulfilled.

The Contractor shall submit manufacturer's detailed descriptions of alternatives and he shall draw attention to any aspect of each component, which does not fully comply, with the requirements of this specification. These detailed descriptions, including and departure from the requirements of the Specification may, after approval by the Engineer, be included among the Contract documents and each item shall be in accordance with the description of it. Approval of a manufacturer's description shall not include approval of any departure from the requirements of the Specification unless the departure is specifically approved by the Engineer in writing.

Where Plant differs from that specified, the tenderer should submit with his Tender drawings showing any amendments of system design necessary to suit the Plant. The Engineer will either approve these drawings or issue others if he approves the components concerned.

## TESTING AND COMMISSIONING

* 1. **General**

As many tests as (where the test has failed) in the opinion of the Engineer are possible shall be arranged together. Four copies of the Contractor's records of all tests shall be furnished to the Engineer.

All material which is specified for tests at the Manufacturer's works must satisfactorily pass such tests before being painted or otherwise coated.

All test instruments shall be to approval and shall be calibrated by a competent as may be approved by the Engineer.

Full witnessed testing and inspections will be carried out on our plant and equipment, including:

* All pumps
* All motors
* Valves, Actuators Penstocks
* Standby diesel plant
* Chemical dosing plant
* Electrical Switchgear and Motor Control Panels
* Electrical reticulation and installations
* Other items as may be required shall be inspected and tested.

All major items of plant shall be offered for inspection prior to their being dispatched from the manufacturer's or his Subcontractor's works.

The Engineer shall be entitled at all reasonable times during manufacture to inspect, examine and test on the Contractor's premises the materials, workmanship and performance of all plant to be supplied under the Contract. If the plant or any part thereof is being manufactured at a plant other than the Contractor's he shall obtain for the Engineer permission to inspect, examine and test such plant as is required. Any such examination, inspection or testing does not relive the Contractor of his obligation under the Contract.

Where the Contract provides for testing on the premises of the Contractor or any subcontractor, the contractor shall provide free of charge all assistance, labour, materials, electricity, fuel, water, stores, apparatus, and instruments as may be required and reasonably demanded for carrying out of the tests.

If after inspecting, examining or testing any plant the Engineer should decide that such plant thereof is defective or not in accordance with the Contract he may reject the said plant or part thereof by giving the Contractor, within a reasonable time, written notice of such a rejection, stating therein the reason for rejection.

* 1. **Tests at Manufacturers Works**

All electrical and mechanical plant shall be tested at the manufacturer's works in accordance with the requirements of the current relevant British Standards.

In particular, the following tests shall be carried out for specific items:

* Control Panels and Switchgear
* The following tests shall be carried out for each control panel before the panel is dispatched from the manufacturer's works:
  + Visual inspection
  + Inspection of provisions for cable entries
  + Checking access, type of cable gland, etc.
  + High voltage power frequency pressure test at 2 kV for 1 minute, followed by an insulation test.
  + The relays with variable controlled supply to ensure relays close at 85% nominal voltage and hold closed down to 65% nominal voltage
  + Test tripping of relays occurs at 60% nominal voltage
  + Observe any special tests applicable to the installation
  + Injection testing of current transformers for correct polarity and ratio, and protection relays for correct operation.
  + Functional testing including simulation of operation of sequence controls (e.g. level controls, etc.)
  + Checking of time delay settings and protection relay setting
  + Checking of fuses, MCB's and MCCB's etc. for correct type and rating
  + Check inter-locks
  + Insulation tests.
  + Any other tests required by the Engineer or his Representative.

**Electric Motors**

Electric motors having a rating of 11 KW or less shall be tested in accordance with IEC 60034Table 60.3.1.4 column 5 designated "Routine Check".

Motors having a rating of more than 11 KW shall be tested in accordance with IEC 60034 Table 60.3.1.4 column 3 designated "Basic".

All rotational and temperature rise tests shall be performed with the motor set up in normal working position, i.e. either horizontal or vertical in accordance with the particular drive application.

Motors shall not be dispatched for works assembly with associated mechanical plant until test certificates have been approved by the Engineer.

Electrical motors rated 11 KW and above shall be tested for vibration in accordance with the principles contained in ISO 3945, and IEC 60034 Part 50.

As required by the British Standards, the tests shall include, as applicable:

* Detailed load tests or type tests on each motor to determine temperature rise, efficiency, speed and power factor, at different loads ranging from no-load to 110% of the continues maximum rating of the motor.
* Open-circuit test
* Short-circuit or locked-rotor test
* Voltage or pressure tests
* Over-speed test
* Capacity/Amperage Test
* Power Factor Test
* Insulation test

High voltage and insulation resistance test shall be made when the apparatus are hot.

The power and power factor measuring instruments shall be connected in such a position as to allow for all losses in the complete system and not for the motor alone.

**Pump sets**

Each pump shall be tested individually at the manufacturer’s works in full accordance with ISO 14 and/or ISO 2548, ISO 5198 with its own motor over its full working range from their closed valve condition to maximum discharge points.

Each pump shall be run, and tests carried out in accordance with ISO 2548, ISO 5198 Part 1, or other standards as approved by the Engineer, to ensure that performance, power absorbed, and efficiency meet the guaranteed characteristics as shown in the Data Schedules.

Each pump set shall be tested for efficiency at each head/ quantity/ speed duty.

The pumps shall be tested complete with all shaft bearings, thrust bearings, and directly driven auxiliaries, or where this is impracticable, the Contractor shall state what allowances shall be made for the losses incurred by these items and shall demonstrate the accuracy of these allowances to the satisfaction of the Engineer.

Such tests shall show that the pump has general characteristics of head, efficiency, input power, net positive suction head, and other properties as appear on the proposed curves submitted with the bid.

Such tests shall also prove that the specified head, efficiency, input power and net positive suction head and other properties at the design point and establish that the pump is free from overheating, cavitation and excessive vibration over the specified range.

The speed of the pump shall be stated when recording various readings of head/ quantity pertaining to the pump. Head/quantity curves and pump efficiency / quantity curves shall be drawn as may be necessary. In addition, the curve of overall efficiency of the pump set and power absorbed against the quantity pumped shall be drawn. If necessary, the values of motor efficiencies obtained during the motor works tests may be used. The curve produced shall be used to demonstrate that the Plant will be able to meet the full range of operating conditions at site.

The pump set shall be free from cavitation and vibration over the whole working range.

Pump castings shall be subject to a pressure test of 1.5 times the maximum pressure obtained with the delivery valve closed. The positive suction head shall be considered in determining this pressure.

The Contractor shall satisfy the Engineer as to the mechanical reliability of the plant and its capability of fulfilling the whole of the conditions. The contractor shall detail the type of apparatus available for testing, and the method of measuring pump discharge. He shall satisfy the Engineer as to the accuracy of the instruments used in the tests and shall, if required, carry out calibration tests.

**Valves, actuators, and penstocks**

All parts, which shall be subject to pressure in service, shall be subject to a hydrostatic test to a pressure not less than 1.5 times the maximum possible working pressure. Valves and actuators shall be tested at the "closed valve head" of the pump plus 10% on one side of the valve and zero pressure on the other. The valves shall be operated for two opening and closing cycles under the action of the actuators against the required pressure. Valves without actuators shall be similarly tested to ensure drop tightness. Penstocks shall be subjected to on and off seating tests where applicable.

**Diesel Generating Sets**

Each set shall be tested for output and performance in accordance with the requirements of BS 649 and BS 5000 Part 99. Tests shall include all function tests, operation of all safety devices, load tests and temperature tests. Care must be taken to derate the test results to site conditions.

**Transformers**

Each set shall be tested for output and performance in accordance with the requirements of IEC 60076, ISO/IEC 17025, ISO 14726, IEC 60296, IEC 60354, ISO 29.060 Tests shall include all BIL, Temperature rise, function tests, Transformer Leakage, operation of all safety devices, load tests and temperature tests. Care must be taken to derate the test results to site conditions.

The primary voltage shall be 11kV while the secondary shall be 400 Volts.

**Cable and wiring**

All cable and wiring shall be fully factory tested. A sample of each cable rating/size shall be tested in the presence of the Engineer, the tests being those required by the British or International Electrotechnical Commision or equal or more stringent other National Standards Institution.

* 1. **Test Certificates**

Test certificates and reports shall be submitted in triplicate to the Engineer within three weeks of works testing of the following equipment:

* Motors
* Control Panels and Switchgear
* Armoured Cables
* Distribution Boards
* Motors
* Diesel Generating Plant
* Pumps
* Transformers
* Cables
* Valves
* Other as may be identified
  1. **Tests After erection on Site**

All Plant shall pass such tests on site as are required by the Engineer to prove compliance with the contract independently of any tests which may already have been carried out at the Manufacturer's works. All electrical pressure tests made at the Manufacturer's works shall be repeated at voltages to be approved by the Engineer, and all pump performance tests shall be repeated on Site.

The Contractor shall prepare all on site test results and certificates for all items as required by the IEE Regulations and relevant British Standards. These certificates and test results shall be provided in triplicate with copies included within the operation and maintenance manuals.

The Contractor shall maintain on Site marked up copies of all changes to the installations as they proceed. These changes shall be agreed with the Engineer on a weekly basis and shall be included on the Record Drawings produced by the Contractor for all installed equipment as specified elsewhere.

All skilled labour, supervision, apparatus, electricity, water, fuel and the like for tests, and instruments required for carrying out the tests efficiently will be the responsibility of and at the expense of the Contractor. The accuracy of the instruments shall be demonstrated if required.

Tests on completion shall be carried out to ensure that the Plant is complete, has been correctly installed, is reliable in operation under the conditions at site and is able to operate over its whole working range. In addition, the efficiency and performance of the Plant shall be checked as far as possible over the whole works

Range and the values obtained will be compared with those obtained during the tests at the Contractor's premises.

The Contractor shall include for all tests that may be require by any statutory Authority.

On completion, all plant and pipe work systems shall be properly balanced, left in working order and instructions given on the efficient operation and maintenance of the plant to the Engineer satisfaction.

If, in the opinion of the Engineer, the Plant does not comply with this Specification, the defect shall be remedied at no cost to the Employer.

* 1. **Continuous Test Period**

The Plant shall be tested, under normal operating conditions over a continued period of 30days. The Plant shall, at the discretion of the Engineer, be divided into sections for the purpose of these tests but each and every section shall be tested for the full period of 30 days continuous operation. Where sections of Plant form an integral operation the section of the Plant shall be tested together to ensure the correct and proper functioning of the water pumping, storage, and flow systems,

The Contractor shall arrange to run all Plant before submission for final testing to ensure that the period will not be interrupted for adjustment or breakdown.

## INSTRUCTIONS AND TRAINING OF LOCAL STAFF

The Contractor shall allow operator’s access to the Site during the erection and commissioning of the systems as part of their training programme. There shall be in addition to this, a period of three weeks minimum of official instructions and training after the end of the commissioning period and prior to hand over of the complete systems.

The Contractor shall make available for instruction, competent staff and all information necessary for the effective execution of the training programme. The Contractor must instruct and train the trainees in such a way that the operation, maintenance and if necessary, repairs to the systems can be handled competently by the respective personnel. The engineer or his chosen representative may attend some of these sessions and if necessary instruct the Contractor to either change mode of instruction or the instructor.

## WORKS EXECUTED BY THE EMPLOYER OR BY OTHER CONTRACTORS

The Employer reserves the right to execute, on the Site, works not included under this contract and to employ for this purpose either his own employees or other contractors whose contracts may be either a subcontract under this contract, or an entirely separate contract. The Contractor shall ensure that neither his own operations nor trespass by his employees shall interfere with the operation of the Employer, or his contractors employed on such works and the same obligations shall be imposed on the Employer or other contractors in respect of work being executed under this contract.

## SEQUENCE OF OPERATIONS AND DELAYS TO OTHER CONTRACTORS

The Contractor shall be deemed to have included in his pricing of the Tender for costs associated with works carried out outside normal working hours where such works have been necessary to meet the requirements outlined in Section 28 above.

## CONTRACTOR'S SITE OFFICES, WORKSHOPS, STORAGE AND WORKING AREAS

The contractor shall have stated in his tender the additional areas that he requires for his workshops, storage and working areas. The Employer reserves the right to allocate the areas of the land smaller than the Contractor may require. In such cases the Contractor shall make his own arrangements for obtaining the use of the additional areas that he requires. The location of all offices, stores, and the like shall be to the approval of the Engineer.

## USE OF SITE

The lands and other places outside the site, which are under the control of the Employer, shall not be used except with the approval of the Engineer.

The Contractor shall at any time remove any vehicles, wagon, barge or vessel or any other obstruction under his control that may be required to be moved by the Engineer for any purpose. The Contractor shall move such obstruction promptly on instruction given.

The Contractor shall maintain access for the inspection, operation, and maintenance of any of the Employer's plant or works, which lies within the site or elsewhere.

The Contractor shall maintain access for the inspection, operation, and maintenance of any of the Employer's plant or works, which lies within the site or elsewhere.

The Contractor shall not use any portion of the site for any purpose not connected with the works unless the written permission of the Engineer has been obtained.

Except with written permission of the Engineer, to be given when necessary for the execution of the Works, the contractor’s employees will not be permitted to enter any of the Employer's buildings or lands or sites under the control of other contractors or the Engineer. The Contractor shall warn his employees that any person found within such buildings or sites without authority is liable to be removed from the works in accordance with the Conditions of Contract.

## POSSESSION OF SITE

The Contractor shall restrict his activities to those areas of the Site adjacent to the work being executed and shall avoid any encroachment upon land outside the areas for which possession has been given. Any trespass or damage or any claim arising from such encroachment shall be the contractor's sole responsibility and he shall hold the Employer indemnified against all claims arising from such trespass or damage.

## INTERFERENCE WITH THE WORKS

The contractors shall not interfere in any way with any existing works, whether under the control of the Employer or of a third party, whether or not the position of the works is indicated to the contractor by the Engineer, except where such interference is specifically described as part of the works, either in the Contract or in an instruction from the Engineer.

## REJECTED MATERIALS AND DEFECTIVE WORK

Materials or work which, in the opinion of the Engineer, do not comply with the specification, shall be classified as rejected materials or defective work, and shall be remove from the works and replaced as directed by the Engineer.

## EXISTING WORKS AND SERVICES

The Contractor shall acquaint himself with the positions of all existing works and services including water mains, sewers, storm water drains, cables for electricity, telephone lines and telephone, electricity and lighting poles before any excavation is commenced.

The Contractor will be held responsible for any damage, however caused, during the execution of the works, to the existing works and services.

Such existing works and services, where exposed by the execution of the works, shall be properly shored, hung-up, and supported to the satisfaction of the Engineer and of the authority concerned. The Contractor shall exercise special care when refilling trenches or other excavations around such existing works or services and water meters. Stop cock boxes and the like shall not be covered up.

Poles supporting cables and the like adjacent to the works, shall be kept securely in place until the works are completed and shall then be made as safe and permanent as before.

Notwithstanding the foregoing requirements and without lessening the Contractor's responsibility, the Contractor shall inform the Engineer immediately any existing works have been exposed and shall comply with any requirements of the authority concerned.

Only when and as directed by the Engineer shall the contractor change the position of existing works or services to meet the requirements of the proposed work.

The Contractor shall make adequate provision so that when carrying out his work, no interference, damage, or pollution is caused to highways and footpaths, or to any mains, drains, sewers, and the like or other parts of the works. Wherever loads have to be carried over the ground in which pipes, valves, culverts, and the like are buried, the contractor shall take all precautions including where necessary the provision and use of sleepered road, light gauge railways or other means to prevent damage occurring to such underground works. The Contractor shall not store any plant or materials or spoil heaps over existing water services, or in such positions that interference with access to the services is created. Approval by the Engineer of the means of protection employed shall not relieve the contractor of any responsibility in respect of damage occasioned by his operations.

The laying of pipework, ducts, drains, and the like shall be arranged so as to cause as little interference as possible with the smooth operation of existing works.

When breaking out and making good existing structures the contractor shall disturb the existing structures as little as possible. All structures shall be made good with the materials like those used in existing works, or such materials which are considered by the Engineer to be of similar appearance and suitable in all other respects.

## OVERHEAD POWER LINES

Where work is being carried out near overhead power lines, the Contractor is responsible for ensuring that all persons working in such areas are aware of the relatively large distance that high voltage electricity can "short" to earth when cranes or other large masses of steel are in the vicinity of power lines.

The Contractor's attention is drawn to [BS 7354:1990](http://shop.bsigroup.com/ProductDetail/?pid=000000000000413162)**,** [BS 5486-1:1977, IEC 60439:1973](http://shop.bsigroup.com/ProductDetail/?pid=000000000010111135)**,** which gives safe clearances for the various voltages.

The Contractor shall take all necessary precautions to ensure the safety of his employees and all other persons where work is being carried out near overhead power lines.

## EXISTING ACCESS

Existing access to lands property and all other places shall be maintained by the contractor during the continuance of the Works to the Engineer's satisfaction.

## EXCAVATION ACROSS ROADS AND TRACKS

Before excavating across any public or private road or track, the contractor shall give the Engineer 10 days’ notice of his intention to excavate and shall include, in writing, the precautions he proposes to take for continuance of passage and traffic, and details of the warning signs and lights to be provided and operated. The excavation shall not commence until the written approval of the Engineer has been given.

## LIAISON WITH POLICE AND OTHER OFFICIALS

The Contractor shall keep in close contact with the police and other officials in the area concerned regarding their requirements for the control of workmen, movement of traffic, or other matters and shall provide all assistance and facilities which may be required by such officials in the execution of their duties.

## PRESERVATION OF TREES

No tree shall be removed without prior written permission of the Engineer who will limit the removal of trees to the minimum necessary to accommodate the permanent works. If trees are removed or damaged by the contractors or his employees, without approval then the contractor shall replace such trees.

## PROTECTION FROM WATER

The Contractor shall keep the whole of the works free from water and shall be deemed to have included for all pumping, sorting, temporary drains, sumps and other measures and provisions necessary for such purposes and clearing away and making good to the satisfaction to the Engineer any damage caused thereby.

## PROTECTION AGAINST FIRES

The Contractor is advised that, always, it is necessary to guard against fires starting within the site or in the environs thereof, particularly as the result of the works or from the actions of his employees. The Contractor shall have available, always, adequate fire-fighting equipment such as safety gears and shall deal with all fires on the Site howsoever caused.

## WATCHING, FENCING AND LIGHTING

The Contractor shall employ competent watchmen and guard the works both by day and night. Any excavations, material dumps, spoil dumps or other obstructions likely to cause injury to any person or thing shall be suitably fenced off and adequately marked and identified.

## WATER AND POWER FOR USE ON THE WORKS

The Contractor shall be solely responsible for the location, procurement and maintenance of a water supply adequate in quality and quantity to meet his obligations under the contract. The Contractor may purchase water for normal and reasonable use on the works from the Employer when and where available and at current rates.

The contractor shall be solely responsible for the location and continuity of the supply of water for use on the works. Supplies may be derived from boreholes, rivers, and streams, but shall in all cases be to the Engineer's approval, and the abstraction of water from any sources shall not interfere with permanent water supply. The Contractor shall be solely responsible for the transporting of water from its sources to the point at which it is required for construction purposes, and in such quantities and quality as to enable the works to proceed without hindrance due to the shortage to adequate water supplies.

The Contractor shall take care to avoid unnecessary use of water and to prevent any water running to waste.

The Contractor shall make his own arrangements for power supplies and shall be solely responsible for the location, procurement, and maintenance of a power supply, adequate to meet his obligations under the Contract, nor, in respect of any such failure, shall the contractor have any claim under the contract against the Employer.

## FUEL SUPPLIES

The Contractor shall arrange for obtaining, storing, and distributing all fuel oils required for the completion of the Works.

## TELEPHONE AND COMMUNICATIONS

The Contractor shall be responsible for obtaining a suitable means of communication between all sites and compounds for the duration of the contract. This is particularly relevant during the testing, commissioning, and thirty -day continuous operation of the plant where communications between sites and compounds must be established before the commencement of the testing and commissioning programme.

## SANITATION

The Contractor shall provide adequate sanitation and refuse collection and disposal facilities complying with the laws and local by-laws for all houses, offices, workshops, and the like erected on the site, all to the satisfaction of the Engineer.

The toiled facilities provided at the Site by the Civil Works contractor may be made available, to the employees of the contractor supplying and installing the mechanical and electrical plant. However, it is the responsibility of contractor to make his own arrangements.

The Contractor shall warn his employees and Subcontractors that any employee found fouling the Site shall be removed from the site immediately in accordance with the conditions of contract.

## FIRST AID AND MEDICAL SERVICES

The contractor shall provide and maintain all equipment necessary to render first aid in case of accidents, snake bites or other emergencies. This equipment shall be kept in readiness at the Works, at camps and wherever the Contractor's staff may regularly live and work. The Contractor shall ensure that there are persons available at all such places with knowledge of simple first aid procedures and able to administer snake bite treatment.

## INSPECTION BY ENGINEER DURING DEFECTS LIABILITY PERIOD

The Engineer will give the Contractor due notice of his intention to carry out any inspection during the Defects Liability Period. 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 shall take note of all matters and things to which Engineer has directed to be acted on.

## REFERENCE DOCUMENTS

|  |  |  |  |
| --- | --- | --- | --- |
| BS 10 (Changed to BS 4505) | : | 1962 | Specification for flanges and bolting for pipes, valves, and fittings |
| BS 21 | : | 1985 | Specification for pipe threads for tubes and fittings where pressure-tight joints are made on thread (metric dimensions). |
| BS 88 | : |  | Cartridge fuses for voltages up to and including 1000 V a.c. and 1500 V d.c. |
|  | Part 1: | 1988 | Specification for General Requirements. |
| BS 89 | : |  | Direct-Action Indicating Electrical Measuring Instruments and their Accessories. |
|  | Part 1: | 1990 | Specifications for definitions and general requirements common to all parts. |
|  | Part 3: | 1990 | Specification for special requirements for ammeters and voltmeters |
|  |  | 1975 (1987) | Specification for direct acting electrical recording instruments and their accessories. |
| BS 143/1256 | : | 1986 | Specification for malleable cast iron and cast copper alloy threaded pipe fittings. |
| BS 76 | : |  | Power Transformers |
|  | Part 1: | 1978 | General |
| BS 183 | : | 1972 (1982) | Specification for general purpose galvanized steel wire strand. |
| BS 381 C | : | 1988 | Specification for colours for identification, coding and special purposes |
| BS 534 | : | 1990 | Specification for steel pipes, joints and specials for water and sewage. |
| BS 639 | : | 1986 | Specification for covered carbon and carbon manganese steel electrodes for manual metal arc welding. |
| BS 729 | : | 1971 (1986) | Specification for hot dip galvanized coatings on iron and steel articles. |
| BS 775 | : |  | Specification for Contractors. |
|  | Part 2: | 1974 (1984) | a.c. Contractors for voltages above 1 kv and up to and including 12 kv. |
| BS 848 | : | Fans for General Purposes |  |
|  | Part 1: | 1980 | Methods of testing performance |
| BS 970 | : |  | Specification for wrought steels for mechanical and allied Engineering purposes. |
|  | Part 1: | 1991 | General inspecting and testing procedures and specific requirements for carbon, carbon manganese, alloy, and stainless steels. |
| BS 1363 | : |  | 13 A plugs, socket-outlets and adapters. |
|  | Part 3: | 1989 | Specification for adapters |
| BS 1376 | : | 1974 (1985) | Specification for colour of light signals. |
| BS 1387 | : | 1985 (1990) | Specification for screw and socketed steel tubes and tubulars and for plain end steel suitable for welding or for screwing to BS 21 pipe threads. |
| BS 1440 | : | 1985 | Specification for copper alloy ingots and copper alloy and high conductivity copper castings. |
| BS 1449 | : | 1991 | Steel plate, sheet and strip |
| BS 1452 | : | 1990 | Specification for flake graphite cast iron. |
| BS 1486 | : |  | Lubricating nipples |
|  | Part 1: | 1959 (1982) | Lubricating nipples and adapters for use on machinery and tools |
| BS 1501 | : |  | Steel for pressure purpose: plates. |
|  | Part 1: | 1980 (1990) | Specification for carbon and carbon manganese steels. |
|  | Part 2: | 1988 | Specification for alloy steels. |
| BS 1564 | : | 1975 (1983) | Specification for pressed steel sectional rectangular tanks. |
| BS 1650 | : | 1971 | Specification for capacitors for connection to power frequency systems |
| BS 1789 | : | 1985 | Specification of bourdon tube pressure and vacuum gauges |
| BS 1794 | : | 1952 (1984) | Specification for chart ranges for temperature recording instruments. |
| BS 1853 | : |  | Tubular florescent lamps for general lighting service |
|  | Part 1: | 1990 | Specification for internationally specified lamps. |
| BS 2494 |  | 1990 | Specification for elastomeric seals for joints in pipework and pipelines. |
| BS 2569 | : |  | Specification for sprayed metal coatings. |
|  | Part 1: | 1964 (1988) | Protection of iron and steel by aluminum and zinc against atmospheric corrosion. |
|  | Part 2: | 1965 (1988) | Protection of iron and steel against corrosion and oxidation at elevated temperatures. |
| BS 2633 | : | 1987 | Specification for Class 1 arc welding of ferritic steel pipework for carrying fluids. |
| BS 2692 | : |  | Fuses for voltages exceeding 1000 V a.c. |
|  | Part 1: | 1986 | Specification for current limiting fuses. |
|  | Part 2: | 1956 | Expulsion Fuses |
| BS 2779 | : | 1986 | Specification for pipe threads for tubes and fittings where pressure-tight joints are not made on threads (metric dimensions). |
| BS 2789 | : | 1985 | Specification for spheroidal graphite or nodular graphite cast iron. |
| BS 2926 | : | 1984 | Specification for chromium and chromium-nickel steel electrodes for manual metal-arc welding. |
| BS 2971 | : | 1991 | Specification for Class II arc welding of carbon steel pipework for carrying fluids. |
| BS 2898 | : | 1992 | Specification for continuously hot-dip zinc alloy coated steel flat products: tolerances on dimensions and shape. |
| BS 2914 | : | 1972 (1979) | Specification for surge diverters for alternating current power circuits |
| BS 3274 | : | 1960 | Specifications for tubular heat exchangers for general puposes |
| BS 3416 | : | 1991 | Specification for bitumen-based coatings for cold application, suitable for use in contact with potable water. |
| BS 3496 | : | 1989 | Specification for E glass fibre chopped strand mat for the reinforcement of polysester and other liquid laminating systems. |
| BS 3505 | : | 1986 | Specification for unplasticised polyvinyl chloride (u-PVC) Pressure pipes for cold potable water. |
| BS 3506 | : | 1969 | Specification for unplasticised PVC pipe for industrial uses. |
| BS 3532 | : | 1990 | Method for specifying unsaturated polyester resin systems. |
| BS 3600 | : | 1976 (1988) | Specification for dimensions and masses per unit length of welded and seamless steel pipes and tubes for pressure purposes. |
| BS 3506 | : | 1969 | Specification for unplasticised PVC pipe for industrial uses. |
| BS 3532 | : | 1990 | Method for specifying unsaturated polyester resin systems. |
| BS 3600 | : | 1976 (1988) | Specification for dimensions and masses per unit length of welded and seamless steel pipes and tubes for pressure purposes. |
| BS 3601 | : | 1987 | Specification for carbon steel pipes and tubes with specified room temperature prepares for pressure purposes. Switches for household and similar fixed electrical installations. |
|  | Part 1: | 1889 | Specification for general requirements. |
| BS 3691 | : | 1990 | Specification for E glass fibre roving for the reinforcement of polyester and epoxy resin systems. |
| BS 3693 | : | 1992 | Recommendations for design of scales and indexes on analogue indicating instruments. |
| BS 3871 | : |  | Specification for miniature and moulded case circuit breakers. |
|  | Part 1: | 1965 (1984) | Miniature air-break circuit breakers for a.c. circuits. |
| BS 3923 | : |  | Methods for ultrasonic examination of welds. |
|  | Part 1: | 1986 | Methods for manual examination of fusion welds in ferritic steels. |
| BS 3939 | : |  | Graphical symbols for electrical power, telecommunications and electronics diagrams. |
| BS 4099 | : | 1986 | Colours of indicator lights, push buttons, enunciators’ and digital readouts. |
|  | Part 1: | 1986 | Specification for colours of indicator lights and push buttons. |
| BS 4190 | : | 1967 | Specification for ISO metric black hexagon bolts, screws and nuts. |
|  |  |  | Guide on the reliability of electronic equipment's and parts used therein. |
|  | Part 2: | 1974 (1987) | Terminology. |
| BS 4211 | : | 1987 | Specification for ladders for permanent access to chimneys, other high structures, silos and bins |
| BS 4343 | : | 1968 | Specification for industrial plugs, socket-outlets and couplers for a.c. and d.c. supplies |
| BS 4346 | : |  | Joints and fittings for use with unplasticised PVC pressure pipes. |
|  | Part 1: | 1969 | Injection moulded unplasticised PVC fittings for solvent welding for use with pressure pies, including potable water supply. |
|  | Part 2: | 1970 | Mechanical joints and fittings, principally of unplasticised PVC. |
|  | Part 3: | 1982 | Specification for solvent cement. |
| BS 4360 | : | 1986 | Specification for weldable structural steels. |
| BS 4368 | : |  | Compression couplings for tubes |
|  | Part 1: |  | Specification for heavy series couplings (metric) |
| BS 4504 | : |  | Circular flanges for pipes, valves, and fittings (PN designated), |
|  | Part 3: |  | Steel, cast iron, and copper alloy flanges. |
|  | Sect 3.1: | 1989 | Specification for steel flanges. |
|  | Sect 3.2: | 1989 | Specification for cast iron flanges. |
| BS 4515 | : | 1984 | Specification for welding of steel pipelines on land and offshore. |
| BS 4533 | : |  | Luminaires |
| BS 4568 | : |  | Specification for steel conduit and fittings with metric threads of ISO form for electrical installations |
|  | Part 1: | 1970 | Steel conduit, bends and couplers. |
|  | Part 2: | 1970 (1988) | Fittings and components. |
| BS 4607 | : |  | Non-metallic conduits and fittings for electrical installations: Specification for switchgear and control gear for voltages up to and including 1000 V a.c. and 1200 V d.c. |
|  | Part 1: | 1977 (1990) | Circuit Breakers: |
| BS 4772 | : | 1988 | Specification for ductile iron pipe and fittings |
| BS 4800 | : | 1989 | Schedule for paint colours for building purposes |
| BS 4865 | : |  | Dimensions of gaskets for pipe flanges to BS 4504. |
|  | Part 1: | 1989 | Specification for non-metallic flat gaskets (including gaskets for flanges to BS 4772). |
| BS 4870 |  |  | Specification for approval testing of welding procedures. |
|  | Part 1: | 1981 | Fusion welding of steel |
|  | Part 3: | 1985 | Arc-welding of tube to plate joints in metallic materials |
| BS 4921 | : | 1988 | Specification for sheradised coatings on iron or steel. |
| BS 4941 | : |  | Motor starters for voltages up to and including 1000 V a.c. and 1200 V d.c. |
|  | Part 1: | 1979 (1990) | Direct-on-line (full voltage) a.c. starters |
| BS 4999 | : |  | General requirements for rotating electrical machines |
|  | Part 0: | 1987 | Specification introduction and information on other parts. |
|  | Part 101: | 1987 | Specification for rating and performance. |
|  | Part 111: | 1987 | Specification for build in thermal protection for electric motors rated at 660 V a.c. and below |
|  | Part 143: | 1987 | Specification for tests |
| BS 5000 | : |  | Rotating electrical machines of particular types or for particular applications. |
| BS 5135 | : | 1984 | Specification for the arc-welding of carbon-manganese steels |
| BS 5150 | : | 1990 | Specification for cast gate valves |
| BS 5153 | : | 1974 (1991) | Specification for cast iron check valves |
| BS 5155 | : | 1984 (1991) | Specification for butterfly valves |
| BS 5156 | : | 1985 (1991) | Specification for diaphragm valves |
| BS 5163 | : | 1986 (1991) | Specification for predominantly key operated cast iron gate valves for waterworks purposes |
| BS 5227 | : | 1984 | Specification for a.c. metal-enclosed switchgear and control gear rated voltages above 1 kV and up to and including 72.5 KV. |
| BS 5253 | : | 1990 | Specification for alternating current disconnectors and switches |
| BS 5292 | : | 1980 | Specification for jointing materials and compounds for installations using water low-pressure steam or 1st, 2nd and 3rd family gases. |
| BS 5308 | : |  | Instrumentation Cables. |
|  | Part 1: | 1986 | Specification for polyethylene insulated cables. |
|  | Part 2: | 1986 | Specification for PVC insulated cables. |
| BS 5311 | : | 1988 | Specification for high-voltage alternating current circuit breakers |
| BS 5316 | : |  | Specification for acceptance tests for centrifugal, mixed flow and axial pumps |
| BS 5391 | : |  | Specification for acrylonitrile-butadiene-styrene (ABS) fittings for use with ABS pressure pipes |
|  | Part 1: | 1976 | Fittings for use with pipe for industrial uses |
| BS 5419 | : | 1977 (1990) | Specification for air break switches, outbreak disconnection's, air break switch disconnection's, and fuse-combination units for voltage up to the including 1000 V a.c. and 1200 V d.c. |
| BS 5420 | : | 1977 (1988) | Specification for degrees of protection of enclosures of switchgear and control gear for voltages up to and including 1000 V a.c. and 1200 V d.c. |
| BS 5423 | : | (1987) | Specification for portable fire extinguishers |
| BS 5424 | : |  | Specification for control gear for voltages up to and including 1000 V a.c. and 1200 V d.c. |
| BS63 | : |  | Specification for high voltage switches |
|  | Part 1: | 1991 | High-voltage switches for rated voltage above 1 kV and less than 52 kV |
| BS 5467 | : | 1989 | Specification for cables with thermosetting insulation for electricity supply for rated voltages up to and including 600/1000 V and up to and including 1900/3300 V. |
| BS 5486 |  |  | Low-voltage switchgear and control gear assemblies. |
|  | Part 1: | 1990 | Requirements for type tested and partially type tested assemblies |
|  | Part 2: | 1988 | Particular requirements for busbar trunking systems. |
| BS 5490 | : | 1977 (1985) | Classification of degrees of protection provided by enclosures. |
| BS 5493 | : | 1977 | Code of practice for protective coating-of iron and steel structures against corrosion. |
| BS 5500 | : | 1991 | Specification for unfired fusion welded pressure vessels |
| BS 5514 | : |  | Reciprocating internal combustion engines: performance |
|  | Part 1: | 1987 | Specification for standard reference condition and declarations of power, fuel consumption, and lubricating oil consumption |
|  | Part 4: | 1979 (1984) | Speed governing |
|  | Part 7: | 1988 | Specification for codes for engine power |
| BS 5728 | : |  | Measurement of flow of cold potable water in closed conduits |
|  | Part 1: | 1979 (1987) | Specification for single meters |
|  | Part 2: | 1980 (1988) | Specification for installation requirements for single meters. |
| BS 5733 | : | 1979 | Specification for general requirements for electrical accessories. |
| BS 5792 | : | 1980 (1986) | Electromagnetic flowmeters. |
| BS 5856 | : |  | Specification for motor starters for voltages above 1 kV a.c. and 1.2 kV d.c. |
|  | Part 1: | 1980 (1985) | Direct-on-line (full voltage) a.c. starters. |
| BS 5953 | : |  | Guide on power transformers |
|  | Part 1: | 1980 | Application of power transformers |
| BS 6004 | : | 1991 | Specification for PVC insulated cables (non-armoured) for electric power and lighting. |
| BS 6007 | : | 1991 | Specification for Rubber insulated cables for electric power and lighting. |
| BS 6207 | : | 1991 | Mineral insulated copper sheathes cables with copper conductors. |
| BS 6231 | : | 1990 | Specification for PVC-insulated cables for switchgear and control gear wiring. |
| BS 6346 | : | 1989 | Specification for PVC-insulated cables for electricity supplies. |
| BS 6500 | : | 1990 | Specification for Insulated flexible cords and cables. |
| BS 7079 | : | 1990 | Preparation of steel substrates before application of paints and related products. |
|  | Part 0: | 1990 | Introduction |
|  | Part C2: | 1989 | Method for the grading of surface profile of abrasively blast cleaned steel using a comparator |
| BS 7365 | : | (1990) | Specification for hard drawn aluminium wire overhead line conductors |
| BS 7430 | : | 1992 | Code of practice earthing |
| PD 6499 | : | 1981 | Guide to insulation co-ordination within low voltage systems including clearances and creepage distances for equipment. |
| BS CP 1016 | : | 1980 | Code of Practice for the use of Semiconductor Devices. |
| PO D2155 C | : |  | Solderless Connections made by Wire-Wrapping Method (or equivalent Standard) |
| PO D2237 | : |  | Terminal Tags for Solderless Wrapped Connectors |

## SUB-SECTION 2 - MECHANICAL REQUIREMENTS GENERAL

## INTRODUCTION

This Section covers workmanship, materials of construction and other miscellaneous items applicable to all items of plant and equipment, together with general requirements for particular items of mechanical plant. All component parts of the Works shall, unless otherwise specified, comply with the provisions of this Section or be subject to the approval of the Engineer.

## MATERIALS AND WORKMANSHIP

All submerged moving parts of the plant, or the pins and spindles, etc., of the submerged moving parts or the faces, etc., in contact with them shall be of corrosion resistant metals. All parts in direct contact with various chemicals, shall be completely resistant to corrosion, or abrasion by these chemicals, and shall also maintain their properties without aging due to the passage of time, exposure to light or any other cause.

Where "stainless steel" is specified or used it shall have resistance to atmospheric corrosion not less than that provided by ISO 3763, ISO 377, Grade 410 S3. Particular attention shall be made to the prevention of seizure by fretting where two corrosion resistant metals are in contact, by the selection of materials of suitable relative hardness and surface finish and the application of lubricants. Where bronze is specified or used it shall be zinc free.

Particular attention shall be paid to the prevention of corrosion due to the close proximity of dissimilar metals. Where it is necessary to use dissimilar metals in contact, they shall be selected so that the bimetallic corrosion is as low as possible.

Workmanship and general finish shall be of first class commercial quality and in accordance with best workshop practice.

All similar items of plant and their component parts shall be completely interchangeable, Spare parts shall be manufactured from the same materials as the originals and shall fit all similar items of plant. Machining fits on renewable parts shall be accurate and to specified tolerances so that replacements made to manufacturers' drawings may be readily installed.

All equipment shall operate without excessive vibration and with the minimum of noise. All revolving parts shall be dynamically balanced so that when running at all operating speeds and any load up to the maximum there shall be no vibration due to lack of balance.

All parts which can be worn or damaged by dust shall be totally enclosed in dustproof housings.

## DESIGN LIFE

Unless otherwise specified, all items of Plant shall be rated for continuous service at the specified duties under the prevailing atmospheric and operational conditions on site.

All materials and equipment shall de designed for long life(minimum 25 years for major equipment) with a minimum of maintenance and the Contractor may be called upon to demonstrate this for any component either by the service record of similar equipment elsewhere or by records of extensive type tests.

Routine maintenance and repair shall, as far as possible, not require the services of highly skilled personnel.

Except for consumable items such as gland packing, carbon brushes, etc., which normally require replacement more frequently, no part subject to wear shall have a life from new to replacement or repair of less than three years of continuous normal operation and where major dismantling g is required to replace a part, such life shall be not less than ten years.

## WELDING

Welded parts consisting of steel to B.S.4360, B.S.1501-Grade 490A, RT, DIN 17100 or similar steel shall comply with requirements not less than B.S. 5135 or equivalent standard. B.S. 5135 gives the requirements for preheating the work before welding. Circumferential welds, etc. shall be fabricated and tested in accordance with B.S. 5500, B.S.2633 or equivalent standards where applicable. All joints shall have the plate edges accurately prepared to the appropriate profile for welding. The parts shall then be assembled and accurately checked before welding proceeds. The welding and fabricating procedure shall be such that residual stresses are a minimum and distortion avoided. Special attention shall be given to ensure that distortion does not occur after machining to affect the alignment and operation of the part concerned.

Welding procedures shall be in accordance with B.S. 4870. Each unit shall be fabricated, and welding completed before final machining or other fitting work is carried out. All fillet welds shall be continuous. Electrodes used shall be low hydrogen type and shall comply with requirements not less than B.S. 639 or equivalent standard for carbon steels, and B.S. 2926 or equivalent standard for stainless steels. Only stainless steel, electrodes shall be used for welding stainless steel. Stainless steel to be welded shall be suitably stabilized. Heated storage and ovens shall be provided for the electrodes. Only skilled, qualified, and tested welders shall be employed. The welders shall be tested in accordance with B.S. 4871 Part 1, or another equivalent standard. Detailed records of welding shall be kept; showing the name of each welder against each run in a weld and any welder found to be producing an unacceptable number of defects should be removed until he has passed the test again.

Where valve bodies, sleeves, etc., are of welded construction all longitudinal butt welds in the shell plates shall be completely radiographically tested. All circumferential butt welds in pipes shall, where possible, have at least 100 mm in 1,000 mm of their lengths radiographically tested.

All welds shall be 10 per cent ultrasonically tested. Ultrasonic testing shall be carried out in accordance with B.S. 3923 and the Contractor shall propose a standard of acceptance. All fillet welds shall be tested by ultrasonic crack detection, or other approved means. For all other items of plant the Contractor shall allow for the cost of adequate radiograph examination of the welds. The positions to be examined will be indicated by the Engineer. The "International Institute of Welding Collection of Reference Radiographs of Welds" shall be used as a guide for the interpretation of radiographs and as a basis for comparison regarding the nature and extent of weld defects. The minimum grade for acceptance shall be blue.

**Castings**

All cast iron shall be of standard grey close-grained quality to ISO 185, ISO 2892: Grade 220 or better. The structure of the castings shall be homogeneous and free from non-metallic inclusions and other injurious defects. All surfaces of castings, which are not machined, shall be smooth and shall be carefully fettled to remove all foundry irregularities.

Minor defect not exceeding 12 ½ percent of total metal thickness and which will not ultimately affect the strength and serviceability of the casing may be repaired by approved welding techniques. The Engineer shall be notified or larger defects and no repair welding of such defects shall be carried out without prior approval. If the removal of metal for repair will reduce the stress-resisting cross-section of the casting by more than 25 per cent, or to such an extent that the computed stress in the remaining metal exceeds the allowable stress by more than 25 per cent, then that casing may be rejected. Castings repaired by welding for major defects shall be stress-relived after such welding.

Non-destructive tests will be required for any casing containing defects whose extent cannot otherwise be judged, or to determine that repair welds have been properly made.

## FORGINGS

All major stress-bearing forgings shall be made to a standard specification, which shall be submitted to the Engineer for approval before work is commenced. They shall be subject to internal examination and non-destructive tests for the detection of flaws, and shall be heat-treated for the relief of residual stresses. The name of the maker and particulars of the heat treatment proposed for each such forging shall be submitted to the Engineer. The Engineer may arrange for such forgings to be inspected at the place of manufacture with a representative of the Contractor.

## FIXINGS

Nuts, bolts studs and washers for incorporation in the Plant shall conform to the requirements of the appropriate British or other approved standard. Nuts and bolts for pressure parts shall be of the best quality bright steel, machined on the shank and under the head and nut. Bolts shall be of sufficient length such that one thread shall show through the nut when in the fully tightened condition.

Fitted bolts shall be a light driving fit in the reamed holes they occupy, shall have the screwed portion of a diameter such that it will not be damaged in driving and shall be marked in a conspicuous position to ensure correct assembly at Site.

Washers, locking devices and anti-vibration arrangements shall be provided where necessary and shall be subject to the approval of the Engineer.

Where bolts pass through structural members taper washers shall e fitted where necessary to ensure that no bending stress is caused in the bolt.

Where there is a risk of corrosion, bolts and studs shall be designed so that the maximum stress in the bolt and nut does not exceed half the yield stress of the material under all conditions.

All bolt nuts and screws, which are submerged in water, shall be made of nickel-bearing stainless steel.

## ALLOWANCE FOR WASTAGE

The Contractor shall supply as specified and to the satisfaction of the Engineer reasonable excess quantities to cover wastage of those materials which will normally be subject to waste during erection, commissioning and setting to work.

## LUBRICATION

1. **General**

Provision shall be made for suitable lubrication to ensure smooth operation, heat removal and freedom from undue wear. Plant selected shall require minimum lubrication attendance and down time for lubricant change.

The Contractor shall furnish a complete schedule of recommended oils and other lubricants. The number of different types of lubricants shall be kept to a minimum. The schedule and the name of the supplier of the lubricants shall be submitted to the Engineer for approval before incorporation in the instruction manuals. In the case of grease lubricated roller type bearings for electric motors lithium base grease is preferred.

The Contractor shall supply the first fill of oil and grease from approved lubricant suppliers.

All grease nipples, oil cups and dipsticks shall be readily accessible, being piped to a point as near as practicable to the lubrication point.

1. **Grease Lubrication**

Where lubrication is effected by means of grease, preference shall be given to a pressure system, which does not require frequent adjustment or recharging. Frequent, for this purpose means more than once weekly and grease systems having shorter periods between greasing should be avoided. Where necessary for accessibility grease nipples shall be placed at the end of the extension piping and, when a number of such points can be grouped conveniently, the nipples shall be brought to a battery plate mounted in a convenient position with spacing in accordance with the recommendation of BS 1486 Part 1. Button head type nipples shall be used for normal grease lubrication. (Anti friction bearings requiring infrequent charging shall be fitted with hydraulic type nipples). Where more than one special grease is required a grease gun for each special type shall be supplied and permanently labelled.

1. **Oil Lubrication**

Oil sumps shall be fitted with oil level indicators of the sight glass type, or where this is not practicable, with dipsticks. The indicators shall show the level at all temperatures likely to be experienced in service. The normal, maximum, and minimum levels at 300 C shall be clearly visible in the sight glass types as viewed from the normal access floor to the particular item of plant, and they shall be easily dismantled for cleaning.

All sight glasses shall be firmly held and enclosed in metal protection in such manner that they cannot be accidentally damaged.

All lubrication systems shall be designed so as not to present a fire hazard and particular care shall be taken to prevent leakage of lubricants and to avoid leaking lubricants coming into contact with any electrical equipment, heated surfaces or any other potential sources of fire.

Gearboxes and oil baths shall be provided with adequately sized filling and draining plugs and suitable means of oil level indication.

Roller chain drives shall have oil bath reservoir lubrication.

Drain Points shall be located or piped to a position such that an adequately size container can be placed beneath them. Where a large quantity of oil is involved or drainage to a container difficult, a drain valve and plug shall be provided at the point of discharge.

Bearings equipped with force fed oil lubrication shall be automatically charged prior to machinery staring up and pressure monitored during operation with automatic shutdown of machinery and alarm on low oil pressure.

Access, without the use of portable ladders, to lubrication systems shall be such as to permit maintenance, drainage and re-filling, without contamination of the charged lubricant.

The design of breather shall consider the humidity and atmospheric contamination at the vent point and measure be incorporated to prevent contamination of the lubricant.

The Contractor shall supply flushing oil for each lubrication system when an item of plant is ready for preliminary running and a sufficient quantity of the approved lubricants for settings to work and for the commercial operation of the plant for two year after the Taking-Over Certificate has been issued.

## MACHINERY, LIFTING, DISMANTLING, GUARDS, NOISE AND VIBRATION

1. **Alignment**

Machinery bedplate design, packing and fixing shall be such as to minimize distortion and vibration. Aligned machinery shall be mounted on either bed or sole plated permitting removal and reinstatement without a requirement to rigidity.

Bedplate shall incorporate fine adjustment of the vertical and horizontal alignment between driver and driven members.

1. **Lifting**

All machinery shall be fitted with lifting facilities; large structures shall be provided with jacking points.

1. **Machinery Dismantling**

Tapped holes or other provisions must be made in all main castings, for the insertion of jacking screws or the fixing of drawings fear to facilitate dismantling. On items of machinery subject to frequent dismantling, bolts or studs shall be employed in preference to setscrews.

1. **Guarding**

Guards shall be provided to prevent access to electrical apparatus and moving parts of machinery. They shall be designed to be secure but removable without disturbing other parts of the Plant. The Contractor shall ensure that stationery points, requiring access, are located safely, outside the guards. Large guards shall be equipped with small removable panels for the inspection and checking of enclosed components.

1. **Noise and Vibration**

The Contractor shall provide a quiet installation. All items of plant and equipment shown on the drawings shall be carefully chosen with a view to quiet operation.

All plant shall operate without excessive vibration and the minimum amount of noise. Should the overall sound level of any item of plant exceed 85dB (A) at 1 metre radius the Contractor shall include for suitable sound attenuation to achieve this level. This will apply in the audible frequency range 20 Hz-20 kHz. Above 20 kHz, the Contractor must state whether any fundamental frequencies are generated in the ultrasonic region. Where plant is operating in the vicinity of residential buildings then the sound level at 1 metre radius from the outside of the pump or plant house enclosure or building shall not exceed 65dB (A).

The Contractor shall provide and fix all material for the prevention of transmission of noise and vibration through the structure. All fans, motors, A/C package units, compressors, diesel engines and other motive plant shall be mounted on resilient mountings in such a manner that the plant foundations are isolated from the floor or structure. In addition, all rotating plant shall be statically and dynamically balanced. Mechanical vibration shall be isolated by the use of anti-vibration mountings and flexible connections to ensure an isolation efficiency of 95% from the building structure.

## GEAR BOXES

Gearboxes shall have a life of 100,000 hours, be selected in accordance with A.G.M.A recommendation for horsepower calculation and service factor application and employ a standard reduction ratio. Angle mounted Gearboxes, shall have a rating, choice of bearings, seals and lubrication system which are suitable for such mounting. Dependence on splash lubrication alone is not acceptable but it may be used in conjunction with a forced feed method to reach all bearings and gears. Calibration of the oil dipstick and its position together with that of the sump drain plug will require special consideration.

## BEARINGS

1. **Below Water Bearings**

The Contractor shall select the most appropriate type of bearing for the Plant being supplied. Equipment with vertical shafts shall have thrust and guide bearings. All bearings shall be designed to exclude the ingress of water except where the bearings are water lubricated. Sealed for life units are acceptable subject to a minimum design life of 90,000 hours operation at maximum loading. Plant which may be subject to vibration whilst stationary shall be provided with bearings designed to withstand damage from such a cause. Below water bearings shall be of the journal type, of ferro-asbestos, rubber gunmetal or equal and journal of stainless steel.

1. **Above Water Bearings**

Single journal plain bearings shall have phosphor bronze or synthetic lubrication impregnated bushes and carbon or stainless steel journals respectively. Synthetic bearings shall only be used where bearing condition can readily be inspected. Plain type bearings shall be self-lubricating by either grease, forced oil or impregnation. Ball and Roller type bearings shall be adequately lubricated by oil or grease and sealed to prevent leakage of lubricant along the shaft. Attention shall be given to ensure that dismantling of bearings is simple and free from risk of damage.

Bearings fitted to gearboxes shall have a minimum design life of 100,000 hours at maximum loading.

## PUMPS

1. **General**

Each pump shall be designed and constructed to be suitable for the particular liquid to be pumped. Pumps shall be of the type specified and arranged as indicated in the Specification and Drawings. Pumps shall be designed to give the specified output against all losses including those relating to the pump station pipe work and valves. The Contractor shall match the pump characteristics to the pipe systems networks to achieve the highest pump efficiency and reliability. The pumps shall have a non-overloading characteristic over the complete range of head and quantity delivered and the drive shall be capable of operating the pumps against maximum run out conditions and still have a 10 per cent margin. 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.

Centrifugal pumps shall have head/quantity characteristics which fall continuously from the maximum pressure at closed valve conditions and which are steep in order that variation in head shall have a minimal effect on the quantity discharged.

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 valves failed to close.

The overall pump set efficiency must not be less than 75% unless stated otherwise in the bills of quantities.

1. **Pump Casings**

The pump design shall ensure that alignment is maintained between the various assemblies by recesses, spigots and dowels and shall be such that all components liable to wear can be replaced. Components shall be permanently marked with the manufacturer's number and where dowels are not used, permanently marked for correct assembly. The pump casing shall have replaceable wear rings. The casings of the pumps shall be of a suitable grade of close-grained cast iron to ISO 185, ISO 2892 Grade 220 or nickel iron and have flanges to match the specified pipework. The waterways through the pumps shall be smooth in finish and free from recesses and obstructions.

Pumps shall be designed to facilitate maintenance and manholes, or hand holes shall be provided to allow the interior of the casings and bearing seals to be examined without dismantling the pump. It shall be possible to remove pump impellers with the minimum disturbance to pipework and by suitable joints to allow the pump to be removed without dismantling the main pipework.

All joints shall be machined and faced, and bolt holes shall be drilled and bored. Location pins shall be provided where necessary, also starting screw holes, the latter being provided with setscrews. For all submersible pumps the casing shall be stainless steel.

1. **Impellers**

The impellers and guide vanes (if any) shall be of suitable material, accurately machined and smoothly finished to minimize hydraulic losses. The rotating elements shall be statically and dynamically balanced before final assembly. The impeller shall be readily withdrawable from the pump casing without the need to disconnect pipework. For all submersible pumps the impellers shall be stainless steel.

1. **Pump Shafts**

The pump shaft shall be of high tensile or 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. Where a change in diameter of the shaft occurs, the shoulder shall be reduced or undercut to the appropriate BS to reduce stress concentration. The shaft shall be complete with easily renewable stainless-steel protecting sleeves at glands and bearings.

1. **Bearings**

All bearings shall be liberally rated to ensure cool running to meet the load factors specified.

For vertically mounted pumps, the bearing shall be a combined thrust and journal type; designed to prevent any thrust loads being imposed upon the drive motor. The pump bottom bearing shall be lubricated by an enclosed water lubricated sleeve bearing suitable for clean water supply where pumped fluid is raw (potable water) applications.

Where grease points are necessary they shall be fitted with removable screwed plugs which shall be accessible without removing guards. All bearings having automatic lubrication shall also have provision for hand lubrication.

1. **Shaft Seals**

The Contractor shall select a seal, compatible with his plant and best suited for the worst conditions likely to be met when the Plant is in operation. All seal materials shall be compatible with and/ or resistant to the fluid or gas being handled. For potable water, seal materials shall be those specifically approved for use in the Water Industry.

Stuffing boxes shall be provided with renewable gland packing. Glands subject to abrasive liquors or negative pressures shall embody suitably positioned lantern rings and a clean water continuous flushing system, operative whenever the Plant is in motion or a corrosive element is present. Gland adjustment nuts shall be readily accessible for routine maintenance. Gland drain pipework shall be installed, incorporating rodding facilities and adequate inclines discharging to the nearest sump or drainage channel.

Mechanical seals which are on pumps subject to abrasive liquor or gas, or subject to negative pressures or corrosive elements, shall be provided with a clean water continuous gland flushing system, operative when the item of plant is in motion or a corrosive element present. A back-to-back sealing arrangement with a flush/cooling system shall be accepted as satisfying the requirements of this Clause.

Special care in the selection of materials shall be taken to avoid binding and electrolytic action between the shaft sleeve and the seal components, particularly where long periods of idleness are inherent in the duty cycle as in the case of standby pumps.

The gland water connections supplying water seals of the pumps shall be provided with suitable filters to prevent abrasive matter in suspension from entering the glad stuffing box. These filters shall be designed to facilitate easy cleaning.

1. **Pump Sleeves**

When the flow past submersible motors is less than the minimum required for cooling when the submersible pumps are installed at the recommended depth, cooling sleeves or shrouds shall be installed on the pumps to induce flow past the motors to the pump inlet strainer.

The cooling sleeves shall be of such dimensions as to provide a minimum velocity of water flow past the motor as recommended by the manufacturer of the pump.

The material of the sleeve can be of stainless or galvanized steel and shall be connected to the pump through a bolt & nut arrangement.

1. **Pumps Miscellaneous**

Cooling and lubrication water pipework shall be fitted with flow indicators where specified, with a provision to show alarm/trip the pumps in case of failure.

Horizontal pumps shall be mounted on common fabricated steel bedplate manufactured from substantial rolled steel section of welded construction with machined pad mounting both pumps and motors. Folded plate type bedplates shall not be acceptable. Pumps and motors shall be doweled in position to allow for easy relocation in the event of their being removed. The pump shall be connected to its driving motor by a flexible coupling of a type approved by the Engineer which shall be adequately guarded.

On horizontal pump sets fitted with hydraulic balance devices the couplings shall permit free movements of pumps shafts under load.

On vertical pump sets where the shaft couplings are of the screwed type the couplings shall be positively locked.

The Contractor shall ensure that adequate N. P.S.H. is available to ensure the pumps operate without cavitation under the worst operating conditions. In any case the NPSH available shall not be less than 2 metres above the NPSH required in any case.

Indicating pressure gauges each with an isolating cock and rubber shall be provided on the suction and delivery side of each pump except that a suction gauge is not required on submersible type pumps. All pressure gauges shall be provided with high and low-level adjustable contacts which can be used to provide additional pump protection where specified.

1. **Performance**

The guarantees given in respect of output, overall efficiency and N.P.S.H. shall be verified with Class C tests in accordance with ISO 2548, ISO 5198 at the manufacturer's works in the presence of the Engineer. No negative tolerance shall be applicable to the guaranteed values for Flow, Head, or Efficiency. The tests shall be performed by pumps driven by their own motors.

The NPSH tests shall be carried out at the guaranteed duty point, at the maximum run out conditions and at three points in between. Clause 2.13 provides general specifications common to all types of pumps. For the specific case of borehole submersible pumps, Clause 2.13 is amended as follows.

*Submersible Borehole Pumps*

1. Submersible borehole pumps shall be of radial or mixed flow type, multi-stage units suspended from surface plates by vertical riser pipes and driven by submersible electric motors. The pump and the motor shall be delivered as a single pumping unit completely assembled.

The speed of these pumps shall usually be 2,900 or 1500 rpm.

1. The materials and the pump construction will be suitable for the groundwater quality
2. The impellers shall be cast in high-grade zinc-free bronze or stainless steel.

The pump body shall be cast in zinc-free bronze, stainless steel or cast iron. The body shall be capable to withstand a hydraulic pressure, equal at least to one and a half (1.5) times the shut-off head.

In case of impellers of enclosed type, the bowls shall be equipped with wear rings of renewable type, made of zinc-free bronze, and having larger bearing surface.

The pump shaft shall be of stainless steel with journals sleeved with renewable, hardened stainless steel sleeves.

All bolts, nuts, studs, washers, etc. shall be manufactured in stainless steel.

The pump body shall have separate sections for each stage, which shall have matching faces machined and spigotted, to allow accurate location and alignment of the sections during assembly. The fixing nuts, bolts, washers and studs or bolts shall be manufactured in stainless steel.

The pump shall be fitted with removable shaft bearing sleeves, bearing bushes, casing wear rings and impeller wear rings. Each impeller shall be located on the shaft by identifiable distance sleeves or similar, such that re-assembly of the rotating element can be carried out without the necessity of accurate measurement. The rotating assembly shall be statically and dynamically balanced after which each part of the assembly shall be identified and marked to ensure identical re-assembly after maintenance, etc.

Bearings shall be water lubricated and where rubber type bearings are used the bearing material shall be securely bonded to a metal housing. Rubber bearings shall only be used where there is sufficient pressure difference through the bearing to afford adequate lubrication and cooling of the bearing.

Bearings shall be positively retained within the pump body to prevent the possibility of the bearing rotating; a press fit alone shall not be acceptable.

The pump shall be fitted with a suction case of a material suitable for the liquid being pumped and shall be provided with long bearings to stabilize the shaft and motor shaft and to avoid radial thrust on the motor bearing. A screen shall be incorporated having a minimum open area of four (4) times the eye of the impeller.

The submersible motor shall be of the completely enclosed type for continuous duty under water operation on 380 V 50 Hz, 3 phase AC. The motor shall be equipped with an approved seal, located at the top of the motor, where its shaft extends through the motor housing, to isolate the well water from the liquid filled in the motor. The liquid shall be either water or a high dielectric strength mineral oil, and it shall be circulated throughout the motor for cooling the motor, stator windings and bearings. Motor performance shall be in accordance with the relevant section of ISO 13373-9: Part 99.

Motor thrust bearing ratings must be ample to carry the thrust load imposed by the pump when operating under the maximum anticipated pumping head. Motor thrust bearings shall be capable of operating with rotation in both directions, and the thrust capacity when operating in reverse shall not be less than the rated capacity.

An expansion chamber or diaphragm shall be provided to relieve thermal expansion of internal motor fluid due to temperature and shall provide motor internal and external pressure balance under all conditions of temperature and pressure.

The drive shaft shall be of a 13% chromium steel or equivalent corrosion resistant material. Outer shell shall not be less than 0.012 m thickness and shall be of material to resist corrosion.

1. The strainer shall be constructed entirely of stainless steel and shall have a net inlet area equal to at least four (4) times the impeller inlet area.
2. The bearings shall be water lubricated. The motor thrust bearing should be capable to carry the thrust load corresponding to maximum head, operating with rotation in either direction.
3. The pump cable will be also a part of the delivery. It will be a flat cable suitable to the type of the starter.
4. The borehole pump column (rising pipe) including discharge elbow shall be supplied and installed together with the pump. It will comprise several sections at the option of the Supplier so that the total length may be adjusted by plus or minus 2 m.

The column shall be manufactured from threaded or flanged steel pipes. The flanges shall be provided with suitable grooves to facilitate the installation of the power cable of the pump motor.

Flange diameters should agree with the internal diameter of the borehole casing.

The pipe sections shall be internally lined and externally coated with epoxy bituminous paint or other approved anti-corrosive protection. The bolts and nuts should be made of stainless steel.

1. The surface plate (pump base) shall be of a design, which will ensure a watertight, capping of the well and shall be rigid and strong enough to support the entire weight of the suspended parts when filled with water. The plate shall provide suitable openings for the power cable, well vent and water level indicator.

The plate shall also support the discharge connection (discharge elbow) and therefore the surface plate shall be provided with a welded connection piece consisting of a double flanged steel pipe section as a support for the discharge elbow.

The capping should be fitted directly on the upper portion of the inner casing.

1. The discharge connection (elbow) shall be flanged, at a diameter similar to the rising pipe, and with a pressure rating consistent with the surface pressure to be delivered by the pump.

The discharge elbow shall be equipped with a discharge pressure gauge.

**Flanges**

1. **General**

All flanged connections of pumps, pipework, valves, and other relevant equipment shall have flanges in accordance with ISO 7005Table 16, unless otherwise specified in the Particular Specification Sections.

1. **Sump Pumps**

Suitable submersible sump pumps shall be installed in all basements liable to flooding. The pumps shall be float switch operated and be complete with non-return valve, galvanized steel discharge pipe work, cables and electrical control gear. Switchgear shall be suitable for fifteen starts per hour. The pumps shall be rated to deliver the specified flows at the worst head conditions possible in the relevant area.

1. **Jointing**

All flanged joints shall be made with 3 mm thick full-face canvas reinforced rubber insertion gaskets to ISO 7483Part 1. During installation, all pipes shall be hung on their respective supports and lined up so that their joint faces are parallel before flanges are bolted together. In making joints, no springing of pipes into position shall be allowed.

Joints on flanges that exist or have been installed under other contracts shall be made with the same materials and suitable for the flange faces.

## PIPEWORK

1. **Pipework General**

All pipe systems shall be arranged, installed, supported, and provided with all necessary means of venting, draining and expansion, all to the approval of the Engineer.

The pipework layout shall be designed so that item of equipment and sections of pipework can be removed from the pipeline without major disturbance to the adjacent pipework. Care shall be taken to ensure that pipework thrusts are not transmitted to machinery or associated apparatus. The Contractor shall indicate on his detailed drawings the thrust blocks required to anchor his pipework.

The Contractor shall provide flexibility in the pipework at joints in the main structures and shall submit proposals for the approval of the Engineer. Flexible joints or collars and cut pipes shall be allowed on all pipework where necessary to allow for some margin of error in the building work. Wherever possible flexible joints shall be provided with tie bolts or other means to transfer longitudinal thrust so that external anchorages may be kept to minimum. Flexible joints shall also be provided for ease of erection and future dismantling.

All necessary supports, saddles, slings, fixings bolts and foundation bolts shall be supplied to support the pipework and its associated equipment in an approved manner. Valves, meters, strainers, and other devices mounted in the pipework shall be supported independently of the pipes to which they connect.

Dead legs shall be avoided but where this is not possible provision shall be made for flushing the pipe works. Changes in pipe bore size shall be achieved by using proprietary fittings or fabricated section to avoid sudden changes.

Where relevant, formed bends and offsets shall be used and be cold formed in a standard pipe-bending machine. They shall have an inside radius of not less than 4 times the outside diameter of the pipe.

Flushing and drain connections on pipework below 150 mm shall be made using proprietary welded fittings with G series internal parallel threads to ISO 228-1 which shall be immediately sealed with hexagon headed shouldered plugs and seals. Holes thus made in the pipe shall have burrs removed and be finally pulled through to removed loose particles.

Template or closure pipe shall be provided where necessary to facilitate erection. The design and construction of the template pipes shall be to the approval of the Engineer, and the Contractor will be responsible for establishing the dimensions of the template pipe such that there will be no strain placed on the connected items after installation.

All nuts, bolts, washers, flanges, gaskets, flanged tied adapters, drain valves, special connection materials shall be supplied under the Contract.

Approved flange adapters shall be fitted where necessary to facilitate the removal of valves, etc. Adequate provision shall be made for anchoring pipes at these joints.

Hydraulic pipework shall be sized to maintain fluid velocities below those specified and provide a safety factor of 4:1 on the design pressure, which shall be taken as 120 per cent of the pump closed valve head.

Compressed air pipework shall be sized such that the air flow velocity does not exceed 8m/s. To provide adequate condensate drainage, the pipework system shall be run with a horizontal fall of not less than 1 in 50 in the direction of air flow and incorporated drainage points at distances of not less than 30m. Drainage points shall be formed by use of equal tees with a down-pointing leg fitted preferable where changes of direction of flow occur.

Pipework materials, sizes, pressure ratings, fittings, coupling arrangements and medium carried shall be as detailed in the Particular Specification, pipework being in metric sizes throughout.

**Steel Pipework**

General purpose steel pipework with screwed fittings shall be of galvanized mild steel to ISO 1239heavy grade with fittings of galvanized malleable iron to ISO 5922, ISO 12743, having tapered internal and external threads to ISO 7-1

Steel pipe and fitting over 80 mm diameter, shall be carbon steel in accordance with ISO 77.140.75 with pipe sizes to ISO 4200 Joints shall be flanged. Pipes shall be fabricated in accordance with ISO 559 with welding in accordance with ISO 3690 or BS ISO 9001 and ISO 13847.

After fabrication and machining of flanges all pipework and fittings shall be tested to a test pressure equal to 1 ½ times the flange pressure rating.

Where pipes are to be joined with sleeves or couplings, a sufficient length of pipe shall be left bare of coating to accommodate the sleeve or coupling.

Plain-ended pipes shall be supplied rounded at both ends. An adequate number of pipes shall be supplied rounded throughout their length so that they may be cut and such pipes shall be clearly marked.

Couplings for use with steel pipes shall comply with ISO 559 except where other types of couplings are shown on the contract Drawings or specified in other sections of this Specification. Components of flexible joints from different manufacturers shall not be used together.

Tests on pipes shall be made in accordance with the relevant British Standard in the manufacturer's works when required by the Engineer and in the presence of the Engineer. Two copies of the results of all such tests shall be submitted to the Engineer.

Flanges on steel pipes shall be welded in accordance with ISO 3690 or ISO 9001 and shall have raised or flat faces. Gaskets for use in flanged joints shall consist of rubber complying with ISO 23711 for type 1 rings or rubber reinforced with cotton and complying with ISO 4633 or as instructed by the Engineer. On flat face flanges the gaskets shall extend over the full flange area and on raised face flanges they shall cover the raised face only. No asbestos shall be used on any flanges of pipework or fitting carrying potable water.

Steel pipes, which are to be welded, shall have the ends prepared by the manufacturer of suit the type of welded joints shown on the Contract Drawings. The pipes shall be free of external and internal coating for 75 mm from each weld line.

After fabrication all welding scale and beads as well as hardened fluxes shall be removed, and joints shall be free of pores and as smooth as possible. Where specified all pipes and special fittings shall then be degreased and grit blasted prior to coating with an approved fusion bonded epoxy coating. The coating shall be tested to ensure the correct thickness and the absence of pores using spark-testing equipment. Bends branches and other fittings for use with steel pipe shall comply with British Standard or other approved standards. Calculations for the design of all special fittings shall be submitted to the Engineer before manufacture commences.

Pipes shall be stacked on firm bases using two timber packers only under the barrel pipes.

Fittings and specials of any type shall be stored in a single layer only. Pipes and fittings shall always be adequately protected from damage during transport, storage, and handling. Pipes shall be fitted in the factory with end caps and reinforcement adequate to prevent distortion during transport, storage, and handling. Rubber rings and other pipe jointing material shall be stored under cover away from direct sunshine.

All pipe systems shall be arranged, installed, supported, and provided with all necessary means of venting, draining and expansion, all to the approval of the Engineer.

The pipework layout shall be designed so that item of equipment and sections of pipework can be removed from the pipeline without major disturbance to the adjacent pipework. Care shall be taken to ensure that pipework thrusts are not transmitted to machinery or associated apparatus. The Contractor shall indicate on his detailed drawings the thrust blocks required to anchor his pipework.

The Contractor shall provide flexibility in the pipework at joints in the main structures and shall submit proposals for the approval of the Engineer. Flexible joints or collars and cut pipes shall be allowed on all pipework where necessary to allow for some margin of error in the building work. Wherever possible flexible joints shall be provided with tie bolts or other means to transfer longitudinal thrust so that external anchorages may be kept to minimum. Flexible joints shall also be provided for ease of erection and future dismantling.

1. **Accuracy of Work**

The fabrication, machining and finish of all pipe lengths shall be such that when assembled either in the shop or on the site, the appropriate tolerances are obtained. Clearance at joints shall be sufficiently small to avoid turbulence, etc. and thus avoid vibration and all moving parts shall operate freely without risk of undue wear or jamming. Finished faces shall be free of any wind or twist.

Pipe dimensions shall conform to the following tolerances:

* Roundness = 0.2% on a gauge length of D/4
* Ovality, = 0.2 % D
* Step between adjacent strakes, 2.0 mm maximum.
* Straightness, = 20 minutes
* Line and level, each section shall be set within 2 mm of the true line and level.

1. **Cutting Pipes**

The cuttings of pipes for making up lengths shall be carried out by a method, which leaves a clean square end. Steel pipes used for cutting shall have been rounded throughout their length and shall be clearly marked as such. Cutting shall be carried out by cutting disc or by oxy-acetylene and the cut end shall subsequently be ground to the correct profile for the method of jointing in use.

1. **Welded Joints**

Line-up clamps shall be designed to prevent tears, scare, or indentations of the pipe walls and keep misalignment of pipes at a minimum. Interior line-up clamps are required for the diameter pipe.

All welding shall be carried out in accordance with specific procedures prepared by the contractor and approved by the Engineer. Adequate precautions shall be taken to protect welding operation from wind, rain, blowing sand, etc.

All welders employed on the Works shall be fully qualified and shall have successfully passed all tests required by ISO 9606 or the relevant API code for the type of work each individual welder does. Welder qualification tests shall be carried out in the presence of the Engineer or his authorized representative. The Contractor shall provide all necessary labour, pipe welding materials, and equipment for performing welder qualification tests on site. Arrangements for laboratory tests of coupons, if required, will be made, and paid for by the Contractor. The Contractor shall maintain a list of approved welders agreed upon with the Engineer and no other employees shall perform welding operations on the Permanent Works.

Before welding, the pipe ends shall be swabbed with a leather or canvas belt disc to remove dirt, loose mill scale, rust, oil, grease, and other matter which may be injurious to the weld. Cleaning of pipe ends shall be done by power wire brushing and/or grinding. Pipe ends damaged such that they no longer meet joint specifications shall be relevelled by a suitable machine. Pipe ends shall be aligned with line-up clamps such that the longitudinal weld seams of the adjacent pipes staggered by at least 20 degrees. Stringer bead shall be applied by at least two welders welding in opposite quadrants. The number of filler and finish beads shall be in accordance with approved procedures.

Completed weld shall have a substantially uniform cross-section around the entire circumference of pipe. At no point shall the crown surface be below the outside surface of the pipe nor be raised above the parent metal by more than 1.5 mm. All joints on which welding has started shall be completed before the end of each day's work. At night or when work is not in progress, pipe ends of the pipeline shall be securely capped with a suitable cover to prevent the entrance of dirt, small animals, water, and foreign matter into the pipeline. Tie-ins shall be carefully aligned to limit residual and/or reaction stresses after completion of the weld. Tie-ins shall be made within the temperature range of 100 to 300 C. All production welds shall be subject to visual inspection by the Engineer. Visual inspections may be carried out at any stage of the welding of a joint. Each weld shall be clearly marked adjacent to the weld indicating the identification of the welder. Steel die stamping will not be permitted.

Non-destructive testing shall be carried out on all welds, both in the shop and on the site. All longitudinal butt welds shall be radiographically tested. All circumferential butt welds carried out in the shop shall have 100 per cent of their length radiographically tested at positions indicated by the Engineer. Junctions between longitudinal and circumferential welds shall be included in this test. The remainder of the shop and site welds shall be ultrasonically tested throughout 100 per cent of their length. Ultrasonic testing shall be carried out in accordance with ISO 17640 and the standard of acceptance shall be approved by the Engineer.

Where ultrasonic tests indicate a flaw or defect in the weld this shall be examined using radiographic means.

In the case of fillet welds the Engineer may require dye penetrate tests to be carried out on selected welds.

The Contractor will pay for the testing, and he should include these costs and expenses during pricing of the Schedule of Prices.

The Engineer retains the right to have cut out and removed one weld only for each welder at no cost to the Employer.

Welds rejected by the Engineer shall be cut out and replaced by the Contractor. If the cut-out weld is found on test not to meet the Specification, the cost of the cutting out and joining shall be borne by the Contractor. If the weld is found satisfactory, the cost shall be borne by the Employer.

Welds rejected by the Engineer may, at his discretion, be repaired subject to the following:

* Repair to the filler weld, which would penetrate the stringer bead, will not be permitted.
* Arc burns shall not be repaired by welding but shall be removed by grinding provided that no reduction in wall thickness is made more than 12 ½ per cent of the nominal wall thickness.

The Contractor shall maintain records of all repairs of whatever nature of pipe and pipeline describing and locating such repairs.

Welding pipes together which have been cut shall be done with one weld if it is practical to pull the line into position, otherwise, two welds shall be made by setting in a piece of pipe at least 2 m in length.

The testing of welds shall be in accordance with the requirements of the International Institute of Welding, Collection of Reference Radiographs. These shall be used as a guide to the interpretation of radiographs and as a basis for comparing the nature and extent of weld. The minimum grade for acceptance shall be blue.

**Flexible Joints**

Any flexible joints in steel pipework shall be of the type specified or as shown on the Drawings. Flexible joints between pipes having integral sockets shall be formed by a shaped rubber gasket fitted within the socket or by a rubber ring of circular cross section (O-ring) placed on the pipe spigot. The type of flexible joint to be used shall be subject to the approval of the Engineer. Before any joint is made all parts of joint shall be clean and free from mud, oil, grease or other deleterious matter. Fixed gaskets shall be lubricated strictly in accordance with the manufacturer's recommendations. O-ring gaskets shall not be lubricated. Component of flexible joints from different manufacturers shall not be used together. After jointing, the position of O-rings shall be tested with a feeler to ensure that they are correctly positioned. If any ring shows a significant departure from a line following a pipe circumference, the joint shall be broken and remade using a new ring. After completing the joint any damage to the protective coating shall be made good.

**Flanged Joints**

Flanged joints shall be made with rubber gaskets and shall be fitted without twist or distortion. Pipes and fittings shall be fully supported so that the flange faces are parallel and concentric. The flanges shall be drawn together uniformly by tightening opposite pairs of bolts in succession and no bolts shall be omitted. The size and number of bolts in flanged joints shall be in accordance with ISO 7005and ISO 9349, ISO 7186, ISO 2531, ISO 8179 for the pressure rating of the pipeline given on the Drawings. Bolt threads shall be coated with an approved paste such as Loctite before use unless otherwise instructed by the Engineer

1. **Bonding**

All flexible, flanged and similar discontinuous joints shall be bonded across the joint to provide electrical continuity throughout each buried pipeline.

1. **Deviations at Joints**

The maximum deflection at each joint shall not exceed the following:

* For any type of flexible joint, three quarters of the maximum permissible deflection stated by the manufacturer:
* For welded joints in steel pipework, the deflection shown on the Contract Drawings. The ends of the pipes shall be cut to suit.
* No deviations shall be made as flanged or solvent welded joints.

1. **Protection of Buried Pipes**

External and internal protection to pipes shall be made good after completion of joints as directed by the Engineer. Protective tape of a type acceptable to the Engineer shall be applied in two separate layers. Each layer shall be would with an overlap equal to half the tape width and shall extend at least 150 mm beyond the area requiring protection.

1. **Gaps for Equipment**

Where gaps must be left in pipework for the later installation of equipment such as valves and other items, the ends of the pipes shall be accurately aligned one with the other across the gap paying strict attention to bolt positions if relevant. The length of the gap shall be accurately determined with the aid of dimensional sketches, which shall be submitted to the Engineer before the work is carried out.

All gaps left for valves or other equipment shall include space for dismantling joints.

1. **Ductile Iron Pipework**

Unless shown otherwise on the Drawings, ductile iron pipes and fittings shall be in accordance with the followings:

ISO 2531: 1974 "Ductile iron pipes, fittings and accessories for pressure main lines"

BS 4772: 1971 “Specification for ductile iron pipes and fittings"

Flanged joints shall be drilled in accordance with BS 4504 and shall be supplied complete with galvanized steel nuts and bolts, and appropriate gaskets.

Self-anchored flexible joints shall be of the spigot and socket type, but the joint shall be tied together to prevent longitudinal movement. The joint shall permit an angular deviation of 20 relative to the pipe axis after assembly and shall be subject to the approval of the Engineer.

All spun ductile iron pipes shall be Class K9. All standard branched fitting shall be Class K14. All other standard fittings shall be Class K12.

All puddle flanges shall be of the thrust resisting type.

All ductile iron pipes and fittings shall receive a cement mortar lining in accordance with ISO 4179, and an external surface finish in accordance with ISO 8179 comprising a sprayed zinc coating to give a coverage of 130 g/m2 , followed by a bituminous varnish of 70 micron minimum dry film thickness.

1. **uPVC pipework**

Unplasticized PVC (uPVC) pipes shall comply with ISO 161/1 or as stated on the drawings. Joints shall be either made with rubber sealing rings or shall be solvent welded as specified. Solvents shall comply with BS 4346 Part 3. Ferrules, straps and other metal fittings shall be gunmetal.

1. **Small Bore pipework**

Small bore pipe works up to 15 mm OD shall be manufactured from stainless steel tubing with suitable compression type fittings. All small-bore pipework and capillary tubes shall be adequately and securely clipped or clamped. Compression fittings & bends shall be kept to a minimum, as pulled bends of generous radii are preferred. Compression couplings shall be heavy series to BS 4368 Part 1.

Any gauges, transducers or switches, etc., fed via small bore pipework shall have an individual isolating cock adjacent to each component with adequate space being allowed for component removal for servicing.

1. **Puddle Flanges**

Puddle flanges shall be fitted to pipes where the structure through which they pass is required to take thrust resulting from the pipe. Puddle flanges shall also be fitted where a water barrier is required. All puddle flanges shall be clearly shown on the Contract Drawings and the resultant thrust clearly indicated. Puddle flanges shall only be fitted with the Engineer's prior approval.

After the pipework is installed, the contractor shall seal the ends of all ducts, pipes, or trenches leading into building. The seals shall be approved water, gas and fire sealing transit units with appropriate fillers Insert blocks shall be fitted to duct and trench entries. All steelwork on such transit assemblies and frames shall be hot dip galvanized. Where detailed in the specification or shown on the Contract Drawings, transit frames will be incorporated in the construction by the Civil works contractor.

1. **Reference Marking**

Prior to dispatch from the manufacturer's works each pipe section shall be marked with an appropriate reference number for future identification.

1. **Protection of pipework**

Immediately after the completion of fabrication at the works or on site and during transport and storage, pipe ends shall be protected from external damage and sealed against ingress of dirt by suitable caps, plugs or other similar means. After cleaning and inspection, machined surfaces of all steel and ironwork shall be covered with preserving fluid of approved types or otherwise protected and all flanges shall be fitted with bland discs bolted to each face.

1. **Branch Pipes and Bosses**

Whenever any small-bore pipework makes a connection into the pipeline system, a boss or branch pipe shall be provided which shall be at least twice the diameter in width and one diameter in thickness of the tapped hole which it contains.

Bosses shall be located at the main pipe horizontal centre line and those provided for water sample cocks shall be tapped 38 mm (1.5") BSP and have reasonable access for sampling. Bosses provided for instrumentation equipment shall be tapped 25mm (1") BSP with a reducer fitted to suit the small-bore pipework and isolating cock. Unused bosses shall be fitted with bland plugs having a central squared projection for tightening or removal.

Bosses shall be provided from pump performance monitoring. These shall be installed on all pump suction and delivery pipes at least 2 pipe diameters from the pump flange unless otherwise specified in the Particular Specification. Each tapping shall be provided with ½ inch isolating cock.

1. **Testing Pipework**

Before testing commences the Contractor shall ensure that all anchor and thrust blocks are complete or that temporary supports have been installed. Thrust from temporary pipe ends or branch pipes shall be adequately strutted and the section under test closed off with stop ends, blank flanges or other closure fittings.

All pipes shall be cleaned before testing by flushing or as agreed by the Engineer.

All tests shall be carried out in the presence of the Engineer and for this purpose the Contractor shall give the Engineer 24 hours’ notice in writing of any pressure tests, which he intends to carry out.

Within 24 hours of the completion of any test the Contractor shall submit two copies of a full record of the test to the Engineer. The record shall be in a form acceptable to the Engineer.

The pipe work to be tested shall be filled with clean water, making sure that all air is expelled. Mortar lined pipe shall then be kept under nominal working pressure for 24 hours. The pressure shall then be raised to the specified test pressure using a hand-operated force pump, which is fed, from a calibrated tank. The test pressure will depend upon the particular circumstances and will be specified by the Engineer but for general guidance only will be about 1.5 times the maximum sustained operating pressure.

The test pressure shall be held for the period instructed by the Engineer, pumping in water as required from the calibrated tank, and the amount of water used per hours shall be noted. The pressure shall be held for 24 hours and there shall be no loss of water.

1. **Commissioning pipe work**

Pipes for the conveyance of potable water shall be flushed with clean water and then sterilized in accordance with the recommendation contained in BSCP 2010, Part 2, and ISO 13623 Part 1 as specified.

Commissioning shall not be commenced until the Engineer has approved the whole of the installation in writing.

## VALVES AND PENSTOCKS

1. **Valves and Penstocks-General**

Valves shall be provided as specified on the Drawings and in the Particular Specification, and shall be specifically designed for use in raw and treated water and in chemical solutions used in water treatment.

Valves shall unless otherwise specified be double flanged and flanges shall be as specified in Section 2.15.

All valves and penstocks shall be of the sizes shown on the Drawings or started in the Documents and shall be obtained from manufacturers approved by the Engineer.

Where specified valves shall be fitted with easing screws and a clean-out box in the base.

All valves bodies shall give the following information

Manufacturer's Name or Trade mark

Hydraulic test pressure PN

Size of valve DN

Direction of flow “Arrow”

Valves should be protected by fusion bonded epoxy or equivalent, internally suitable for potable water and to a minimum of 150 microns or in aggressive soils of 300 microns thickness.

1. **Valve Access**

All valves, hand wheel, spindles and headstocks shall be positioned to give good access for operational personnel.

Extension spindles shall be supplied wherever necessary to achieve the specified operating requirements.

Valves buried or installed in underground chambers where access to a hand wheel would be impractical shall be key operated.

It shall be possible either to remove and replace or to recondition seats and gates. Gland packing shall be accessible without removal of the valve from the pipe work.

1. **Operation**

The operating gear of all valves and penstocks shall be such that they can be opened and closed by one man against an unbalanced head 15 per cent in excess of the maximum service value and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required operating torque of 150 Nm.

All hand wheels shall be arranged to turn in a clockwise direction to close the valve or penstock and the direction of rotation for opening and closing shall be indicated on the hand wheels.

Unless otherwise stated the hand wheels shall be coated with black plastic and incorporate facilities for padlocking in either the open or closed position.

Headstocks and valves of 50 mm, or greater, nominal bore shall be fitted with mechanical position indicators to show the amount which the valves is open or closed in relation to its full travel, i.e. 0.25, 0.50, 0.75, 1.

1. **Materials**

Valve bodies’ discs and wedges shall be of cast iron, with facing rings, seating rings, wedge nuts and other trim of corrosion resistant bronze, all as specified.

The valves stem, thrust washers, screws, nuts and other component exposed to the water shall be of a corrosion resistant grade of bronze or stainless steel.

Valve bodies and other components of plastic or other non-metallic materials shall be compatible with the medium and of robust industrial design.

1. **Wedge Gate Valves**

All wedge gate valves, unless otherwise specified shall be of the non-rising spindle type and be in accordance with the relevant clauses of ISO 24512.

Valves shall have good quality cast grey iron bodies, high tensile brass spindles, gun-metal nuts, wedge gates with gun-metal faces and seat, bronze gland bushes and bonnets fitted with soft packing glands. Valves greater that 400 mm diameter shall have detachable bolted covers for inspection, cleaning and flushing purposes.

Valves shall be proved with renewable seats and it shall be possible to remove the gates without removing the valve body from the pipework.

The gate face rings shall be screwed into the gate or alternatively securely pegged over the full circumference.

Unless otherwise detailed on the Contract Drawings, gate valves in chambers, and other similar locations shall be provided with hand wheels. Valves, which are to be buried in the ground, shall be provided with extension spindles, protection tubes, spindle caps, spindle supports and surface boxes.

Valves larger than 400mm diameter and accessible for maintenance shall be fitted with a studded cast iron cover at the bottom of the valve body for inspection, cleaning and flushing purposes.

Where necessary to meet the requirements of Section 2.16.3, gate valves shall be provided with appropriate thrust bearing guides, and /or gearing and /or bypass valves. When reduction gearing is employed, the gear ratio shall not exceed 4:1. Valves of 450 mm diameter and above shall always be provided with reduction gearing for manual operation. Valves of 600 mm diameter and above shall always be provided with a bypass valve.

Each valve shall be tested in accordance with the requirements of ISO 5996 open-ended in each direction.

Where specified, resilient seat type valves shall be provided. The wedge shall have a resilient Nitrile Rubber bonded to the cast iron wedge. The gates of all resilient seal valves of the same size and class shall be completely interchangeable, and be shaped so that the shoulders of the gate seal against the valve bonnet when the gate is fully open. Stem sealing shall be by O-rings, which shall be replaceable under pressure with the gate fully raised.

1. **Butterfly Valves**

Rubber seated butterfly valves shall be airtight when shut-off. Valves shall be suitable for the application/pressures and for mounting in any position and shall comply with BS 5155, for double flanged valves, except where otherwise specified. All bolts, nuts and other fixings, which will be in contact with the contents of the pipelines or, in the case of buried valves within the ground, shall be stainless steel.

Butterfly valves shall be suitable for frequent operated as well as for operation after long periods of idleness in either the open or closed position.

Unless otherwise specified valves shall be hand operated with hand wheels driving through 900 gearboxes.

The valves body shall be cast grey iron, the flanges and hubs for the shaft bearing housing being integrally cast with the valve body.

The disc shall be ductile iron having edges machined with rounded corners and polished to a smooth finish. The valves disc shall rotate through an angle of 90 degrees from the valve opened to the fully closed position where the seating shall be at an angle normal to the axis of the pipe. Adjustable mechanical stops shall be provided to prevent over-travel of the valve disc in both the open and closed positions.

Particular attention shall be given to the pipe work both upstream and downstream of all butterfly valves to ensure that the disc cannot foul the adjacent pipe.

The shaft shall be fabricated of stainless steel. The shaft, disc and mechanical stops shall be capable of absorbing the full operating torque with a minimum design safety factor of five. Shaft seals, when used, shall be rubber 0-ring type. Packing shall be either rubber 0-ring or self-adjusting chevron type.

The valve seat shall be replaceable and formed of nitrile rubber 70/75 IRHD securely clamped into a machined groove in the valve body or to the edge of the disc by seat retention members, or equivalent so as to prevent leakage and to hold the seat securely during operation. The seat retention members shall be of stainless steel and securely clamped with stainless steel fasteners. All fastenings shall be set flush so as to offer the least resistance possible to the flow through the valve.

Valve seats which extend over the face of the flanges to secure the seat in place, or which require surface grinding and/or hand fittings of the disc, or designs which require the adjoining pipe flange to retain the seat in place and resist line pressure, are not acceptable.

Each valve shall be tested in accordance with the requirements of BS 5155 for body, seat and disc strength tests. Seat and disc strength tests shall be carried out in each direction and the valve shall be droptight.

Metal-faced butterfly valves shall generally be as above except.

1. The valves shall have metal to metal seating
2. The valves shall be designed for operation in the partly closed, throttled position, for long periods.
3. The valves shall not be of tight shut-off type and the leakage rate shall not be greater than the following figures: 300 mm - 0.075 l/s; 1200 mm - 0.225 l/s.
4. **Non-Return Valves/ Dual Plate Check Valves**

Non-return valves shall be installed as shown on the Drawings, suitable for the operating condition and where applicable conform to ISO 5996. Long pattern valves shall generally be used.

Dual plate check valves shall possess high speed closing characteristics by use of heavy flaps with external weights where specified but designed for minimum slam condition when closing. They shall be of flanged type suitable for mounting on a horizontal pipeline.

Dual plate check valves shall conform to API 594 and API 598. They shall have resilient sealing. The spring action shall optimise the equal closing rates of each plate especially when the friction coefficients are uneven due to one plate resting upon one another. The plates shall not drag on the seat while opening. The plates shall not vibrate under full or partial flow condition.

The minimum body-wall thickness shall conform to those given in Table 1B of API Standard 594. The face-to-face dimensions of valves (including valves with ring-joint facings) shall conform to those mentioned in Table 2B of API Standard 594.

Flaps shall be fitted with renewable bronze or gunmetal sealing faces, which shall mate accurately with renewable bronze on gunmetal seating rings in the valve body. All seating/seals shall be positively located.

Covers shall be provided to allow ample access for inspection, cleaning and servicing and shall be supplied complete with tapped boss fitted with an air release cock.

Valves greater than 500 mm diameter shall be provided with lifting eyes, feet and jacking screws.

Hinge pins/shafts and internal fixing devices shall be stainless steel. Hinge pins/shaft shall preferable by square in section to ensure positive location of flaps and provide for secure fixings.

For valves with external levers and adjustable balance weight the hinge pins/ shafts shall extend through a renewable sealing gland on the side of the body.

Valves installed on delivery lines at Infiltration galleries shall be of the single door swing type and fitted with heavy-duty external level suitable for back flushing.

Valve body design shall be such that there is adequate clearance around and at the back of the flap to minimize jamming by rags, solid matter, etc. The valve body shall be furnished with a clearly visible cat, forged, machined-in, or die-stamped arrow to indicate the direction of flow through the valve.

Dual plate check valves for potable water shall be free acting type single flap or multiflap with external by-pass and hand operated control valve as necessary. Flaps shall be of design and weight to suit the prevailing hydraulic conditions and shafts shall turn in close fitted low friction bearings.

Each valve shall be tested in accordance with ISO 5996 or if outside the size of this standard to the form as set out in ISO 5996 and to the nominal pressure designation/ test pressure relationship set out therein or 700 kPa for 30 minutes whichever is the greater.

For potable water application where space is at a premium wafer type double flap non-return vales with spring assisted closing may be specified. These valves shall have cast iron bodies and flaps with resilient seats and be fitted with stainless steel hinge pins and springs.

1. **Air Release Valves**

Air valves shall normally be installed at high points in pipework and as shown on the Drawings. The valves shall be capable of exhausting air from pipework automatically when being filled, the air being released at a sufficiently high rate to prevent the restriction of the inflow rate.

The valves shall also automatically release air accumulating in pipework during normal conditions. Air valves shall be designed to prevent premature closure prior to all air having been discharged from the line.

Similarly, the valves shall be capable of ventilating pipework automatically when being emptied, the air inflow rate being sufficiently high to prevent the development of a vacuum in the pipelines.

The material of the body and cover shall be cast grey iron.

Vent-O-Matic Air valves shall be of the double orifice type with a large orifice for ventilation or exhaustion of the pipeline and a smaller orifice for automatic release of air under normal working pressure. The valves shall be suitable for the maximum working pressures in the system and tested for pressure tightness in steps of 200 kPa up to the maximum working pressures and then for mechanical strength at 1.5 times maximum working pressures. All air valves shall be provided with isolating valves and flanged end connections.

The orifice shall be positively sealed in the closed position, but the float (ball) shall only be raised by the water and not by a mixture of air and water spray.

The seating shall be designed to prevent the float sticking after long periods in the closed position.

1. **Pressure Reducing Valves**

Pressure reducing valves shall be of automatic control type whereby fluctuating high inlet pressures are controlled by means of a pilot to lower pre-set outlet pressures regardless of changes in flow rates.

Downstream control pressures are set locally by simple adjustment to the pilot or relay device. An integrated manometer incorporated with the device allows for ease in setting the desired pressure. The control accuracy shall be ± 2.5% of set value.

The valves shall be designed with minimal maintenance and proven reliability with the relay/ pilot device removable without breaking supply for checking, maintenance, or replacement of the component. This shall be by way of isolating cocks or similar arrangement.

Shut-Off is drop tight by full face sealing.

The valve body shall be of high-grade cast iron or ductile iron with all other components of appropriate non-corroding materials. The valve ends shall be flanged.

Cover on valves of 200mm and larger should have two blind tapped holes for lifting eyebolts or similar arrangement for ease in handling.

1. **Pressure Sustaining Valves**

Pressure sustaining valves shall be of the automatic control type whereby the upstream pressure is restricted at the calibration value and the downstream network is supplied if the upstream pressure stays over the calibration value.

Upstream control pressures are set locally by simple adjustment of the screw at the top of the device. An integrated manometer incorporated with the device allows for ease in setting the desired pressure. The control accuracy shall be ± 2.5% of set value.

The valves shall be designed with minimal maintenance and proven reliability. Shut-Off is drop tight by full face sealing.

The valve body shall be of high-grade cast iron or ductile iron with all other components of appropriate non-corroding materials. The valve ends shall be flanged.

Cover on valves of 200mm and larger should have two blind tapped holes for lifting eyebolts or similar arrangement for ease in handling.

1. **Pressure Relief Valves**

Pressure relief valves shall be designed to prevent the pressure in the pipeline immediately upstream of the valve rising above a pre-set value. The valve shall remain closed at lower pressures.

Adjustment of the pressure at which the valve opens to relieve pressure shall be made by screw on the relief valve or by changing weight as appropriate. A pressure gauge indicating upstream pressure shall be incorporated.

1. **Diaphragm Valves**

Diaphragm valves shall be of the straight-through design with minimal flow resistance and glandless construction conforming to requirements of ISO 16138

The valves shall be made up to two durable body parts and the diaphragm, all interchangeable with replacement parts for easy maintenance.

The diaphragm shall be moulded in a reinforced, flexible material of a grade to suit the specified duty and liquid content of the system. In the open state the diaphragm shall lift clear and not obstruct the flow of liquid. The internal surfaces of the valve body shall also be lined with material compatible with diaphragm duty.

Diaphragm valves shall be completely leak tight and suitable for pressures up to 20 bar.

The valves shall be operated by hand wheel unless otherwise specified on the contract Drawings. Hand wheels shall have adequate leverage to give the closure effort required and a facility to lock in any position.

Where indicated on the Drawings diaphragm valves shall be supplied with extended spindles or extensions for pedestals.

1. **Ball Float Valves**

Ball float valves shall be designed for installation on the inlet pipe to a storage tank and shall automatically shut off when the water reaches a predetermined level. They shall be of the single-beat type with balancing piston and direct float and level operation.

Valves shall be designed for a working pressure of 2000 kPa. Valves shall be drop-tight when they are held shut by the floating ball. Valves shall be tested for leakage at 2000 kPa when they shall be drop-tight, and shall be tested for body and valve element strength with the valve closed and a test pressure of 3000 kPa applied to the inlet end.

Valves shall be constructed of mechanite cast iron to ISO 945-1 Grade 220 with gunmetal trim to ISO 6509-2 Grade LG2. The valves shall incorporate rubber faces. The ball float shall be made in tinned copper and the float lever shall be mild steel.

1. **Solenoid-operated Valves**

Solenoid-operated valves shall be of the direct acting type, full bore and balanced. They shall not depend upon pressure differential for their operation.

Valve bodies shall be of cast iron or stainless steel as specified with screwed or flanged ends. Sealing shall be by `O' rings.

Solenoids shall have direct current coils and an integral rectifier for use on a 220 V A.C. supply unless otherwise specified. The coils shall be encapsulated in epoxy resin.

Limit switches with voltage-free changeover contacts shall be provided for remote signalling of open and closed positions.

Enclosures shall have a minimum degree of protection IPW 67 to IEC 60529. A manual mechanical override shall be fitted.

1. **Isolating Cocks**

For isolation of small-bore pipe work tapping for instrumentation equipment, etc., and for individual component isolation, the cocks shall be stainless steel, 0.25 turn ball or plug valves with the operating handle arranged to indicate the open and closed positions. Where specified, means shall be provided for securing the valve body to a front panel or rear surface.

Where corporation cocks are specified, these shall be similar to the above isolating cocks but shall have a detachable key handle for fittings onto a squared operating shaft, the shaft end being marked to indicate the open and closed valve positions.

1. **Penstocks**

All penstocks shall be of the rising type unless otherwise specified and the spindles shall be of adequate size to avoid bucking under load.

All spindle nuts shall be self-aligning and their length shall be not less than twice the spindle diameter.

The top part of the penstock frames shall be sufficiently robust and substantial to prevent the frames bowing and if necessary, additional holding down bolts shall be fitted.

On rectangular penstocks, the inverts shall be flush with renewable synthetic rubber seals on the bottom of the door. The rubber shall be suitable for the application and of an approved type.

Penstocks shall be designed to ensure watertight closure at maximum head encountered in service

Materials of construction shall be as follows:-

Stems and Spindles -Stainless steel

Stem Nuts -Gun metal BS 1400 - LG2

Sealing Faces -Appropriate to the conditions to be encountered in service

Fixing bolts, nuts -Stainless steel & Washers

Simple template shall be supplied as soon as possible after approval of drawings to enable the civil contractor to position the holes for holding down bolts for all penstocks over 1.0 m square.

1. **Extension Spindles and Pedestals**

Extension spindles shall be adequately sized to prevent bucking and shall be attached to the valve/penstock stem by a suitable adapter incorporating two muff couplings, scarf lap jointed and pinned with at least two coupling joints included. Universal joints and waterproof sleeves shall be provided where specified. Extension spindles shall be manufactured from 080M40 (EN 8) steel.

Intermediate bearing support or guide brackets of cast iron, with slotted holed for site adjustment, shall be fitted to long shafts where necessary. Bearings shall be of PTFE or similar approved type.

Penstock and valve pedestals shall be of cast iron or heavy duty, welded, mild steel construction, with a substantial bases and fixing provision. the base and top of the pedestals shall be machined normal to the axis of the drive shaft.

Where necessary, support guide bushes shall be fitted at the base of the pedestal.

The pedestal height shall be such that the hand wheel is approximately

1 metre above the operator's floor level.

Cover of an approved type shall be provided for all rising spindles to totally enclose them when in the fully raised position.

## INSTRUMENTS AND ANCILLARIES

1. **General**

All instruments, gauges, and control equipment, which perform similar duties, shall be of uniform type and manufacture throughout the Works to facilitate ease of maintenance and the stocking of spare parts.

Panel mounted instruments shall have damp-protecting and dust-protecting cases. Instrument mounted outside instrument panels shall have weatherproof and dustproof cases. Instrument cases shall be of corrosion-resistant material or finish. Instrument screws (unless forming part of a magnetic circuit) shall be of brass or bronze. Access to terminal compartments of instruments mounted outside panels or other enclosures shall not expose any working part, moving parts and contacts shall be adequately protected. All shall be as per IP54 and IP55.

Unless otherwise specified, instruments shall be finished in the manufacturer's standard colour. Instrument dials shall be of such materials that no peeling or discoloration will take place with age.

Plant-mounted indicators and gauges shall be sized to give full legibility when viewed from a position with convenient and easy access or from the point at which and operation requiring observation of the gauge is performed. The minimum diameter for any gauge shall be 100 mm except where forming part of standard instruments and accessories such as air sets.

Dials and bezels shall be of bronze and internal components shall be of stainless steel, bronze, or other corrosion-resistant materials.

Equipment mounted in enclosure shall be suitable for continuous operation at the maximum internal temperature possible in service, due account being taken of internally generated heat and heat dissipated by other plant. All components shall be rated adequately, and circuits shall be designed so that changes of component characteristics within the manufacturer's tolerances shall not affect the performance of plant. All equipment shall be designed to operate without artificial cooling. Instruments shall be easily withdrawable from cases without interrupting their circuits.

Equipment provided with anti-condensation heaters shall be capable of operating without damage if the heaters are left on continuously.

Measuring instruments shall have zero and span adjustment.

Instruments not mounted in panels shall be supplied complete with all brackets, stands, supporting steel work and weatherproof enclosures (separate from the instrument cases) necessary for securing them in their working positions and affording complete protection at all times including periods of servicing, adjustment, calibration and maintenance. Instruments mounted in open areas, which could be vandalized, shall be mounted in lockable vandal proof boxes.

1. **Water Meters**

Water meters shall be of the in-line helical vane type conforming to the Class B requirements of ISO 4064-1.

Meters shall have flanged cast SG iron casings to ISO 1083 coated with two-pack epoxy enamel.

The rotors shall be manufactured from polypropylene with stainless steel shafts.

The counter covers shall be provided with a hinged polyacetal or brass cover to protect the counter face from dirt and damage.

The meter shall be flanged to ISO 7005and be supplied complete with a low loss strainer to prevent any large particles in the water from clogging or damaging the meter.

**Electromagnetic Water Meters**

Electromagnetic water meters shall consist of self-contained integrated measuring instrument that determines and displays continuously the volume of water flowing through it by measuring the velocity of water indirectly using external electromagnetic sensors, and conform to ISO 20456, ISO 9104, ISO 6817 - 1980 (1986) for Electromagnetic Flow meters.

The unit shall be capable of withstanding pressure above PN 20 with a protection class of IP67, while maintaining an accuracy of ± 0.5%. Empty pipe detection, flow direction and self-diagnostic features shall be built in features with simple commissioning and calibration.

The data outputs shall be by means of an LCD – indicator, current output, and pulse output, allowing for the reading of cumulative flows and real-time measurement with volumes indicated in cubic meter per hour. It shall be possible to change the units according to the wishes of the operator. The device shall also have a zero-point adjustment.

The power source shall be from mains electricity with electrical protection devices against current surges and spikes. A rechargeable battery pack shall be included so that during power outage, flows can be continually measured for a period of 24 hours. All necessary cabling and protection devices shall be included.

The unit shall be made from non-corrosive material.

The electromagnetic flow meter shall be placed in accordance with the manufacturers recommendations with flange end connections. In addition, the unit shall be placed in a water meter chamber with lockable lid.

1. **Level Meters, Switches, and Indicators**

Level transmitters shall be of the float, pressure bulb, displacer, and diaphragm or air-bubbler types. Float operated transmitters shall have counterweights. Floats and displacers of transmitters and switches shall be of corrosion-resistant materials and shall be coated with epoxy resin.

Level switches of the buoyancy type shall consist of a mercury switch with changeover action enclosed in a non-corrosive material. A balance weight shall also be incorporated in the switch to counteract the buoyancy effect for the specific gravity of the fluid. The connecting cable shall be sealed into the switch.

Buoyancy switches shall be installed with a minimum of two metres of spare connecting cable neatly coiled at a supporting bracket which shall be fitted as shown on the Contract Drawings. The connecting cable fixing shall facilitate any alteration in operating level within the limit of the spare cable referred to above.

Level switches operating on the conductivity principle shall have three electrodes per relay or control unit except where a differential between the "cut-in and cut-out" valves is not required or where two or more relays are associated with the same vessel, when a common "earth" electrode shall be used.

Electrodes for the same vessel shall be mounted on a common plate, which shall be made in section if desirable to facilitate handling. Electrode head shall permit an adjustment in = 45 or = 90 operating levels of not less than 90mm without necessitating cutting or extending electrodes.

Electrodes insulated for most of their length is preferred. The thickness of electrodes and points of intermediate support shall be chosen so that no bending of the electrodes occurs under plant operation conditions. This includes temporary bending.

Relay units operating with level electrodes shall have adjustable sensitivity. Electrodes for use in fluid of low or variable conductivity shall have conductivity discs.

Proprietary level indicators shall be fixed to the external faces of storage tanks and pressure vessels where specified and shown on the Employer's Drawings. The indicators shall be of an approved manufacture. The details of which shall be submitted with the Tender. The indicators shall clearly show the water level within the tank or vessel under all conditions. Floodlighting aiming angles shall be agreed and adjusted on site to ensure that the level indicators are always visible.

1. **Pressure Meters and Switches**

Pressure gauges shall comply with BS 1780. Pressure gauges, transmitters and switches shall have over range protection. No plastic material shall be used in their construction. Internal parts shall be of stainless steel, bronze or approved corrosion-resistant material. Pressure gauges shall have concentric scales.

Where compensation of more than 2% of the instrument span is needed for the difference in level between the instrument and the tapping point, the reading shall be suitablly adjusted and the amount of compensation shall be marked on the dial.

## PAINTING AND PROTECTIVE COATINGS

1. **Paint General**

All paints shall be obtained only from suppliers approved by the Engineer. Unless otherwise agreed by the Engineer, all paints forming part of anyone painting system shall be obtained from the same sources. Paints shall be supplied in sealed containers of not more than 5 litres capacity and shall be used in strict rotation.

All pigment and fillers used in manufacture of paints shall comply with the appropriate British Standards.

Painting specification for specific items are covered in the Particular Specification Clauses.

1. **Painting General**

All items of structural steelwork, mechanical machinery, valves, and pipe work, supplied under the Contract shall be supplied having a metal protection system corresponding to one of the specifications tabulated at the end of this Section.

Preparation, application, and conditions of work shall be in accordance with ISO 12944-9.

1. **Preparation of Surfaces Receiving Paint**

**Preparation of Surfaces Receiving Paint**

Before paint is applied to any surface the appropriate surface preparation, as described in the Contract, shall be carried out in accordance with the following:

* 1. Bare Metal Surfaces
     1. Blast Cleaning

Blast cleaning shall be carried out to a minimum standard of ISO 8504second quality, unless stated elsewhere, using chilled iron grit or shot to grade G17, S17 or finer.

The abrasive used for blasting shall be free from contamination and any recovered materials shall be cleaned to the satisfaction of the Engineer. The maximum amplitude, (peak to trough), of the blast cleaned surface shall not exceed 100 microns. Surfaces shall be protected within four hours of having been blast cleaned.

* + 1. Pickling

Steel shall be pickled by the "Footner" process, as defined in ISO 12944-9, the first priming coat of paint shall be applied as soon as the steel had dried and is still warm.

* + 1. Flame Cleaning

The flame clean surface shall be cleaned of all loosed material. The first priming coat shall be applied while the steel is still warm. The sequence of operation for flame cleaning steelwork shall be planned and controlled to avoid the risk of distortion and buckling.

* + 1. Mechanical Cleaning

Mechanical cleaning shall be carried out by power driven tools such as abrasive grinding discs, chipping hammers or needles guns, followed by steel wire brushing and dusting to remove all loosened material. Excessive burnishing of the metal through prolonged application of rotary wire brushes shall be avoided. Surfaces shall be protected within four hours of having been mechanically cleaned.

Note: Methods of surface preparation utilizing (b), (c), (d) will only be permitted with the written permission of the Engineer.

* 1. Welds and Weld Affected Areas

Unless otherwise described in the Specification, welds and surfaces which have been affected by welding shall be prepared for painting by the same process as described in the Contract for the adjoining metal.

* 1. Painted Surfaces

Painted surfaces shall be cleaned of all dust immediately prior to the application of further paint. Any loose paint and rust shall be removed. Areas contaminated by oil and grease shall be cleaned with white spirit. Where required by the Engineer, the whole surface shall then be cleaned by washing down with a solution of an approved liquid detergent, followed by rinsing with clean fresh water and allowed to dry thoroughly before paint is applied.

**Galvanizing and Metal Coatings**

Surface preparation for the application of metal coatings shall be in accordance with the following British Standards:

* ISO 1461; Hot Dipped Galvanized Coatings
* ISO 14713, ISO 17668; Sheradized Coatings
* ISO 2063, ISO 19207; Part 1 Sprayed Metal Coatings

Sprayed metal coatings, which are subsequently to be painted, shall have a nominal thickness of 100 microns. The nominal local thickness of coatings shall comply with Clause 5 (a) and (b) of BS ISO 2063, ISO 19207; Part 1

All materials and fabricated parts to be galvanized shall be of the full dimensions shown or specified with all welding, punching, cutting, screw tapping, removal of burrs, etc., completed before the galvanizing process commences.

All galvanizing shall be done by the hot-dip process with spelter of which not less than 98% shall be pure zinc. The zinc coating shall be uniform, clean, smooth, and as free from spangle as possible. The zinc coating shall weight not less than 400 g/m2 of area covered and be not less than 0.6 mm in thickness.

No parts likely to come in subsequent contact with oil shall be galvanized. Bolts shall be completely galvanized but the threads of all nuts shall be left un-coated.

All galvanized parts shall be protected from damage to the zinc coating due to poorly ventilated damps conditions and abrasion during the periods of transit, storage, and erection. Damaged areas of the coating shall be cleaned back to bright metal leaving feathered edges of the surrounding galvanized coating and touched up with a zinc-dust paint or other flake metallic compound.

All galvanized parts must be finally protected on site by an approved paint system.

Sampling and testing shall be carried out in accordance with ISO 1461; or ISO 2063, ISO 19207; Part 1, whichever is appropriate. All metal-sprayed steelwork shall be protected within four hours of spraying with one coat of approved etching primer. Where a metal coating is required only on part of an assembled section, it shall be applied before the rest of the section receives its first priming coat.

**Storage of Paint**

The paint shall be stored in sealed containers in a lock-up store where it is not exposed to extreme temperature. The temperature of the store shall be kept between 40 C and 270 C; and special storage conditions recommended by the manufacturer shall also be observed. Paint which has not been used within the "shelf life" period specified on the containers or within 12 months of the date of manufacture, whichever is the lesser shall be replaced. Paint from painter's kettles shall be returned to the store at the end of each working period where it shall be kept in a sealed container. This is not permissible for any two-pack paints such as Epoxy type. Before it is re-issued for use it shall be thoroughly mixed and no fresh paint or thinners shall be added.

**Application of Paint**

Preparation, application, and conditions of work shall be in accordance with ISO 12944,

Brush or airless spray shall be used to apply all primers, undercoats, and finishes, except where otherwise specified.

Consecutive coats shall be in distinct but appropriate shades.

All paint shall be supplied from the store to the painters, ready for application, and addition of thinners or any other material shall be prohibited. Any instructions given by the paint manufacturer shall be strictly followed. All painting shall be carried out by the painters under adequate supervision. Paint shall be applied to the dry surfaces, which have been prepared in accordance with Clause 2.18.3 .

Paint shall not be applied under the following conditions:

* When the ambient temperature falls below 40C or relative humidity rises above 90%
* During rain, snow, fog or mist.
* When condensation has occurred or is likely to occur on the steel

Two-pack paints of epoxy resin type shall not be applied when the temperature falls below 50 C or as required by the paint manufacturers, nor shall it be applied when the temperature is likely to fall below the shall be applied by the method described in the Specification to produce a continuous firm of uniform and even thickness.

As soon as the first priming coat has dried, an extra stripe coat of paint shall be applied by brush, to the edges, corners, crevices, bolt heads, rivet heads and welds, using paints of a similar composition to the priming coat but of a contrasting shade. Successive coats shall have different shades for identification and each coat shall be thoroughly dry before the application of a further coat.

Particular care shall be taken to maintain the full paint thickness at all corners and edge and special attention shall be given to the application of protective coatings after welding.

The total dry paint film thickness of the paint system on the sealed surfaces shall not be less than 275 microns. The dry paint film thickness shall be measured by Elcometer or other instruments approved by the Engineer. In order to obtain the dry film thickness specified, the Contractor should ensure that the coverage rate given by the paint manufacturer would enable this thickness to be obtained. Wet film thickness gauges may be used for checking but shall not be used after the expiration of the 'pot life" stipulated by the manufacturer and the paint of limited "pot life" shall not be mixed with fresh paint or have thinners added to them.

Painted fabricated steelwork which is to be stored prior to erection shall be kept clear of the ground and shall be laid out or stacked in an orderly manner that will ensure that no pools of water or dirt can accumulate on the surface. Suitable packing shall be laid between the stacked materials. Where cover is provided, it shall be ventilated.

Where primer painted steelwork is to be stored out of doors before being over coated shall not be exposed for periods longer than the following:-

Etch Primers nil

Etch primers on metal coatings two weeks

Chromate primer two weeks

Zinc chromate primers two weeks

Zinc rich primer 25/37 microns thick four weeks

**Repairs to Damaged Surfaces**

Areas of paint which have been damaged shall be cleaned to bare metal or metal coating where this has been applied and the edges of the undamaged paint bevelled with sand paper. Where a metal coating has been damaged, the affected areas shall be rubbed down to remove excessive rust, cleaned and an additional coat of an approved primer applied. The full-specified painting system shall then be re-applied and new paint shall overlap the existing paint by at least 50 mm all-round the affected part.

**Painting of Existing and Previously Painted Surfaces**

In general, all surfaces shall be suitable prepared by cleaning, abrading, and degreasing, etc., and may be repainted with the finishing systems as detailed in Section 2.18.18. Decorative paints such as Deluxe Trade Gloss Finish or similar type finishes may be applied to clean, dry, and well-prepared surface direct without primer, etc.

Exposed surfaces should be primed and brought forward in the normal manner, i.e.: prime where necessary followed by undercoat and gloss finish as detailed in Section 2.18.18, but sound surfaces may in general be recoated with the finishing paints only. Where two pack materials have been used and where adhesion of the new paint may be difficult, the weakness in adhesion may be overcome with the use of an etch primer. An etch primer such as Deluxe Primer S68 can be used in most applications. Care should be taken to avoid over application of this primer since this can create additional problems.

**Paint Specifications**

The Contractor shall give full details of the preparation, type of materials, methods, and sequences he proposes to use to comply with the requirements for the protection of the Plant. In the case of materials,, he shall submit details of the basic raw materials sources, volatile matter content, nature of solvent number of constituents including the percentage of epoxy resin, type of application, coverage, time interval between coats, recommended number of coats, toxic properties, shelf life and details of 'patch' repairing.

For epoxy-based paints the total percentage of epoxy resin in the dry film shall not be less than 25 per cent.

No thinner shall be used unless approved by the Paint Manufacturer. To prevent loss of adhesion and solvent entrapment the Paint Manufacturer's instructions shall be rigidly followed particularly with respect to the minimum and maximum periods between coats and the permissible temperature and humidity range for application.

The Contractor shall submit for review an overall colour scheme for the exposed surfaces of all Plant. All final coats shall be in the colours thus approved.

Protection During Transportation

All Plant shall receive adequate protection in the workshop or factory to ensure that metals is not affected by corrosion during transportation, loading and off-loading, storage, and site erection.

The Contractor shall supply full details of the extent to which blasting, metal spraying and painting will be carried out in his supplier's workshop, on the site of the work prior to erection or in-situ after erection. If it is decided to carry out the bulk of the painting on the site of the work, a properly equipped painting shop shall be set out using a specialist organization, experienced and skilled in the preparation of surfaces and the application of protective coatings under the prevailing conditions.

**Parts Built into Concrete**

Cast iron or mild steel parts to be built into concrete over a depth of 75mm shall remain unpainted. Immediately before it is cast in situ it shall be made perfectly free from dirt, scale, loose rust, paint, oil, lime wash or any other coating.

**Inspection and Tests**

The Plant shall be inspected and reviewed at the various stages of the coating application both at the Manufacturer's Works and at the site of the work. Samples may be taken from the paints as delivered and submitted to such tests as are deemed necessary. The completed paint systems shall be tested by instruments to ensure that the protection is of adequate thickness and is free from pinholes and the adhesion shall be checked by the removal of a small section of the coating. The Contractor shall supply all instruments and apparatus required for carrying out such tests.

**Corrosion Resistant Materials**

No blast cleaning or painting shall be applied to corrosion resistant materials such as stainless steels, Ni-resistant cast iron, bronze and other metals used for seals, bearings, lighting fittings, etc.

**Box and Tubular Sections**

Box and tubular section shall be permanently sealed. All such sections shall be thoroughly dried out using hot dry air before final sealing and painting is carried out. After sealing all sections shall be tested for air tightness.

**Machined Surfaces.**

Machined surfaces such as gear-teeth shall be coated with a thick layer of grease. Other machined surfaces such as shaft ends, deep plates and other bright parts shall be coated with two coats of an anti-rust solution, which can be removed easily when required. Permanently bolted-machined interfaces such as flanges shall be coated with a thin coat of anti-rust compound before assembly.

**Manufacturer's Standards Finishes**

Where it is the usual practice of the manufacturer of items such as pumps, electric motors, switchgear, control panels and similar Plant, to apply a high standard of protective paintwork in the shop before dispatch this will normally be acceptable provided that such standard finishes are at least equal to the surface finish specified.

Full details of such manufacturer's standard finishes shall be given to the Engineer for his approval prior to manufacture. Special care shall be taken to ensure that standard finishes are suitable for the particular conditions applicable to the individual items of Plant.

**Switchboards**

The interiors of control panels switchboards and switchgear, shall be finished with white enamel paint (two coats) and shall comply with the appropriate ISO for enamel finish and the exteriors of such panels shall be to ISO 87.040colour 00 A 05 (mid grey) to give a minimum reflection value of 42%. Instruments shall be finished dull black and control handles, push buttons and similar fittings shall be chromium plated or otherwise durable finished to the approval of the Engineer.

**Paint Systems**

The following paint system shall be used for the items of Plant listed.

The coatings are defined in accordance with ISO 12944: 1977 "Code of practice for Protective coating of Iron and Steel Structures Against Corrosion "and systems shall be designed to give a maintenance free period of between ten and twenty year.

System P1

USES: Any immersed, wetted or buried steelwork.

PREPARATION: Abrasive blast clean to B.S. Second Quality

PAINTING

Painting shall correspond to ISO 12944SKB with an additional primer coat.

1. Apply two-pack zinc phosphate primer (KP 1A) single coat to 70 micron D.F.T.
2. Apply three coats of two-pack coal tar epoxy (KF 3A) to a total D.F.T. of 450 microns. Final colour black.

System P2

USES: Steelwork exposed to weather.

PREPARATION: Abrasive blast clean to B.S. Second Quality

PAINTING

Painting shall correspond to ISO 12944SL5

1. Apply two-pack zinc phosphate primer (KP 1A) single coat to 70 micron D.F.T.
2. Apply three coats of two-pack coal tar epoxy (KF 3A) to a total D.F.T. of 450 microns. Final colour black.

System P3

USES: Steelwork exposed to weather.

PREPARATION: Abrasive blast clean to B.S. Second Quality

PAINTING

Painting shall correspond to ISO 12944BS 5493 SLS

1. Apply two coats of two-pack epoxy zinc phosphate primer (KP 1A) to total D.F.T of 140 microns.
2. Apply two coats of two-pack epoxy undercoat (KU 1B) to total D.F.T. of 200 microns.
3. Apply one coat of chlorinated rubber finishing coat (HF 1D) to 100 microns D.F.T.

Alternatively, the finishing coat could be two-pack polyurethane (KF 2D) to 100 microns D.F.T. in accordance with ISO 12944. SK4 painting system. Final coat shall be a colour in accordance with ISO 87.040 and approved by the Engineer.

Systems P4

USES: Internal plant and pipework, cranes within pump houses and miscellaneous steelwork not exposed to weather.

PREPARATION: Abrasive blast clean to B.S. Second Quality

PAINTING

Painting shall correspond to ISO 12944SF5.

1. Apply two coats of two-pack epoxy zinc phosphate primer (KP 1A) to total D.F.T. of 140 micron.
2. Apply one coat Alkyd undercoat (FU 2A) to 35 micron D.F.T.
3. Apply two coats Alkyd finishing coat (FF 3B) 70 micron D.F.T
4. Apply two coats Alkyd topcoat (FF 3B) to 70 micron total D.F.T

Final coat shall be a colour in accordance with ISO 87.040 and approved by the Engineer.

System P5

USES: Buried steel pipe work prior to the application of pipe wrap.

PREPARATION: Abrasive blast clean to B.S. Second Quality

PAINTING

1. Apply single coat of two-pack epoxy zinc phosphate primer (KP 1A) to 70 micron D.F.T.
2. Apply single coat of two-pack coal tar epoxy (KF 3A) to 150 micron D.F.T.

Final colour black.

System P6

USES: Hand railing, steelwork, etc., which has been galvanized.

PREPARATIN: Degrease and wash surface

PAINTING

Painting shall correspond to ISO 12944SF8 after suitable pre-treatment.

1. Apply pre-treatment primer in accordance with Clause 11.3.2 of ISO 12944
2. Apply two coats Alkyd Primer (FP 3A) to 70 micron D.F.T
3. Apply two coats Alkyd undercoat (FU 2A) to 70 micron total D.F.T.
4. Apply two coats Alkyd topcoat (FF 3B) to 70 micron total D.F.T.

Final colour shall be in accordance with ISO 87.040 and approved by the Engineer.

Systems P7

USES: Internal surfaces of Pipes, valves and fittings,

PREPARATION: Abrasive blast clean to B.S. Second Quality

PAINTING

1. Apply single coat of two-pack epoxy zinc phosphate primer (KP 1A) to 70 micron D.F.T
2. Apply two coats of two-pack epoxy (KF 3A) to 300 micron D.F.T Epoxy to be approved for use with potable water.

**Wrapping of Buried Pipe work**

All buried steel pipes and fittings shall be coated and wrapped with a cold applied self-adhesive pipe wrap. Comprised of an extruded, heavy, highly conformable thick PVC carrier combined with a layer of rubber rich tropical grade bituminous compound.

Minimum thickness of PVC shall not be less than 0.76 mm with total thickness of wrap not less than 1.65 mm.

Minimum physical characteristics of wrap to be:

Tensile strength 13.6 Mpa

Elongation 230%

Tear resistance 47 N force

Impact strength 7.2 Joules

Adhesion to ASTM D1000

(1800 Peel) 3.7 N/cm

Dielectric Strength 20,000 V min.

Operating temperature 200C-750C

Insulation resistance 1,000,000 megaohms

All pipes shall be prepared in accordance with system P4 (Clause 2.18.18).

The dry, primed pipe lengths shall be spirally wrapped with the specified tape wrap using 150 mm wide tape and 25mm minimum overlap during application. Sufficient tension shall be applied to ensure complete conformity of the tap to the pipe. The spigot end of the pipe shall be left unwrapped for a minimum distance of 150 mm to allow for engagement.

All field joints shall be wrapped after pipe laying and testing. Any exposed metal surfaces and the existing coating shall be cleaned and primed as stated previously. The tape wrap shall then be applied to the prepared joint area overlapping the pipe barrel wrapping a minimum distance of 75 mm using 100mm width of tape applied with a 50mm overlap. Sufficient tension shall be applied during application so as to ensure complete conformity of the wrap to the joint area.

End laps between adjoining rolls shall be a minimum of 150mm.

**Chemical Plant**

**General**

All chemical plant and equipment shall be non-corrodible for the conditions in which it is being used.

The Contractor shall provide glass reinforced chemical mixing tanks. and any necessary GRP protective lining to prevent chemical attack on concrete tanks.

**Chemical Dosing Pumps**

Chemical dosing shall be by means of electrically driven metering pumps, or gravity solution feeders unless otherwise stated in the Specification or on the Drawings.

The metering pumps shall be manually adjustable and shall be calibrated to allow setting at the required dosage. Dosing adjustment shall be possible while pumps are running. The metering pumps shall have an accurate dosing range down to 10% of their maximum output. Metering pumps shall be provided with dosage charts or tables in an approved durable material suitable for wall mounting.

Metering pumps shall be of the mechanical diaphragm type with a repeatable accuracy of less than 5 per cent. Output shall be adjustable through a stepless variable stroke mechanism. Materials in contact with the liquid shall be polypropylene or stainless steel. Diaphragm materials shall be buty1 or PTFE. Bedplates shall be protected from gland drip. The pumps shall be driven by close-coupled motors with reduction gears and cam mechanisms housed in an enclosed oil bath.

Gravity solution feeders shall comprise a constant level tank with a float controlled inlet valve, and outlet regulation orifice discharging to atmosphere and into the inlet of the pipe delivering the solution to the dosing point. The regulating orifice shall be either of the fixed orifice type through which the output can be adjusted by varying its height relative to the liquid level in the constant level tank, or an orifice with discharge area varied by a tapered needle. In both cases the orifice shall always be drowned to avoid blockage through crystallization. Materials in contact with the liquid shall be stainless steel, rubber, PVC, polypropylene, or PTFE.

**Chemical Dosing Pipe work**

Chemical dosing pipe work and valves shall be of uPVC or polyethylene unless otherwise required in the Particular Specification. Where possible all pipe work shall be routed so that it can be fixed to walls. Where possible all pipe work shall be routed so that it can be fixed to walls. Rigid pipe work, including uPVC, shall be fixed to walls and in ducts using clamps or brackets spaced at such intervals so as not to cause noticeable sagging in the pipe work between supports. Flexible pipe work shall be laid on galvanized mild steel (GMS) cable tray securely fixed to walls. Pipe work spanning between walls shall also be supported by GMS cable tray. Adequate drainage and flushing points shall be provided on chemical dosing pipe work.

**Mechanical Mixers**

Mixers for preparing chemical solutions or slurries shall be of the electrically driven propeller type suitable for permanent mounting in a vertical position. The mixers shall be sized to agitate the whole contents of the mixing tank to dissolve the chemical concerned within a reasonable time, or to prevent any settlement in tanks containing slurries. The mixers shall be driven by close-coupled motor with gears housed in an enclosed oil bath. Bearings shall be sealed against ingress of dust. The shafts and propellers shall be of stainless steel.

**GRP Lining**

Glass-fibre reinforced polyester (GRP) lining to concrete tanks shall be applied using the wet lay-up process. The lining shall have a minimum thickness of 3 mm and have a glass content of chopped strand mat of not less than 30%. It shall be finished with a resin rich surface layer containing binding tissue.

The polyester resin shall be commercial grade inert to aluminium sulphate solution and shall comply with the minimum requirements of ISO 3672-2. Fillers shall not be permitted.

Reinforcing materials shall be a suitable grade of glass-fibre having a glass finish compatible with the resin used and complying with the relevant requirements of ISO 3672-2. Fillers shall not be permitted.

Reinforcing materials shall be a suitable grade of glass-fibre having a glass finish compatible with the resin used and complying with the relevant requirements of ISO 26262 and ISO 14130, ISO 15039, ISO 1887, ISO 9163, ISO 3597

The concrete surface shall be thoroughly cleaned and dried before the GRP is applied. The reinforced material shall be overlapped by not less than 50mm. The final surface of the lining shall be finished smooth and free from crazing and cracks; and defects shall be ground and repaired by a method agreed by the Engineer's Representative.

**Floor Trench Covers, Chequer Plating and Egg Crate Flooring**

Unless otherwise specified, pipes and cable are to be laid in ducts below the finished floor level. The ducts shall be covered with steel plates with diamond chequering or other approved non-slip pattern, or with egg crate flooring. The plates or flooring sections shall be of sufficient thickness not to bend or spring in ordinary usage and shall fit evenly and truly into steel angle frames or kerbing with suitable attachment for building into the concrete floor.

The Contractor shall supply complete drawings showing the arrangement of trenches, chequer plates and egg crate flooring section, fully dimensioned so that the trenches can be formed and the kerbs built into the floor by the civil works contractor. The plates and flooring sections shall be divided into suitable sizes and lengths for lifting, with two holes in each section. One set of lifting keys shall also be supplied at each location.

**Foundation Bolts and Fixing Arrangements**

All foundation bolts and fixing bolts required to secure the items to be supplied and erected under this contract shall be provided.

The Contractor shall provide, within the time (s) specified, dimensioned foundation drawings showing the type of foundation or fixing required for each item of plant. The contractor shall state the mechanical strength of large fixing bolts, which shall be of an approved size and diameter. Galvanized where not embedded in concrete, with galvanized nuts and washers.

**Brackets, Fixings, Anchor Points and Pipe and Valve Supports**

All bracket, hangers and fixings, anchor points and supports for the satisfactory installation of all pipe work, valves and other equipment shall be supplied and erected. The supports shall prevent excessive movement of the pipe work and eliminate extraneous stress on pump casings and other items of plant.

Where pipe and valve supports or anchors at attached to structures, the loadings imposed at the points of attachment shall be stated by the Contractor on submission of the relevant foundation drawings and approved by the Engineer.

All necessary nuts, bolts and washers for such fixings shall be included.

**Guarding and Protection of Moving Parts**

Moving parts of machinery including all shafts, couplings, collars, projecting key heads, gear wheels, belt drives, chain drives and all other moving machinery shall be guarded where necessary to give complete protection to operating personnel. All setscrews on revolving shafts shall be countersunk or suitably protected. Guards shall be of an approved design, fitted where necessary with inspection doors. All guards shall be arranged so that they can be removed without disturbing the parts of the equipment they protect. Guards for shaft couplings shall at least be equal to ISO 20474

**Schedule of Test**

**General**

This Section is to be read in conjunction with the details contained within the Specification, in particular Section 1.26.

As many tests as possible shall be arranged together. Five copies of the Contractor's records of all tests shall be furnished to the Engineer.

All material which is specified for tests at the manufacturer's works must satisfactorily pass such tests before being painted or otherwise coated.

All test instruments, fuels and consumables required for the tests, commissioning and setting to work the Plant shall be supplied by the Contractor. Test instruments and tools shall be to approval and shall be calibrated by a competent authority as may be approved by the Engineer.

**Tests at Manufacturer's Works**

The mechanical equipment supplied under this Contract will be tested to prove compliance with the requirement of this Specification and with the relevant British Standard specification where applicable.

1. **Tests After Erection on Site**

All Plant shall pass such tests on site as are required by the Engineer to prove compliance with the Contract independently of any tests, which may already have been carried out at the Manufacturer's Works. In particular, all pump performance tests made at the Manufacturer's Works shall be repeated on site.

If, in the opinion of the Engineer, the Plant does not comply with this specification, the defect shall be rectified at no cost to the Employer.

## STANDBY POWER GENERATING PLANT

1. **General**

The diesel generating sets shall consist of diesel engines and alternators mounted together on common base plates. They shall be suitable for continuous duty of twenty-four (24) hours per day, for operation under the climatic conditions and altitude as set out in the Particular Technical Specification, and shall be running at 1,500 rpm.

The generating set shall be capable of delivering continuously 110% of its rated output for one hour in every twelve (12) hours, without any part impaired.

The Plant shall be designed to operate continuously in ambient temperature of up to 50°C (indoor conditions). They will be located indoors with canopy protection.

1. **Engines**

Engines shall be industrial four stroke, water cooled, direct injection machines and shall operate at not more than 1,500 rpm. Standardization of types is required such that all machines of the same output shall be from the same manufacturer. Where the requirement is for machines of different sizes, every attempt shall be made to supply machines from the same manufacturer which share many components in common.

The site rating of the engine shall be calculated in accordance with BS 5514 and shall have an inherent overload capacity of 10% for 1 hour in every 12 hours. The engine shall be capable of operating at full load for a minimum of 500 hours without attention to filters or injectors, and for 15,000 hours between major overhauls.

An automatic speed governor complying with class A2 of BS 5514 Al (ISO 3046) shall be fitted. Facilities shall be provided to manually trim the engine speed by ± 5%. An independently acting, shaft driven over-speed device shall be fitted to trip the set at 120% of the rated speed. The device shall require resetting by hand before the engine can be re-started.

Engines driving generators of 2 MVA or less shall be started and controlled using 12/24 V (as applicable) supply from heavy-duty lead acid batteries. The engine starter motor shall be of the reselect type and the batteries sized to give six 30 second consecutive starts of the engine at an ambient temperature of 0°C. The sets shall be provided with trickle chargers as well to allow for charging of the batteries when the standby generators are not running. For small generators (up to 250 kW) the batteries may be set–mounted. For larger sets the batteries shall be separately mounted. A charging dynamo with automatic cut out, voltage regulator, ammeter, and all necessary cables shall be provided. The engine shall be provided with a contact (starting) key.

The engine lubrication system shall be of the closed circuit wet-sump forced feed type supplied by an engine-driven pump. The pump shall be fitted with pressure regulating and relief valves, sump suction filter and renewable micro-felt flow line filter.

In the case of water-cooled engines, the engines cooling system shall be by means of a heavy-duty air blast radiator, mounted on the generator base plate, together with an engine driven fan and water circulating pump(s). A thermostatically operated bypass valve shall be fitted in the cooling system to maintain an optimum operating temperature during starting and running conditions. The radiator cooling air shall be exhausted to the atmosphere via a louvered opening and a bellows connection to the radiator. A further louvered opening shall be provided to supply cooling and charge air.

A charge air intake filter (or filters) shall be fitted. This shall be of the heavy duty type to BS 1701 and shall be suitable for operation in a dust laden atmosphere. Where the engine is turbo-charged, the filter shall be of dry filter.

The engine shall be capable of operating with fuels complying with clause A, B1 and B2 of BS 2869. The fuel feed shall be via a fuel filter of the fine steel wire mesh type.

Cyclic irregularity of the engine/alternator combination shall not exceed that specified in BS 5514 Al (ISO 3046).

1. **Alternators**

The alternator shall provide 3 phase, 415 V, 50 Hz output and shall be suitable for operating under load conditions with a power factor of 0.85 lagging.

The alternator shall be of the salient pole, revolving field, brushless, self-regulating type and shall be three phase. The unit shall be manufactured in accordance with BS 4999 and shall be continuously rated and capable of withstanding a 10% overload for 1 hour in every 12-hour period. The unit shall additionally withstand a short circuit rating that an equivalent transformer can be able to withstand for not less than 3 seconds according to IEEE or Uganda Power regulations.

The alternator shall conform to BS 5000 part 99, shall be tropically finished and insulated with class F insulating materials, complying with BS 2757.

The alternator shall be capable of supplying an unbalanced load where the current of the highest loaded phase exceeds that of the lowest loaded by 40%.

The winding insulation shall be to class H, but the machine shall be designed to limit conductor temperatures to class B. The machine shall be designed to operate continuously in ambient temperatures up to 500C.

The exciter shall be of the revolving armature type with the armature overhung on a shaft extension at the non-driving end. The output of the exciter shall be rectified by a rotating silicon diode rectifier bridge to supply the main generator field windings. The exciter field shall be controlled through automatic voltage regulation (AVR)

The machine shall be protected to IP55 with open circuit air-cooling. The air ducts shall be designed to reject falling drops of water, and they shall be fitted with grills to keep out vermin.

An anti-condensation heater shall be provided where temperatures normally fall below 10 degrees Celsius even if only occasionally and this shall be energized automatically when the generator is out of service and the ambient temperature reaches the prescribed limit.

The alternator shall be equipped with a static voltage regulator and brushless excitation, holding voltage within a maximum deviation of 2.5% from nominal value, between no-load and full load conditions.

The maximum instantaneous voltage drops during maximum load conditions, when starting the largest motor, shall not exceed 5% of the nominal voltage. This requirement must be strictly observed and the successful starting warranted.

The alternators shall be effectively cooled by open forced air ventilation. The ventilation openings shall be screened against ingress of small insects and rodents.

All rotating components shall be properly, statically, and dynamically, balanced.

Alternator bearings shall preferably be of the cartridge type, preventing contamination by dirt or moisture when the alternator is dismantled. The bearings shall be grease lubricated. Easily accessible nipples for re-greasing shall be provided.

All bearings shall be liberally rated to ensure average life rating of not less than five (5) years of continuous operation.

The alternator shaft shall be directly coupled to the diesel engine via a flexible coupling.

1. **Control Panel**

The control panel shall be constructed to BS 5486 with a rating of not less than IP 55. In the case of small generators (up to approximately 250 kW), the control panel may be mounted on the set itself, but for larger sets the control panel shall be separately mounted. Where the panel is separately mounted it may be necessary for some direct reading gauges to remain set-mounted. In this case, the instruments shall be mounted together on a panel fixed to the set, but where they generate alarms or other electrical signals these shall be transmitted to the separately mounted control panel.

The control panel shall contain the following items:

* On/off switch for control circuitry
* Engine stop/start push buttons
* Emergency stop push button with twist reset
* Combined frequency /RPM meter
* Oil pressure gauge
* Water (or oil) temperature gauge
* Ammeter for each phase (Ammeter with selector switch)
* Voltmeter and phase selection switch
* DC ammeter (battery starting/charging current)
* DC voltmeter (battery volts)
* Indicator lamps for:
* Low oil pressure
* High water (or oil) temperature
* Over speed
* Hours run meter
* Off/auto anti-condensation heater switch

In the case of a generator with electric starting, consideration shall be given, when selecting the relays and other electromagnetic devices in the control system, to the voltage drop which occurs during operation of the starter motor.

All control panels shall be complete with a mains powered battery charger and battery. In the case of an electric starting generator the battery shall be the starting battery and shall be rated accordingly.

1. **Exhaust Systems for Diesel Engines**

The exhaust system shall incorporate silencers suitable for use in an industrial area and shall include all necessary supports and other items to make a complete installation. Exhaust tubing shall be heavy gauge mild steel to BS 3600, and shall include a stainless steel bellows close to the engine to reduce vibration and permit engine movement.

The system shall be suspended from the walls and roof by suitable brackets and angle ties which shall include mountings to prevent the transmission of vibration and noise to the building.

The system shall be adequately lagged and fixed within the building. Where the roof is of combustible material and the walls of the building are of incombustible material, the exhaust shall be routed to atmosphere through the wall rather than the roof. Where both the walls and roof are of combustible material, special care shall be taken to protect the building from the exhaust piping and the hot gases discharged from it.

The exhaust system outlet section shall be horizontal and where possible it shall point in the direction of the prevailing wind.

1. **Daily Service Tank**

A daily service fuel tank holding sufficient fuel for twelve (12) hours operation at full load shall be provided for each generator. In the case of a small generator (up to 250 kW) the tank may be set mounted, but for larger machines the tank shall be mounted on a frame. Fuel supply to the generator shall be by gravity.

The tank shall be constructed in mild steel and the fittings in materials other than:

Yellow brass, including low grade alloys of copper and zinc

* Lead and zinc
* Galvanized metals
* Natural rubber

The tank shall be complete with the following fittings:

* Local indication of fuel level, to be provided at a position where it can be easily read during fuel delivery.
* Drain pipe situated at the lowest point in the tank, complete with isolating valve.
* Outlet pipe complete with water trap and isolating valve.
* Filling point at the top of the tank with removable gauze filter.
* Vent pipe. This shall be routed to atmosphere with a continuous rise from the tank and shall be terminated with an inverted ‘U’ bend and vermin screen.
* Bund wall with the envelope having sufficient volume to contain the whole content of the tank.

The tank shall have an ullage volume above the normal maximum contents level of the tank of not less than 5% of the maximum volume of the tank.

The vent pipe shall be located not less than 50 mm above the highest possible fuel level.

1. **Protections**

The generating set shall be shut-down in case of:

* Low oil pressure.
* High water or oil temperature.
* Over-speed.
* Phase imbalance above the specified
  + - - Loss of phase
    - - Over/Under Voltage.
    - - High fuel differential pressure.
    - - High exhaust temperature.
    - - High differential temperature between cylinders exceeding 50 degrees Celsius.

1. **Tests**
2. **Factory Tests**

The generating sets shall be tested in the presence of the Engineer;s representative fully loaded, in the factory, and relevant test certificates signed by the manufacturer and the Engineer’s representative shall be submitted. The alternators shall be tested in accordance with BS 5000 part 99. Special attention must be paid to starting capacity where it is required to be higher than twice alternator rating.

The diesel engines shall be tested individually for output, fuel consumption and general performance in accordance with BS 5514.

All ancillaries of the diesel engine shall be coupled up and run through the test.

The fuel used for testing shall be of the same type and class as recommended for regular operation.

Each test shall include one (1) hour of operation at 10% overload, following a period of full load running, to ensure that the engine is mechanically sound and vibration free. Vibration of the diesel engine shall be observed, measured, and indicated on the Test Certificate.

Fuel consumption at steady conditions and full load shall be tested and recorded. In any case fuel consumption shall not exceed 0.25kg/kWH.

Governor tests shall be carried out for the engine to ensure its compliance with BS 5514 part 4.

The generator so secured for this project must have a local representative agent with capacity to attend to emergency repairs and well stocked spare parts shop for at least one year prior to the tender being floated. This the bidder will have to demonstrate through appropriate licenses unless it is a well known service provider.

1. **Site Tests after Installation**

Site test shall be carried out in accordance with Clause A-15.The tests will be witnessed by Employer’s, Project Manager’s/ Engineer’s and Contractor’s representatives.

1. **Spare Parts**

The Supplier shall submit with his Bid a price list of spare parts reasonably required for a period of two years of operation under normal routine maintenance. Spare parts critical to the maintenance of the gen-set shall be specially marked on the list submitted.

The spare parts to be procured shall be determined by the Project Manager. The Supplier should prove his ability to promptly supply spare parts as may be needed at any time within the expected life of the equipment.

1. **Guarantee**

A comprehensive guarantee of twelve (12) months is required.

1. **Technical Documentation**

A technical book shall be handed over with the generating set. It will include description, operation instructions, maintenance instructions with trouble-shooting (fault finding) details, electrical diagrams, drawings with identification numbers of parts, and parts identification lists.

1. **Surge Analysis and Surge Vessel**

The Contractor shall carry out the analysis, design, supply & construction and installation of surge protection devices.

The surge control equipment, wherever installed shall be capable to withstand the Total working pressure and the expected residual surge pressure at the point of installation. Adequate care must be taken to ensure that the equipment installed will not unbalance the general hydraulic conditions in routine. The surge control system shall be designed so as to ensure that the maximum operating pressure at every point in the pipeline is less than 1.1 times the working pressure.

The detailed designs and drawings shall be submitted for the approval of the Engineer. No supply, construction and installation work shall be taken up without prior approval of the Engineer.

The surge pressure vessel shall be designed and constructed to ISO 3834, ISO 14731 or equivalent, constructed category 1, 2 or 3 post weld heat treated and with a corrosion allowance of 2 mm or according to manufacturer’s specifications. Tile vessel shall be cylindrical, carbon steel, fusion welded with domed ends and mounted vertically on steel supports. The vessel shall be provided complete including the following fittings as minimum requirements but to fit the manufacturer’s specifications:

(a) Access cover with opening not less than 500 mm in diameter; according to manufacturer’s recommendations.

(b) Water inlet / outlet branch flanged to ISO 7005 or equivalent with isolation valve, dismantling joint and all necessary accessories.

(c) 100mm dia. drain branch with gunmetal valve and hand wheel with drain pipe work discharging to drainage channel.

(d) Spring loaded gunmetal safety valve.

(e) 150mm dia. pressure gauge complete with gunmetal isolating cock.

(f) Magnetic water level indicator with isolating valves.

(g) Air inlet fitting incorporating an air release valve and isolating and non-return valves.

(h) Lifting lugs.

(i) Name plate giving vessel details.

(j) Access ladder.

(k) Isolating valve with gearing and hand wheel and all necessary bends and fittings.

1. **Air Compressor**

Each compressor (duty/standby) shall be oil less air-cooled type, suitable for outdoor installation, capable to charge the pressure vessel from full of water in approximately 10 minutes or as recommended by the surge vessel supplier, directly or indirectly driven by an electric motor, control panel for start-stop and controlling the air compressors and maintain the pressure in the air receiver, complete with base plates and weather proof shade canopy.

The compressor performance shall be in accordance with ISO 1217 or equivalent for the site condition and duty cycle specified and shall include the following components but not limited to:

(a) Heavy Duty suction air filter/silencer

(b) Solenoid operated un-loader valve

(c) Pressure relief valve

(d) Non-return valve

(e) Isolating valve

(f) Protective guard between motor and compressor.

(g) The pipe work between the air compressors and the surge vessels shall be of HDG steel pipe. And shall be suitably coated and wrapped as necessary.

Where necessary, depending on load factor, the compressor shall include cylinder jacket and after cooler facilities for cooling the delivered air, the after cooler having a suitable pressure relief valve and automatic drain valve.

1. **Air Receiver**

The compressor shall deliver air into an air receiver manufactured in accordance with BS 487 Class III Grade E or F or equivalent, of a capacity recommended by the manufacturer, to accommodate the specified design pressure and internal volume.

The receiver shall incorporate the following items:

a) One safety relief valve.

b) One automatic drain valve.

c) One hand drain valve.

d) One pressure gauge (0-30 bar).

e) Pressure and temperature switches to suit the control.

f) Inspection access to permit internal examination of the receiver.

g) 'Lifting facilities as determined by low ambient temperature areas to minimize condensation and the inlet and outlet pipe connections shall be arranged to promote air circulation.

1. **Separators**

The air distribution main shall include a separator designed to remove suspended moisture in the air main.

1. **Compressed Air Filters**

The air supply shall incorporate filters of the disposable element type as near as possible to the point of use.

Filtration shall be carried out using two filters in series and another two in parallel for maintenance purposes, the first filter graded for course filtration and the second for fine filtration as defined in the Specific Requirements. The compressor shall incorporate air filters in the suction side.

1. **Drain Traps / Strainers**

Automatic drain traps shall be provided for air receivers, filters, and separators. Strainers shall be provided for protection of the drain traps. Ball traps shall have cast iron bodies with stainless steel internal parts.

1. **Air Pressure Control**

Control equipment to provide fully automatic control of the compressor from the magnetic water level in the surge vessel. A time delay shall be incorporated to prevent operation of the compressor during water level changes under surge conditions and a push button feature shall be provided for manual test of the system. The control equipment shall be housed in a wall mounted panel fabricated from mild steel to form a rigid box construction of neat appearance providing an enclosure to IP54.

The compressor shall be arranged to maintain the air pressure in the system within the specified limits by means of pressure switches in conjunction with unloader valves and timers to prevent prolonged off-load running.

The frequency of starting and stopping shall be within the limitations of the drive arrangement.

Where two compressors are operated on a duty/standby basis, the duty compressor shall operate whenever the low-pressure switch closes and shall cease operation when the high pressure switch opens. The duty cycle will be automatically cyclic so no compressor remains duty forever. Duty change of daily weekly or monthly cycle will ber agreed with the Engineer and client before construction of the panel.

Should the pressure fall to the standby low pressure, the standby compressor shall operate in conjunction with the duty compressor and shall similarly cease operation when the high- pressure switch opens.

The circuits for the compressor motor starters shall be completely separate. Either unit shall be capable of duty or standby operation and periodically their modes will be reversed.

The contractor shall supply all cabling between the switchboard and the control panel, between the control panel and the compressors, between the control panel and the level electrodes on the surge vessels and earthing of all equipment.

1. **Painting AND Corrosion Protection**

Corrosion protection shall be as specified in Section 2.18 – Painting and Corrosion Protection for the hydro-mechanical equipment.

Decorative colours shall be in accordance with the Code numbers shown in BS 381C and SABS 1091, SABS 1200 HC as applicable, or as directed by the Engineer.

1. **Tests on Completion.**

The Tests on Completion of mechanical plant shall consist of:

a) First stage, or dry testing, which the Contractor shall commence without undue delay upon completion of erection.

b) Second stage, or wet testing, which shall take place as soon as practical after the completion of the entire works.

Installation of all Plant and dry and wet testing shall be complete by the dates detailed in the related Schedule provided in Part 1 of the Bidding Document

**First Stage (Dry) Testing**

**General**

All surge vessels and equipment shall be carefully inspected and subjected to air pressure test at 35 bar or as determined by the Engineer at the Site after erection to show that it is satisfactory. These tests shall be carried out in the presence of and to the satisfaction of the Engineer, who shall, at least 5 working days prior to the testing, have been provided with the most recently acceptable draft of:

a) The appropriate Operating and Maintenance Manual;

b) The acceptable proposed dry testing procedure, prepared in appropriate detail to the relevant British Standard.

**Second Stage (Wet) Testing**

Second stage testing shall be carried out after the successful completion of first stage (dry) testing and as soon as practicable after the completion of the whole of the Works

and shall be completed by the dates detailed in the related Schedule provided in Part 1 of the Bidding Document

**Test Certificates**

a) The results of all off-site (factory and other locations) and Site tests carried out by the Contractor in accordance with the requirements of the Specification shall be recorded, certified, and submitted to the Engineer in triplicate.

b) No separate payment for providing all certificates and reports will be made and payment shall be deemed to be included in the rates and sums listed in the Bill of Quantitie

## SUB-SECTION 3 - ELECTRICAL REQUIREMENTS GENERAL

## INTRODUCTION

This Section covers the supply and installation of all electrical plant and equipment including all necessary calculations, technical details, catalogues, drawings, etc., for the plant, machinery apparatus, equipment, systems, articles, and associated accessories as outlined on the Drawings and described in the Sections of the Specification.

The final rating of switchgear, electrical protection devices, cable ratings, etc., shall, in general, be dependent upon the ratings and characteristics of the pumping sets and mechanical plant being supplied and the adopted method of starting. In this respect it shall be deemed that Contractor has taken this into consideration and has offered compatible electrical and mechanical plant and equipment.

The final arrangement of switchboards, switchgear and motor control panels is dependent upon the equipment offered and therefore subject to approval.

## VOLTAGE AND SUPPLY SYSTEM

The supply to the Site is provided by the national electricity supplier and will, in general, be 66,000, 33,000 or 11,000 V, 3 phase, 3 wire 50 Hz, stepped down through suitable rated transformers to 3,300, 660, 380 V/220 V for distribution and service connections to the various pumping stations and compounds.

It shall be the responsibility of the Contractor to ascertain the voltage supply systems at the various sites and compounds. As shown on the Employer's Drawings, loads may be such that a 3300/660/380 V supply can be extended directly to the compound without the need for a step-down power transformer.

The Contractor shall also be responsible for liaising fully with Uganda Power with respect to:

* Providing a detailed assessment of the load demands at each site
* Agreeing methods of starting for the proposed motors
* Finalizing details of metering requirements, terminations, glands, lugs, and the like to suit the Uganda Power meters and cables
* Advising Uganda Power of the approved programme of Works so that Uganda Electricity Distribution Company Limited, can plan their installation
* Agreeing with Uganda Electricity Distribution Company Limited, of any other requirement for power correction like power factor correction banks.
* Follow up to ensure installation and power connection is done in time.

## CABLES

1. **General**

This Section of the Specification deals with the materials and types of cables, which may be used along with termination and identification requirements for the cables. Full details, catalogues, etc., shall be submitted with the Tender.

All cable supplied for use under the Contract shall be British Approval Service for Electric Cables (BASEC) approved and shall be manufactured to the following British Standards, as appropriate, BS 5308 (Parts 1 and 2), BS 5467, BS 6004, BS 6007, BS 6207, BS 6346, BS 6480, BS 6500 and BS 7430.

The Tenderer shall submit, at no extra charge, full descriptive pamphlets and technical literature of the type of cables and cable manufacturer's offered.

Manufacturer’s test certificates for multicore cables shall be submitted to the Engineer for approval before any cables are installed. All cables shall be accompanied by the manufacturer's original guarantee, and shall be delivered to Site in the original wrapping.

Cable ratings and sizes have been indicated on the drawings and included within the Schedule of Prices. These rating have been based upon the assessed load details, ambient conditions and de-rating factors associated with each compound or pump station. The Contractor shall be responsible for finally checking the sizes/ratings of all cables and overhead line conductors to suit the loads. The sizes of the cables and conductors shall consider voltage drops, thermal capacities, fault levels, de-rating factors and ambient conditions. Details shall be made available by the Contractor for discussion and approval. The Contractor shall be guided by BS 7671:2011 or any other later edition of the same while sizing the cables.

1. **Materials and Minimum Size**

Cables shall have standard copper conductors, with minimum cross sectional areas as follows:

* Motor supply cables 4.00 mm2
* Cabling to control devices external to switchboards 2.50 mm2
* Telemetry control/digital signal cables 0.75 mm2
* Domestic lighting 1.50 mm2
* Domestic general power 2.50 mm2

The neutral core of a cable or the neutral cable of a circuit shall be of the same cross-sectional area as the associated phase.

1. **XLPE Single Wire Armoured Cable**

XLPE/SWA/PVC – cross linked low density polyethylene insulated, stranded copper conductors, extruded PVC bedding, galvanized steel wire armoured, flame retardant black PVC sheathed overall, suitable for use on an earthed system at a rated voltage of 0.6/1 kV or 3.6kV as specified. Conductor temperature shall not exceed 900 C for continuous operation and 2500 C for short circuit. Cables shall comply with BS 5467.

Installation shall be direct in the ground, in underground service ducts or inside buildings clipped direct to a surface or cable tray.

Non-magnetic armour of hard drawn aluminium shall be used on single core cables.

1. **PVC Insulated Single Wire Armoured Cable**

PVC/SWA/PVC-PVC insulated, extruded PVC bedding, galvanized steel wire armoured, flame retardant black PVC sheathed overall, stranded copper conductors suitable for operation on a system at a rated voltage of 0.6/1 kV or 3.6 kV. Conductor temperature shall not exceed 700 C for continuous operation. Cables shall comply with BS 6346 and BS 6746 19990/

Installation shall be direct in the ground, in underground service ducts or inside buildings clipped direct to a surface or cable tray.

Non-magnetic armour of hard drawn aluminium shall be used on single core cables.

The cables shall be used on the low voltage (380 V) systems for cable ratings up to and including 10 mm2, or control system as appropriate shall be

* multi-core, PVC insulated, extruded PVC bedded, single steel wire armoured, PVC over sheathed, or
* Single core, PVC insulated and sheathed, unarmoured, or
* Single core, PVC insulated, aluminium wire armoured with overall black PVC sheath

1. **Polyethylene Insulated Armoured Instrument Cable**

Cables for use as instrument cable shall be to BS 6622 and shall be multi-pair, polyethylene insulated and bedded, single wire armoured PVC over sheath.

1. **Sheathed and Insulated Flexible Cords**

These cords shall be to BS 6500 and shall be 850 rubber insulated, H.O.F.R sheathed.

Flexible cords shall only be used for the following;

* Final connection between fused connection units, having flex outlets, junction boxes, and their associated appliance
* Lighting pendants

The minimum cross-sectional area of conductors in flexible cords shall be 0.75 mm2 (24/0.2 mm) and the length not exceed 400m

1. **Flexible Cables – Power**

Flexible cables where required and used to supply submersible motors shall be 600/1000 Volt grade EP rubber insulated with Niplas outer sheath having flexible, annealed, and tinned copper conductors. Alternative, special, standard manufacturer cables may be considered. Details to be provided.

1. **PVC Insulated Cable**

This cable type shall be PVC insulated 600/1000-volt grade copper cable to BS 6004 and shall only be used when enclosed within a conduit or trunking.

1. **PVC Insulated and Sheathed Cable**

This cable type shall be PVC insulated PVC outer sheathed 600/1000-volt grade copper cable to BS 6004 and BS 6346 and shall be used as meter tails or transformer tails to switchgear if it is protected from mechanical damage. This type of cable shall also be used for direct surface run domestic wiring.

1. **Screened Cable**

These cables shall be PVC insulated, lapped with a non-hygroscopic tape, tinned copper wire braided. Signalling cable shall conform to BT Specification CW 1128 with armouring to CW 1198.

1. **Mineral Insulated Cable**

These cables shall be to BS 6207 and shall have copper conductors with copper outer sheath and PVC over sheath, 600/1000-volt grade.

This type of cable may only be used in specific environments or for specific services such as fire alarm systems, or similar type requirements.

1. **Telephone Cables**

Telephone cables shall be thermoplastic insulated multipair telephone type cables having twisted pairs of copper conductors.

1. **Bare Copper Earth Wire (BCEW)**

An earth wire shall be run with any selected cable, and be buried in the trench with it. The minimum size of earth wire shall be as shown on the Employer's/Engineer’s Drawings or half the cross-sectional area of the cable with which it is laid, whichever is the larger, and fixed to the power cable with nylon tie clips at regular intervals not exceeding 2,000 mm. The earth wire shall consist of annealed bar stranded copper conductor.

1. **Earth Bonding Cables**

Earth bonding cables shall be PVC/PVC type and have stranded copper conductors PVC insulated and sheathed.

## CABLE INSTALLATION

1. **General**

The Contractor shall plan and position all cable runs so that they do not foul other services, maximum accessibility is maintained, and unsightly crossovers are avoided. The cable routes shall be planned along with other services so that agreed service reserves are followed. Details shown on the Employer's Drawings are indicative only.

All cables shall be neatly run, dressed, and supported to the approval of the Engineer.

All cable supports and racks together with fixing bolts, clamps, nuts and screws for indoor situations and in cable trenches shall be included,and shall be made from galvanized steel or cast silicon aluminium. The Engineer shall approve cable supports, and racks. All supports, and racks shall be arranged for easy removal.

The Contractor shall submit a cable schedule so that all information relating to the cables is maintained. This information includes all items such as, type, dimensions, length, dates of manufacture, dispatch, delivery to Site, installation, initial tests, connecting up and final testing and commissioning. In addition, the Contractor shall maintain a daily/weekly record of the cables as installation proceeds. These records shall be witnessed as necessary and shall form the basis of the Record Drawings.

Where cables are run together in the same tray, trench, or conduit they shall be suitably de-aerated or spaced to maintain current rating. Crossovers shall be avoided where possible. Power and signal cables shall be run separately to minimise interference. Cables of dissimar voltage rating shall not be placed in the same trench. Tray or rack unless the lower voltage rated cable has the same insulation as the highest rated voltage cable in the same tray, trench or rack.

Where several cables are terminated in equipment, they should finally approach the equipment from a common direction.

The Contractor shall supply all cable tray, cable trunking, saddles, cleats, hangers, brackets, trays, ladders, ties, nuts, bolts, screws, washers, packing and marker tape as may be necessary to complete the installation.

Marker tape shall be 150 mm wide, yellow with black printing "DANGER-ELECTRIC CABLES."

Where cables cross other services or other cables the required separation shall be maintained. In addition, concrete cable tiles shall be provided between the services to maintain the separation and protection, the tiles extending for 1000 mm either side of the existing services.

Power cables shall be installed without tees or joints unless approved by the Engineer. Cables shall not be installed in areas of direct sunlight. Where this is unavoidable, approved sunshields shall be supplied and installed.

All cable shall be suitably protected. Those running on the external surfaces of structures shall be protected against the effects of ultra-violet light. Where cables are sleeved through conduit or ducts, all ends shall be bushed to prevent damage to cable sheathing. The Contractor shall be deemed to have allowed for cable protection in his rates.

The as-installed drawings provided by the Contractor shall clearly show all services and cables detail dimensions.

1. **Installation Direct in the Ground**

The Contractor shall carry out all excavation, supply and install pipes or ducts where required, prepare the trench bottom, lay cables, provide, and install markers and warning tape, backfill, consolidate, compact, and make good, including the removal and disposal of all surplus material.

Power cables of rated voltage up to 1,000 V shall be buried at a minimum depth of 600 mm to the cable, Power cables of rated voltage above 1,000 V up to and including 11 kV shall be buried at a minimum depth of 1,000 mm to the cable centre. This may only be varied due to the presence of other cables or services.

The bottom of excavated trenches shall be free of sharp stones and other obstacles and shall be covered with sand or fine sifted soil compacted to a depth of 75 mm.

Cable shall be unrolled from the drums in such a manner as to avoid loops and kinks, and care shall be taken when laying to avoid damage to the outer sheath by drawing over sharp obstacles or stones. A sufficient number of rollers shall be provided so that the cable does not touch the ground or twist during pulling.

Cable shall be snaked into the trenches to avoid tension in the cables during backfilling or from subsequent settlement. After laying, cables shall be covered with a minimum depth of 100 mm of sand or fine sifted soil. The cables shall be overlaid with marker tape, before backfilling the trench with soil.

Where cables of different voltages are laid together at the same depth, vertical cable tiles shall be used to separate the cables.

Controls and communication cable shall be laid not closer than 1,000 mm to high voltage cables.

When cables are in position in the trenches, an inspection will normally be required by the Engineer before backfilling commences. The first stage of backfilling is to be sifted soil or sand (as specified for the trench bottom) with cover being provided to a minimum of 70mm over the cable. Soft excavated materials free of stones is then backfilled with the backfill rammed every 150mm.

Small stones extracted from the excavated material may be mixed in with the backfill in the final stages, but large stones are to be removed from site. Surface material and any hard-core removed prior to excavation is to be backfilled last and well rammed to restore the under surface to original conditions. Excess backfill is to be removed from the site.

The contractor is responsible for reinstating any damage to gates, hedges, kerb stones, concrete paving, etc, and normally for the surface of any privately owned made up roads. For public roads reinstatement of made up road surfaces will be carried out by the road authority and the trench backfill must be left in a suitable condition as required by the road authority.

Approved surface route markers shall be situated at all joints, bends at minimum intervals of 30 metres on straight runs, as specified. Whenever the cables change direction markers shall be so placed that the change in direction is readily seen.

No cables shall be buried direct in the ground within buildings or concrete covered areas.

1. **Installation in Underground Ducts**

Where cables are laid under roads and paved area more than 1,000 mm wide, they shall be installed in continuous runs of approved underground ducting, generally supplied, and installed by others unless otherwise specified or shown on the Employer’s Drawings. The Contractor shall be responsible for advising the civil works contractor of all required cable duct locations, these locations being agreed with the Engineer and shown on the Contractor’s reticulation Working Drawings.

Underground ducts shall be constructed of impact resistance uPVC and laid at a minimum depth of 600 mm (to the duct center), surrounded by at least 75 mm of sieved sand. At road crossings, uPVC ducts of minimum diameter 100 mm shall be laid at a minimum depth of 1,000 mm (to the duct center). The duct shall be encased by 150 mm concrete on all sides.

When installing cables in ducts the following measures shall be observed.

* Cables shall be pulled in a straight line
* Rollers shall be positioned at the edges of draw pits both at the drawing in and drawing out points over which the cables shall be drawn
* uPVC pipes and cables sheaths shall be coated with an approved lubricant
* Sufficient draw-in points shall be provided, and adequate room allowed for installation of cables
* Rollers shall guide the pulling rope.

In general, only one power cable shall be drawn into one duct. Where multiple cable systems are used, smaller cables (16mm2 and below) may occupy the same duct. However, details must be agreed with the Engineer, and included on the Contractor’s Working Drawings. Cables drawn in same trench must be spaced in compliance with BS 7671:2011 or the must current version.

When a duct is laid in the ground, a draw wire shall be pulled through with at least 1000 mm excess at each end and the draw wire left if the duct is not to be used immediately.

1. **Sealing Cable Entries into Buildings**

Where cables pass through walls below ground level, the point of entry shall be sealed against the ingress of water. This shall be achieved with “petroleum tap” and mastic or silicon foam.

Where cables pass in or out of any duct entries into or within buildings, such entries together with any spare ducts, shall be sealed against the ingress of moisture by means of duct stoppers and bituminous compounds or by any other method approved by the Engineer. The stopper shall have a fire resistance of at least 30 minutes.

1. **Marking of Underground Cables**

The location of all direct buried underground cables shall be identified by:

* Brass plates fixed to the exterior surface of all walls of buildings 300mm above ground level and directly above the point where cables pass though the wall;
* Marker posts on road verges, etc., at intervals of not more than 100m and at all junctions and changes of direction along the route;
* Marker posts at 10m intervals within an enclosed site and at all junctions and changes of direction along the route.

Marker posts shall be of concrete, not less than 15 mm high above ground level with an inscribed brass or enamel metal plate. The inscription shall indicate the presence of a cable below, the depth and voltage rating.

A drawing or sample of a typical marker post shall be submitted for the approval of the Engineer.

1. **Installation in Cable Trunking**

Cabling trunking shall be manufactured from heavy-duty mild steel of thickness not less than 1.25 mm and hot dipped galvanized. The Contractor shall ensure that the size of the trunking is adequate for the number of cables to be installed together with 50 per cent spare capacity or as per the relevant BS standards. Trunking shall have minimum dimensions of 50mm x 50mm.

Segregation of cable shall be carried out if required using continuous sheet steel barriers with the bottom edge welded to the trunking.

The trunking shall have two return flanges for rigidity. Where necessary, additional strengthening straps shall be fitted internally. The cover shall overlap the trunking and be made of the same gauge. Fixing screws for covers shall be recessed and be of the self-retaining quick fix type. All bends, tees and intersections shall be of the gusset type and shall, wherever possible, be purpose made by the manufacturer and of a matching design to the main trunking.

Earth continuity straps shall be provided at all connection and jointing points along the route of the trunking to ensure complete earth continuity.

Cables shall be retained in the trunking when the cover is removed by means of straps. Internal connecting sleeves shall be fitted across joints in the trunking and earth continuity ensured by bonding each section of trunking to a continuous each wire.

Non-flammable fire barriers shall be inserted where the trunking passes through walls or floors. Conduit connections to trunking shall be made by flanged couplings and male bushes.

Trunking shall be supported at intervals as detailed in the IEE Wiring Regulations. Crossings over expansion joints shall be made in flexible conduit.

Should it be necessary to cut or drill a section of trunking or a trunking fitted the bared ends shall immediately be given a coat of zinc rich cold galvanizing paint.

Cable and trunking runs shall be determined by the Contractor and agreed by the Engineer before any work is started. The run shall be at least 150 mm clear of plumbing and mechanical services.

Trunking systems erected outside a building shall be weatherproof.

1. **Installation in Troughs and Trenches**

Where the building structure incorporates purpose built covered trench systems, to accommodate the cables, power distribution cables may be laid on the floor of the trench providing all cables are readily accessible without the need to disturb other cables. Where the Engineer considers too many cables are present, or where the trenches are not suitable for laying cables on the floor of the trench, supports shall be provided. Control and instrumentation cables shall be segregated and installed on supporting steelwork or cable trays secured to the walls of the trench.

Where the building structure incorporates general service trenches containing pipework, chemical lines and other services, all cabling shall be segregated from other services and run on the trench walls, Crossovers shall be kept to a minimum and cabling shall be taken above wet service pipework.

Cable trays shall be of perforated steel with formed flanges and of minimum thickness not less than 1 mm for trays up to 100 mm width, not less than 1.25 mm for trays from 100 mm to 150 mm width and not less than 1.5 mm width for trays from 150 mm to 300 mm width.

Cable tray and supports shall be to BS 6946 and hot dipped galvanized to BS 729.

Wherever possible, cable trays shall be installed in full lengths without cutting. Should it be necessary to cut or drill a length of tray, the bared ends shall be dressed and immediately be given a coat of zinc rich cold galvanizing paint. Similarly, for PVC coated trays, the bared end shall be immediately sprayed using a PVC aerosol.

All cables shall be firmly secured to the tray using purpose made saddles, as approved by the Engineer, together with proprietary cable cleats.

1. **Installation in Buildings**

Cables required to be run on walls, ceiling, or other structures shall be carried on substantial cleats, either in-groups or singly at spacings determined by rating requirements, supported on tray or ladder racks, or enclosed in conduit or trunking.

No cables shall be buried directly in the ground within buildings or concrete covered areas.

All cables shall be neatly run vertically or parallel to adjacent walls, beams, or other structural members.

Allowance shall be made for expansion and contraction of the cables.

Where cables cross a building expansion joint, due allowance shall be made for cable movement.

The spacing of clips, saddles and clear shall be such as to prevent the sagging of the cables during their installed life. The method of fixing clips, etc. shall be by means of non-corrodible screws inserted into approved wall fixings.

Cables hangers, cleats, saddles, brackets, and similar supporting devices shall be of an approved type and of adequate strength for the cables they are supporting. They shall be treated to withstand site conditions without corroding. Self-locking plastic buckle clips and strapping shall not be used.

Hangers shall be spaced according to the recommendations in the IEE Wiring Regulations.

Ladder racking shall be constructed from heavy galvanized steel secured to walls or ceilings, or by performed galvanized interlocking channel, cast into the structure.

Cables shall be located between 5 mm pegs spaced at 40 mm centres across a rung so that a 40mm or 80 mm space is maintained between cable centres. Cleats shall be used where the ladder racking is vertical.

Wherever ladder sections are cut and shaped on site, cut edges shall be dressed and immediately painted with a coat of cold galvanizing compound.

Cable shall be run at least 150 mm clear of plumbing and below heating and hot water pipe work.

1. **Cable Installation in Conduit**

Conduits shall, in general, be galvanized heavy-duty gauge steel screwed type for outdoor applications. Accessories shall either be malleable cast iron or pressed steel. PVC conduit will be considered for certain installations as specified. Conduits and fittings shall comply with BS 4568, 4607 and 6099 as appropriate and shall not be less than 20 mm diameter.

A space factor of 40% shall not be exceeded, and conduit of less than 20 mm diameter will not be permitted. The tubing is to be perfectly smooth inside and out and free from imperfections. Both ends of every length of tubing shall be reamed with all sharp edges removed before erection.

Where conduits converge, adapter boxes shall be used. Conduits shall be connected by means of male brass bushes and couplings. Where conduits are greater than 25 mm, straight through joint boxes shall be of the trough type.

Where conduit or fittings are attached to equipment casings, the material of the casing shall be tapped for a depth of not less than 10 mm or male bushes and flanged couplings may be used.

Hexagonal lock nuts shall be used at running joints. They shall seat firmly and evenly on to mating faces. All junction boxes, draw-in boxes, and inspection fittings shall be placed so that the cable can be inspected, withdrawn and rewired during the life of the installation.

Generally, not more than two bends or offsets or one coupling will be permitted without a suitable inspection accessory, Fish wires shall to be left in conduits during erection. The whole of the installation shall be arranged for a loop-in type of system with joints being carried out at switches, isolators, or appliance fittings.

Ends of conduits which are liable to be left open for any length of time during building operation shall be plugged to prevent the ingress of dirt and covers shall be fitted on all boxes.

Generally, conduits shall not cross expansion joints of buildings. Where they cannot be installed in any other manner, a galvanized flexible conduit shall be used across the expansion joint. A total of 150mm movement shall be allowed.

Surface conduits shall be secured and fixed by means of distance spacing saddles or clips which allow the conduits to be taken directly into accessories without sets or bends. Conduits shall be run in a square and symmetrical manner. Runs shall be properly ventilated and allow for drainage of condensation. All surface conduit runs shall be marked out for approval by the Engineer before the installation is carried out. Where large multiple parallel conduit runs occur, galvanized trunking may be used instead.

Conduits installed on structural steelwork shall be secured by girder clips, drilled, and tapped to the steelwork. Power driven fixings shall be used only with the approval of the Engineer. Any drilling or access which is required through any structural member of the building shall be clearly shown on the Contractor's Drawings submitted to the Engineer for approval. The Engineer may either restrict the size and locations of approved drilling or access, or may instruct the Contractor where such drilling or access shall not be allowed.

Exposed threads and plates where galvanizing has been damaged shall be cleaned and then painted with two coats of an approved metallic zinc based paint. This treatment shall be applied as the work proceeds.

Concealed conduits shall be securely fixed to prevent movement before laying of screed, floating of plaster, casting of columns or other building operations necessary after the conduit installation.

Crampers or similar fixings shall be used for attaching the conduit to blockwork, etc. Building nails will not be accepted.

At least 15 mm shall be allowed for finished over the conduit. Where this cover cannot be maintained them expanded metal shall be fitted over the conduit. Conduit cast into reinforced concrete shall be fixed to shuttering to give a flush finish, and the conduit boxes shall be of a type approved by the Engineer for use in such locations.

Conduit installed in voids, false ceilings, and other concealed routes shall be installed as specified for surface conduits. Draw-in wires shall not be pulled into the conduits during erection. Wiring shall be carried out after the false ceiling or permanent ducts have been completed. Conduit installed in floor shall be sealed against ingress of moisture.

The Engineer shall inspect the conduit installation before the building operation conceals the work.

Flexible conduits shall be of the waterproof galvanized type of PVC wire-wound type with cadmium plated mild steel couplings. Lengths of flexible conduit shall be sufficient to permit withdrawal, adjustment, or movement of the equipment to which it is attached and shall not be used as a means of providing earth continuity. A single earth conductor of adequate size shall be installed external to the conduit complete with earth terminations.

Where conversion from rigid conduit to flexible metallic conduit is to be made, the rigid conduit shall terminate in a trough type box. The flexible conduit shall extend from this box to the equipment; the earth continuity cable shall be secured to the box and to the piece of equipment. The use of lid facing screws, etc. will not be permitted.

Adapter shall incorporate a grub screw or a gland to prevent the flexible conduit becoming loose.

In locations where, galvanized conduit would be liable to corrosion, PVC conduit shall be considered.

PVC conduit shall be of the oval or round high impact non-flame propagating type as specified and self-extinguishing to BS 6099 part 2. Surface and concealed installations shall be generally as described for steel conduit.

PVC conduit fittings shall comply with BS 4607. They shall all be white unless specified otherwise.

Jointing shall be carried out using a PVC solvent and socketed accessories. Expansion couplers shall be fitted in straight surface runs every 12m. The free end shall be sealed with non-setting mastic to form a waterproof seal.

Purpose made bends may be used providing that the cable-bending radius is maintained. Cracked or crinkled conduit will be rejected.

The conduit shall be suitable for use in ambient temperature of between 100 C and 600 C and shall not be installed in areas that receive direct sunlight. A separate protective conductor (earth continuity conductor) shall be installed.

Adaptable boxes and accessories shall be made from heat resistant insulating material. The minimum wall thickness of boxes having a nominal internal depth of 16 mm or less shall be 1.5 mm. For deeper boxes the minimum wall thickness shall be 2mm. All boxes which are intended to support luminaries or other heat sources shall have either external fixing lugs riveted to the metal fixing inserts or utilize steel insert clips.

## CABLE TERMINATIONS, JOINTS, AND IDENTIFICATION

1. **General**

Cable terminations shall be provided to suit the requirement specified and shall be either crimp type lugs; crimp type insulated wiring pins or soldered connections.

Where crimp type terminations are used lugs shall only be applied using a crimping tools having a ratchet, which only releases after the correct pressure has been applied.

Excessive solder and "Dry" solder connectors will not be accepted. Care shall be taken to eliminate "dry" solder joints and in removal of excess solder.

Cables lugs shall be of such a size that only the minimum amount of solder is required to sweat the lugs solidly onto the tail ends.

The foregoing termination methods are not essential in "domestic" lighting and power installations beyond the final distribution board.

At termination the cores of the cables shall be left of sufficient length beyond the termination to form cable tails for connecting to the equipment. Tails shall be adequately insulated, and each cable core shall have its phase identification clearly marked.

Terminations shall be long enough to allow one additional termination.

The installation requirements associated with both the low voltage and control cables are such that, in general, no joints are necessary, the cable distances being such that one complete cable length is required between the various items of Plant. The Tender shall be submitted on this basis, joints only being permitted where authorized by the Engineer. Where joints are permitted they shall be made as set out below.

* Joints in cables shall be made in accordance with the cable manufacturer's recommendations to suit the cable type
* All cables shall be joined colour to colour and shall be tested for insulation resistance and continuity before jointing commences
* The seals of the cables shall not be removed until preparations for jointing are complete.
* Joints shall be finished on the same day they are begun, and protection from weather shall be provided by the Contractor
* Cast resin moulded type joints shall be used for PVC multicore cables
* The jointing cores shall be insulated by means of several wrappings of PVC tape and then coated with PVC past
* The cable armouring shall be made continuous within the joint and be filled with copper bonding tape and clamps
* A split mould, preferably of PVC, shall encase the joint and be filled with a proprietary brand of polyester resin

1. **Termination of screened signal cables**

Where the termination of a screened signal cable is required the cable shall be bonded to earth at one end only and the termination carried out as follows:

* Screen to earth connection - A suitable length of overall sheath shall be removed, the conductors separated from the screen and the screen insulated using a PVC sheath self- coloured green/ yellow. A 30 mm long silicone rubber over sleeve shall be installed over the point of separation of the conductors, screen, and overall sheath.
* Isolated screen -Suitable length of the overall sheath and the screen shall be removed and a 30 mm long silicone rubber over sleeve installed over the point of separation of conductor and overall sheath.

1. **Cable glands-general**

Glands shall comply with BS6121. They shall protect the inner and outer cable sheaths against ingress of dirt and moisture and provide mechanical support. Where cable glands are exposed to the weather these shall be protected by heat shrink plastic tape or purpose moulded sleeves covering the gland continuously from overall sheath to the gland neck.

Where the apparatus enclosure classification required sealed cable gland entries, sealing shall be achieved by using threaded cable gland holes and polyfluorethylene (PTFE) tape.

Where terminations are to be effected for XLPE or PVC insulated cable, a compression type gland shall be used with means of securing armour wires with the body of the gland, and shall be of a size suitable for the cable used. The gland shall provide both armour moisture seal and outer sheath seal.

PVC gland shrouds shall be provided for all terminations.

Cable glands shall be both electrically and mechanically sound and shall be complete with backnuts and bonded earth tags.

BW type indoor glands shall have a minimum of exposed armouring between sheath and gland. Self-adhesive PVC tape shall be applied to exposed armouring and glands before the shrouds and fitted.

1. **Identification of Cores and Wires**

Terminal blocks shall be identified by using purpose made indelible markers.

Each core shall be identified, at points of termination, using colour coded slip-on ring type markers.

The wire and associated terminal number shall be identical

Where source and destination terminal blocks have different numbers, cores shall be double ferruled with both numbers.

Unless otherwise specified it shall not be necessary to identify termination in domestic installation beyond the final distribution board.

1. **Power Cable Terminations and Joints**

Power cables shall be terminated in suitable boxes arranged for bolting to switchgear, motor starters and motors. Each cable entry into a terminal box shall be made through a suitable gland.

Boxes shall be of adequate proportions to accommodate all cable fittings including stress cones or other means of insulation grading. Boxes shall be openable for inspection without disturbing the gland plate, cable, or termination.

Where air insulated terminations are used, the cable crutch shall be protected by a heat-shrink sleeve.

Cores shall have either crimped lugs or sleeves to match either post terminals or bolted clamp terminals.

Glands for armoured cables shall provide a positive armour clamp to the box or switchgear coating. This clamp shall completely support the cable weight so that no tension is applied to the termination. The clamp shall also provide earth continuity and be of adequate size to withstand the full fault current of the system for one second.

Where single core glands are required, these shall be non-magnetic. The gland plate shall also be of a non-magnetic material. Removable connections for bonding across the gland insulation shall be provided. The gland insulation shall withstand a test of 2 kV AC for one minute.

Aluminium cores of power cables shall be terminated using approved bimetallic connectors. All glands shall be provided with an earthing tag. For cables of 4 mm2 or less, a serrated washer may be used instead for earth continuity.

1. **Multicore and Control Cable Terminations**

A sufficient number of terminals shall be provided to terminate all cable cores. For control and auxiliary wiring an additional 20% of this number shall be provided as spares.

Terminal blocks for terminating cables up to and including 35 mm2 shall securely clamp the conductor, without damage, between two plates by means of a captive screw; pinch screw type terminal blocks shall not be used.

For cables above 35mm2 stud or bolts terminal shall be used, each cable being fitted with a suitable lug.

Not more than one core of internal or external wiring shall be connected on any one terminal. Where duplication of terminal blocks is necessary, purpose made solid links shall be incorporated in the design of the terminal blocks.

Terminals which remain energized when the main equipment is isolated shall be suitable screened and labelled.

Terminal blocks for different voltages or circuit type shall be segregated into groups and distinctively labelled.

Plant which must be dismantled for maintenance shall have multicore cable terminations made off through glands onto an adaptable box. The box shall have terminal blocks, and connections shall be made to the equipment by single core wires and flexible waterproof plastic conduit. A separate earth core shall link the box to the equipment.

The Contractor shall supply and install complete approved marshalling boxes for both indoor and outdoor use, as required for terminating and marshalling all power and control cables at each item of Plant or en-route as required. Spare pairs shall be included to facilitate cross patching in the event of a fault developing on the operational pairs. All marshalling boxes and terminal within panels and mimic panels shall accommodate all control cable requirements. Details of which shall be agreed and approved by the Engineer.

## SWITCHGEAR AND CONTROL EQUIPMENT

1. **Introduction**

This Section of the Specification covers all switchgear and control equipment up to 1,000 VAC, including distribution switch and fuse boards, multimotor control centres, control panels and desks, as well as individual units, This Section shall be read in conjunction with Sections 3.7, 3.8, 3.9 and all other related Sections of the Specification.

LV switchboards and panels shall comply fully with BS 5486, and be rated and ASTA certified for operation on a 6.6Kv, 415/240 V 3 phase 4 wire 50 Hz supply. They shall have a minimum prospective short circuit fault rating of 10 kA or as may be shown on the Employer's Drawings. The fault ratings shall be commensurate with the fault levels of the network to which the components connected. The Contractor shall be responsible for establishing the fault level at each site or compound and designing the panels accordingly.

The Contractor shall be responsible for checking the panel and switchgear manufacturer's drawings, together with all necessary interfacing requirements with Uganda Electricity Distribution Company Limited, and other. He shall signify his approval in writing to the Engineer, and submit copies of all manufacturers’ drawings for the Engineer's approval. The Contractor shall be responsible for carrying out measurements of prospective short circuit current and earth fault loop impedance at each LV switchboard/distribution board upon completion of the works and shall incorporate the actual values onto the 'as-installed' drawings.

1. **Construction-General**

Switchboards and control panels shall be flush fronted and recessed, manufactured from 2.0 mm minimum thickness mild steel, multi-cubicle type. They shall be of folder and welder construction forming rigid units. Floor mounted panels shall be equipped with a mild steel channel bed frame at least 100mm high to ensure rigidity and shall be impervious to corrosion by rust. Small units may be of the wardrobe type.

The switchboards and control panel shall generally be of the industrial/enclosed modular cubicle type the switchboards and panels being of the cubicle pattern suitable for floor or wall mounting, comprising a sheet steel cubicle with front access as required and specified complete with bus bars, circuit-breakers, fuse switches and MCCB's. They shall be of uniform height, rigid construction, and neat appearance.

Where rear access is possible removable covers shall be provided for cabling etc. Separate cable compartments shall be provided.

All switches and breakers shall be individually labelled, showing the circuits controlled, by means of laminated plastic labels showing black letters on a white background.

Busbars shall be copper on insulated supports and capable of withstanding the fault level on the system at that point.

Switchgear shall be heavy-duty, cast metal enclosed type, dustproof, and capable of operating on load at the rated current. Contacts shall be heavy-duty silver surface type.

Cubicles shall be rigidly constructed. Those accommodating heavy-duty switchgear shall be provided with an angle iron or heavy gauge folder steel framework, panelled in zinc-anneal or galv-anneal.

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.

Ventilation shall be provided where required, with fine 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 folder edge or ridge. Moulded sealing strips may be submitted for approval as alternative.

Switchboards and control panel shall consist of incoming fused switches, circuit-breakers or isolators, and outgoing circuits controlled by fused switches, switch fuses, MCB's and MCCB's required and as shown on the Employer's Drawings.

No live metal shall be exposed by the removal of normally closed or fixed door or panels. Shrouds or insulated barrier pieces shall be provided.

The use of either circuit-breakers or fused units is subject to final approval by the Engineer. Alternatives to the use of the circuit breakers indicated will be considered, but only as an alternative.

Entry of cables, ducts, and conduits shall be neatly made and head boxes shall be provided as required. All entries and opening shall be vermin-proof.

The maximum height of panels shall be 2,200 mm above finished floor level.

Where switchboards are split for delivery each section shall have a maximum width of 2,000 mm and a maximum mass of 1,000 kg with removable eyebolts provided for lifting.

The switchgear, distribution boards and terminal cabinets shall fit in the spaces provided as indicated on the drawings. If there is any reason a board will not fit into the space indicated on the drawings, the attention of the Engineer shall be drawn in good time to enable alternative arrangement to be made, either to the board or to its fixing position. It shall be the responsibility of the Contractor to verify the suitability of the space provided before trays of boards are fixed.

Unless otherwise specified, all contactors and relay control circuits shall be connected to an AC supply of a maximum of 240 volts.

Isolation of a control circuit supply to one or a group of starters shall not interrupt supplies to other starters.

All fuses shall be of the HRC type to BS88. Fuses rated 30A and below shall be mounted in approved withdrawable fuse Carriers. Carriers containing links shall be coloured white, whilst carriers containing fuses shall be coloured black.

Timer delay relays shall have a good repeat accuracy and the direction of adjustment for increasing and decreasing the timing period shall be clearly marked.

The circuit breaker associated with each starter shall be a triple pole unit rated for installed motor duty and shall comply fully with the relevant British Standard. A padlocking facility shall be provided for locking in the OFF position.

The circuit breaker shall generally be housed within the same compartment as the starter with which it is associated and shall be mechanically interlocked with the compartment door.

The control supply shall be broken by auxiliary contact on the circuit breaker in the open position.

The switchboards and panels shall be designed so that they can be extended in the future with the addition of further busbar/cubicle sections.

1. **Mounting**

Fixings for floor mounted switchboards and panels shall be by not less than four holding-down bolts at the front and rear of the equipment. They shall not be visible from outside the panel, but be readily accessible from within.

At least four lugs shall be provided for bolting wall mounted switchboards and panels to the wall. Fixings holes shall not be provided inside the panel, which shall stand at least 10mm from the wall surface.

Fixings for post/column switchboards and panels shall be provided outside the enclosure. The back of the enclosure shall be drilled to accept fixings.

All mounting brackets, supports and additional items shall be supplied and installed to securely support the switchboards, panels and cubicles in position.

1. **Cubicles**

Separate cubicles shall be provided for each of the following:

* Incomer
* Bus-section
* Motor starter
* Common controls
* Telemetry
* Distribution board
* Feeder
* Outgoing terminations
* Other specified equipment

Each cubicles having its own door shall be totally separate from any other so that work can be safely carried out in one cubicles while other are still live.

1. **Doors and Covers**

Doors shall be adequately sized to accommodate all equipment readily and neatly that will be mounted on them. They shall open at least 120 degrees, be rigidly constructed, suitably braced and provided with at least two substantial hinges, which shall be captive when the door is closed.

Lockable catches shall be used each being provided with 3 keys on individual ring having a nameplate showing its identity details. Locking combination requiring different keys shall be approved before manufacture.

Where padlocking facilities are specified, the padlocks will be supplied.

No equipment shall be mounted on covers. Large covers equivalent to half full height and above shall be provided with handles to facilitate removal and replacement.

Each door and cover shall be provided with an internal welded earthing stud, and shall be bonded to the switchboard main earth bar.

Doors and covers giving access to potentially live conductors shall be proved with prominent warning labels,

Suitable shrouds or covers shall be provided for all live terminal and termination, such that the operators or maintenance staff cannot make accidental contact.

Where required, provision shall be made for inter-locking the incoming KPLC supply and standby diesel supply such that paralleling cannot take place under any circumstance. The inter-locking shall be by an approved means, castelle keys being provided such that the front covers for any unit cannot be opened when the switch is in the "ON" position and the switch cannot be operated when the cover is in the open condition. Flexible earth continuity bonds shall be provided for all hinged and swing panels.

1. **Component Mounting**

Each cubicle shall be provided with removable rust proofed steel back plate bolted to studs welded onto the rear of the cubicle. All components, other than door mounted, shall be located on the back plate by bolting into tapped holes or using self-tapping screws. Nuts used to fix components shall be captive on the back plate. DIN rail type fixing may be used where appropriate.

Components shall be so mounted to prevent shock being transmitted from large components and thereby adversely affecting their proper function. The components shall be arranged to give adequate accessibility for maintenance and for removal of any one component with the minimum disturbance to the wiring. Plug in connectors shall be used where possible.

1. **Cabling Arrangement**

Cabling shall enter panels through removable gland plates of not less than 3 mm thick steel or brass (for single core cables) fitted at least 350 mm above floor level, the final height being dependent on the cable sizes and bending radii. They shall be rustproofed and provided with a welded and bonded earthing stud and adequately sized to accommodate present and known future cabling requirements. Access to both sides of each gland plate when it is in position shall be possible from within the equipment. Cabling shall enter at the top and/or bottom of panels as appropriate, and have a suitable means of fixing.

Gland plates are not necessary on small individual starters where access shall be by "knock outs" Gland plates shall be removable for drilling.

1. **Bolts, Nuts, Washers and Screws**

All bolts, nuts, screws, and washers used for the construction of the switchboard shall be nickel or cadmium plated, except fixings on the face of the switchboard, which shall be stainless steel.

1. **Protection and Finish**

The internal colour shall be white, and the protection of externally mounted components shall be no less than that of the panel on which they are mounted. External colours shall be grey unless otherwise specified or approved. Full colour details to be submitted with the Tender.

Cases shall be rubbed down, undercoated with suitable primer, and finished in not less than 2 coats of hard enamel, oven baked where practicable,

Externally mounted panels shall be protected to IP65 (weatherproof), with a rear sloping weather canopy projecting over the front by at least 150 mm. Door-mounted components shall be protected by a vandal resistant secondary glazed door so that all controls and indicators are clearly visible. Doors shall be locked and provided with stays.

Protection classification for all internal boards and panels shall be IP54 unless there is a specific requirement and the manufacturer considers that a particular compartment requires louvered ventilator. In such a case, the classification shall be not less than IP31. Louvres shall be provided with fine mesh screens, as specified in Clause 3.6.2.

Externally mounted panels shall also be protected from the sun, a sun canopy being provided. The canopy shall overhang the panel by a minimum of 500 mm on all sides and shall provide an air gap above the panel of at least 200 mm. Proposals shall be submitted with the Tender.

1. **Auxiliary Supplies and Anti-condensation Heaters**

Control supplies shall be 110 V or 220 VAC, derived from a transformer within the panel or a 4 wire 3 phase supply fused on its primary and secondary winding, each cubicle being separately sub fused so that a fault in one cubicle does not affect others.

Supplies to equipment mounted on the panel such as instruments shall be 110 V or 220 V AC derived from the control supply. Major items of equipment shall be separately fused. Other items within the same cubicle may be collectively fused, but separately from the control supplies.

Anti-condensation heaters shall be provided in all control panels, switchboard and motors to prevent internal condensation due to atmospheric or load variations.

Anti-condensation heaters within switchboards and panels shall be provided at the bottom of each cubicle to maintain an internal temperature of 50 C above ambient. An adjustable thermostat with clear scale shall be installed at the top of each cubicle to limit the maximum temperature. Each heater shall be individually fused and provided with an isolation switch.

All heaters shall be rated for 110 V or 220 V AC and shall derive their supply from the control supply circuit.

Motor heaters shall be switched by normally closed contacts on the main contactor (s) such that the heater is energized when the motor is de-energized and vice versa. The heater circuit shall include an isolating switch and indicator lamp to show 'Heater Circuit On'. The heater shall be energized from a 110 V or 220 V 50 Hz supply.

When maintaining plant fitted with heater it will be necessary to switch off both the main isolating switch and the switch for the heater. A warning notice of this danger shall be fitted near the terminal box of every remote heater and at every panel or switchboard with heaters.

All such plant, whether fitted with a heater device or not, is to be provided with suitable drainage and to be free from pockets in which moisture can collect.

All indication lamps shall be separately fused and protected.

All panels, switchboards and three phase motor starter shall be fitted with line indication lamps so that the operators and maintenance staff can readily identify the operation of all phases.

All protection components, under/ over voltage relays, phase failure relays, etc., shall be provided with a visual identification to show when operation has occurred. Details shall be provided.

In addition to the individual lock-off emergency stops specified for each motor and rotating plant the composite motor control panels and/or switchboards supply separately mounted starters shall be provided with an emergency "main" button such that all rotating plant can be immediately shut down. Auxiliary contacts shall be provided to enable this shut down circuit to be extended to remotely sited main buttons should this be a future requirement.

All switchboards and motor control panels shall be fitted with a separately fused 13 ampere switched socket for maintenance.

In addition, larger panel shall be fitted with their own-switched internal lighting system to facilitate maintenance. The fused circuit shall be extended from the live side of the incoming switch, suitable warning notices shall be provided to advise operators that the isolation of the main incoming switch/breaker does not render these circuit in operative.

1. **Busbars and Main Connections**

Each switchboard or control panel as may be required shall be equipped with a set of 3 phase and neutral air insulated busbars rated for a current of not less than the future connected load.

Busbars, risers, and droppers shall be ASTA certified and manufactured from solid copper fully complying with BS 5486, Part 2, enclosed in a separate chamber and shall be continuous over each section of panel as assembled prior to shipping, with the facility for future extensions at both ends of the panel. Busbars shall not be drilled for outgoing connections, which shall be made with clamps.

The riser and dropper bars shall be of an approved a minimum prospective short circuit fault corresponding to the let through energy of a protective MCCB of equal rating to the busbar rating and connected to a prospective symmetrical fault level of 10 kA r.m.s.

The busbars shall be housed in their own compartment running the length of the switchboard or panel and shall not be exposed when any of the access doors or plates (other than those provided for busbars access) of the panel are moved for maintenance or other work.

Auxiliary bus wiring between units shall be protected and accommodated in areas other than the main busbar chamber.

All busbars shall be air-insulated, with tinned and bolted connections, clearly painted in correct colour of red, yellow, blue of the phase and black for the neutral. Wrapping with the colours SHALL NOT be accepted.

It shall be possible, by removing covers, to readily gain access to all busbar, riser, and dropper joints to check tightness of nuts and bolts.

The framework and cable armouring clamps shall be efficiently bonded (with continuous copper strip) mechanically and electrically to the building and switchboard main earthing system. A high conductivity copper earth bar shall be bolted and efficiently bonded to the main frame to run the full length of each panel. This shall be colour coded yellow/green. Flexible earth continuity conductors/bonds shall be provided for all hinged doors and swing panels

1. **Balance**

The entire installation shall be balanced to the satisfaction of the Engineer and the Contractor shall carry out such alterations to switchboard connections as may be required to balance the installation.

1. **Circuit Lists**

The switchboards and distribution boards shall be fitted with a typed circuit list in the form of a card within a transparent envelop fixed to the inside door or each panel and distribution board. The form of the chart shall be to the approval of the Engineer and shall contain the following details:

* 1. Incoming cable type and size including any circuit protective conductor
  2. Size and type of incoming protective device
  3. Measured values of earth fault loop impedance and prospective short circuit current at the board
  4. Size and type of protective device on all outgoing circuits
  5. Size and type of cables on all outgoing circuits including circuit protective conductors.
  6. Block layout of switchboard components to assist maintenance staff in the identification, operation, and function of each component.

## MEDIUM VOLTAGE CIRCUIT BREAKER SWITCHGEAR (GAS-INSULATED, VACUUM)

1. **Scope**

This specification defines the technical requirements for indoor, gas-insulated switchgear (GIS), equipped with vacuum circuit breakers with rated maximum voltage of 7.2 kV. This specification covers the design, manufacture, factory production testing and field service assistance during installation and commissioning of SF6 gas-insulated vacuum circuit breaker switchgear and associated equipment.

1. **Related Documents**

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to this Section.

1. **Submittals**
   * 1. Submit shop drawings and product information in the quantities listed according to the Conditions of the Contract. All transmittals shall be identified by purchaser name, purchaser location and purchaser’s order number.
     2. Approval documents shall include:
        1. General arrangement drawing showing dimensioned elevation and floor plan, foundation details and one-line diagram
        2. Panel arrangement drawing showing layout of devices on the panel doors
        3. Three-line diagrams
        4. Schematics
        5. Nameplate engraving drawings
        6. Electrical bill of material
     3. Final documents shall include:
        1. Documents listed in B above
        2. Wiring diagrams
        3. Recommended spare parts list for start-up support
        4. Instruction manual
     4. Product data: Include features, characteristics and ratings of individual circuit breakers and other components.
     5. Shop drawings: Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components and location and size of each field connection. Include the following:
        1. Nameplate legends
        2. Bus configuration with size and number of conductors in each bus run, including phase and ground conductors of main and branch buses
        3. Current ratings of buses
        4. Short-time and short-circuit ratings of switchgear assembly
        5. Detailed wiring diagrams showing wiring for power, signal and control systems including differentiation between manufacturer-installed and field-installed wiring
2. **Quality Assurance**

Manufacturer qualifications: Engage a firm with at least 20 years’ experience in manufacturing medium-voltage gas-insulated vacuum circuit breaker switchgear. The manufacturer’s proposed product shall have been produced for at least 10 years prior to the due date for the equipment proposal. The manufacturer of the switchgear assembly shall also manufacture the medium-voltage circuit breakers.

* + 1. Comply with requirements of latest revisions of applicable industry standards, specifically including the following:
       1. Gas-insulated switchgear
          1. IEC 62271-200 - High-voltage switchgear
          2. IEC 62271-1 - High-voltage common requirements
          3. IEC 60044-7 – Current transformers
          4. IEC 60044-8 – Voltage transformers
          5. ANSI/IEEE C37.20.2 (Where applicable.) – Metal-clad switchgear
          6. ANSI C37.55 (Where applicable.) – Conformance tests
          7. UL-Listed (Optional. Availability depends on section detailed requirements.)
          8. ANSI/IEEE C37.20.7-2007 – Internal arcing tests
       2. Circuit breakers
          1. 62271-100 – High-voltage circuit breakers
          2. ANSI/IEEE C37.04 - Rating structure for high-voltage circuit breakers
          3. ANSI/IEEE C37.09 – High-voltage circuit breaker testing
          4. ANSI/IEEE C37.06 – Preferred ratings for high-voltage circuit breakers
          5. ANSI/IEEE C37.010
          6. ANSI C37.54 (Where applicable.) – Conformance tests
       3. Current transformers (CTs)
          1. ANSI/IEEE C57.13 – Instrument transformers
          2. IEC 60044-1 – Current transformers
          3. IEC 60044-8 – Current transformers (electronic)
       4. Voltage transformers (VTs)
          1. ANSI/IEEE C57.13 – Instrument transformers
          2. IEC 60044-2 – Voltage transformers
          3. IEC 60044-7 – Voltage transformers (electronic)
       5. Disconnect, isolation and three-position switches
          1. IEC 62271-102 – Disconnectors and earthing switches
       6. General
          1. ANSI/NFPA 70 (NEC)

1. **Delivery, Storage, and Handling**
   * 1. Deliver in convenient shipping groups. Shipping groups shall not exceed 10 feet in length.
     2. Outdoor walk-in single-aisle switchgear shall be shipped fully assembled except for necessary shipping splits for transportation and handling.
2. **Products**

The medium-voltage gas-insulated vacuum circuit breaker switchgear assembly shall be type 8DA10 (single-bus) or 8DB10 (double-bus)

1. **Ratings**
   * 1. System configuration: Switchgear shall be suitable for application in three-phase, three-wire, 50 Hz grounded-neutral system.
     2. Electrical ratings:
        1. Rated nominal system voltage, kV: 6.6
        2. Maximum design voltage, kV: 7.2
        3. Rated main bus current, A: station dependent
        4. Rated interrupting (short-circuit) current, kA symmetrical: station dependent
        5. Rated short-time current, kA:
        6. Rated power-frequency withstand voltage, kV (one-minute):
        7. Rated impulse withstand voltage, kV (BIL):
        8. Continuous current rating of the main circuit breaker:
        9. Continuous current rating of the tie circuit breaker:
        10. Continuous current rating of the feeder circuit breaker:
2. **General Requirements**
   * 1. The medium-voltage, gas-insulated vacuum circuit breaker switchgear shall be metal-clad and shall meet ANSI/IEEE C37.20.2 except for differences related to fixed circuit breaker construction and isolated-phase bus arrangement. All components of the switchgear (for example, circuit breakers, bus bar, disconnect switches, grounding switches, VT’s, etc.) shall be in grounded aluminium metal enclosures. The construction shall withstand forces (repeatedly, without distortion) caused by closing and opening of the circuit breaker. The switchgear shall be capable of withstanding all stresses produced by fault conditions up to and including the rated short-circuit current specified in 2.02.B without damage.
     2. The switchgear shall be classified as arc-resistant with type 2A accessibility, in accordance with ANSI/IEEE C37.20.7-2007 test requirements
     3. Each current carrying component of the equipment shall be capable of continuous operation at the specified ratings without exceeding the maximum temperature rises stated in the ANSI/IEEE and IEC standards.
     4. The switchgear line-up shall be designed and manufactured with provision for future expansion on each end except where the arrangement does not allow extension. Future extension of the switchgear will require the main busbar to be de-energized and the SF6 gas evacuated. Manufacturer shall offer as an option a future bus extension disconnect switch to avoid de-energization of the main busbar. When extending either end of the switchgear, it shall only be necessary to evacuate the bus extension switch SF6 gas compartment and remove end panels for the associated busbars. No other gas compartment shall be affected. The future extension switch will not add any section to the line-up length.
     5. The enclosures housing the primary (medium-voltage) components shall be constructed of gas-tight cast aluminium. Ferrous metal components shall be finished with electrostatically applied paint finish in manufacturer’s standard light grey colour. Mechanism parts not suitable for painting shall be plated for corrosion resistance.
     6. The medium-voltage enclosure shall be factory assembled and modular in design. Medium-voltage components shall be enclosed in cast aluminium, hermetically sealed, single pole (phase) enclosures to eliminate the possibility of phase-to-phase faults in the switchgear.
     7. The medium-voltage enclosure shall be pressurized with SF6 gas to isolate energized components from environmental influences, thus allowing long intervals between maintenance. Minor maintenance of the primary components shall be required at 10-year intervals and major maintenance at 20-year intervals. The switchgear shall be designed so that normal service, inspection, maintenance, grounding of high-voltage cables and elimination of electrostatic charges can be carried out safely with adjacent sections energized.
     8. A continuous ground bus shall run the length of a switchgear group for reliable grounding. Each feeder section housing shall be connected to the switchgear ground bus.
     9. Conductors and connectors for the busbars shall be copper, designed to carry rated continuous current at 40°C ambient temperature and shall withstand the rated short-circuit current specified in 2.02.B. The surfaces of the conductors shall have a smooth finish to prevent any electrical discharges. Disconnect and ground switch contacts shall be silver-plated to provide high conductivity and shall match the rating of the associated busbar or circuit breaker.
     10. The front of each switchgear section shall consist of four separate compartments for the following main components:
         1. Protective relays and controls located in the top compartment. Terminal blocks, CT connections, VT connections and miscellaneous control devices shall be in this compartment. Connection terminal blocks for purchaser’s external connections will be in this compartment. Operation of the switchgear shall not be affected by opening any of the low-voltage compartment doors.
         2. Three-position switch operating mechanism with all serviceable items accessible from the front.
         3. Circuit breaker operating mechanism with all serviceable items accessible from the front.
         4. The lower compartment shall be available for additional mounting of low-voltage components or external connection, if required.
     11. Each section shall have a mimic diagram of sufficient size. The mimic shall be black in colour to contrast with the switchgear finish and be plainly visible to an operator. Mimic diagrams shall show circuit breakers, disconnect switches, grounding switches and busbar connections. Busbar VTs or busbar cable connections should also be shown. The mimic diagram shall be on the front of each section in conjunction with the mechanical switch and circuit breaker position indicators.
     12. SF6 gas compartment: Each busbar to circuit breaker gas compartment shall be suitably divided into separate sections that are isolated by gas-tight bushings. The division of compartments shall consider the effects of faults within the compartments such that in the event of an internal fault, a pressure relief device operates before internal pressure exceeds the design limit of the compartment. The individual gas-sealed compartments shall be capable of being separately evacuated for inspection or maintenance while keeping the adjacent compartments pressurized to rated pressure. Leakage of gas from the switchgear enclosures shall not exceed 0.1% of the gas per compartment per year.
     13. Switchgear feeders shall be compartmentalized in single-phase, isolated-phase construction, with:
         1. A minimum of four gas compartments per standard feeder without optional equipment.
         2. If SF6 gas-insulated busbar voltage transformers are specified, these shall be installed in separate gas housings, isolated from the main busbar by gas-tight bushings with their own gas monitoring and pressure relief system. Busbar voltage transformers shall be furnished with a three-position switch and primary fuses.
     14. The gas compartments shall be provided with ring type seals at intersections between compartments and at positions where sliding or rotating shafts enter a compartment. The seals shall be capable of withstanding the gas pressure of the compartments under all service conditions. Seals shall be O-Ring type.
     15. Pressure relief devices: Each gas compartment shall be provided with a pressure relief device to limit the pressure in the event of an internal fault. Designs without pressure relief are not acceptable. The pressure relief devices shall be designed such that discharges resulting from internal faults shall be directed away from locations where personnel may be present. The preferred location for the busbar pressure relief shall be such that gases are exhausted through the top of the enclosures. All pressure relief device designs shall be proven by arc fault design tests in accordance with IEC 62271-200 and IEEE C37.20.7 standards.
     16. Insulation: Sulfur-hexafluoride (SF6) gas and epoxy cast-resin insulating materials shall be employed for the insulation of primary conductors of each phase from the grounded metal enclosure. The insulating gas shall be pressurized higher than atmospheric pressure. Solid insulators shall be non-hygroscopic, epoxy cast-resin, free from voids and contaminants. The contour of the insulators shall be such that a uniform voltage gradient is produced over the entire surface. Epoxy cast resin bushing-type insulators shall be provided at the intersections between compartments. The bushing-type insulators will support the live conductors and (where necessary) provide a gas-tight barrier between compartments. The design of the gas-tight bushing-type insulator shall be such that it is possible to inspect, maintain, or pressurize each gas section individually without interfering with adjacent gas sections.
     17. Gas monitoring: The gas compartment shall be provided with a pressure indicator. Dry contacts provided on the indicator shall change state if the pressure falls below pre-set limits. A separate gas monitoring system is required for each of the following:
         1. Each main busbar phase (phase A, B and C).
         2. Each set of busbar voltage transformer (VTs) if required. (Three-phase VT compartments shall be monitored together.)
         3. Each circuit breaker. (Three-phase interrupter compartments monitored together.)
3. **Vacuum Circuit Breaker**
   * 1. The circuit breakers shall be vacuum type. Gas, oil or air blast circuit breakers will not be accepted. The circuit breaker shall be designed to withstand impacts and vibrations under rated and short-circuit current conditions. The vacuum interrupters shall be made from a metal alloy that will withstand high switching duties and shall include ceramic insulators securely fused to the end fittings. The moving contact activating rod shall be carried on bellows, protected from the sputtering of molten metal during switching operation by a shield. The terminals of the vacuum interrupters shall be supported using epoxy cast resin supports or bushings. Each circuit breaker shall be provided with a suitable mechanically operated indicating device, marked OPEN and CLOSED in wording or symbols. The indicating device shall be visible at all times from the front of the panel. Circuit breaker operating mechanisms shall be of the motor charged, stored energy type and equipped with a SPRING CHARGED indicator. Circuit breaker mechanisms shall be trip free and designed for operation from a control power source rated at either 24 Vdc or 48 Vdc.
     2. The circuit breakers shall be rated in accordance with ANSI/IEEE C37.06 and IEC 62271-100 and shall have the ratings specified in section 2.02.B of this specification. The rated operating sequence (duty-cycle) shall be O-15 sec-CO or 0-0.3 sec-CO-3 min-CO per ANSI/IEEE C37.04 and related IEC standards and the overall switchgear short-time rating shall be two seconds per ANSI/IEEE C37.20.2 clause 5.4.5. The circuit breaker short-time rating shall be three seconds per ANSI/IEEE C37.04 and related IEC standards. The circuit breakers shall be designed to withstand the transient recovery voltage (TRV) that occurs during the interruption of load currents and short-circuit currents within its rating. The vacuum circuit breakers shall not produce excessive overvoltage because of current chopping. The design shall reduce the current chopping value to less than 5 A.
     3. The circuit breaker operating mechanism shall be in a separate cabinet at the front of the circuit breaker section, allowing access from the front of the switchgear while the primary equipment is in service at any time. The operating mechanism shall be designed for high speed opening and closing of the circuit breaker under all operating conditions. All mechanical parts shall be adequately sized to ensure consistent operation of the mechanism when subjected to forces due to specified short-circuit currents. The maximum difference in opening time between the three poles shall not be more than two milliseconds. It shall be possible to lubricate and service the moving or auxiliary parts of the mechanism by removing the front cover plate.
     4. Closing shall be accomplished by means of a motor charged, spring operated, stored-energy type mechanism with electrical release. It shall not be possible for the circuit breaker to close unless the closing spring is fully charged. A visual, mechanical indicating device shall be provided to indicate the status of the stored-energy closing spring. The indicator shall show charged symbol when the mechanism is fully charged (ready to close the circuit breaker) and a discharged symbol when it is in any other condition. Provisions for manually charging the closing spring shall be provided. Tripping (opening) of the circuit breaker shall be by means of a spring, that is automatically charged when the circuit breaker is closed.
     5. The operating mechanism shall be provided with a shunt release and the necessary auxiliary switches. An operations counter shall be fitted to the mechanism and designed to indicate the total number of opening operations. The operating mechanism shall be provided with the following control and interlocking features:
        1. Local manual close and trip by mechanical push buttons shrouded to prevent inadvertent operation
        2. The operating mechanism shall automatically recharge the closing spring after the completion of a closing operation
        3. A control power cutoff switch for disconnection of the control power
        4. Local electrical close and trip at the circuit breaker
        5. Local-remote selector switch at the circuit breaker with provisions for connection to Purchaser’s supervisory control system, if required
        6. Operations counter.
4. **Disconnecting and Ground Switch**
   * 1. To isolate the circuit breaker and feeder from the system, a three-phase, three-position (Connected-Open-Ready-to-Ground) switch shall be utilized.
     2. The three-position switches shall be in each phase of the bus compartment in separate compartments such that when in the disconnected or grounded position, no live parts are accessible in the interrupter compartment when the main bus is energized.
     3. Access to the three-position switch operating means shall be mechanically and electrically blocked when the circuit breaker is in the closed position to prevent maloperation. It shall not be possible to switch directly from connected to grounded position. A keyed selector shall prohibit simultaneous access to manual disconnect and grounding switch operating means. The grounding position shall allow for safely grounding the feeder circuit by closing of the circuit breaker. The ratings of the three-position switch shall be coordinated with the system ratings. Means shall be provided to allow for visual confirmation of the switch position from the front of the switchgear using a portable computer. The switch positions shall be clearly visible. If view windows are furnished, they shall be illuminated and accessible without opening any access doors. This provision shall be available for use with the switchgear energized. All operations shall be performed without requiring the opening of any doors.
     4. The manually operated mechanism for the three-position switch shall require one operating handle for changing the switch position from connected to disconnected (open). A different handle shall be required for changing the switch position from disconnected to ready-to-ground position. A mechanism operated position indicator shall be located on the front of the switchgear panel and indicate Connected-Open-Ready-to-Ground. Additionally, a mechanical indicator shall be visible from the rear of the switchgear. This flag indicator shall be located on the main shaft of the switch operator.
     5. The three-position switch operating mechanism shall be provided with the following control features:
        1. Local manual operation of the 3-position switch, utilizing two separate operating handles, provided as accessories.
        2. If an electrically operated mechanism is provided, manual operation shall block electrical operation. The operating mechanism shall allow local and remote electrical operation of the disconnect switch with automatic cutoff when switch has reached complete travel between positions.
        3. Auxiliary switches as required for interlocking and remote indication.
        4. The position of the switches shall have a means of visual verification according to ANSI/NFPA 70 (NEC). The use of permanently installed micro-cameras and a laptop computer shall be acceptable.
     6. Where two switching devices (for example, circuit breaker and three-position switch) require interlocking, the interlocks shall be designed to prohibit simultaneous operation of the devices. The interlock system shall prevent either device from being blocked in an intermediate or undefined position. The system shall operate effectively for either electrical switching commands or manual.
5. **Current Transformers (CTs)**
   * 1. CTs utilized with the GIS shall be low-voltage, toroidal type, free from dielectric-stressed cast-resin components and shall be located outside the gas-tight enclosure.
     2. Each main circuit breaker shall have one set of CTs,
     3. Each feeder circuit breaker shall have one set of CTs,
     4. Each tie circuit breaker shall have one set of CTs,
     5. All CTs shall be installed around the outside of the cast aluminium phase housings or around the feeder cables so that the CT is free of dielectric and thermal stress. CTs shall be located on the cable termination side of the circuit breaker.
     6. CTs shall be multi-ratio (MR) as shown on the drawings and shall have a short-circuit ratings not less than that of the associated switchgear. They shall be capable of carrying the rated primary current for a period of one minute with the secondary windings open-circuited as specified in IEEE C57.13 or related IEC 60044-1 standards.
6. **Voltage Transformers (VTs)**
   * 1. VT ratings and locations shall be as indicated on the drawings. They shall comply with the requirements of this section. VTs shall be according to IEEE C57.13 or related IEC 60044-2 standards.
     2. Busbar VTs single-phase, inductive VTs shall be housed in individual SF6 gas filled compartments or shall be solid-insulated metal-enclosed and mounted on the top of the appropriate busbar phase enclosure.
     3. Each busbar VT shall be primary fused (current limiting type) to avoid a bus shutdown resulting from a VT failure. The current limiting fuses shall be in a SF6 gas-insulated housing or solid-insulated metal housing.
     4. The busbar VTs shall be equipped with a three-position switch (Connected-Open-Ready-to-Ground) to allow for maintenance on the busbar VT or fuses without de-energizing the switchgear.
     5. The busbar voltage transformer and fuse housings for each phase shall be connected by a piping system, resulting in an individual gas-compartment and monitoring system for each busbar voltage transformer/fuse set. The pressure shall be monitored by means of an indicator on the front of the switchgear, if they shall be SF6 gas-insulated.
     6. For evacuating and gas filling the busbar voltage transformer, fuse system or replacement of a manometer (pressure gauge), a separate valve with identification label shall be provided.
     7. Each single-phase busbar VT/fuse enclosure shall be provided with its own pressure relief device.
     8. All secondary leads for VTs shall be wired to a moulded-case circuit breaker, located in a corresponding low-voltage compartment.
7. **Cable Terminations**
   * 1. The design of the cable terminations (inclusive of its accessories) shall meet the design objectives of the gas-insulated switchgear, including electrical ratings, loss of SF6 gas, “safe-to-touch”, etc. Cable termination system shall be “CONNEX” (Pfisterer) plug-in cable termination system or approved equal. The design of the complete cable termination shall be suitable for the switchgear short-circuit current and BIL as specified. Cable termination system shall be plug-in type as per DIN 47637 and EN 50181 standards.
     2. The number of cables, size and type for each incoming and outgoing feeder shall be shown on the drawings or provided as an Appendix to this specification. Each termination kit shall include suitable tinned copper braid for connection of the cable ground shield. A copper lug shall be crimped at one end of each grounding braid. A suitable shipping cover shall be provided and fitted securely at each cable termination point in the switchgear. These covers should only be removed just prior to field termination of cables. Shipping covers must be replaced with dielectric-rated cable plugs or dielectric rated covers prior to energization.
     3. Cable preparation and assembly of termination tool kits shall be the responsibility of the purchaser or the purchaser’s installing Contractor.
8. **Metering and Relaying**
   * 1. Multifunction digital-meters shall be UL-Listed or UL-Recognized, microprocessor-based units suitable for three- or four-wire systems. Units shall be mounted on the instrument compartment door and as follows:
        1. For incoming monitoring for main circuit breakers, multifunction power meter with either Profibus or Modbus or DNP3.0communication protocol shall be provided.
        2. For feeder circuit breakers,multifunction power meter with either Profibus or Modbus or DNP3.0communication protocol shall be provided.
     2. Multifunction protective relaying. Microprocessor-based three-phase relays shall be UL-Listed or UL-Recognized and shall be provided as follows:
        1. Main circuit breakers
           1. The relays shall include the following protection functions: 50/51, 50N/51N, 67/67N, 27, 59, 81O/U and 25.
           2. The relays shall provide monitoring of the CT and VT circuits and alarm on circuit failure.
           3. The relays shall provide a graphic mimic display visually indicating the position (open/closed) of the circuit breaker, protection function trip and metering data. Unlimited user-configurable Human Machine Interface (HMI) screens shall allow the user to create unique single line displays with a simple tool or from an existing library.
           4. The relays shall provide key locking to prevent unauthorized switching either local or remote.
           5. The relays shall be capable of internally performing main-tie-main auto-transfer and auto-restore functions.
           6. The relays shall have programmable logic capabilities to permit use in protection and control systems. Programming software must be compliant with IEC 61131 standard for PLC programming.
           7. The relays shall have a modular communications processor to permit field change between Modbus RTU, Profibus-DP, Profibus-FMS, DNP3.0, IEC 60870-5-103 and IEC 61850 protocols. The relays shall be able to support either RS-485 or fiber optic communications.
           8. The relays shall provide complete sequence-of-events recording, time stamped in milliseconds. The relays shall provide oscillography (waveform) capture, with configurable pre- and post-fault data capture times.
           9. The relays binary inputs shall be provided with chatter blocking and filter time. The chatter blocking shall block a binary input indication and prevent the generation of indications when the signal cannot be interpreted. The filter time indicates how long a signal must be present before it shall be interpreted as an indication. This shall serve to suppress short, intermittent changes. These two features shall be available and settable separately for each binary input indication.
           10. The relays shall provide four protection settings groups. Setting group changes shall be available locally through front function key and binary input; remotely through operator or service communication interface using a personal computer and via system interface (Profibus, Modbus, etc.).
        2. Bus protection – full differential
           1. The relay shall be low-impedance percentage differential relays.
           2. The relays shall have three restraint winding inputs.
           3. The relays shall have a through-fault restraint setting to prevent tripping due to high current external faults.
           4. The relays shall have a CT monitoring element to block differential trip if a CT secondary circuit has failed and shall provide alarm function.
           5. The relays shall provide complete sequence-of-events recording, time stamped in milliseconds. The relays shall provide oscillography (waveform) capture, with configurable pre- and post-fault data capture times.
           6. The relay shall have the capability to be applied as single-phase bus relays.
           7. The relays shall have modular communication for simple integration into SCADA systems. The communication protocol shall be either Profibus DP or Modbus RTU or DNP3.0 to IEC 61850.
        3. Feeder protection with communications
           1. The relays shall provide the following functions: 50/51, 50N/51N, 67, 64, 87N, 37, 49, 46, 27, 59, 81O/U, 50BF, 46, 47, 25, 79 and 21FL.
           2. The relays shall monitor the CT circuits and alarm on circuit failure.
           3. The relays shall be capable of being used in a reverse interlocking bus protection scheme.
           4. The relays shall have nine programmable function keys to replace control switches.
           5. The relays shall have programmable logic capabilities to permit use in protection and control systems. Programming software shall be compliant with IEC 61131 standard for PLC programming.
           6. The relays shall have a modular communications processor to permit field change between IEC 61850, Modbus RTU, Profibus-DP, DNP3.0 and IEC 60870-5-103 protocols. The relays shall be able to support either RS-485 or fiber optic communications.
           7. All relay terminal blocks including CT blocks shall be pluggable to ensure ease of relay replacement and maintenance testing.
           8. The housing shall be a sealed dust proof environment for the relay internal electronics. Head build up must be dissipated through the surface area of the steel enclosure. The relays thus shall be designed to maintain their tested insulation characteristic standards per IEC, IEEE, even if deployed in environments not covered in IEEE C37.90 “usual service conditions.”.
           9. The relays must provide 20 flexible functions that shall be used to create additional protection functions to maximize application flexibility.]
        4. Generator circuit breaker protection – Simple overcurrent with communications
           1. The relays shall provide the following protection functions: 59, 51V, 81, 27, 32/32R, 40, 87G, 46 and 51G.
           2. The relays shall provide current differential protection for the generators.
           3. The relays shall monitor the CT and VT circuits and alarm on circuit failure.
           4. The relays shall have programmable logic capabilities to permit use in protection and control systems. Programming software shall be compliant with IEC 61131 standard for PLC programming.
           5. The relays shall recognize and alarm CT open circuit or short circuit conditions.
           6. The relays shall support either RS-485 or fiber optic communications.
           7. The relays shall have modular communication for simple integration into SCADA systems. The communication protocol shall be either Profibus-DP Modbus RTU DNP3.0 to IEC 61850.
        5. Software / data information – relay software
           1. The relay shall be configured through Windows based software current up to Windows XP Pro.
           2. The relays shall provide complete sequence-of-events recording, time stamped in milliseconds under all conditions. The relays shall provide oscillography (waveform) capture, with configurable pre- and post-fault data capture times. All internally and externally generated binary values shall be configurable to appear in the custom generated fault. Information containing time, date, interrupted current amps per phase, time in pickup, trip open, close or user programmed status points, etc., shall be displayed.
           3. Logging of system and protective events, last 200 events (accessible via front RS-232 or 485 communications port and rear service communications port used to connect to a personal computer having an RS-232 or 485 port or USB via conversion).
           4. Log of last eight faults (maximum five second record time) containing date and time stamps, pickup and tripping signals, interrupted current amps, voltage, etc. The analog quantities displayed in the oscillography shall have the option for viewing in either primary or secondary quantities.
           5. Fault records shall be in the industry standard Comtrade format that shall be imported or exported.
           6. The relay shall provide four protection settings groups. Setting group changes shall be available locally through front function key and binary input; remotely through operator or service communication interface using a personal computer and via system interface (Profibus DP, Modbus RTU, DNP3.0, IEC, etc.).
           7. All logging settings, annunciations, fault records, Binary I/O and LED assignments must have easy to print options and easy file transfer capabilities.
           8. Relay software shall have feature for archiving or retrieving an entire project that includes all subfolders and relay files in one simple to use feature.
           9. A measurement supervision feature shall be providing for monitoring external current and voltage transformers connected to the relay.
           10. The software shall have the capability of entering the settings in both primary and secondary quantities.
           11. The current transformer polarities shall be reversible using a setting in the software when it becomes necessary.
           12. The software shall include a commissioning tool for all hardware (BI/BO/LEDs) and SCADA mapped points.
           13. The software shall be compatible with earlier version relay firmware releases.
           14. The software shall have a capability to assign an IP address to the relay allowing for a web browser commissioning tool feature to view relay information online.
        6. Automatic transfer scheme: (if required)
           1. The main circuit breaker protection relay bay controller shall be factory programmed to operate a three circuit breaker transfer (main-tie-main) scheme as indicated on the drawings accomplished through the logic program capability and digital input and output capability of the protection relay/bay controller.
           2. The main circuit breaker relay/bay controllers shall control and monitor the position of the two main circuit breakers and the tie circuit breaker as defined on the drawings. The status of each circuit breaker shall be monitored from each main circuit breaker.
           3. When the voltage and/or frequency protection reaches the transfer setting and maintains that value for the programmed delay period, the automatic transfer sequence shall be initiated.
           4. The transfer shall not occur unless the source to receive the load has voltage and frequency within the specified ranges and is not in overcurrent pickup.
           5. Phase rotation shall be determined by the relays and shall match between sources prior to transfer.
           6. All time delays range and incremental adjustment shall be programmable via software. Settings shall be adjustable at the LCD display and keypad or via software of the normal power supply relay.
           7. An external three-position momentary-type test switch shall be provided for the test-automatic-reset modes. The test mode shall simulate one source failure. The reset position shall bypass the time delays on either the initial transfer to or retransfer to normal.
           8. LED indicating lights on the front of both the normal power main circuit breaker relays shall be set and labeled as follows:

Breaker closed

Alternate source breaker closed

Normal source available

Alternate source available

Trip

Pickup

Local Control

Automatic Control

* + - * 1. One of the function keys on the front of the relay/bay controller for each main circuit breaker shall be labeled Metering. The factory default metering display shall be displayed on the LCD screen by pressing the Metering function key. The screen shall display voltage per phase, current per phase, power functions including watts, vars and VA, power factor and frequency.

1. **Control Wiring**
   * 1. Factory installed, complete with bundling, lacing and protection where necessary and complying with the following:
        1. Flexible conductors of No. 14 AWG for wires across hinges, control and CT and VT circuits and for interconnections between shipping units.
        2. Conductors sized according to ANSI/NFPA 70 (NEC) for the duty required.
2. **Accessories**
   * 1. Voltage indication test LEDs: three voltage indication test LEDs suitable for verification of voltage present at the cable side of the circuit breaker to work with the installed LRM voltage indication system.
     2. Operation tools: set of operation tools shall be provided such as one operation handle for the disconnect switch, one operation handle for grounding switch, one charging handle for circuit breaker, two selector keys, touch-up paint and grease packs.
     3. Video monitor: one laptop computer, one copy of software to view the micro-cameras and required one firewire and one USB 2 cable shall be provided for verification of three-position switch position.
3. **Execution**

**Installation**

* + 1. General: electrical Contractor or switchgear installer shall install switchgear in accordance with manufacturer’s written instructions and the following specifications. The installing Contractor or switchgear installer shall utilize a factory trained and certified service representative to assist in installation and commissioning of the MV GIS.

**Adjustments and Cleaning**

* + 1. Protective-relay settings: Set relays in accordance with the purchaser’s coordination study (not part of this Contract).
    2. Inspect interior and exterior of installed switchgear. Remove paint splatters and other spots, dirt and debris. Touch-up scratches and mars of finish to match original finish.

**Testing**

* + 1. The switchgear furnished under this specification shall be fully tested and documented by certified production test reports in accordance with IEC 62271-200.
    2. As a minimum, the following production tests shall be conducted for the medium-voltage portion of the switchgear in accordance with IEC 62271-200:
       1. Power-frequency voltage (high-pot) test one minute
       2. Dielectric test of auxiliary circuit with 1 kV 1 sec 50 Hz
       3. Measurement of the resistance of the main circuit
       4. Partial discharge test
       5. Mechanical operation test
       6. Pressure test of gas-filled compartments
       7. Gas tightness test of factory gas-filled compartments as per shipping splits
       8. Test of auxiliary devices
       9. Verification of the correct wiring
       10. Measurement of gas condition after filling.

**Warranty**

* + 1. Equipment manufacturer shall warrant that all goods supplied are free of non-conformities in workmanship and materials for one year from date of initial operation, but not more than 18 months from date of shipment.

**Demonstration**

Switchgear manufacturer shall provide a factory-authorized service representative for a period of three days to train Owner's maintenance personnel in the following:

* + - 1. In procedures and schedules related to startup and shutdown, troubleshooting, servicing and preventive maintenance
      2. Review data in the maintenance manuals.

Schedule training with Owner with at least three weeks advance notice.

## MOTOR STARTERS

1. **General**

All starters and controllers shall comply in all respects to BS 587 and/or BS 775; Part 2, and BS 5424: Part 1, and shall form complete individual package units or complete units within the switchboards.

The control and protection arrangement shall be suitable for the type, size, voltage and duty capability of the relevant motor and the supplier shall state in detail the control and protection equipment which he proposes to be used for each type and size of motor.

The starters shall be of the triple pole air breaker type. Unless otherwise stated, for motors up to and including 7.5 kW the starters shall be of the "Direct-on-Line" type capable of operating the relevant motor 15 times per hour, suitable for remote automatic and local push button manual operation.

Unless otherwise stated, for motors over 7.5 kW the starters shall be of a current limiting type suitable for remote, automatic, and local manual operation. The type of starter shall be selected with due regard to the nature of the load being driven to ensure that the starting current does not exceed 2.5 times the full load current. Current limiting starters shall be of the autotransformer, or star delta, soft starter, or Variable Speed Drive type. Electronic soft start devices shall be used for motors above 55kW. The number of starts per hours for each motor rating shall be stated, this generally being a minimum of 5. Details are to be included in the Data Schedules.

In general each motor starter shall be equipped with the following basic equipment:

* Door interlocked, fault make/load break, on load, incoming main circuit breaker.
* Contactors which shall be of the air break type fitted with arc chutes, magnetic blow outs and heavy hard drawn copper main contact. Interlocks shall be provided to prevent simultaneous closure of the start and run contactors.
* Timing relay, where required, shall be electromagnetically-operated controlled timing of contactor sequence; a fully adjustable eddy current retarding mechanism shall be provided where necessary to suit the nature and conditions of the motor.
* Continuously rated operating coil (voltage to suit control conditions of 230 V).
* Auxiliary contacts for remote automatic control
* Adjustable over voltage relay unit
* Adjustable under voltage relay unit
* Overload relay device suitable for adjustment with calibration plates scaled in amperes. A door mounted reset facility shall be provided
* Control circuit fuses and links
* Relay to protect against single phasing.
* Ammeter of the moving iron type mounted on the starter and operated by a current transformer, where justified by rating, and complete with phase selector switch.
* Provision for remote emergency stop button, float controls, etc..
* Hours run counter
* Anti-condensation heater with thermostatic control
* Supply on, Running and Tripped indicator light
* Phase identification lights
* Test facility
* Hand/off/manual selector switches as required.
* Motor winding over-temperature release shall be provided in conjunction with the specified thermistor protection
* Duty selection switch as appropriate
* Manual Stop/Start push-buttons
* Relays to operate in conjunction with anti-vibration protection on larger motors(above 200kW)
* Relays to operate in conjunction with bearing temperature thermocouples on larger vertical spindle motors(above150kW).

\* These facilities shall be door mounted.

Each starter shall be provided with a test facility enabling the control circuits to be energized only when the starter isolator and cubicle door are open. It shall not be possible to close the cubicle door with the test facility still switched on.

General layouts of the switchboards, control panels, etc. shall be submitted for approval before commencing manufacture. The final layout of all switchboards, panels, etc. shall be to suit the motor loads, standby diesel sets and mode of operation.

Suitable relays and timers shall be provided to prevent the simultaneous starting of the pump sets unless the operating and protection systems are designed to accommodate the resulting starting surges.

1. **Instruments, Indications and Alarm**

The operating push buttons, switches or handles of all circuit-breakers, motor starters, isolators, etc. shall be located on the front of cubicles, or for cubicles of the desk type, on the face of the desk. There shall be visual indication of the "ON" and "OFF" positions. The stop push-buttons (and remote emergency stop buttons) shall always be operable and for all modes of operation.

All operations of fault and alarm circuits shall be clearly and individually indicated by lamps on the fascia of the switchboard. Fault and alarm lights shall remain on until the associated fault or alarm condition has been cleared and the system reset. An audible alarm shall also be provided to indicate operation of any major fault or alarm function. Acknowledgement of the major fault or alarm condition shall also cancel the audible alarm.

Indicating lamps shall incorporate a lamp test feature with either individual push to test or a common lamp test button.

Lamps on outdoor equipment shall be shaded from sunlight so that their operation can be clearly seen all times of the day.

Push buttons fitted on the panel shall be of the shrouded type, unless otherwise specified, and shall have a label indicating their function.

Indicating lamps on panels shall be rated to withstand not less than 20% continuous over voltage and shall be so designed that the heat from the bulb does not discolour the panel.

Indicating lamps fitted into the fascia of switch and instrument cubicles or panels shall be adequately ventilated.

Lamps shall be easily replaceable from the front of the panel by manual means preferably without the use of extractors.

The bezel of metal or other approved material holding the lamp glass shall be of an approved finish and easily removable from the body of the fitting so as to permit access to the lamp and lamp glass.

The lamps shall be clear and fit into a standard form of lamp holder. The rated lamp voltage should be 10 per cent in excess of the auxiliary supply voltage, whether AC or DC. For AC circuits lamp units shall be connected to the 110 V supply and shall have an integral transformer providing a 6 V supply to the lamp.

The lamp glasses shall comply with BS 1376 and BS 4099 and are to be in standard colours, red, green, blue, white and amber. The colour is to be in the glass and not an applied coating and the different coloured glasses are not to be interchangeable. Transparent synthetic materials may be used instead of glass, provided such materials have fast colours and are completely suitable for use in tropical climates and remain unaffected by the lamp temperature.

To comply with BS 4099, as a general principle, the following colours shall be adopted:

Green - Supply available but switch, starter, etc., in the open position

White-Switch or starter, etc., closed and plant running correctly

Red- Overload trips operated or major fault on plant

Amber - Warning signal, i.e. overloading of machine, high temperature, etc.

Blue- As necessary for other indication

Indicating lamps and push buttons shall be clouted in accordance with IEC 73 and as follows:

Indicating Lamps Colours

On White

Off Green

Fault Red

Alarms Yellow/Amber

Heaters Blue

Push Buttons Colour

Start Green

Stop Red

Alarm Accept Acknowledgment Black

Emergency Stop Red

A separate indicator light or other means of indication shall be provided for each separate motor protection device to indicate activated.

Live line indication shall be provided at all panels so that the supply status in all compounds, pumps stations or facilities is readily available to operators and maintenance staff.

Indicating light bezels manufactured from plastic will not be acceptable.

All electrical indicating instruments shall comply with BS 89, BS 3693 and IEC 51, be of the moving iron spring-controlled type self-contained instruments to Class 1.5 or better. Instrument size shall be 96 mm square with quadrant scale.

All instruments shall be back-connected mechanisms well protected by strong cases which shall be earthed and fully insulated. They shall be clearly readable with black markings on a white background. A red pointer shall be provided, adjustable (with a tool) from the front of the instrument, to indicate the normal or maximum reading.

Instruments shall be of the industrial grade and shall have a means of zero adjustment from the front without the need for dismantling. They shall be capable of sustaining the normal full load current, voltage, (via current transformer of other transducer as necessary) and shall not be damaged by the effects of faults in the system being monitored. Scales shall be of the 2700 type.

All wiring, space and connections and other items shall be provided for tariff meters, ammeters, voltmeters, selector switches and the like as applicable.

Instruments shall be flush mounted on the cubicles and effectively sealed against ingress of moisture, dust, and insect. Instrument mounting height shall not exceed 1.80 meters above floor level. Unless otherwise specified instrument full scale deflection shall be at least 120% of the normal operating point (i.e. nominal voltage or full load current).

All relay cases shall be black gloss finish.

All voltage circuits of instruments shall be protected by a fuse in each unearthed phase, situated as close as practicable to the point of connection.

Voltage selector switches shall give phase to phase, phase to neutral readings. The class of accuracy of all metres, voltage transformers and current transformers shall be provided with the Tender.

Voltmeters shall be suitable for operating from the secondary side of the 110 V voltage transformer.

Ammeters in motor circuits shall be capable of withstanding the staring current of the motors and shall have a compressed overload scale for this purpose. The full load current shall be defined with red line. Voltmeter scale shall have a red line indicating normal voltage.

Current transformers shall have short circuit ratings not less than those of the circuits with which they are concerned, and shall fully comply with BS 3939.

Separate current transformer shall be provided or protection and instrumentation duties. The rated burden of all current transformers shall be a minimum of 150% of the sum of the burden to be imposed.

All protective relays, where provided, shall be fitted with indicating flags.

Instruments and relays shall be removed from the switchboards for transport and delivery and shall be packed in case and transported and delivered with the associated switchboard.

Where specified, capacitors for correcting power factor shall be incorporated in the panel. Such capacitors shall comply fully with BS 1650.

All motors shall be provided with emergency stop push buttons mounted on or adjacent to the motors, which shall lock out the control circuit and shall require a key to reset the circuit.

1. **Control Panel Cabling**

Control wiring for motor control panels, switchgear, etc., shall be 600 volt grade PVC or XLPE insulated multi-stranded copper wire to BS 6004 or BS 6007. The minimum size shall be 1.5 mm2 stranded conductor.

All terminals shall be referenced and detailed on the schematic diagrams to be submitted to the Engineer.

It shall be possible to gain access to any terminal of any component to be able to remove and replace the wire from that terminal without recourse to special tools, and without the need to disturb other components.

All wiring shall be neatly run bunched in neat forms. All wiring accessories of plastic materials, such as cleats, conduits, strapping, etc., shall be non-corrodible and resistant to flame propagation.

Crimped pin extensions shall be fitted to all control circuit cables to prevent wandering strands before being inserted into clip-on type terminal blocks.

Cabling shall enter the panel from above or below as applicable and as specified elsewhere in the Specification. Cables shall be terminated using external boxes or internal gland plates.

Where necessary cable tray work shall be provided for supporting and fixing cables, and full glanding and terminating equipment and facilities shall be provided. Gland plates shall be mounted not less than 150 mm above the cubicle bottom. It shall be possible to terminate all cables without requiring access to live interiors.

Primary cabling shall be completely isolated from all control wiring, etc., and auxiliary terminals shall be likewise isolated from primary terminals.

All terminal boards and terminal blocks shall be of a type providing a positive mechanical clamp on connection. Terminals for the connection of all external cabling shall be situated near their respective gland plate and at a minimum distance of 200 mm from it.

Separate terminals shall be provided for incoming and outgoing connections and not more than two wires shall be connected to any one terminal.

Supplies for the motor heaters shall be controlled automatically by the main contactor such that the heater is on when the motor is de-energised. Motor heaters shall be separately fused and provided with termination facilities. Details shall be provided for approval.

## SWITCHBOARD AND CONTROL PANEL COMPONENTS

1. **General**

Switchboard and motor control panels shall include all components specified together with the following, fully detailed drawings and manufacturers specifications and component details and catalogues shall be provided for approval.

1. **Air Circuit-breakers**

Air circuit-breakers shall be 3-pole and neutral or 4-pole where used in conjunction with a standby generation scheme, spring-operated, withdrawable type having the following minimum features:

* Mechanical and electrical interlocking.
* Mechanical open, closed, spring-charged, and tripped indication.
* Trip-free mechanism
* Manually or motor wound spring closing mechanism
* Facilities for padlocking
* At least one unused volt-free changeover auxiliary contact, wired down to outgoing terminals.
* Magnetic and thermal adjustable overload, short circuit, and earth fault protection with facilities to prevent unauthorized adjustment.
* Mechanical trip push-buttons

Additionally, and where necessary

* Closing solenoid
* Shut trip coil
* Under voltage trip coil

These features shall be provided to suit the specified operational requirements at the various compounds, the details of which shall be agreed.

If circuit-breaker carriages cannot be comfortably handled by one man, a suitable trolley shall be provided.

1. **Contactors**

Contactors shall be block type, equipped with auxiliary contacts for all necessary indication, local and remote-control requirement together with a means of mechanical indication to show when it is energized. They shall generally be of the triple pole air break type, electromagnetically operated with inherent no volt feature. Each contactor shall have a minimum of three spare auxiliary contacts.

Rating of contractors shall be strictly according to manufacturer's instructions

Contractors shall be suitable for continuous heavy duty and normally fitted with 220 volt coils. They shall be of the robust construction to BS 775, BS 4941, Part 1 and BS 5424 Part 1, 1997 where applicable, and rated at not less than the current carrying capacity of the outgoing circuit.

Contractors shall comply with IEC 158, Part 1 and those for motor circuits shall have made and break capacity of the motor starting current and mechanical duty of double the frequency of starts under the most extreme operating conditions with an absolute minimum of three consecutive starts from cold and five starts in any one hour when hot.

1. **Current Transformers (CT)**

Current Transformers shall be of an appropriate class and accuracy for the application, with outputs such that the combined relay, Instrument and internal burden is not greater than 60% of the rated output of the CT. They shall be securely fixed but have provision for easy removal and replacement. Details shall be submitted for all CT types being supplied.

1. **Fused Switches and Isolators**

Fused switches and isolators shall comply fully with BS 5419 and shall be air-break, door interlocked and pad lockable in the off position, preventing the cubicle door from opening. They shall be mounted on cubicle back plates, with a spindle connecting each switch or isolator to a door-mounted actuator. Spindles shall be kept short or be provided with an intermediate support, so that they readily engage the actuators when the door is closed.

Fused-switch units, where installed, shall be of the flush type, totally enclosed in sheet steel cases and door. Units shall be dustproof and capable of operating on load at the rated current. Contacts shall be heavy duty silver surfaced type, and in open position the fuse elements shall be disconnected from both line and load terminals. HRC fuse elements shall be fitted to each unit, of correct rating for the outgoingconductors which they protect. Where operating handles of the units protrude in front of the board, they shall be of either the removable or telescopic type.

Fuse switches not forming part of composite panel shall be as specified above but suitable for wall mounting in an enclosed sheet steel case.

Fused switches shall be fitted with appropriately rated HRC fuse links in each phase and a solid line in the neutral.

Sufficient auxiliary contracts shall be provided to isolate all incoming power supplies to the cubicle. The fuse switch main contacts shall be open in the test position.

Moving contacts of fused switches shall, for maintenance purposes, be safely and readily removable as a complete assembly when the remainder of the switchboard is energized.

The fuse switch associated with each starter shall be a fully shrouded triple pole unit rated for installed motor duty and shall be housed within the same compartment as the starter with which it is associated and shall be mechanically interlocked with the compartment door.

A padlocking facility shall be provided for locking in the OFF position and minimum of four spare auxiliary contact shall be provided in each unit.

Switch fuse units shall be generally as specified for the fused-switch units and shall be of a similar pattern and from the same manufacturer.

1. **Fuses and Links**

Fuses shall be of the high rupturing capacity cartridge type complying with BS 88 and rated according to their function in accordance with the manufacturer’s recommendations. They shall be fixed inside panels behind a 3mm polished bakelite escutcheon panel which shall be readily removed, and to face the doors, at sufficient spacing to facilitate easy fuse/link withdrawal.

Fuse holders and carriers shall be coloured black, and link holders and carriers white.

Both fuse holder and fuse element where provided shall be correctly rated for the duty required. Fuses and links shall be grouped where appropriate according to their functions and shall be clearly marked both on the panel and the associated wiring diagrams.

Spare fuses shall be provided and fitted into clips within the switchboards, three fuses to be provided for each of the ratings installed. Details to be agreed to suit each switchboard/panel.

1. **Hours Run Counters**

Hours run counter shall be of the cyclometer type, suitable for flush mounting and non-resetable, having 6 digits (minimum) plus tenths, and with a readily visible indicator to show that they are operating.

1. **Moulded Case Circuit-breakers**

Moulded case circuit breakers shall be manufactured in accordance with the requirement of BS 3871 Part 1, BS 4752 Part 1, or IEC 157.

Unless otherwise specified circuit breakers shall be category P2 in accordance with IEC 157 requirements of the fixed pattern, triple pole and neutral, and four pole where used in conjunction with a standby generator unit.

Moulded case circuit breakers shall employ a trip free mechanism capable of simultaneous operation of all poles and providing contract clearance and contact position indication sufficient to allow the circuit breaker to be employed as an isolator. Contact clearance shall conform to the minimum figures specified in draft BS PD 6499 and/or the equivalent IEC standard. Circuit-breaker closing mechanisms shall be manually operated unless otherwise specified.

Unless otherwise specified moulded case circuit-breakers shall be fitted with a thermal overload device to provide an inverse time characteristic and magnetic trip device adjustable for all ratings of MCCB more than 100 A. The following, minimum, features shall be included:

* Mechanical and electrical interlocking
* Mechanical open, closed, and tripped indication
* Trip-free mechanism
* Facility for padlocking without the use of loose components
* At least one unused volt free changeover auxiliary contract, wired down to outgoing terminals, for remote indication.
* Shunt trip coil and under voltage trip where required.

Full details of the units being offered shall be submitted with the Tender.

1. **Miniature Circuit-breakers**

Miniature circuit breakers shall be manufactured in accordance with the requirements of BS 3871, Part 1. Unless otherwise specified miniature circuit breakers shall be category M5 and Type 1, 2, 3 or 4 as specified.

Miniature circuit breakers shall be single pole or triple pole as specified and shall be suitable for the type of load that they feed. They shall be fault rated so that back-fuse protection is not required and shall include clearly marked ratings.

Miniature circuit breakers shall be suitable for bolted or clip fastening to busbar assemblies and may be assembled together to form a distribution board.

Unless otherwise specified miniature circuit breakers shall be provided with manual trip free mechanism and thermal and magnetic trip elements to provide inverse time overload and instantaneous over current operation to the characteristic required.

For special application, as required by the IEE Regulations or as specified herein or shown on the Drawings or in the Schedules, miniature circuit-breakers employing residual current detection and tripping operation shall be employed.

Such units shall be rated to detect and operate at an earth leakage current of 30 mA, unless specified otherwise.

RCD's shall be used in conjunction with, and not in place, of miniature circuit breakers, the MCB's providing the overload and short circuit protection requirements of the circuit.

1. **Overload Relays**

Overload relays shall be of the thermal type with inherent ambient temperature compensation and single phasing protection. They shall be of the manual reset type, having mechanical indication of the tripped conditions, respectable without opening the compartment door.

Calibration shall be adjustable between 80 and 150% of motor full load current.

On motor drives, of 100 kW and above, over current relays shall be of the definite minimum and inverse time limit pattern.

1. **Voltage Protection Relays**

Regulation at certain towns has proven to be a source of plant failure and damage. Adjustable protection relays suitable for providing both under voltage and over voltage protection shall be included within the starter units. Full details shall be submitted with the Tender. The relay units shall suitable for voltages of + 10% and - 15% of the nominal voltage.

1. **Phase Failure Relays**

Phase failure relays shall be connected to all phases and neutral and shall de-energise at or below 90% of rated voltage on any one or more phase. The relays shall be separately fused with contacts wired down to outgoing terminals.

1. **Push Buttons**

Push buttons shall be at least 25 mm in diameter with chromium plated or similar Bezels. Plastic Bezels will not be acceptable.

They shall generally match indicating lamps in style, start push button being recessed to prevent accidental operation.

Emergency stop push buttons shall be of the "stay put" mushroom-headed type. Composite motor control panels shall include a door mounted emergency stop button that will automatically shut down all pumping

1. **Relay Units**

Relay shall be either of the plug in or block type.

Plug-in relays shall be fitted with transparent plastic dustproof covers, retaining clips andbases into which the relay plugs and external connection, made using easily accessible screw clamp terminals. Bases and relays shall be keyed to prevent relays being plugged into incorrect bases.

Block type relays shall be totally encapsulated.

Relays shall have changeover contacts and a means of visually indicating that they are energized.

The pin configuration of each relay shall be printed on the casing and on the schematic diagrams.

Time delay relays shall be of the multi-pin plug-in type and adjustment for increasing and decreasing the timing period shall be clearly marked.

1. **Residual Current Devices (RCD's)**

Residual current devices shall be back connected (behind the door), current operated, with a sensitivity of 30mA, door mounting so that the test push-button and operating lever is readily accessible.

Operation of RCD's shall not be impaired by any DC component in the current.

1. **Selector Switches**

Selector switches shall be of the rotary type spring loaded to ensure clean controlled operation having bezels at least 50mm square with all switch positions fully and clearly identified.

They shall be equipped with sufficient contact of the correct rating and type, if necessary by means of auxiliary relays, to enable all control/indication/alarm requirements to be fulfilled.

Operating handles shall be interchangeable and securely fixed to the switch mechanism by a keyed shaft and recessed retaining screws.

Where lockable switches are provided it shall be possible to operate them without the key, but also possible to lock them in any positions and withdraw the key.

1. **Terminals**

Removable DIN rail terminals shall be provided for all wiring, mounted at an angle to provide ease of access, with centre-disconnecting like type terminals for analogue signal circuits, isolation or test purposes, sufficient, suitable sized earth terminals, and earthing end stops

All terminal boards and terminal blocks shall be of a type providing a positive mechanical clamp on connection. Terminals for the connection of all external cabling shall be situated near their respective gland plate and at a minimum distance of 150 mm from it.

All main phase terminals shall be suitable marked to ensure that the correct phase rotation is obtained when the plant is connected to the supply.

Separate terminals shall be provided for incoming and out-going connections and not more than two wires shall be connected to any one terminal.

Barriers shall be provided on all banks to group terminals into logical divisions and between power terminals of different phases.

Control terminals shall be separated from power terminals.

Outgoing terminals shall be grouped on a common rail in the termination section. Each group shall comprise terminals common to a motor starter reference or alternatively, for control circuit wiring, grouped or barriered according to the voltage levels.

In all cases care shall be taken to ensure that terminals are easily accessible after all wiring has been installed and terminated. All connections shall be made on the front of terminal blocks.

No more than two conductors shall be connected to one side of a terminal. Outgoing cables shall be wired so that all panel wiring is connected to one side only.

The terminal numbers, voltage grouping, and terminal block layout shall correspond precisely with wiring diagrams so that quick and accurate identification of wiring can be made.

All terminals shall show the circuit wire number reference.

1. **Thermostats**

Thermostats shall be of the tamperproof adjustable type, with a range centred on the temperature at which they will normally be set and not close to one end. They shall not be mounted close to heat-generating equipment.

1. **Timers**

Timers shall be of the electronic, synchronous or cam type only depending upon the application. They shall have linearly calibrated scales, in units of time, each scale division being a maximum of 5% of full scale. Repeat accuracy shall be within 0.5% of full scale.

Electronic and synchronous timers shall be of the plug-in or block type, provided with "energized" and "timed out" indicators. They shall be surface mounted when within cubicles but where front mounted to give operator access, they shall be flush mounted and provided with a lockable cover to prevent unauthorized interference.

Plug-in units with retaining clips shall plug into bases to which external connections are made using screw clamp type terminals that are easily accessible. Timers and bases shall be keyed to prevent mismatching.

The pin configuration of each timer shall be printed on the casing.

1. **Transformers**

Small transformers for auxiliary supplies shall be double wound, screened, and suitably rated, with all windings of copper and terminals fully shrouded. Each transformer shall be provided with an indelibly marked and permanently fixed label to indicate ratio, rating, voltage, currents, and connections.

Primary and secondary circuits shall be fused (or MCB protected) and neutral linked with one side of the secondary earthed.

Where 110 V socket outlet supplies are required transformers shall have a centre-tapped earthed secondary winding, both ends of the winding being fused.

1. **Spare Ways**

The drawings generally indicate the number of spare circuits that are to be provided and equipped under this Contract as part of the manufacture of the switchboards, motor control panels and distribution boards. Where spare ways have not been indicated, the following shall apply.

For switchboards, a minimum of two spare, equipped, ways shall be provided, the rating of the protection devices being commensurate with those shown for active circuits.

For motor control panels, a minimum of two spare equipped ways shall be provided, the spares relating to the provision of the protection, MCCB or similar but not starters. However, space shall be provided for the inclusion of future starter units. The ratings of the protection devices shall be commensurate with those shown on the drawings.

A minimum of two TP/N spare, equipped ways shall be provided in distribution boards, the ratings being commensurate with those shown on the Employer's Drawings. In addition, a minimum of two blanking plates shall be provided for the future inclusion of additional circuit breakers.

Details shall be submitted for final agreement and approval.

## SWITCHBOARD AND PANEL WIRING

Ample wiring space shall be provided within the switchboards and panels and all wiring shall be carried out in a neat and systematic manner with cable supported clear of the panels and other surfaces at all points to obtain free circulation of air.

In all cases, the sequence of the wiring terminal is to be such that the junction between multi-core cables and the terminals is effected without crossover. Insulated bushes are to be provided where necessary to prevent the chafing of wiring.

All panel wiring is to comply with the requirements of BS 6231 Type A or B, as appropriate. Conductors are to be copper and have a minimum cross section equivalent to 7/0.67 mm (2.5 mm2) or 1/1.78 mm (2.5 mm2) but single stranded conductors should only be employed for rigid connections, which are not subject to movement or vibration during shipment, operation, or maintenance. Flexible conductors equivalent to 30/0.25 mm (1.5mm2) or smaller sizes generally shall only be employed with the written approval of the Engineer.

No wire may be teed or jointed between points.

Electrical wiring and instrument are to be located so that leakage of oil or water cannot affect them.

Bus wiring between control panels, etc., is to be fully insulated and to be completely segregated from the main panel wiring.

All metallic cases of instruments, control switches, relays, etc., mounted on control panels or in cubicles, steel or otherwise, are to be connected by means of copper conductors of not less than 2.5 mm2 section to the nearest earth bar. These conductors may be bare or have insulation coloured green or green/ yellow striped.

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. Also colour coding of remote control and local control wiring shall be provided. Voltage of control systems shall be clearly stated.

Colour coding shall be:

Red - Red phase

Yellow - Yellow phase

Blue - Blue phase

Black - Neutral

Green/Yellow - Earth

Grey - 110 V AC

White - D.C

Cable for specialist applications such as co-axial shall be of an approved type.

All wiring shall have crimped terminations, only one wire being held by any one crimp. Crimped lugs shall be of the insulated type without conductor exposure between the crimps and wire insulations.

The type of crimp used shall be appropriate for the type of terminals to which it connects.

Terminations shall be neatly arranged leaving adequate length for one additional termination.

Wiring shall be neatly laid in limit compression insulated cleats, insulated straps or, where more than ten wires follow the same route, in plastic slotted-sided trunking with clip-on cover. Where trunking is used, the ratio of effective overall cross-sectional area of cables shall not be greater than 40% of the trunking cross sectional area.

Hoes in steelwork, etc., through which cables pass shall be protected using nylon grommets, or edging strip suitable for the size of hole.

Cables used for control, extra low voltage, and instrument signal transmission likely to be affected by interference shall be screened and or spaced from each other and from heavy current power cables, at a distance to ensure that resultant electrical "noise" is insufficient to cause any form of malfunction of associated equipment.

All wiring shall be identified at each end by means of glossy plastic ferrules showing the wire number as on the schematic diagrams. Ferrules shall be colour coded, 'Z' type and indelibly marked.

## ELECTRIC MOTORS

1. **General**

All motors shall be of a make approved by the Engineer and shall be suitable for operating from the specified power supply. Motors shall comply in all respects with the relevant parts of BS 4999 and BS 5000, and shall be designed to run at high power factor and efficiency but not less than class IE3 at the prescribed plant duty.

Motors shall be three phase, squirrel cage, induction type, continuously rated for the heaviest specified duty, totally enclosed, and suitable for operation on the electricity supply and determined by the Contractor in relation to the power requirements, ambient temperature, altitude and normal working conditions of the mechanical plant offered.

The starting (locked rotor) current of any motor shall not exceed 6 times the full load operating current, Motor starting torque shall be at least 120% of the pump torque requirements throughout the starting sequence. Motors shall be capable of running backwards at rated speeds under backflow conditions without damage to the motor.

In addition to the requirements of BS 5000, the motors shall be capable of satisfactory operation with a frequency variation of ±=5% above or below the normal frequency of 50 Hz.

The design of the motor shall be adequate in all respects for the number of starts per hour required when the pumping plant is in normal operation but never less than 5 starts per hour.

Where an insulation Class is specified the requirements of BS 4999 shall be met. The limit of temperature rise shall be for the appropriate Class of insulation quoted. Class H insulation shall be provided, but with Class B temperature rise limitations.

Motors shall be fitted with locating type bearings and/or heavy type thrust bearings at the non-drive end and roller type bearings at the drive end and according to the type of motor offered, but all bearings shall be of adequate proportions and design suitable for the particular application, and shall have ample capacity all allow the pump to operate for short periods with the discharge valve closed.

Details of the bearing types being proposed, grease, oil, shall be submitted for all the motors together with details of the grease lubricated bearings for horizontal split case motors.

The motors shall be built of high-grade components and materials in accordance with the best practice for the type of plant offered.

Motors 5 kW and above shall be fitted with temperature sensitive thermistors embedded in the motor to control a winding over-temperature relay mounted in the control cubicle. Each motor shall have at least 3 thermistors. The thermistors shall be suitable for connection to a monitoring unit in the motor control circuit to provide protection against winding failing due to overheating. The motor starters shall trip in the event of high winding temperature being experienced.

The motors shall be capable of delivering a minimum of 10% more than the maximum power absorbed by the equipment being driven. The motors, where practicable, are to be selected to provide an element of commonality, thus flexibility in use at each site, particularly dosing pump motors.

Only ISO standard roller and/or ball grease lubricated bearings shall be fitted.

The grease lubrication shall be applied using hydraulic type nipples, which are freely accessible, without, and dismantling, or otherwise piped out to a readily accessible location.

“Sealed for life" bearings may only be used with the approval of the Engineer.

Continuously rated anti-condensation heaters shall be installed in all motors above 5 kW that are to be installed or in damp or cold environments. The supplier shall size them to suit the motor frame size.

Heaters shall be located within the motor so that the heat dissipated does not damage the insulation of any of the windings or associated cables.

Terminals boxes shall be separated from the frame and shall be reversible to allow cable entry at the top, bottom or either side, suitable for cable glands required. Terminal mountings shall be arranged such that the motor supply wiring can be disconnected without disturbing its internal connections.

The end of each winding shall be brought out to a separate terminal, connecting links being provided to facilitate interconnection of individual terminals.

A diagram of connections shall be fixed inside the terminal box cover, which shall be provided with watertight, oil resisting gaskets.

Where motor anti-condensation heaters are fitted, additional terminals and a separate cable gland entry shall be provided. A warning label on the terminal box cover shall be provided stating" WARNING, LIVE HEATER TERMINALS, ISOLATE BEFORE REMOVING COVER".

Plates shall be fixed on each motor, giving the following information:

BS No \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ No. of Phases \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Manufacturer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Motor kW \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Serial No \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Votage \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Insulation Class\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Current at FL \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Frequency \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Speed \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

IEE Efficiency class-----------------

All motors rated more than 160 kW shall be fitted with suitable vibration control devices to automatically shut down the motor in the event of excessive vibration. The Contractor shall stipulate the vibration tolerances associated with each motor rating above 100 kW and shall recommend appropriate control devices, details of which shall be submitted for approval. The tolerances must be within the limits stipulated by the British Standards or IEC

For motors larger than 100kW, kilowatt hour meters, with maximum demand indicators shall be provided.

Vertical spindle motor units rated more than of 5 kW shall be fitted with a thermocouple at the upper thrust bearing to shut down the motor in the event of the bearing temperature exceeding a recommended value. Details shall be provided for approval.

Motor that are water-cooled shall include suitable protection to safeguards against the lack of water flow.

Where required by the specified operation system, motor circuits shall include suitable rated rotary off, manual or automatic switches.

The Contractor shall submit details of the painting specification and colour range being proposed. The Employer will finally decide on the colour, this being accordance with the manufacturers standard colour charts.

All motors shall be provided with two earthing terminals.

The motors shall be commercially silent in operation and shall run free from vibration. They shall be of robust design with frames and covers constructed in cast iron. Fan covers, and cowls shall be of a strong and durable material (plastic, PVC or GRP will not be acceptable). The rotors shall be fully keyed to the shafts and shall be balanced both statically and dynamically.

Motors shall be labelled to correspond to their respective starters. These shall be at least 40mm x 75 mm x 2mm in stainless steel on non-ferrous metal. Details shall be agreed.

Air vents and other opening where provided would be screen protected.

All the motors shall be to class IE3 (premium) efficiency.

1. **Submersible Motors**

A submersible motor shall be capable of continuous operation under water at the conditions specified. Heater requirements do not apply to these units.

The motor shall be installed vertically and rigidly coupled to the multistage/single stage submersible pump such that both the pump and motor are completely flooded. The windings of the motor shall be insulated with an approved waterproof plastic or other approved material as recommended by the manufacturer. The motor shall be squirrel cage rotor motor with the rotor suitably supported in lubricated plain bearings.

The cable from the motor shall be sealed at its exit by a watertight cable gland. Sufficient cable shall be provided to meet the installation requirements. For all submersible pumps the motor shall be stainless steel.

1. **Surface Motors**

Surface mounted motors shall be weather proofed fully tropicalised, and suitable in all respects for external operational duties in the climatic conditions prevailing. The connections of the motors shall be brought out to terminals at the side of the frame and properly clamped and terminated within a cable box complete with correct gland to accept the size and type of cable specified. In general, the glands shall be downward pointing at an angle to pass the cables clear of the base frame and plinth.

1. **Cable for Submersible Motors**

Cables for submersible motors shall be a 600/1000 volt grade multicore cable and consist of conductors of high conductivity tinned copper wire, EPR insulated and with super tough rubber sheath. The cable shall be suitable for suspension within a borehole approximately 60-300 meters deep and shall include all necessary internal support (i.e. steel core or similar) to prevent undue strain being imposed on the cable conductors. Two clips shall be supplied for each length of riser.

Details of the cable proposed shall be provided with the Tender.

1. **Emergency Stop/Lock-Off Push Buttons**

Emergency stop/lock-off push buttons shall be provided adjacent to the pumping units specified. Each shall be of the surface mounted weatherproof push to break and mushroom type with latching device to resist the push button return movement so that contacts remain normally open unit the latch is released by a counter clockwise direction.

The buttons shall be robust and watertight suitable for the environment at the various location, with IP enclosure. Certain stop buttons will be wall mounted, others will be mounted on frames 1,000mm above the floor level, as stated in the Particular Specifications. The frames, boxes, terminations, screws, and fixings shall be supplied.

1. **Power Factor**

The overall power factor of the plant under any load or operating condition shall not be lower than 0.92 lagging. Power factor correction capacitors shall be provided for each motor above 5 kW rated output. In addition, capacitors shall be fitted to smaller motors and necessary to maintain the minimum power factor specified above.

1. **Safety Devices and Controls**

The control requirements for the pumping plant have generally been specified elsewhere. The Contractor shall include for all requirements to meet both the manual and automatic control of the plant and pump sets. In addition to the safety devices already specified, the Contractor shall provide for other protection devices and equipment that are necessary to protect against any operating conditions which would be liable cause damage to the plant, for example, lack of water at the pump suction.

1. **General**

The variable-speed drives shall be purposely designed and manufactured for pumping applications. The variable-speed drives shall be suitable for all loads with variable torque characteristics.

The variable-speed drives shall be capable of starting and running high inertia loads such as centrifugal pumps.

The variable-speed drive supplier shall carry a comprehensive range of spares, which shall continue to be available for at least 5 years after the production of the variable-speed drive model has been discontinued.

The variable-speed drives shall be compatible for use with the various asynchronous squirrel cage induction motors typically used to power pumping plant.

The variable-speed drives shall be of sufficient capacity and shall produce a quality low distortion output waveform to achieve full rated nameplate shaft power output of the motor. The variable-speed drives shall be capable of operating any standard squirrel cage induction motor of the specified variable-speed drive’s power rating without any modifications to the motor or the variable-speed drive.

1. **Design**

The variable-speed drives shall be fully digitally controlled.

The variable-speed drives shall consist of the following major components:

* full-wave bridge 6 pulse rectifier;
* DC link capacitors;
* Inverter stage with Insulated Gate Bipolar Transistor (IGBT) or Integrated Gate Commutated Thyristor (IGCT) power modules across the entire range (GTO or BJT devices shall not be acceptable);
* Control and display panel.

The variable-speed drives shall have high efficiency and have low maintenance requirements. The variable-speed drives shall provide an adjustable output frequency and voltage utilizing the principles of Pulse Width Modulation (PWM) or Direct Torque Control designs. These techniques shall provide full nameplate motor voltage as well as distortion free sinusoidal currents at the terminals of the motor to obtain full motor rated torque at rated frequency. The operating characteristics shall not exceed those recommended by the motor manufacturer.

The mechanical design of variable-speed drives shall adhere to the following guidelines;

* the internal layout of the variable-speed drives shall maintain separation between the control signals and the power conductors to minimize EMC noise related problems;
* the variable-speed drives shall be assembled in such a way as to facilitate easy maintenance;
* the location of the nameplate or label of the variable-speed drives shall be easily accessible and contain all the necessary information to determine the variable-speed drives rating and to also assist with identification;
* all incoming and outgoing cables shall enter and exit from the top and/or the bottom of the variable-speed drives;
* gland plates shall be provided as standard for the correct fitting of cables with cable glands to ensure safety and reliable operation;
* The variable-speed drives shall be of compact design and have the ability to be mounted side-by-side without separation for greater space saving.

The variable-speed drives enclosure shall be protected to a minimum IP20.

1. **Standards**

The variable-speed drives shall be designed and constructed in accordance with the requirements of the IEEE standards.

The variable-speed drives shall be UL and cUL listed for power conversion equipment for use in pollution degree 2 environments and labelled accordingly.

The variable-speed drives units shall be certified for compliance with the following standards:

|  |  |
| --- | --- |
| BS EN 60146-1-:1993,  IEC 60146-1-1:1991 | Semiconductor converters. General requirements and line commutated converters. Specifications of basic requirements. |
| BS EN 60204-1:1998, IEC 60204‑1:1997 | Safety of machinery. Electrical equipment of machines. General requirements |
| BS EN 60204-11:2001,  IEC 60204‑11:2000 | Safety of machinery. Electrical equipment of machines. Requirements for HV equipment for voltages above 1000 Vac. or 1500 V d.c. and not exceeding 36 kV |

The variable-speed drives, when installed in accordance with the recommendations and guidelines of the variable-speed drives manufacturer, shall comply with the requirements of the EMC Directive as defined by the EMC product standard for power drive systems BS EN 61800-3:1997 “Adjustable speed electrical power drive systems. EMC product standard including specific test methods.”

The variable-speed drives shall be factory tested upon asynchronous induction motors using a variety of user parameters. The factory tests shall simulate operation within actual variable-speed drive installations. The variable-speed drive supplier shall provide copies of the Certificates of Type Test and the factory tests carried out on the particular equipment to be delivered to site and signed by the Engineer or his authorised representative.

The variable-speed drives shall meet or exceed the following standards:

|  |  |
| --- | --- |
| BS EN 61800-2:1998,  IEC 61800-2:1998 | Adjustable speed electrical power drive systems. General requirements. Rating specifications for low voltage adjustable frequency a.c. Power drive. |
| BS EN 61800-4:2003 | Adjustable speed electrical power drive systems. General requirements. Rating specifications for a.c. power drive systems above 1 000 V a.c. and not exceeding 35 kV. |
| BS EN 61800-5-1:2003 | Adjustable speed electrical power drive systems. Safety requirements. Electrical, thermal and energy. |

Protection functions and features

The variable-speed drives shall include the following protective features to ensure the security and safe operation of the plant:

* ability to disable panel buttons whilst in remote control mode
* parameter protection with 2 levels of setting
* automatic restart after a fault, etc.
* expansion to serial communication network using RS485 and simple protocol (USS).
* closed loop internal PID control for regulation.
* ability to have selection between MANUAL and AUTO through use of selector via variable-speed drives digital input terminals.
* ability to provide optional AC line reactors for power factor improvement, harmonic control, prevention of zero voltage notching or surge protection from low impedance supplies.

1. **Control signals**

The variable-speed drives shall have two analogue inputs (0-10V or 0/4-20mA) and six fully programmable digital inputs.

The variable-speed drives shall accept any of the following speed setting input signals:

* 0-10V DC;
* 0-20 mA or 4-20 mA;
* Motorized potentiometer using up/down digital inputs;
* Fixed frequencies using digital inputs;
* RS485;
* Keypad display for local hand operation.

The variable-speed drives shall have at least one analogue output signal (0/4-20mA) which can be programmed to:

* output frequency;
* output current (load);
* DC-Iink voltage;
* motor torque;
* motor speed;
* set point frequency.

The variable-speed drives shall incorporate two volt-free outputs (240VAC, 1A) for remote indication of following:

* motor running;
* set point speed reached;
* fault indication (over-temperature, over-current, etc.);
* PID high and/or low speed limits reached.

The variable-speed drives shall have an RS485 interface as standard allowing the variable-speed drives to be used in conjunction with an external system within a multi-drop LAN configuration. The interface shall allow all the various parameter settings of the variable-speed drives to be programmed via BMS control. In addition, the variable-speed drives shall have the capability to retain these setting within the non-volatile EEPROM memory.

The variable-speed drives shall incorporate a clear and easy to operate user-interface panel. The preferred design is to have a 4-digit green LED display with a membrane keypad.

The information to be displayed in the variable-speed drives display mode shall be:

* output frequency;
* speed of motor;
* status of motor (running, stop, fault, etc);
* motor current per phase
* motor torque
* fault status
* PID feedback signal
* DC-Iink voltage
* set point frequency
* motor output voltage per phase to neutral and phase to phase
* serial link status

## GENERAL SERVICES

1. **Labels and Notices**

Labels shall be provided to describe the duty of or otherwise identify all items of equipment, mounted internally and externally, with clear, concise, and unambiguous wording. Each label shall be permanently secured to the panel surface adjacent to the item to which it refers but not to trunking covers or other readily removable items, using plated screws.

All component labels shall have circuit designations, which can be easily correlated with the drawings. Labels shall be provided on or adjacent to fuse carrier bases, where provided, to indicate the rating of the fuse to be employed. Labels shall be manufactured from laminated plastic or similar white/red/white for danger and warning labels. Otherwise white/black/white. Edges shall be beveled and lettering at least 5 mm high. In addition to component labels, each cubicle door shall bear a large identification label (minimum lettering size 8 mm), whilst each panel shall bear a large overall identification label (minimum lettering size 12mm). In addition to individual terminal number each group of terminals shall be provided with a "Function Description" label.

Warning notices, in red lettering on white background, shall be provided on all automatic start-up equipment.

Component "stick on" block diagram identification labels shall be fixed to the inside of each cubicle and starter panel.

The diagrams shall match the component layouts so that easy identification of all components is possible.

1. **Shrouding**

Shrouding shall be provided such that it is not possible to touch a live conductor, with or without a tool, unless a positive step has been taken (using a tool) to remove a cover, shroud, etc. All such covers and shrouds shall bear adequate labels identifying the potential danger.

1. **Control Circuits**

All circuits shall be designed as far as possible to fail to safety. Generally, control relays shall de-energise for the safe condition.

Safety interlocks, designed to prevent injury to personnel or damage to equipment, shall be direct in operation.

Circuits shall be as simple as possible subject to necessary operational and safety constraints, involving a minimum number of components.

Where automatic control of several items of equipment is provided by a PLC, then a simple back-up automatic control system, independent of the PLC, shall be provided to give rudimentary unmanned control in the event of PLC failure. Such a system need not to be efficient or even provide 100% plant availability, but it shall come into operation automatically in the event of normal control system failure.

1. **Steel Conduit and Fittings**

Steel conduits and fittings shall comply with BS 4568, 4607 and 6099 as appropriate. Distance type saddles shall be use for all surface-exposed steel conduit.

Conduits shall be installed in such a manner that all cables can be drawn in after erection by means of a draw-in tape. Conduit joints shall be painted with approved metallic paint. Elbows and tees shall be avoided where practicable, and normal bends or sets used. Exposed outlet boxes shall be cast metal type, and flush boxes shall be cast or sheet metal. No knockouts shall be removed unless used. Where conduits enter sheet metal boxes they shall be lock-nutted back and front. Burrs and obstructions shall be removed before installation of boxes and conduits.

No conduit shall be smaller than 20 millimetres in diameter

Boxes shall generally be galvanized steel, small, circular 60mm type with steel covers.

Adaptable boxes shall be galvanized steel with overlapping lids but without "knockouts".

Brass round or cheese head screws shall fix box covers.

1. **Plastic Conduit and Fittings**

Plastic conduit, where approved for use by the Engineer, shall be heavy gauge, high impact, Fittings, fixing and accessories shall be of the same manufacture and colour as the conduit.

All accessories shall be fitted with earthing terminals.

1. **Trunking**

Trunking shall be heavy duty, galvanized, minimum coating designation being grade G275, manufactured from grade Z2 steel.

1. **Cable Tray and Accessories**

Galvanised cable tray shall be perforated, heavy-duty return flange type, hot dipped galvanized after manufacture.

Plastic coated cable tray shall be diamond pattern, heavy duty, black PVC covered.

Rigid PVC cable tray where approved for use by the Engineer, shall be manufactured from rigid Unplasticized PVC having a thickness of not less than 3.0 mm. It shall be perforated and have provision for a cover. The material of manufacture shall be self-extinguishing or non-flammable and suitable for use in ambient temperature of -20 to -800C.

Fixings shall be carried out using manufacturer's recommended brackets and supports.

1. **Low Water Level Sensor**

Low water level electrode sensor units, shall be provided within all infiltration gallery central sump and within certain storage tanks and water inlet chambers. The sensor shall be supplied complete with all required cabling, fixings, and terminations. The units required for installation within the boreholes shall be complete with two clips for each length of riser.

These shall be programmed to initially give a warning but eventually shall be able to stop the pumps running in case of no fluid.

1. **Sump Pump Controls**

Submersible drainage pump units shall be supplied complete with suitable float operated on-off controls. The pump units shall be supplied with control panels/starter units as specified, cables, supports, fixings as required.

1. **Coordination**

The Contractor shall be fully responsible for the necessary liaison and coordination of all works on site.

Cross site cable runs shall be basically as indicated in the drawings. However, the final routes and layouts shall be to suit pipe work, drainage, cables, foundations, and the like. The Contractor shall produce drawings for approval indicating the proposed routes of his cable. These shall in general follow an agreed service reserve.

1. **Locks**

Sufficient padlock with individual keys of a type approved by the Engineer shall be provided for locking the following items.

* Lockable, lock-off, isolating fuse switches and feeder pillars and the like, and
* Inter-locks, lock-off, ACB's (and/or Castelle interlocks)

Each shall be provided with four keys and be individually identified.

1. **Continuity**

All conduits, trunking, duct, trunking, cable tray etc shall be mechanically and electrically continuous thought. Where steel conduits cross expansion joints, flexible steel conduit sections, PVC served, shall be inserted, or other approved means used to provide the necessary continuity and flexibility.

1. **Radiated Interference**

The Contractor shall ensure that radiated interference from all items of Plant is suppressed to the limits specified in BS 800 and BS 833.

## EARTHING

1. **General**

The system of earth on the LV reticulation will generally be TN-S as defined in the IEE Wiring Regulations (16th Edition). Earthing systems shall comply BSCP 1013 and BS 7430 and the current edition of the IEE Wiring Regulations. Separate earth protective conductors shall be employed throughout on mains, sub-mains and all final circuits.

As a minimum the metalwork of all items of electrical plant, electrical system neutral points, power and control cable armouring and screens, and extraneous metalwork including structural steelwork and pipe work, shall be connected to the earthing installation.

Earthing continuity in non-electrical plant shall normally be achieved via metal to metal faces, metal hinges, and metal fixings. Earth straps shall only be supplied where earth resistance is high or there is risk of corrosion or similar which could in the future increase resistance and affect earth continuity.

All structural steelwork within the site shall be bonded to the earth system.

All pumping plant shall include an earth continuity conductor or tap which shall extend from the pump/motor frame/bed plate to the main station/switchboard earthing system.

The final arrangement of the earth electrode system shall be to the requirement of the supply authority and to the satisfaction of the Engineer.

The earth resistivity at the sites may vary and the Contractor shall include for taking earth resistance reading both before and at least once during construction, and one final reading, at every earth point to ensure the specification values are obtained.

Each system shall be varied according to the immediate location. Each local earth system shall be installed progressively until the value of earth resistance is obtained to the satisfaction of the Engineer.

At the various compounds, an earth busbar system shall be supplied, connected to earth electrodes, to which the following shall be connected.

* Star points of all transformers on the medium voltage side.
* Sheathing of cables.
* Metalwork at the compounds, other than carrying cables.
* Earth wires from equipment, external to main pump stations that is fed only from that pump station.
* Main incoming water pipes.
* The building metallic structure.
* The lightning protection system where provided.
* Fencing as finally agreed.

The earthing continuity of each metal sheathed cable shall be maintained by efficient bonding between the cable sheath, the gland, and the metal case of the switchgear or other metal clad accessory or appliance at which the cables terminate. In addition, ICEW's or BCEW's shall be run with all cables as specified or as shown on the drawings.

3 Core cables may be used to single phase items of equipment; the third conductor being used as the insulated copper earth wire.

The size of all earth wires bonding equipment to a main earthing system shall be such that a current of three times the fuse rating of the circuit or one and one half times the overload setting of the circuit breaker can flow without adverse effects.

All joints between wires and other earthing metalwork shall be mechanically sound and soldered.

The earth leads shall be insulated until the connection is made to the electrode system. A bolted test link shall be installed to facilitate regular testing of the earth electrode system resistance.

The insulation of the earth lead shall be insect and rodent resistant.

All materials used in any earthing installation shall be adequately protected against corrosion and earth lead shall be protected against any mechanical damage.

Earth values shall be measured and must be below the prescribed values in the IEE regulations. In any case not more than 5 Ohms.

1. **Installation**

The earthing installation shall comprise an earth terminal, earth busbars, circuit, earthing conductors, equipotential bonding conductors, main earthing conductor and earth electrodes. The circuit earthing and equipotential bonding conductors shall be of the radial, grid or ring form as dictated by the plant layout.

The earthing installation shall be protected from mechanical damage and corrosion.

Joints in tape conductors shall be riveted and soldered, brazed, clamped, bolted, or exothermically welded. Non-corrosive flux shall be used for soldered joints. Clamped and bolted type joints shall be tinned and shall only be used above ground.

The interconnection of conductors below ground shall be by means of exothermic welding or brazing. Compression type lugs shall be provided for the termination of cables.

Earthing conductors shall be buried directly in the ground or secured to building structures, cable racks and trays using proprietary fixings.

Where the soil is aggressive to copper, buried earthing conductors shall be protected by an approved sleeving.

An equipotential bond shall be provided to all buried metal pipework at the point of entry into a building or chamber where electrical apparatus is installed. Electrical continuity across all pipe joints within the structure shall be ensured. Where pipe work incorporates a compression coupling (e.g. Viking-Johnson coupling), a bond shall be provided to any isolated section.

Cable armouring and screens shall be bonded to earth at both ends unless otherwise specified. Cable armour shall not be used as the sole earth protective conductor.

1. **Conductors**

Circuit and main earthing and equipment bonding conductors shall be high conductivity copper tape or 1000 V grade PVC insulated multi-stranded cable. PVC cable insulation shall be striped green/ yellow. Cable lengths shall be continuous and intermediate jointing is not permitted.

The main bonding conductor shall be not less than 16 mm2 and supplementary bonding of non-electrical plant not less than 10mm2. All connections shall be made using compression type cable lugs, taped on completion to completely seal the lug and any bare copper from the atmosphere. The surface to which earthing bonds are fixed shall be cleaned free from paint and other non-conducting material and coated with petroleum jelly.

The Contractor shall provide the following supplementary bonding conductors, which shall be made in 2.5 mm2 cable if mechanically protected;

1. All sink and shower units to pipe work
2. All small power outlets and sink units within a 2.5-meter radius of each other
3. All metallic tanks
4. **Earth Electrodes**

Earth electrodes where used shall be copper or copper clad high tensile steel rods having minimum copper thickness of 0.25 mm and outer diameter not less than 16mm. The rod shall penetrate a minimum of 2,400 mm below ground level. Where multi-rods are used they shall be separated by not less than the driven length.

Earth rods shall have hardened tips and caps and be extendable. Bare copper tape buried at a minimum depth of 600 mm shall be used for interconnection of rods.

Where soil conditions make the use of rods type electrodes impracticable a grid configuration may be used comprising horizontally buried bare high conductivity copper tape of dimensions 15mm x 4 mm minimum. Tape shall be buried at a minimum depth of 600mm.

All earth electrodes shall be buried in a mixture of well ground charcoal and common salt in a ratio of 2:1.

Earth rods shall be proved with a non-ferrous clamp for the connection of the earthing conductor. Each connection between conductor and earth electrode shall be suitably protected against corroding elements in the soil with bituminous tape.

The connection shall be made in a concrete inspection chamber set flush with the finished ground level. The inspection chamber shall be permanently marked ELECTRICAL EARTH'.

Marker posts and plates shall be provided to mark the position of the electrodes and buried connections. The markers shall be like those provided for cable routes.

1. **Main Earthing Terminal**

Where specified, a main earth terminal shall be installed in a convenient location. This shall comprise a high conductivity copper bar of sectional area at least that of the main earthing conductor. The terminal shall be supported on porcelain barrel type insulators and wall-mounted.

The terminal shall be of sufficient length to accommodate, with 25% spare capacity, bolted copper tape connection to:

* 1. the earthing conductor(s) between the earth terminal and earth electrodes
  2. circuit protective conductors between the earthing terminal and exposed conductive parts
  3. the main equipotential bonding conductors between exposed and extraneous conductive parts
  4. the system neutral earthing conductor (where specified)

Facilities (i) and (iv) shall be removable with a tool to permit measurement and testing.

Earth studs shall have a minimum size of M8.

1. **Tests on Site**

On completion of the earthing installation the Contractor shall measure the resistance of each electrode installation and of each complete earthing system to the general body of the ground. All other tests stipulated in the Reference Standards shall also be carried out.

The contractor shall carry out tests to verify that exposed metalwork within the buildings is effectively bonded and install supplementary bonding connections as necessary to ensure proper continuity. Supplementary bonding shall be provided to individual suspended systems throughout the buildings.

The resistance to each of each complete network shall not exceed five (5). In case the measured value is above 5, measures shall be taken to reduce the amount to less than five. These may include change of material, increase of cable size, enriching the soil.

1. **Lightning Protection**

Where buildings structures or sections of the plant are to be protected against lightning or static charges, an earthing system shall be provided. The installation shall be carried out in accordance with BS 6651.

The down run conductor shall be of hard drawn high conductivity copper of 25 mm \*3 mm section. The tape shall be fixed to the outside of the structure by means of standoff saddles. Where indicated, connection shall be made to the concrete reinforcing the route of the tapes and the fixings shall be discussed with the Engineer before installation.

Where specified, the conductors shall be PVC insulated to prevent corrosion and to blend with the building fabric.

A test link shall be installed in each down conductor adjacent to the earth rod at a height of 1,200mm above ground level. The overall resistance of the earth termination system to earth shall not exceed 10Ω. If this requirement is not met the number of earth electrodes shall be increased or they shall be interconnected until a value of 10 Ω is attained.

Earth rods shall be not less than 16 mm diameter copper or copper-clad steel, provided with hardened tips and driving caps. Each rod shall be provided with a non-ferrous clamp for connections of the copper strip. Each connection shall be housed in an inspection chamber set at ground level.

Where feasible, the lightning, protection grounding system may be inter-connected with the system earth to ensure equipotential under all conditions.

A provisional sum may be included for supply and installation of the lightning protection system, the details of which will be agreed as may be required to suit the operation and protection of the compound. Use of surge diverters to relevant BS standards shall be considered in case the bond is not sufficient.

## SMALL POWER AND LIGHTING DISTRIBUTION SYSTEM

1. **General**

The complete internal and external lighting and small power requirements shall be provided for all buildings, pumping stations, booster stations and compounds.

Each installation shall include the distribution board, wiring, lighting fittings, socket outlets, earthing and lightning protection and external floodlighting as required together with all conduits, trays, and accessories as necessary to complete the whole of the installations as specified and as shown on the drawings.

In general, fluorescent fittings shall be used for internal lighting with weatherproof fittings for exterior fittings mounted on building structures above and adjacent to the door openings.

External wall mounted luminaries shall be installed using a back-entry conduit system terminating behind the respective fittings with an end box mounted on the building fabric. Appropriate neoprene seals shall be used to prevent ingress of moisture. The final connections of each fitting shall be sleeved with silicon glass over sleeving.

The final circuit arrangement and phasing shall be agreed for all compounds and buildings to suit the requirements of the IEE Regulations and the Contractor's working drawings.

1. **Wiring**

The installation maybe surfaces within pump houses, etc, but concealed in offices, dwellings, and similar structures. The circuit wiring being continuous on a loop-in, loop-out system. The final connection to the fittings shall be by lid and cord grip, the circuit wiring terminating within the conduit box at a suitably rated terminal block. The final connection from the block (via the cord grip) to the fitting shall be carried out in heat resisting 3 core PVC/PVC (or similar) cable, white in colour.

1. **Internal Lighting**

Luminaries shall be complete with all supports, suspensions, flexible cables, pendants, and plugs. They shall be connected to the main circuit wiring heat resisting flexible cables of a minimum core size of 24/0.20 mm.

Protective classification shall be IP42.

The earthing of all luminaries shall be by a separate core in the connecting flex cable or cable system, securely bonding the earth terminal on the fitting to that of the interconnecting cables.

Where adjacent luminaries are connected to different phases of the supply, a label shall be fitted internally warning of the presence of the phase-to-phase voltage.

Luminaries shall not transmit load to suspended ceilings unless the ceiling and lighting is of integrated design with the appropriate supports.

Lamp holders for flexible pendants shall be of the all-insulated skirted pattern with cord grips.

The fixings, connection boxes and other parts of the luminaries shall be erected at times to suit the building programme. The glassware, diffusers, shades, lamps, and tubes shall not be fitted until all building works are complete. Fittings shall be left clean inside and outside are ready for use.

1. **Incandescent Fittings**

Incandescent fittings shall be of the types shown on the drawings and included in the Schedule of Prices, and shall be supplied complete with their lamps. Lamp holders in enclosed fittings shall be of a heat resistant type and shall be connected with heat resistant cable. Generally, Bayonet Cap lamp holders and lamps shall be used.

1. **Fluorescent Fittings**

Fluorescent fittings shall be of the type shown on the drawings and as indicated in the schedule of prices, shall be supplied complete with their lamps. They shall be complete with tubes, auxiliaries and all other items required for their complete installation. The fittings shall have completely enclosed wiring channel for accommodating wiring and auxiliaries, and supporting the lamp holders, reflector and diffuser as applicable.

In general fluorescent fittings complete with reflectors shall be used for lighting within the buildings and weatherproof fluorescent fittings with IP65 enclosure shall be used for exterior fittings mounted on building structures above or adjacent to the door openings.

Diffusers where specified shall be of flame retardant extruded acrylic or GRP material. They shall be either opal or prismatic pattern as specified.

A gasket shall be fitted between the diffuser and the body to form an effective seal.

The luminaries shall comply with BS 4533 for Class 1 ordinary, indoor normal atmospheres and Class 11A for chemically corrosive atmospheres, where appropriate.

Fluorescent luminaries shall have two suspension or fixing points and shall be complete with lamps.

Fluorescent lamps shall comply with BS 1853.

Unless otherwise specified, lamps shall be coloured 'white' for industrial use and 'warm white' for commercial and domestic lighting. Lamp caps shall be of the bi-pin type.

1. **Lighting Switches**

All lighting switches shall generally be metal clad surface mounted in pump houses and similar area and flush in domestic and office buildings. They shall be fitted into approved surface or flush conduit boxes. Lighting switches shall be minimum 6 Amp rating of the type specially designed for AC circuits. Exterior switches shall be of IP65 enclosure pattern. All switch boxes shall be provided with earthing terminals. Mounting height shall generally be centred at 1.4 m above FFL subject to site and building details. Metal clad switches shall be to BS 3676.

Internal lighting switches shall have white moulded plates and shall comply with BS 3676. They shall be supplied complete with box, cover plate and fixing screws. External lighting switches shall be of the metal clad, galvanized and weatherproof pattern with rotary action. They shall be surface mounted. Alternatively, the sealed splash proof pattern with enclosures IP54 to BS 5420 will be considered.

At multi-switch positions, the switches shall be contained in multi-gang boxes.

Where operation of a lamp or group of lamps is required from two separate locations, two-way switches shall be fitted with intermediate switching where shown.

1. **Socket Outlets and Spur Outlets**

The socket outlets in pumps houses and similar shall be generally metal clad and positioned as indicated on the drawings. The socket outlets shall be surface mounted, fitted into approved surface conduit boxes. All boxes shall be supplied with adjustable steel grids and earthing terminals. They shall be 3-pin shuttered and switched where specified. Earthing pins and shutters shall be provided throughout, the outlets being manufactured by Legrand, MK, or similar.

Domestic pattern socket outlets shall be flush mounted, or ratings indicated on the Employer's Drawings, 3-pin (with earth) and shuttered complying with BS 1363. Industrial pattern socket outlets shall comply with BS 4343. Spur outlets shall comply with BS 5733 and shall include a switch and neon light.

Plugs tops shall be provided with all outlets complete with fuses and 100% spare fuses.

Industrial sockets shall be to IP44 protection for surface mounted switch socket outlets used internally and IP67 where used externally. A corresponding plug top shall be issued with each socket.

The light switches and socket outlets shall be of the same rang and pattern where located in one room, structure, or building. The units shall be as manufactured by Legrand, MK, or similar approved. Details shall be provided.

The mounting height to the bottom line of the outlet shall be:

* 250 mm above the worktop surface
* 450 mm above the finished floor level in office areas
* 1,200 mm above the finished floor level in workshop and storage area (excepting over workbenches)
* 1,200 mm above the finished floor level in pump stations.

The above requirements are intended as a general guide. Final details shall be agreed with the Engineer on site to suit the facility, plant layout etc.

1. **Three Phase Power outlets**

Three phase power outlets shall be provided where indicated on the drawings. These shall be surface mounted, switched, complete with plug top and as manufactured by Legrand, MK, or similar approved,

1. **Distribution Boards and Consumer Units**

The distribution boards shall be a moulded case and miniature circuit-breaker type and shall be of the totally enclosed metal clad, cubicle type of surface pattern as indicated. They shall be complete with hinged lid and so constructed that the circuit-breaker toggles are concealed when the lid is closed. The distribution board shall be controlled by an isolating switch integral with the board.

Distribution boards shall be equipped with RCD's, HRC fuses or miniature circuit-breakers, arranged for triple pole and neutral or single pole and neutral outgoing circuits from a three or single phase and neutral incoming supply.

The circuit breakers shall be provided with thermal overload and magnetic short circuit tripping and a quick trip-free mechanism. The Contractor shall ensure that the necessary discrimination between each main panel and final sub-circuit is provided. Circuit breaker distribution boards used throughout the installation shall be of the same pattern, range, and manufacture. All MCBs shall have a short circuit capacity not less than 5kA but must also be consistent with the application.

Doors shall be lockable, hinged and gasketed to give a damp and dustproof enclosure. The degree of protection shall be IP43 (indoors) and IP55 (outdoors). The boards shall conform to BS 5486 and shall be provided with conduit and cable gland entry plate.

The busbars shall be mounted on non-hygroscopic insulators, completely shrouded or PVC insulated, coloured to denote the appropriate phase. The current rating of the busbars shall not be less than the current rating of the incoming circuit. A neutral bar shall be provided with a separate terminal for each circuit.

Fuse carriers used in distributions boards shall be of the fully shrouded pattern and shall employ HRC fuses only. They shall be mounted on the back plates using spacers so that outgoing wiring can pass behind the carriers.

Distribution boards employing miniature circuit breakers shall be capable of accepting breakers of mixed ratings of standard or residual current detection type.

Distribution boards shall be provided with an earth bar to allow connection of circuit protective conductors. The number of connection shall be equal to the number of single ways. A main earth terminal shall be provided to allow bonding of the enclosure in accordance with the requirements of the IEE Regulations. All earth, neutral and phase connections within distribution boards shall be numbered correspondingly by tagging the wires.

A fully detailed and comprehensive circuit list approved by the Engineer shall be fixed inside each distribution board, enclosed in a transparent incombustible envelope.

Consumer units shall be of the flush or surface mounted metal enclosure type complete with all MCBs and isolating switches, basically as specified for the distribution boards. Details shall be submitted for approval.

1. **Fused Connection Units**

The Contractor shall supply and install all fused connection units feeding electrical appliances mounted adjacent to the electrical appliance. For floor-mounted appliances the mounting height to the bottom line of the outlet shall be 450 mm above finished floor level except where otherwise stated on the drawings.

Fused connection units shall be installed such that, where applicable, the connecting flexible cable is no longer than 300 mm.

Fused connection unit shall be to BS 5733 or similar and shall be mounted in enclosures with white moulded cover plates in offices etc and metal clad type in plant rooms, pump stations or similar locations, and shall be of the MK Crabtree or Legrand type as shown on the drawings. Isolators shall be to BS 3676: Pt.1 and shall be mounted in enclosures with white plastic or metal cover plates as shown on the drawings.

1. **Emergency Battery Lighting Unit**

Portable emergency lighting units shall be supplied and installed and positioned

Emergency self-constrained light fittings will be positioned ad indicated on the drawings to provide lighting in the event of a power failure. The lighting units will have between 3 to 5-hour autonomy.

The units shall be double spot light or multi-spot type complete with mounting bracket and charging facilities operated from a 220 V AC supply. The battery light shall be arranged to switch on in event of failure of the AC supply to the fittings and shall operate for minimum of three (3) hours from the battery without re-charging.

Recharging shall be automatic on the restoration of the main supply and the period of the recharging shall be approximately 8 hrs. The fitting shall generally be provided with an earthed metal case housing the battery and switching equipment.

The lamps shall be 12W tungsten halogen operated by a sealed type lead acid battery. A solid-state constant voltage charger shall be provided together with low voltage cut-out protection to protect the battery against over-discharge. The units shall be suitable for the environments in which they are to operate.

1. **Portable Hand-Held Fire Extinguishers**

Portable hand-held fire extinguishers shall be provided as indicated on the drawings, as specified and as included within the schedule of prices. They shall be in accordance with BS 5306; Part 3, BS 5423, and local CFO requirements.

Each extinguisher shall be complete with a suitable wall-fixing bracket. The final mounting /fixing shall be agreed on site.

The 5 kg portable carbon dioxide fire extinguishers shall comply with BS3326; 1960 and BS 5423. The bodies of the extinguishers shall be seamless steel cylinders manufactured to BS 491, BS 1287, or BS 1288.

The 12 kg portable dry powder fire extinguishers shall comply with BS 3465: 1962 and BS 5423. The bodies shall be constructed of steel not less than the requirements of BS 1449 or aluminium to BS 1470: 1972 and shall be suitably protected against corrosion.

1. **Floodlights**

Floodlighting units shall be of a type designed and constructed for the application. They shall be complete with 500/1000 W tungsten halogen lamp, enclosure, reflectors, etc, and all items necessary for their installation.

They shall be of corrosion resistant light alloy with clear toughened glass front, the whole assembled to provide a weatherproof unit with IP65 enclosure.

Galvanised steel poles, complete with horizontal mounting brackets, shall be provided as shown on the drawings. The poles shall be complete with a service door, which shall provide access to the backboard, fused cut-out, gland plate. Sufficient space shall be provided to permit a maximum of three cable terminations.

Wiring between the MCB, fittings and lamp, via the control gear, shall be 20A rating butyl 1 rubber insulated, PVC sheathed cables or equal approved.

A separate earth wire shall be run between each lighting fitting and the earth termination situated at the supply point.

Foundation details shall be provided for approval. All cable glands, fixings and terminations shall be provided.

The mounting of the floodlights and associated brackets shall be such that both horizontal and vertical alignment can be carried out at site after installation.

The floodlights shall be manufactured by Thorn or similar in all respects

The holes for the planted root columns shall be excavated to a depth as recommended by the column manufacturer and the hole diameter shall not be more than twice the diameter of the column base, and shall be to the satisfaction of the Engineer.

The column with bracket affixed shall be placed centrally in the hole in a vertical position on a pad of concrete and the hole filled with concrete in 150 mm layers of 200 mm radial thickness around the column up to a depth of 150 mm below ground level. The excavation shall be backfilled and evenly rammed. A flexible PVC duct not less than 50 mm diameter shall be installed through the concrete surround into the column via the cable entry slot to provide a clear route for the electricity supply cable complete with draw cord.

## ROAD LIGHTING

Road lighting shall be provided at the compounds as indicated on the drawings and as generally specified. The lighting shall utilize galvanized steel poles as specified for the area floodlighting, the top mounting spigot being modified to accommodate an outreach support bracket capable of supporting a 70 W high pressure sodium 50N-T corrosion resistant fitting with IP65 enclosure, strong durable canopy, integral control gear with hinged tray. Details of the poles, outreach bracket and fitting supporting arrangements shall be provided for approval.

The outreach brackets shall be fixed to the pole spigot by at least three Allen screws or similar type fixings, the poles and outreach brackets shall be galvanized steel, the service door, fuse cut-out, wiring and earthing shall be generally as specified for the floodlighting poles.

Road lighting and floodlighting requirements are, in general, photocell controlled from the switchgear. The Contractor shall locate the photoelectric cell units externally on structures at location to be agreed on site. All conduit, wiring, cabling, and connections required for the photocells shall be supplied and installed under this contract. Override test/control switches shall be provided on the face of the switchgear panels to permit the manual operation of all lighting circuits should this be required.

The Contractor shall label all columns with their respective designated numbers, the details of which shall be agreed. This shall be done by means of stencilling the number in black characters onto the column, bollard or mast. Size of characters and locations shall be advised on site and shall be to the approval of the Engineer.

All road lighting columns shall have their access doors orientated in a common manner with respect to the compound way throughout the site and shall have their lanterns orientated as shown on the drawings. Columns shall be positioned at least 1000 mm back from the compound edge, the final distance being agreed to suit overhangs, curbing etc.

## CONTROL AND MONITORING SYSTEMS

1. **General**

The Contractor shall design, supply, and install all equipment for the automatic control and monitoring of the plant being supplied under this contract and to achieve the operating sequences specified. The equipment shall be complete in all respects and shall be suitable for use with the plant offered.

In general, the plant will be controlled from water level probes and switches located in the wet well, flow channels, storage tanks and pumping stations unless otherwise specified, and will operate the motor starters located in the motor control panels. Manual means of controlling the plant shall also be provided at the motor control panels.

The pumping and protection system shall include:

* High level alarms
* Low level alarm/cut- out
* Pressure switches to detect a change in pressure (high/low) to include alarm
* Cut-outs to protect against closed valve, broken pipe, etc., and
* Start and stop for pump sets
* Dry run protection

All protection and safety devices shall initiate an alarm siren on the monitoring/control panel section of the main motor control centre, and will also initiate a warning light, dedicated warning lamps being provided for each protection/safety device. The siren shall be muted, the warning light remaining energised until the fault or protection device has been cleared and reset. A complete monitoring/warning/control system shall be provided for all plant and equipment, details to be submitted with the Tender.

In addition to the control of the pump sets, means of identifying high water level and low water level in the wet wells, tanks, etc. shall also be provided. The activation of either the high or low water probes shall, in addition to stopping or starting the pump set, also initiate a visual alarm. This shall take the form of a suitably labelled red indicator light mounted integral with the relay/changeover switch cabinet positioned within the control room or similar type operator’s areas to suit each compound.

The operation of the pressure switches, high level and low level probes and other safety/warning devices shall automatically energise a warning lamp on the control panels and switchboard the operators are fully aware of the nature of the plant shut down/ operation.

The final method of wiring to the above switches, probes and safety devices, the actual locations of the switches and their settings shall be agreed to suit the layout of the pipe work and the operating parameters of the system. It shall be deemed that the contractor's prices included for all requirements.

1. **Marshalling Cabinets**

Marshalling control cable cabinets shall be provided at the sites to suit the requirements of the control system. The cabinet shall be either independent units protected to suit the environment or may form an integral part of the motor control centre or switchboard. The final locations shall be to suit the overall control systems.

The cabinets shall be complete with access doors and all terminating blocks and units as manufactured by Klippon or similar approved. Sufficient spare units shall be provided to facilitate cross patching from a faulty section of the cable to a healthy section.

1. **General Facilities**

The Contractor shall ensure that all starters, cabinets and the like have sufficient auxiliary spares to meet future requirements.

The pressure switches and control probes shall be of approved manufacture and type, suitable for use with potable water. The Contractor shall include, in addition to the supply and installation of the switches and probes, etc., for all wiring, cables trunking, connections and the like to complete the entire control system as specified, including all wiring to and from switches, floats, probes, switchboards and alarms, etc. Details of the pressure switches, floats and probes shall be submitted with the Tender.

Alarm circuits shall consist of indicator lights which shall re-set automatically only upon cessation of the alarm condition.

The system of level and alarm condition sensing and signal transmission shall be to the approval of the Engineer, with emphasis placed on simplicity of operation and durability of construction.

## CIVIL WORKS ASSOCIATED WITH INSTALLATION OF SERVICES

The Contractor shall carry out all works and supply and install all materials as necessary to provide the following civil works associated with the mechanical and electrical installation being carried out under this contract:

* Foundations for flood lighting, road lighting columns and cabinets
* All foundations, cable trenches and supports for externally mounted motor control cubicles and switchgear.
* All trenching, tilling, sanding, backfilling, compaction, and removal of surplus soil for all cables and associated services
* Cable ducts, pipe work and exhaust sleeves, etc. unless otherwise specified or indicated
* Sun canopies over all externally located cubicles and switchgear, including foundations
* All builders works associated with the installation of the plant
* Any other civil works, as specified or shown on the Employer's Drawings

## SCHEDULE OF TEST

1. **General**

This section is to be read in conjunction with the details contained within the specification, in Section 1.26.

As many tests as possible shall be arranged together. Five copies of the contractor's records of all tests shall be furnished to the Engineer.

All material which is specified for tests at the manufacturer's works must satisfactorily pass such tests before being painted or otherwise coated.

All test instruments, fuels and consumables required for the tests, commissioning and putting the plant into full operation shall be supplied by the Contractor. Test instruments shall be to approval and shall be calibrated by a competent authority as may be approved by the Engineer and the laws of the Country.

1. **Tests at Manufacturer's Works**

During manufacture, the Contractor shall carry out tests on the Plant and materials that are specified in the relevant General Technical Specifications and shall forward to the Engineer duly certified copies of the test results and a certificate stating that the Plant and the materials comply with the specifications.

A team of persons appointed by the Employer shall attend and witness the works testing of the Plant. The Contractor shall provide at least 28 days’ notice of the expected date of the tests, following which the Engineer shall inform the Contractor of the representatives who have been nominated by the Employer to attend and witness the tests.

The Contractor shall provide business class air tickets, accommodation, and transport for these representatives and the means to cover ancillary travel costs as allowed for in relevant sub-clause of Special Conditions of the Contract.

Details of tests to be carried out on particular items of electrical plant shall be as follows. Other items of plant and equipment will be tested as required. Similarly, further tests as necessary will be carried out on the plant as instructed by the Engineer or required by the relevant BS or code of practice.

The electrical equipment supplied under this contract will be tested to prove compliance with the requirements of this specification and with the relevant British Standard specification where applicable.

High voltage and insulation resistance test shall be made when the apparatus is hot.

Test shall include, but not be limited to, the following as may be applicable.

* H.V. pressure tests and insulation resistance check
* L.V. pressure tests and insulation resistance check
* Injection test
* Shunt trip test
* Closing test
* Operation of all inter-locks and protection devices.

1. **Tests of Pumps at the manufacturer’s works**

Each pump shall be tested individually at the manufacturer’s works in full accordance with BS5686 and/or BS5316.

The pump shall be tested complete with its shaft bearings, thrust bearing, and directly driven auxiliaries, or where is impracticable, the Contractor shall state the allowances to be made for the losses incurred by these items and shall demonstrate the accuracy of these allowances to the satisfaction of the Engineer.

Such tests shall show that the pump has general characteristics of head, efficiency, input power, net positive suction head, and other properties as appear on the proposed curves submitted with the bid.

Such tests shall also prove that the specified head, efficiency, input power and net positive suction head and other properties at the design point and establish that the pump is free from overheating, cavitation and excessive vibration over the specified range.

The pumps shall be tested over their full working range from their closed valve condition to maximum discharge points.

1. **Tests of motors at the manufacturer’s works**

All motors shall be tested at the manufacturer’s works in accordance with the requirements of BS5000.

The motors shall undergo works tests to ensure correct assembly and to ensure that they are sound electrically and mechanically.

At the very least the following tests shall be included: -

* Insulation resistance,
* Winding resistance,
* No load current and losses,
* High potential test
* Vibration test
* Temperature rise test
* Efficiency and power factor,
* Locked motor current at full load on stator terminals
* Current and torque against speed during acceleration and
* Momentary overload.

Efficiency and power factor tests shall be taken over the full range from no load to 110% of full load and curves shall be produced from the spot point taken. One of these curves shall pass through the duty point of the motor when driving the pump at the guarantee point and a spot of the power factor and efficiency shall be made at this point.

1. **Test After Erection on Site**

All Plant shall pass such tests on site as are required by the Engineer to prove compliance with the contract independently of any tests which may already have been carried out at the Manufacturer's works. All electrical pressure tests made at the Manufacturer's works shall be repeated at voltages to be approved by the Engineer.

The entire installation shall be tested and commissioned in accordance with the Regulation for Electrical Installation published by the institute/of Electrical Engineers (London) - 16th Edition, including the latest amendments and with the details contained within the General Specification. In addition, attention shall be paid to the specified testing requirements of specialist equipment described in this Specification. Prospective Fault Currents (Ipsc) and Earth Fault Loop Impedance (EELI) shall be measured and recorded at different locations on each installation including at each LV switchboard, distribution board and at the furthest socket outlet from the source on each socket outlet circuit, and at each item of fixed equipment.

Testing and commissioning procedures shall be such as to effectively prove the correct operation of all components and their integration into the systems. The testing shall also prove that the systems function in accordance with the appropriate design criteria.

All systems shall be fully tested and commissioned prior to the Engineer being invited to witness a full demonstration of the system and verification of its functioning and correct commissioning, except where specifically indicated otherwise within this specification.

No equipment other than 380/220 volt lighting supplies shall be energized without the permission of the Engineer. The Contractor shall be responsible for the safety of both plant and personnel from the initial energisation of all plant and until handover.

The results of all tests shall be recorded and inserted into the operating and Maintenance manuals.

If, in the opinion of the Engineer, the plant does not comply with this specification, the defect shall be rectified at no cost to the Employer.

1. **Pumps**

Among tests to be performed on the pumping unit, each pump shall be run at maximum rated speed for at least three rates of flows; corresponding to minimum flow, designated duty point and maximum rate of flow specified, as evidenced by the corresponding head shown by the pressure gauges.

Throttling the discharge valve shall make variations of the flow rate. The rated pump nameplate shall not be deviated, at any rate of flow, from the specified ranges.

If the flows show a noticeable deterioration in the performance of the Plant, or any particular item of the Plant or system, compared to the test results during tests at manufacturer’s work, the Contractor shall immediately take steps to rectify the deficiency as allowed for in the General Conditions of the Contract.

1. **Motors**

Each item of the Plant shall be dried out (if necessary) and checks on the insulation made at regular intervals during the commissioning. Electrical power shall not be applied to any electric equipment until insulation resistance is to acceptable level. The resistance levels shall be measured at different sections of the earthing system. In the event of resistance at any point exceeding the required value, additional earthing shall be installed, at the Contractor’s cost.

All protective systems, interlocks, control and auxiliary circuits shall be checked, and normal and abnormal conditions shall be simulated.

1. **Mechanical Plant**

All mechanical Plant subjected to pressure shall be tested to 1.5 times their working pressure.

These tests shall be carried out when the pipe work is complete to test all joints, individual pipe, which are to be built-in, shall be tested after being built-in.

Mechanical Plant shall be checked for correct assembly and operation.

Valves shall be test operated over their full range to ascertain whether they are properly aligned, free from bends, and other deformation; and whether their operation is free from vibration and satisfactory to the Engineer.

1. **Commissioning and Site Performance Tests**

After complete erection of the Plant at the site, the Contractor shall commission the Plant and operate each pump for a period no less than 150 hours (of which 36 hours shall be continuous) during which time he shall carry out any adjustments or modifications he may deem necessary to achieve best possible efficiencies. The pumps may run singly or in any combination as approved by the Engineer.

After all the pumps have been so operated, Site Performance trials shall be carried out on the Plant under the joint supervision of the Employer, the Engineer and the Contractor in accordance with the Tests on Completion of the Conditions of the Contract to ascertain whether the Plant is capable of performing the specified duties or determine the efficiencies of the pumping sets.

For the purposes of these trials, the head against which the pumping sets work shall be checked by the pressure gauges installed by the Contractor and the head shall be adjusted if necessary by throttling the line valves at the discretion of the Engineer to within 3%.

The water power credited to each pump shall be equal to [QxHx9.8]/[3600xEfficiency], in kW where; Q is the flow rate in meter cubic per hour determined volumetrically as detailed above and H is the head in meters credited to each pump as the difference in gauge reading across the pump.

The input power for each pump shall be computed in kilowatts is the sum of reading of portable Standard Wattmeter, Class I connected as for the measurements of unbalanced three phase power.

The wattmeter, which shall be provided by the Contractor for the tests, shall be calibrated together with their voltage transformers and current transformers and connecting leads, by the Uganda Electricity Distribution Company Limited, at the Contractor’s costs.

The Contractor shall provide an accredited representative and except as otherwise indicated all measuring instruments and all other apparatus, oils and consumable necessary for the Performance Trials, as well as portable radio transceiver for use in communicating during the trials.

The “Completion and Acceptance Certificates” shall not be issued unit all the completion tests have been finished and given results which are satisfactory to the Engineer or until any resultant modifications, repairs and re-testing are, in the Engineer’s opinion, satisfactorily completed

# SURVEYOR’S SPECIFICATION

## INTAKE WEIR

* Topography of existing ground of the weir footprint + 50 m upstream and downstream
* Topography of the spillway and stilling basin area, up to 200 m downstream of the stilling basin, following the river alignment, and a corridor of 10 m of each bank

## WATER TREATMENT PLANT

* Raw water mains,
* elevation at intake point, existing ground + as-built headwall level, and dimensions
* Alignment proposal, we can guide on this, or along the corridor of alignment to the water treatment plant inlet chamber
* Flocculation basin
* Inlet invert of the raw water mains to the floc basin
* The elevations of the flocculation basin bottom and last end of the channels for both basins (As-built Flocculation basin levels)
* The existing ground level around the structures, any key features like water channels, etc. will be useful information for drainage planning
* An outlet of the flocculation basin pipework and channel inverts
* All corner walls coordinate for the flocculation basin basin
* Sedimentation tank
* The elevations of the sedimentation basin bottom and wall elevations for both basins (As-built sedimentation basin levels)
* The existing ground level around the structures and any key features like water channels, drainage pipes, etc. will be useful information for drainage planning or pipework design
* An outlet of the sedimentation basin pipework and channel inverts etc.
* All sedimentation basin collection channels invert elevation etc
* Trough levels off the sedimentation basin
* Filtration Units
* The topography of the existing ground for the filtration units, it’s a water pond so he may need to dewater the site if it's too deep to venture into.
* The treated pipe
* Ground-level along the corridor to the water tank site
* The inverts of the inlets of the existing tanks
* Provide a sketch of the above for any future discussions that may arise due to the need for clarifications.

## INTAKES,TRANSMISSION, AND DISTRIBUTION MAINS

The survey should be conducted at 5 m intervals. Topographic contours density should be conducted to enable the generation of contours at intervals of 0.5 m at an accuracy of ± 20 mm. The drawings shall be produced to scales of not more than 1:2000 (A3).

**General:**

All topographical features should be captured, including existing structures, streams, cuttings at spillway crest and toe, fence, and any other features found on site.

**Reports:**

* Topographical survey report with the following content:
* Control points on site
* Construction and coordination of control points (including the CRS and projection)
* Accuracy of control points
* Detailed Topo Survey
* Methodology
* Results
* Appendix
* Control points data
* Description Cards of the Control Points
* Static GPS Observation report
* Detailed Survey data – ASCII data or CSV
* Detailed survey data – layout plan in .dwg format

## ASSIGNMENT FOR TOPOGRAPHIC SURVEYOR

The task to be performed are:

1. Perform traverse survey connected to the National Datum of 2nd order accuracy level. Transformation of the triangulation points shall be carried out using TOTAL STATION.
2. The accuracy of the transferred coordinates to be:
3. While transferring the grid coordinates, horizontal control shall be established through a closed traverse survey originating and terminating at the main control station of second order. Error if any should be distributed to all stations accordingly. The accuracy of the survey should be according to Second-Order Survey, within ±5 cm.
4. The vertical coordinate of control points shall be fixed by either trigonometric leveling or differential leveling. The accuracy of the survey should be according to Second-Order Survey, within ±20 mm from the original points or should not exceed ±8 x √K mm, where K is the distance in km of the circuit in the loop, whichever is less.
5. Traverse drawing in 1:10,000 scale and error distribution calculations to be submitted.
6. Conduct a detailed topographical survey of the intake weir site and forebay, extending upstream and downstream for a distance of 100 m each length and elevation of a minimum of 20 m at the water wayside and 10 m on the opposite banks especially to be covered at the intake and power station area.
7. Conduct a detailed topographical survey of the waterway area covering the canal/pipe, extending at least 20 m in elevation or 50 m in plan length on the uphill side. The downhill side survey has to be covered either 50 m plan length or to the river bed whichever is shorter.
8. Construct a minimum of two intervisible permanent benchmarks at head works and every 500 m interval of the proposed waterway alignment. All control points shall be marked on the ground by permanent bolts cast-in bedrock for centering and elevation reference. If bedrocks are not available, permanent Bench Marks are to be established in concrete. The minimum size of the concrete pillar is 20 cm x 20 cm x 100 cm. The concrete is to be a rich mix (1:2:4) and cross-mark exposed iron bar of a minimum of 16 mm size. Photographs of used triangulation point to be submitted.
9. A detailed topographical survey of the intake chamber areas shall be conducted, covering at least 300 m upstream and downstream from the chamber and a 200 m wide strip. The opposite bank is to be covered by 10 m in elevation and or 50 m in plan length of the strip covered on the power station side;
10. The density of the topographic survey points shall be sufficiently taken to produce:
    * + - 1. 1:200 scale maps at 1m contour interval to cover intake area, waterway, and powerhouse,
          2. 1:50,000 scale maps at 5 m contour interval for the entire project area;
11. Report on the survey work, generate survey drawings defining boundaries of private and public land, cultivated land, forests, etc. Existing irrigation canals, buildings and other permanent and semi-permanent structures such as sheds, boundary walls, big trees, and large boulders located in the project area are also to be marked on the survey drawings. Diary logs, photographs, and surveyor’s description cards (D-cards) are to be kept and submitted;
12. Implement the changes and corrections as required after submission of the draft topographical survey report;
13. The maps shall be generated in AutoCAD format, and computation details to be submitted.

# ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MONITORING PLAN (ESMMP)

## MANAGEMENT PLAN PRINCIPLES

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

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

## SPECIFIC MANAGEMENT ISSUES

**Management Responsibilities**

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

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

* Occupational health and safety plan
* Traffic management plan
* Public health and safety management plan
* The provisions for the workers grievance mechanism
* Environmental and social monitoring plan (with further detail to the outline of monitoring indicators as presented in the ESMMP) below.

**Environmental Management Guidelines**

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

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

**Environmental Education and Awareness Rising**

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

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

**Decommissioning Process**

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

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

Table 13.1: Construction Phase: Environmental and Social Management and Monitoring Plan

| **Activity** | **Associated Impacts** | **Impact**  **Levels** | **Management Actions** | **Target Areas&**  **Responsibilities** | **Monitoring Indicator** |
| --- | --- | --- | --- | --- | --- |
| **Seeking approvals from NEMA for ESIA, approval of campsite by Directorate of Occupational Health and Safety (DOSH)** | Delay in implementation of the Project due to objections and stop orders | Low | * The Contractor shall ensure that all pertinent permits, certificates and licences have been obtained prior to any activities commencing on site and are strictly enforced/ adhered to; * The Contractor shall maintain a database of all pertinent permits and licences required for the contract as a whole and for pertinent activities for the duration of the contract | All the Project components  Responsibility  WSPS & Contractor | * Number of approvals / permits issued |
| **Construction**  **campsites** | Environmental degradation risks | Medium | * Isolate through fencing the camp sites from access by the public for their safety * Preferably to be located on land already cleared land wherever possible * The Contractor’s Camp layout shall take into account availability of access for deliveries and services and any future works | Campsites  Responsibility  Contractor | * Number of public outcry due to accidents |
| **Access to campsites and construction sites** | Environmental degradation risks and risk to female workers of sexual harassment | Medium | * Utilize to the extent possible the existing public roads to avoid social and economic disruption * Ensure road safety measures for the construction vehicles to the extent possible by observing all traffic regulations * All workers to sign Code of Conduct which addresses SH at the workplace and penalties; * Sensitize workers on dangers and consequences of sexual harassment. | Access Roads  Responsibility  Contractor | * Cases of private land required * Accidents occurrence incidences |
| **Environmental and Social Training and Awareness** | Risks of Environmental and Social degradation risks and occupational health and safety related accidents and risk mitigation of SH and SEA | Medium | * The Contractor and sub-contractors shall be aware of the environmental requirements and constraints on construction activities contained in the provisions of the ESMMP * An initial environmental awareness training session shall be held prior to any work commencing on site, with the target audience being all project affected persons * The Contractor will be required to provide for the appropriate Social Risk Management Training and Awareness as described in this ESMMP, including specific and ongoing training on the COC in his costs and programming * An initial social risk awareness training on SH and SEA shall be held prior to any work commencing on site, with the target audience being all project affected persons. | All Workers  Responsibility  Contractor | * Number of Trainings Held * Availability of Training reports * Attendance list of participants during the training sessions |
| **HIV/AIDS awareness and prevention campaign** | Risks of Increased HIV and Aids transmission in the area | Medium | * The Contractor shall institute HIV/AIDS awareness and prevention campaign amongst his workers for the duration of the contract, contracting and implementing organisation, with preference for an organisation already working on this issue in the Project area; * The campaign shall include the training of facilitators within the workers, information posters in more frequented areas in the campsite and public areas, availability of promotional material (T-shirts and caps), availability of condoms (free), coordination with GBV prevention messages and theatre groups. | All Workers  Responsibility  Contractor | * Number of Trainings Held * Availability of Training reports * Attendance list of participants during the training sessions |
| **Local Labour / Employment** | Delay in Project implementation due to opposition from aggrieved community members | Medium | * Wherever possible, the Contractor shall use local labour, and women must be encouraged to be involved in construction work * The contractor shall ensure compliance to the gender balance as required by the 2/3 gender rule * The contractor shall implement strategies to reduce risk of GBV (e.g. through backlash by husbands, etc.) at the community level related to employment of women | All the Project Lots  Responsibility  Contractor | * Number of workforce employed from the local community * Number of females employed |
| **Setting out and clearance of Project routes and site** | Delay in Project implementation due to opposition from PAPs | High | * The number of Project Affected Persons (PAPs) within the target supply areas of Kyarumba, Kyondo and Lake Katwe sub counties along the pipeline routes shall be identified. | All the Project water lines  Responsibility  WSPS | * Numbers of satisfied PAPS * Extend of route opened to the contractor |
| **Earth moving and**  **excavations (Vegetation clearance, channeling and site preparations)** | Vegetation Cover destruction | Low to medium | * Construction activities will be limited to Project sites / routes which already exist therefore limited destruction to vegetation cover, * Compensatory planting of trees i.e. plant at least twice the number of trees this will be achieved through a tree planning program to be initiated under the works contractor. | All work areas  Responsibility  Contractor | * Soil erosion extend and intensity on site |
| Impacts on Water Resources - water pollution | Low to medium | * No grey water runoff or uncontrolled discharges from the site/working areas (including wash down areas) to adjacent storm water shall be permitted; * Water containing such pollutants as cements, concrete, lime, chemicals and fuels shall be discharged into a conservancy tank for removal from site where applicable * The Contractor shall also prevent runoff loaded with sediment and other suspended materials from the site/working areas from discharging to storm water channels | All work areas  Responsibility  Contractor | * Water quality flowing through storm |
| **Earth moving and excavations (Vegetation clearance, channeling and site preparations)** | Siltation and Sedimentation Control | Low | * Any work along storm water channels will be isolated to prevent silt propagating downstream; * Debris and other material will be prevented from entering Storm water channels; contamination by other pollutants); * Sand/silt traps should be used so as to prevent silt and any other sediments from getting into storm water channels * Site compounds and stockpiles will be located away from shallow wells and storm water channels | civil works areas  Responsibility Contractor | * Silt load in storm water channels |
| Soil Erosion Impacts | Low | * Earthworks should be controlled so that land that is not required for the Project works is not disturbed; * Wherever possible, earthworks should be carried out during the dry season to prevent soil from being washed away by the rain. * Excavated materials and excess earth should be kept at appropriate sites approved by the Supervising Engineer. * The contractor should adhere to specified cut and fill gradients and planting embankments with shrubs and grass to reduce erosion | Civil works areas  Responsibility   * Contractor * Supervising Engineer | * Extend of soil erosion on site |
| **Site Activities** | Risk of Accidents at Work Sites | High | * Contractor to provide a Healthy and Safety Plan (HSP) prior to the commencement of works to be approved by the Supervising Engineer. * Provide Personal Protective Equipment (PPE) including gloves, gum boots, overalls and helmets to workers. Use of PPE to be enforced by the Supervising Engineer. * Fully stocked First Aid Kits to be provided within the Sites, Camps and in all Project Vehicles * Strict use of warning signage and tapes where the trenches are open and at other active construction sites * Contractor to Employ and train Road Safety Marshalls who will be responsible for management of traffic on site | Civil works areas  Responsibility   * Contractor * Supervising Engineer | * Number of fatalities and accidents recorded in the incidence book |
| Solid Wastes impacts | High | * The contractor shall develop a comprehensive Waste Management Plan (WMP) prior to commencement of works * Properly labelled and strategically placed waste disposal containers shall be provided at all places of work * Litter bins should have secured lids to prevent animals and birds from scavenging * All personnel shall be instructed to dispose of all waste in a proper manner * Recycling of construction material shall be practiced where feasible e.g. containers and cartons * Earth spoils shall be disposed of in pre identified sites | Civil works areas  Responsibility  Contractor   * Supervising Engineer | * Quantity of solid Wastes Generated and appropriately disposed |
| **Site Activities** | Sexual Harassment between project workers |  | * The contractor will ensure clear human resources policy against sexual harassment that is aligned with national law * The contractor will integrate provisions related to sexual harassment in the employee COC * The contractors will ensure appointed human resources personnel to manage reports of sexual harassment according to policy | Civil works areas  Responsibility Contractor Supervision | * SH Policy * Number of trainings for staff on SH * HR trained in SH |
| Liquid Wastes Impacts | High | * Water containing pollutants such as concrete or chemicals should be directed to a conservancy tank for removal from the site where applicable * Potential pollutants of any kind and form shall be kept, stored and used in such a manner that any escape can be contained * In case of any form of pollution the contractor should notify the Resident Engineer (RE) * Wash areas shall be placed and constructed in such a manner so as to ensure that the surrounding areas including groundwater are not polluted * No grey water runoff or uncontrolled discharges from the site or working areas to any adjacent Storm water channels. | Civil works areas   * Contractor   Supervising Engineer | * Quantity of liquid Wastes Generated and appropriately disposed |
| **Sanitation issues resulting from both solid and liquid wastes on site**  Risks associated with water born diseases exposed to community and workforce | High | * The Contractor shall -laws relating to public health and sanitation * All temporary/ portable toilets or pit latrines shall be secured to the ground to the satisfaction of the RE to prevent them from toppling over * A wash basin with adequate clean water and soap shall be provided alongside each toilet. Staff shall be encouraged to wash their hands after use of the toilet, in order to minimise the spread of possible disease * Toilets will be sex-segregated in order to ensure the privacy, safety and dignity of women and men | All work areas  Responsibility   * Contractor   Supervising Engineer | * Incidence of reported cases of water related diseases among the workforce and neighbor community |
| **Site Activities** | Fuels, Oils and other hydro-carbons | High | * The contractor shall ensure that the machines and equipment are in good condition when on site. * Ensure proper handling of lubricants, fuels and solvents while maintaining the plant and equipment. * Any chemical or fuel spills shall be cleaned up immediately. The spilt liquid and clean-up material shall be removed, treated and transported to an appropriate site licensed for its disposal. | civil works areas  Responsibility   * Contractor   Supervising Engineer | * Quantity of waste fuels and oils appropriately disposed |
| **Storage of fuel oils, lubricants, chemicals and flammable materials**  **Hazards of fire outbreak, oil and chemical spills.** | High | * Follow specifications of the Occupational Health and Safety Act 2007, EMCA 2015 and others in the development and operation of stores. | All work areas  Responsibility   * Contractor   Supervising Engineer | * Incidence of reported cases of fuel leaks and fire incidences |
| **Noise and Vibration control from plant and equipment**  Risk to health and safety of community and workers | High | * The Contractor shall keep noise level within acceptable limits and construction activities shall, where possible, be confined to normal working hours in the residential areas * hospitals and other noise sensitive areas shall be notified by the Contractor at least 5 days before construction is due to commence in their vicinity * Any complaints received by the Contractor regarding noise will be recorded and communicated to the RE * The Contractor must adhere to Noise Prevention and Control Rules of April 2005 | civil works areas and access roads  Responsibility   * Contractor   Supervising Engineer | * Reported complaints from neighbor community and institutions |
| **Air Quality Control**  Air pollution causing respiratory disorders to human | High | * Workers shall be trained on management of air pollution from vehicles and machinery. All construction machinery shall be maintained and serviced in accordance with the contractor’s specifications * The removal of vegetation shall be avoided until such time as clearance is required and exposed surfaces shall be re-vegetated or stabilised as soon as practically possible * The contractor shall not carry out dust generating activities (excavation, handling and transport of soils) during times of strong winds * Vehicles delivering soil materials shall be covered to reduce spills and windblown dust * Water sprays shall be used on all earthwork areas within 200metres of human settlement. | All work areas  Responsibility   * Contractor   Supervising Engineer | * Cases of respiratory complication at nearby health centre |
| **Traffic management on site** | Risks of Accidents, Injuries or death of workers or community member | high | * Strict use of warning signage and tapes where the trenches are open and active sites * Employ and train road safety Marshalls who will be responsible for management of traffic on site * Contractor to provide a traffic management plan during construction to be approved by the resident engineer | Civil works areas and access roads  Responsibility   * Contractor   Supervising Engineer | * Accidents occurrence incidences |
| **Materials sourcing, from burrow pits and quarries delivery and storage** | Environmental and Safety risks associated with burrowing and opening up of new quarry sites | Medium to High | * Ensure that appropriate authorization to use the proposed borrows pits and quarries has been obtained before commencing, * This should be achieved through preparation of specific Environment and Social Impact Assessment for identified quarries and burrow pits to inspected and approved by NEMA. * Carry out inspection of each of the site’s soil stability before excavation; * Borrow pits and quarries shall be located more than 20 meters from watercourses in a position that will facilitate the prevention of storm water runoff from the site from entering the watercourse; * The Contractor shall give a 14-day notice to nearby communities of his intention to begin excavation in the borrow pits or quarries | Burrow Pits and Quarry Site  Responsibility   * Contractor   Supervising Engineer | * Environmental Status of reinstated burrow pits * Complains from the community on burrow pits and material transportation |
|  | Labour Influx | Medium to High | * The contractor awarded the Project will develop a labour Management Plan (LMP) in consultation with local leaders. * The contractor will ensure effective community engagement and strong grievance mechanisms on matters related to labour including sexual exploitation and abuse * Effective contractual obligations for the contractor to adhere to the mitigation of risks against labour influx, the contractor should engage a local community liaison person. * The contractor will ensure proper records of labour force on site while avoiding child and forced labour * The contractor will ensure comply to provisions of Work Place Injuries and Benefits Act (WIBA) 2007 * The contractor shall require his/her employees, sub-contractors, sub-consultations and any personnel thereof engaged in construction works to individually sign and comply with a Code of Conduct, with specific prevision on protection from sexual exploitation and abuse | Project Corridor  Responsibility   * Contractor   Supervising Engineer | * Number of grievances recorded by disgruntled works force and community |
|  | Gender Inclusivity in Project activities | Low | * The contractor will mainstream Gender Inclusivity in hiring of workers and entire Project Management as required by Gender Policy 2011 and 2/3 Gender Rule. * Special provisions for reporting and addressing any GBV risks at the community level (ie. backlash in the home) related to employment of women * The existing community structures headed by location chiefs should be involved in local labour hire, emphasize the requirement of hiring women, youth and people with disability and VMGs * Protecting Human Risk areas Associated with, Disadvantaged Groups, Interfering with Participation Rights and interfering with Labour Rights * To include promotion of human rights, including gender equality and equity in Employee’s Code of Conduct | Project Corridor  Responsibility   * Contractor   Supervising Engineer | * women and Men employed by the Project |
|  | Children abuse impacts | High | * The contractor will develop and implement a Children Protection Strategy that will ensures minors are protected against negative impacts associated by the Project. * All staff of the contractor must sign, committing themselves towards protecting children, which clearly defines what is and is not acceptable behaviour * Children under the age of 18years should not be hired on site as provided by Child Rights Act (Amendment Bill) 2014 | Project Corridor  Responsibility   * Contractor   Supervising Engineer | * Number of cases reported involving abuse of children |
|  | Gender-based violence at the community level | Medium | The contractor will implement provisions that ensure that gender-based violence at the community level is not triggered by the Project, including:   * Effective and on-going community engagement and consultation, particularly with women and girls; * Review of specific project components that are known to heighten GBV risk at the community level, e.g. compensation schemes for women, employments schemes for women, etc.; * Specific plan for mitigating these known risks, e.g. sensitization around gender-equitable approaches to compensation and employment * The contractor will ensure adequate referrals mechanisms are in place if a case of GBV at the community level is reported related to project implementation | Project Corridor  Responsibility   * Contractor   Supervising Engineer | * plan for GBV occurring at the community level as a result of project implementation * Number of GBV cases happening at the community level that receive survivor-centered referral and care |
|  | Sexual Exploitation and Abuse by project workers against community members | High | * Develop and implement a SEA action plan with an Accountability and Response Framework as part of the C-ESMP. The SEA action plan will follow guidance on the World Bank’s Good Practice Note for Addressing Gender-based Violence in Investment Project Financing involving Major Civil Works (Sept 2018). * The SEA action plan will include how the project will ensure necessary steps are in place for: * Prevention of SEA: including COCs and ongoing sensitization of staff on responsibilities related to the COC and consequences of non-compliance; project-level IEC materials; * Response to SEA: including survivor-centered coordinated multi-sectoral referral and assistance to complainants according to standard operating procedures; staff reporting mechanisms; written procedures related to case oversight, investigation and disciplinary procedures at the project level, including confidential data management; * Engagement with the community: including development of confidential community-based complaints mechanisms discrete from the standard GRM; mainstreaming of PSEA awareness-raising in all community engagement activities; community-level IEC materials; regular community outreach to women and girls about social risks and their PSEA-related rights; * Management and Coordination: including integration of SEA in job descriptions, employments contracts, performance appraisal systems, etc.; development of contract policies related to SEA, including whistleblower protection and investigation and disciplinary procedures; training for all project management; management of coordination mechanism for case oversight, investigations and disciplinary procedures; supervision of dedicated PSEA focal points in the project and trained community liaison officers. | All Workers | * SEA Action Plan * Code of Conduct * Number of staff trainings * SEA FP * Community Liaison Officer trained in PSEA * IEC materials for workers sites and community * Discrete SEA reporting pathway * Relevant policies, e.g. investigations and discipline and whistlblower protection * Monthly minutes from SEA coordination meetings |
|  | Increase of communicable diseases including HIV and Aids | High | * HIV/AIDS Awareness Program and other communicable diseases to be instituted and implemented as part of the Contractor’s Health and Safety Management Plan to be enforced by the Supervising Engineer. * This will involve periodic HIV/AIDS and other communicable diseases Awareness Workshops for Contractor’s Staff * Access to Contractor’s Workforce Camps by outsiders to be controlled * Contractor to provide standard quality condoms to personnel on site | All Workers  Responsibility  Contractor | * Number of Trainings Held * Availability of Training reports * Attendance list of participants during the training sessions |
| **Contractor de-mobilization and site reinstatement** | Associated risks of environmental degradation | Medium | * The site is to be cleared of all construction materials, including litter prior to hand over * Fences, barriers and demarcations associated with the construction phase must be removed from the site * Fences, barriers and demarcations associated with the construction phase must be removed from the site * Rehabilitation Activities of Environmental Cases identified must continue throughout the defect liability period | All work areas  Responsibility   * Contractor   Supervising Engineer | * Closeout audit report findings |

# SECTION 2: STANDARD REFERENCE NUMBERS

**1. Introduction**

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

**2. General Clause on Standard Specification**

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

**Standards**

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

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

Where Standard Specifications are referred to in the Text of the Specifications this is done by reference to a Standard Specification Reference Number (SRN). A table of comparison is annexed to this Specification where the SRN is cross-referenced to Standard Specifications issued by the International Standards Organization (ISO) and to National Standard Specification that will be accepted in their English version by the Engineer as providing for the quality of workmanship etc. required.

The Bidder shall at his discretion base his Bid on one or other of the National Standard Specifications indicated in that table save that where a relevant Standard Specification issued by the ISO exists at the date of Bid, such an International Standard should as a minimum be compiled with. As the National Standards referred to in the table of comparison may expand on or strengthen further the requirements of ISO, Bidders choosing not to comply with one of the National Standards indicated may either indicate an alternative National Standard with which they shall comply or provide with their Bid a full and detailed description of the Standards they propose to attain.

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

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

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

SRN No. Specification

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 Miscellaneous

**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 |  |  |  |

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| **SRN** | **SUBJECT** | **DIN** | **PART** | **BSS** | **PART** | **OTHER** | **REMARKS** |
| 136 | SAND FOR RENDERING | 4226 |  | 1199 |  |  |  |
| 137 | HOT APPLIED JOINT SEALER |  |  | 2499 |  |  |  |
| 138 | WATER STOPS AND WATER BARS | 7865 | 1, 2 | 8007 |  |  |  |
| 139 | TESTING CONCRETE STATIC MODULES (COMPARISON 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**

|  |  |  |  |  |  |  |  |  |  |
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| **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** |
| 208 | GASKET DIMENSIONS TO SSRN 207 (a) & (d) |  |  | |  | 1 | | EN 1514 |  |
| 208 | GASKET DIMENSIONS TO SSRN 207 (a) & (d) (CONT) |  |  | |  | 2 | | EN 1514 |  |
| 208 | GASKET DIMENSIONS TO SSRN 207 (a) & (d) (CONT) |  |  | |  | 3 | | EN 1514 |  |
| 208 | GASKET DIMENSIONS TO SSRN 207 (a) & (d) (CONT) |  |  | |  | 4 | | EN 1514 |  |
| 208 | GASKETS-FOR GROOVED FLANGES | 2693 |  | |  |  | |  |  |
| 208 | GASKETS-GROOVED O-RINGS | 2697 |  | |  |  | |  |  |
| 209 | C.I. PIPE FITTINGS, MALLEABLE, SCREWED |  |  | |  |  | | ISO 49:1994 |  |
| 210 | STEEL PIPES & FITTINGS - GENERAL |  |  | | 534 |  | |  |  |
| 210 | STEEL PIPES - WATER-GENERAL | 2460 |  | | 534 |  | | EN 10224, AWWA C200-97, NFA 49-150  JIS G 3460-88 |  |
| 210 | STEEL PIPES & FITTINGS - DESIGN | 2413 | 1, 2 | | 8010 2.1 |  | | AWWA M11 |  |
| 210 | STEEL PIPES & FITTINGS - WELDING JOINTS | 2559 | 1, 2, 3 | | 8010 2.1 |  | | AWWA M11  ASTM A333/A333M-99 |  |
| 211 | CEMENT MORTAR LINING - D.I. PIPES |  |  | | EN 545 |  | | EN 545, AWWA C.104A, C602-95 |  |
| 211 | CEMENT MORTAR LINING - D.I. PIPES | 2614 |  | |  |  | |  |  |
| 211 | CEMENT MORTAR LINING - D.I. PIPES (CONT) |  |  | |  |  | | DVGW W343  ISO 4179:1985, ISO 6600:1980, |  |
| 212 | CEMENT MORTAR LINING - STEEL PIPES | 2614 |  | | 534 |  | | AWWA C 205, NFA 49-  701DVGW- W343/W346 |  |
| 212 | CEMENT MORTAR LINING - STEEL PIPES (CONT) | 2614 |  | |  |  | | AWWA C 602-95  ISO / DIS 8324 |  |
| 213 | S. PIPES & TUBES-MATERIAL, PROP., TESTS | 1629 |  | | 3600 |  | | AWWA C200-97 |  |
| 213 | CARBON STEEL PIPES AND TUBES |  |  | | 3601 |  | | ISO 2604/2 /3 /6 |  |
| 213 | STEEL PIPES AND TUBES-SPECIAL REQUIREMENTS | 1626 |  | |  |  | |  |  |
| 213 | STEEL PIPES AND TUBES-SEAMLESS | 2448 |  | |  |  | |  |  |
| 213 | STEEL PIPES AND TUBES-WELDED | 2458 |  | |  |  | |  |  |
| 214 | BITUMEN PROTECTION TO IRON AND STEEL - HOT |  |  | | 4147 |  | | (BS 4147 type I, grade 'd') |  |
| 214 | BITUMEN PROTECTION TO IRON AND STEEL- COLD |  |  | | 3416 |  | | (BS 3416 type II) |  |
| 214 | BITUMEN PROTECTION TO STEEL PIPES ETC. | 30673 | Type E4 | |  |  | |  |  |
| 214 | BITUMEN PROTECTION TO DUCTILE IRON PIPES | 30674 | 4 | |  |  | |  |  |
| 215 | EXT. PROTECTION - IRON & STEEL- EPOXY C. |  |  | | none |  | | AWWA C210-97 |  |
| 216 | STEEL FITTINGS - REINFORCING |  |  | | none |  | | AWWA C208-59  AWWA M11 |  |
| 216 | STEEL FITTINGS - DIMENSIONS |  |  | | 534 |  | | AWWA C208-59  AWWA M11 |  |
| 217 | D.I. PIPES & FITT.-SCREWED GLAND JOINTS |  |  | |  |  | | See SSRN 219 |  |
| 218 | D.I. PIPES & FITT.-BOLTED GLAND JOINTS |  |  | |  |  | | See SSRN 219 |  |
| 219 | D.I. PIPES & FITT.-S & S JOINTS |  |  | | 8010 | 2-2.1 | |  |  |
| 219 | D.I. PIPES & FITT.-S & S JOINTS (CONT) |  |  | |  |  | | EN 545 |  |
| 219 | D.I. PIPES & FITT.-S & S JOINTS (CONT) | 28603 |  | |  |  | |  |  |
| 219 | PIPELINES ON LAND; DESIGN, CONSTRUCTION AND INSTALLATION: STEEL FOR OIL AND GAS |  |  | | 8010 | 2.8 | |  |  |
| 220 | D.I. PIPES-ZINC COATING & PROT. SHEATHS | 30674 | 3 | | none |  | |  |  |
| 221 | IRON AND STEEL PIPES-ENAMEL-HOT APPLIED |  |  | | 7873 |  | | AWWA C203-97 |  |
| 221 | STEEL FLANGED PIPES & FITTINGS- ENAMELLED | 2873 |  | |  |  | |  |  |
| 222 | ELASTOMERIC JOINTS RINGS- REQUIREMENTS |  |  | | 2494 |  | |  | Partly replaced by  BS 7874 and BS EN 681-1 |
| 222 | ELASTOMERIC JOINTS RINGS- VULCANISED RUBBER |  |  | |  | 1 | | EN 681 |  |
| 222 | ELASTOMERIC JOINTS RINGS-DRAINS & SEWERS | 4060 |  | |  |  | |  |  |
| 223 | PIPE THREADS-TUBES & FITT. (WATERTIGHT | See ISO DIN |  | | 21 |  | | ISO 7/1:1982; ISO 7/2:1982 |  |

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| **SRN** | **SUBJECT** | **DIN** | **PART** | **BSS** | **PART** | **OTHER** | **REMARKS** |
| 224 | CAST IRON S & S PIPES AND FITTINGS |  |  | 78 | 2 |  | BS 78 Withdrawn, Replaced by BS  4622  Part 2 Obsolescent, Partially replaced by BS 4772 |
| 225 | STEEL PIPES-HOT DIP GALVANISING |  |  |  |  | EN 10240 |  |
| 226 | CARBON STEEL FITTINGS - BUTT- WELDING-GENERAL | 2609 |  | 1965 | 1 |  | BS 1965 Part 2 Withdrawn |
| 2615 | 1, 2 |  |  |  |  |
| 2616 | 1, 2 |  |  |  |  |
| 2617 |  |  |  |  |  |
| 227 | POLYTHENE SLEEVING FOR STEEL PIPES  & FITTINGS | none |  | none |  | ISO 8180:1985 |  |
| 227 | POLYTHENE SLEEVING FOR D. I. PIPES | 30674 | 5 |  |  |  |  |
| 228 | ST. PIPES-DIMENSION & MASSES-PRESS. PURPOSE | 2413 | 1, 2 | 3600 |  |  |  |
| 228 | S. PIPES-DIMENSION & MASSES-PRESS. (CONT) | 2460 |  |  |  |  |  |
| 229 | STAINLESS STEEL TUBES AND WIRES |  |  | 1554 |  |  |  |
|  |  | 4825 | 1 | ISO 2037:1980 |  |
|  |  | 6362 |  | ISO 7598 |  |
| 17457 |  |  |  |  |  |
| 17440 |  |  |  |  |  |
| 230 | STEEL PIPES FOR WATER FLEXIBLE SOCKET & SPIGOT JOINTS | 2460 |  | CP2010-2 |  | EN 10224, ISO  559 |  |
| 230 | STEEL PIPES FOR WATER FLEXIBLE SOCKET & SPIGOT JOINTS | 2460 |  | CP2010-2 |  | EN 10224, AWWA C200-97 |  |
| 231 | FERROUS P. DEFINITION OF NOMINAL PRESSURE |  |  | none |  | ISO 7268:1983 |  |
| 232 | STEEL PIPELINES - TAPE COATING SYSTEMS | 30672 | 1 | none |  | AWWA C214-95 |  |
| 233 | BURSTING DISCS & DEVICES |  |  | 2915 |  | ISO 6718:1991 |  |
| 234 | STEEL PIPES FOR PETROLUEM AND GAS INDUSTRY | 17172 |  |  |  | EN 10208-2, API  5L |  |
| 235 | FITTINGS TO STAINLESS STEEL TUBES |  |  | 4825 | 2 | ISO 2851:1973 |  |
|  |  | 4825 | 3 | ISO 2852:1974 |  |
|  |  | 4825 | 4 | ISO 2853:1976 |  |
|  |  | 4825 | 5 |  |  |
| 236 | FITTINGS TO BRASS TUBES |  |  | 2051 | 1 |  |  |
| 237 | RUBBER GASKET MATERIAL JOINTS FOR PIPELINES |  |  | 2494 |  | ISO 4633; ISO  6447; ISO 6448 |  |
| 238 | STORAGE OF VULCANISED RUBBER |  |  | none |  | ISO 2230:1973 |  |
| 239 | BITUMINOUS VARNISH TO DUCTILE IRON PIPES |  |  | none |  | ISO 8179-2:1995 |  |
| 240 | FOUNDING - SPHEROIDAL GRAPHITE CAST IRON |  |  |  |  | EN 1563 |  |
| 240 | FOUNDING - AUSTEMPERED DUCTILE IRON CASTINGS |  |  |  |  | EN 1564 |  |
| 241 | FUSION BONDED EPOXY COATINGS FOR STEEL PIPES | 30671 |  | none |  | EN 10309, AWWA C213, NFA 49-706 |  |
| 241 | FUSION BONDED EPOXY LININGS FOR STEEL PIPES |  |  |  |  | AWWA C213 |  |
| 242 | FLEXIBLE BOLTED SLEEVE COUPLINGS |  |  | 534 |  | AWWA C219 |  |
| 243 | FLEXIBLE GROOVED AND SHOULDERED COUPLINGS |  |  |  |  | AWWA C606 |  |
| 244 | SPHERICAL JOINTS FOR WELDING, STEEL PIPES |  |  | 534 |  | UNI 6363 |  |
| 245 | BIT. SEAL COAT'GS ON D.I. PIPE CEM. MOR. LINING |  |  | 7892 |  |  |  |
| 246 | POLYMERIC FILM PROT. SLEEV'G FOR IRON PIPES | 30674 | 5 | 6076 |  | EN 534 |  |
| 247 | HOT ENAMEL COATING TO IRON & STEEL PIPES |  |  | 7873 |  |  |  |
| 248 | EXTERNAL ZINC COATINGS ON DI PIPES | 2444 |  | none |  | ISO 8179-1:1995 |  |
| 249 | BOLTS & NUTS FOR PIPELINES | 2507 |  | none |  |  |  |
| 250 | STEEL PIPELINES - THERMOSET PLASTIC COATINGS | 30671 |  | BGC/CW6 |  | AWWA C213, NFA 49-706 |  |
| **SRN** | **SUBJECT** | **DIN** | **PART** | **BSS** | **PART** | **OTHER** | **REMARKS** |
| 251 | STEEL PIPES - POLYPROPYLENE COATING | 30678 |  | none |  | EN 10286, NFA  49-711 |  |
| 252 | STEEL TUBES - ELECTROMAGNETIC TESTING - 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**

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| **SRN** | **SUBJECT** | **DIN** | **PART** | **BSS** | **PART** | **OTHER** | **REMARKS** |
| 300 | uPVC PIPES FOR COLD WATER | 19532 |  | 3505 |  | ISO 2505, 3114,  3606 |  |
| 300 | uPVC PIPES FOR COLD WATER (CONT. 1) | 8062 |  |  |  | ISO 3472, 3472,  3473, 3474 |  |
| 300 | uPVC PIPES FOR COLD WATER (CONT. 2) |  |  |  |  | ISO 161/1 |  |
| 300 | uPVC PIPES FOR COLD WATER (CONT. 3) |  |  |  |  | KEBS 06-149:2 |  |
| 301 | JOINTS AND FITTINGS FOR uPVC PRESSURE PIPES | 8063 | 1, 12 | 4346 | 1-3 | ISO 2035, 2044 |  |
| 16450 |  |  |  | ISO 2045, 2048,  2536 |  |
| 16451 |  |  |  |  |  |
| 302 | uPVC PIPELINES - LAYING AND JOINTING | 16928 |  | See CP |  | CP 312 |  |
| 303 | uPVC PIPELINES - PRESSURE TESTING | 4279 | 1, 7 |  |  |  |  |
| 304 | uPVC PIPELINES - ADHESIVES FOR JOINTING | 16970 |  |  |  |  |  |
| 305 | uPVC PIPES - GENERAL | 8061 |  | 3505 |  |  |  |
| 305 | uPVC PIPES - GENERAL (CONT. 1) | 8062 |  | 3506 |  |  |  |
| 305 | uPVC PIPES - GENERAL (CONT. 2) | 19532 |  |  |  |  |  |
| 306 | uPVC PIPES - PRESSURE TESTS TO DESTRUCTION |  |  | 4728 |  | ISO 1167 | Obsolescent (but still remains current) Replaced by BS EN 921 and partially replaced by BS EN 2782 Part II method 1127P - 1997 but remains current |
| 307 | HDPE PIPES, JOINTS, FITTINGS | 16963 | 1-3 | 3284 (6572) (6730) |  |  | Obsolescent - Partially replaced by BS  6572, BS 6730 |
| 308 | RUBBER RINGS FOR MECHANICAL JOINTS |  |  | 2494 |  |  |  |
| 309 | uPVC UNDERGROUND DRAIN PIPES & FITTINGS |  |  | 4660 |  |  | Partially replaced by BS EN 1401-1 |
| 310 | uPVC PIPES IMPACT TEST 20 DEGREES CENTIGRADE |  |  | 3505 |  | ISO 3127 |  |
| 311 | uPVC PIPES SHORT TERM HYDROSTATIC TEST |  |  | 3505 |  |  |  |
| 312 | uPVC PIPES LONG TERM HYDROSTATIC TEST |  |  | 3505 |  |  |  |
| 313 | uPVC PIPES INTERNAL PRESSURE ENDURANCE TEST | 8061 |  |  |  |  |  |
| 314 | uPVC WATER ABSORPTION TEST | 8061 |  |  |  | ISO 2508 |  |
| 315 | uPVC PIPES - VARIOUS OTHER TESTS |  |  |  |  | ISO 2505, 3114,  3472, 3473, 3474 |  |
| 316 | PIPES - RATE OF LEAKAGE |  |  | 8010:2 |  |  |  |
| 317 | G.R.P. PIPES |  |  | 6464 |  |  |  |
| 318 | PLASTICS PIPES AND FITTINGS FOR USE AS SUB SOIL FIELD DRAINS |  |  | 4962 |  |  |  |
| 318 | POLYPROPYLENE WASTE PIPE AND FITTINGS (EXTERNAL DIAMETER 34.6MM,  41.0MM AND 54.1MM) |  |  | 5254 |  |  |  |
| 319 | THERMOPLASTICS WASTE PIPE AND FITTINGS |  |  | 5255 |  |  |  |
| 320 | GLASS REINFORCED PLASTICS (GRP) PIPES, JOINTS AND FITTINGS FOR USE FOR WATER SUPPLY OR SEWERAGE |  |  | 5480 |  |  |  |
| 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 POLYETHLENE PIPES UP TO NOMINAL SIZE 63 FOR ABOVE GROUND USE FOR COLD POTABLE WATER |  |  | 6730 |  |  |  |

**3.4 OTHER PIPES AND FITTINGS**

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| **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**

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| **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 Witihdrawn |
| 515 | uPVC VALVES | 3441 | 2 |  |  |  |  |
| 517 | FIRE HYDRANT SYSTEMS FOR BUILDINGS |  |  | 5041 | 1-5 |  |  |
| 518 | BUTTERFLY VALVES |  |  | 5155 |  |  |  |
| 519 | DIAPHRAGM VALVES |  |  | 5156 |  |  |  |
| 520 | CAST IRON PLUG VALVES |  |  | 5158 |  |  |  |
| 521 | UNDERGROUND STOPVALVES FOR WATER SERVICES |  |  | 5433 |  |  |  |

**3.6 TESTING METHODS AND EQUIPMENT**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **SRN** | **SUBJECT** | **DIN** | **PART** | **BSS** | **PART** | **OTHER** | **REMARKS** |
| 600 | NON-DESTRUCTIVE TESTING OF WELDS (TUBES) | 8564 | 1 | 3889 (6072) | 1, 2A | AP15LS | BS 3889 Partially Replaced by 6072 |
| 600 | NON-DESTRUCTIVE TESTING OF WELDS (TUBES) (CONT.) | 50120 | 1, 2 | 6072 |  |  |  |
| 601 | SOILS FOR CIVIL ENGINEERING PURPOSE - TEST METHODS | 18196 |  | 1377 |  |  |  |
| 602 | TESTING OF PIPELINE FOR WATER (INTERNAL PRESSURE) | 4279 | 1-7, 9, 10 |  |  |  |  |
| 603 | TESTING OF CEMENT | See EDIN |  | 4550 | 1, 2, 3 | BS EN 196-7  EDIN EN75, 112,  114, 15 | BS 4550 Part 1 & Part 2 Withdrawn  Replaced by BS EN 196-7: 1992 |
| 604 | MATERIAL TESTING - DOCUMENTATION |  |  |  |  | ISO 404, EURONORM 21 |  |
| 605 | MEASUREMENT OF WATER FLOW (WATER METERS) |  |  |  |  | ISO 4064/3 |  |
| 606 | DRINKING WATER QUALITY - TESTING |  |  |  |  | KS 05-459:5 |  |
| 607 | RECOMMENDATIONS AND CLASSIFICATION FOR TOPSOIL |  |  | 3882 |  |  |  |
| 608 | METHODS OF TESTING MORTARS, SCREEDS AND PLASTERS |  |  | 4551 |  |  |  |
| 609 | STRUCTURAL FIXINGS IN CONCRETE AND MASONRY |  |  | 5080 | 1 & 2 |  | Part 1: Method of test for tensile loading  Part 2: Method for determination of resistance to loading in shear |
| 610 | SIZE OF HARDWOODS AND METHODS OF MEASUREMENT |  |  | 5450 |  |  |  |
| 611 | RECOMMENDATIONS FOR TESTING OF AGGREGATES |  |  | 5835 | 1 |  | Part 1: Compactibility test for graded aggregates |

**3.7 SITE WORK CODES OF PRACTICE**

|  |  |  |  |  |  |  |  |
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| **SRN** | **SUBJECT** | **DIN** | **PART** | **BSS** | **PART** | **OTHER** | **REMARKS** |
| 650 | SITE INVESTIGATIONS | 18196 |  | 5930 |  |  |  |
| 650 | SITE INVESTIGATIONS (CONT.) | 18307 |  |  |  |  |  |
| 651 | WATER SUPPLY | 2000 | See BS | BS 6007 |  | CP 310 | CP 310 Withdrawn  Replaced by BS 6007 |
| 651 | WATER SUPPLY (CONT. 1) | 2425 | 3, 5 | BS 8301 |  | CP 301 | CP 301 Withdrawn  Replaced by BS 8301 |
| 651 | WATER SUPPLY (CONT. 2) | 4046 |  |  |  |  |  |
| 651 | WATER SUPPLY (CONT. 3) | 19630 |  |  |  |  |  |
| 652 | BUILDING DRAINAGE | 1986 | 2-4 | BS 8301 |  | CP 301 | CP 301 Withdrawn  Replaced by BS 8301 |
| 653 | WATER PIPELINE CONSTRUCTION | 19630 |  |  |  |  |  |
| 654 | TRENCHING FOR PIPELINES | 4124 |  |  |  |  |  |
| 655 | SEWAGE PIPELINE CONSTRUCTION |  |  |  |  |  |  |
| 656 | WALLING (BRICK & BLOCK MASONRY) | 18330 | See BS | 5390  5628 |  | CP 121 | CP 121 Withdrawn  Replaced by BS 5390 and BS 5628  Part 3 |
| 657 | USE OF STRUCTURAL STEEL IN BUILDING | 18203 | 1, 2 | 449  BS 5950 | 2 | GB 7101-91  SABS 1431 | BS 449 Parts 1 and 2 Withdrawn Part 2: Addendum No. 1 (1975) Replaced by BS 5950 Part 5 (1987) |
| 658 | SEWERAGE |  |  | 8005 |  | BS EN 1610 |  |
| 659 | SMALL SEWAGE TREATMENT WORKS AND CESSPOOLS |  |  | 6297 |  |  |  |
| 660 | TEST PUMPING OF WATER WELLS |  |  | 6316 |  |  |  |
| 661 | METHODS OF MEASUREMENT OF LIQUID FLOW IN OPEN CHANNEL |  |  | 3680 | 1-10 | BS ISO 748  BS ISO 1100-2  ISO TR 8363 | BS 3680 Part 3A Withdrawn  Replaced by BS ISO 748: 1997  BS 3680 Part 3C Withdrawn  Replaced by BS ISO 1100-2  BS 3680 Part 3G Withdrawn  Replaced by ISO TR 8363  BS 3680 Parts 3J, 8F, 8G Withdrawn |
| 662 | MEASUREMENT OF FLOW IN CLOSED CONDUITS (BY CURRENT METERS OR PITOT STATIC TUBES) |  |  |  |  | ISO 7194 |  |
| 663 | CONSTRUCTION AND DEMOLITION OF CONCRETE AND MASONRY |  |  |  |  | ANSI A10, 9-1983 |  |
| 664 | DRAINAGE OF ROOFS AND PAVED AREAS |  |  | 6367 |  |  |  |
| 665 | FOUNDATIONS |  |  | 8004 |  | CP 2004 | CP 2004 Withdrawn  Replaced by BS 8004 |
| 666 | STRUCTURAL USE OF TIMBER |  |  | 5268 |  | CP 112, 2 | CP 112, 2 Withdrawn  Replaced by BS 5268 Part 2  BS 5268 Part 3 |
| 667 | RETAINING WALLS | 4085 |  |  |  |  |  |
| 668 | WATERPROOFING OF BUILDINGS & STRUCTURES | 18195 | 1-4 |  |  |  |  |
| 669 | WATER QUALITY - SAMPLING |  |  |  |  | ISO 5667/2/3 |  |
| 670 | WELDING PROCEDURES - APPROVAL TESTING |  |  | 4870 | 1 | BS EN 288-3  BS EN 288-4 | BS 4870 Part 1 Withdrawn  Replaced by BS EN 288-3  BS 4870 Part 2 Withdrawn  Replaced by BS EN 288-4 |
| 671 | WELDING - APPROVAL TESTING |  |  | 4871 | 1 | BS EN 287-1  BS EN 287-2 | BS 4871 Part 1 Withdrawn  Replaced by BS EN 287-1  BS 4871 Part 2 Withdrawn  Replaced by BS EN 287-2 |
| 672 | LOGGING OF ROCK CORES |  |  |  |  | LOGGING OF ROCK CORES FOR ENGINEERING PURPOSES, GEOL. SOC. OF LONDON |  |
| 673 | TEST FOR STABILISED SOILS |  |  | 1924 |  |  |  |
| 674 | DRAIN AND SEWER SYSTEMS OUTSIDE BUILDINGS |  |  |  | 1, 2 & 3 | BS EN 752 | Part 1: Generalities and definitions Part 2: Performance requirements Part 3: Planning |
| 675 | CONSTRUCTION AND TESTING OF DRAINS AND SEWERS |  |  |  |  | BS EN 1610 |  |
| 676 | IDENTIFICATION OF PIPELINES AND SERVICES |  |  | 1710 |  |  |  |
| 677 | WELDING OF STEEL PIPELINES ON LAND AND OFFSHORE |  |  | 4515 |  |  |  |
| 678 | PERFORMANCE REQUIREMENTS FOR JOINTS AND COMPRESSION FITTINGS FOR USE WITH POLYETHYLENE PIPES |  |  | 5114 |  |  |  |
| 679 | STRUCTURAL USE OF TIMBER |  |  | 5268 | 2, 3 & 5 |  | Part 2: Permissible stress design, materials and workmanship  Part 3: Trussed rafter roof  Part 5: Preservative treatment of structural timber |

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| **SRN** | **SUBJECT** | **DIN** | **PART** | **BSS** | **PART** | **OTHER** | **REMARKS** |
|  |  |  |  |  |  |  |  |
| 680 | STAIRS, LADDERS AND WALKWAYS |  |  | 5395 | 1, 2 & 3 |  | Part 1: Design of straight stairs Part 2: Design of helical and spiral stairs  Part 3: Design of industrial type stairs, permanent ladder and 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.**

|  |  |  |  |  |  |  |  |
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| **SRN** | **SUBJECT** | **DIN** | **PART** | **BSS** | **PART** | **OTHER** | **REMARKS** |
| 700 | IDENTIFICATION OF PIPELINE ACCORDING TO FLUID CONVEYED | 2403 |  |  |  |  |  |
| 701 | GRAPHICAL SYMBOLS FOR GENERAL ENGINEERING - PIPING SYSTEMS | 2406 |  | 1553 | 1 |  |  |
| 701 | GRAPHICAL SYMBOLS FOR GENERAL ENGIINEERING - PIPING SYSTEMS (CONT.) | 2429 | 1 |  |  |  |  |
| 702 | PROJECT NETWORK TECHNIQUES |  |  | 4335 |  |  |  |
| 703 | DRAWING OFFICE PRACTICE - ARCHITECTS AND BUILDERS |  |  | 1192 | 1-4 |  | BS 1192 Part 2 Obsolescent |
| 704 | CONSTRUCTION DRAWING PRACTICE |  |  | 1192 | 1-4 |  | BS 1192 Part 2 Obsolescent |
| 705 | ENGINEERING DRAWING PRACTICE |  |  | 308 | 1 | ISO 128, 2162,  2203 |  |
| 706 | DRAWING PRACTICE FOR ENGINEERING DRAWINGS |  |  | 5070 | 1-3 | BS EN 61082 | BS 5070 Part 1 Partially Replaced by  BS EN 61082-1  BS 5070 Part 2 Withdrawn  Replaced by BS EN 61082-2 |
| 707 | BUILDING AND CIVIL ENGINEERING TERMS |  |  | 6100 | 1-6 |  |  |
| 708 | WATER SUPPLY - MAPS AND PLANS | 2425 | 3, 5 |  |  |  |  |
| 709 | CARTOGRAPHIC REPRESENTATION OF CLIMATE | 50019 | 1 |  |  |  |  |
| 750 | CONCRETE (INC. R/F) - GLOSSARY |  |  | 6100 | 6.2, 6.3 |  |  |
| 751 | VALVES - GLOSSARY |  |  |  |  |  |  |
| 752 | IRON AND STEEL - GLOSSARY FOR PIPES |  |  | 6562 | 1-2 |  |  |

**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 |  | UGANDA M.O.W.E ST. SPEC. |  |
| 804 | CONCRETE BLOCKS (CONT.) |  |  | 6073 | 1, 2 |  | BS 6073 Partially Replaced by  BS EN 772-2 |
| 805 | HOLLOW CLAY PARTITION BLOCKS | 278 |  | 3921 |  |  | BS 3921 Partially Replaced by  BS EN 772-3 & 7 |
| 806 | BRICK WALLING | 105 | 1-5 | 3921 |  |  | BS Partially Replaced by  BS EN 772-3 & 7 |
| 806 | BRICK WALLING (CONT.) | 106 | 1, 2 |  |  |  |  |
| 807 | ASBESTOS ROOF SLATES AND SHEETING |  |  | 690 | 3, 4 |  | BS 690 Part 3 & 4 Withdrawn Replaced by BS EN 494 and 492 respectively |
| 808 | FIXING BOLTS & SCREENS FOR ROOFING |  |  |  |  |  |  |
| 809 | INSULATION BOARD AND HARD BOARD |  |  | 1142 | 1, 2, 3 | ISO 766/7/9,  818/19, 2695,  3340, 3546, 3729 | BS 1142 Partially Replaced by  BS EN 120, 310, 316-323, 324: 1 & 2,325, 382-1 and BS EN 622: 1-5 |
| 810 | BLOCKBOARD | 68705 | 1, 3 | 3444 |  | ISO 1096, 97, 98,  2074, 2426-30 | DIN 68705 Part 1 Withdrawn |
| 811 | PLYWOOD (TROPICAL HARDWOOD) | 4078 |  | 6566 | 1-8 | ISO 1096, 1097 | BS 6566 Replaced by various BS EN Standards on the same subject |
| 811 | PLYWOOD (TROPICAL HARDWOOD) (CONT.) | 68705 | 1, 5 |  |  | ISO 1098 | DIN 68705 Part 1 Withdrawn |
| 812 | SEALING OF EXT. WALL JOINTS | 18540 | SH. 1, 2, 3 |  |  |  |  |
| 813 | CHIPBOARD | 68761 | 4 | 5669 |  |  | BS 5669 Part 1 Partially Replaced by BS EN 120, 309, 310, 311, 312, Parts 1-6 and 317  BS 5669 Part 4 Partially Replaced by BS EN 634-2 & BS EN 1328  BS 5669 Part 5 Withdrawn  Replaced by BS 7916 |
| 68763 |  |  |  |  |  |
| 68764 |  |  |  |  |  |
| 814 | LAMINATED PLASTIC SHEETING | 16922 |  | 3794 |  | BS EN 438 | BS 3794 Withdrawn  Replaced by BS EN 438 Parts 1 & 2 |
| 814 | LAMINATED PLASTIC SHEETING (CONT. 1) |  |  |  |  |  |  |
| 814 | LAMINATED PLASTIC SHEETING (CONT. 2) |  |  |  |  |  |  |
| 815 | WOOD WOOL SLABS | 1101 |  | 1105 |  |  | BS 1105 Obsolescent |
| 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 |  |  | 143 |  | BS EN 10242 |  |
| 824 | FITTINGS TO M.S. TUBING MILD STEEL (CONT. 2) |  |  | 1740 | 1 |  |  |
| 825 | POLYTHENE TUBING FOR COLD WATER SERVICES | 19533 |  | 2782 |  | ISO 161-1  BS ISO 4065  BS ISO 11922-1 |  |
| 825 | POLYTHENE TUBING FOR COLD WATER SERVICES (CONT. 1) | 8072 |  | 6572  6730 |  |  |  |
| 825 | POLYTHENE TUBING FOR COLD WATER SERVICES (CONT. 2) | 8073 |  |  |  |  |  |
| 825 | POLYTHENE TUBING FOR COLD WATER SERVICES (CONT. 3) | 8075 |  |  |  |  |  |
| 825 | POLYTHENE TUBING FOR COLD WATER SERVICES (CONT. 4) | 8074 |  |  |  |  |  |
| 826 | BRASSWORK & FITTINGS FOR TAPS & STOP VALVES |  |  | 1010 | 2 |  |  |
| 827 | BALL VALVES FOR CISTERNS |  |  | 1212 | 3 |  |  |
| 828 | PLASTIC FLOATS FOR BALL VALVES |  |  | 2456 |  |  |  |
| 829 | CAST IRON SOIL, WASTE & VENT PIPES |  |  | 416 |  |  |  |
| 829 | CAST IRON SOIL, WASTE & VENT PIPES (CONT. 1) |  |  |  |  |  |  |
| 829 | CAST IRON SOIL, WASTE & VENT PIPES (CONT. 2) |  |  |  |  |  |  |
| 829 | CAST IRON SOIL, WASTE & VENT PIPES (CONT. 3) | 19522 | 1, 2 |  |  |  |  |
| 830 | GALVANISED MILD STEEL COLD WATER TANKS |  |  | 417 | 2 CL.A |  |  |
| 831 | ENAMELLED CAST IRON BATH |  |  | 1189 |  |  |  |
| 831 | ENAMELLED CAST IRON BATH (CONT. 1) |  |  |  |  |  |  |
| 831 | ENAMELLED CAST IRON BATH (CONT. 2) | 4774 |  |  |  |  |  |
| 832 | PILLAR TAPS | 7572 |  | 1010 | 2 |  |  |
| 833 | GLAZED VITREOUS CHINA W.C. PAN | 1387 |  | 5503 |  |  |  |
| 833 | GLAZED VITREOUS CHINA W.C. PAN (CONT.) | 1381 |  |  |  |  |  |
| 834 | HINGED PLASTIC SEAT TO W.C. PAN |  |  | 1254 |  |  |  |
| 835 | GLAZED VITREOUS CHINA LAVATORY BASIN | 4462 |  | 1188 |  |  |  |
| 835 | GLAZED VITREOUS CHINA LAVATORY BASIN (CONT.) |  |  | 5506 | 2 |  |  |
| 836 | STAINLESS STEEL SINK | 4465 |  | 1244 | 2 |  |  |
| 837 | BRASS “S” AND “P” TRAPS |  |  | 1184 |  |  | BS 1184 Obsolescent |
| 839 | A/C DRAIN PIPES AND FITTINGS | 19831 |  | 3656 |  | BS EN 588-1 | BS 3656 Withdrawn  Replaced by BS EN 588-1 |
| 839 | A/C DRAIN PIPES AND FITTINGS (CONT. 1) | 19841 |  |  |  |  |  |
| 839 | A/C DRAIN PIPES AND FITTINGS (CONT. 2) | 19850 | 1, 2 |  |  |  |  |
| 840 | CONCRETE DRAIN PIPES | See 409 |  | 2870 |  |  |  |
| 841 | PITCH FIBRE DRAIN PIPES |  |  | 2760 |  |  | BS 2760 Withdrawn |
| 842 | CAST IRON DRAIN PIPES | 19500 |  | 437 |  | ISO 6594 |  |
| 19501 |  |  |  |  |  |
| 19502 |  |  |  |  |  |
| 19503 |  |  |  |  |  |
| 19504 |  |  |  |  |  |
| 19505 |  |  |  |  |  |
| 19506 |  |  |  |  |  |
| 19507 |  |  |  |  |  |
| 19508 |  |  |  |  |  |
| 19509 |  |  |  |  |  |
| 195010 |  |  |  |  |  |
| 195011 |  |  |  |  |  |
| 195014 |  |  |  |  |  |
| 195019 |  |  |  |  |  |
| 19521 |  |  |  |  |  |
| 843 | JOINTING COMPOUND FOR C.I. DRAIN PIPES |  |  | BS 6956 | 1, 5, 6, 7 |  |  |
| 844 | C.I. S & S FITTINGS FOR DRAINS | 19519 |  | 437 |  |  |  |
| 845 | STEP-IRONS TO MANHOLES & SEPTIC TANKS | 1211 | 1 | 1247 |  |  |  |
| 845 | STEP-IRONS TO MANHOLES & SEPTIC TANKS (CONT. 1) | 1212 | 1 |  |  |  |  |
| 845 | STEP-IRONS TO MANHOLES & SEPTIC TANKS (CONT. 2) | 1213 |  |  |  |  |  |
| 845 | STEP-IRONS TO MANHOLES & SEPTIC TANKS (CONT. 3) | 4281 |  |  |  |  |  |
| 846 | C.I. MANHOLE COVERS AND FRAMES | 1229 |  | 497 | 1 | BS EN 124 | BS 497 Withdrawn  Replaced by BS EN 124 |
| 4271 | 1, 3 |  |  |  |  |
| 19593 | 1, 2, 3 |  |  |  |  |
| 19594 | 1, 2 |  |  |  |  |
| 19596 |  |  |  |  |  |
| 19597 |  |  |  |  |  |
| 847 | STEEL LADDERS FOR PERMANENT ACCESS | 3620 |  | 4211 |  |  |  |
| 848 | HANDRAILING | 24533 |  | 6180 |  |  |  |
| 849 | GALVANISED CHAIN LINK FENCING | 11991 |  | 1722 | 1 |  |  |
| 850 | OPEN MESH STEEL FLOORING |  |  | 4592 | 1 |  |  |
| 851 | MASTIC ASPHALT FOR ROOFING |  |  | 6925 |  |  |  |
| 852 | ALUMINIUM FOR LOUVRE WINDOWS |  |  | 1470 |  | BS EN 485  BS EN 515  BS EN 573 | BS 1470 Withdrawn  Replaced by BS EN 485 Parts 1-4, BS EN 515, BS EN 573 Parts 1-4 |
| 853 | FIXING ACCESSORIES FOR BUILDING PURPOSES |  |  | 1494 | 1 |  | BS 1494 Part 2 Withdrawn |
| 854 | PRECAST CONCRETE MANHOLES | 4034 |  | 5911 | 2, 3 |  | BS 5911 Part 1 Withdrawn  Replaced by  BS 5911 Part 100 (1988)  Bs 5911 Part 200 (1989) and BS 5911  Part 200 (1994) |
| 855 | PRECAST CONCRETE KERBS & CHANNELS | 483 |  | 7263 | 1 |  |  |
| 856 | WATERPROOF BUILDING PAPERS | 4122 |  | 1521 |  |  |  |
| 52126 |  |  |  |  |  |
| 52127 |  |  |  |  |  |
| 52128 |  |  |  |  |  |
| 52129 |  |  |  |  |  |
| 52130 |  |  |  |  |  |
| 857 | METAL TIES FOR CAVITY WALL |  |  | 1243 |  |  |  |
| 858 | A/C BUILDING PRODUCTS (TESTS FOR SHEETS) | 274 | 1-4 | 4624 |  |  |  |
| 859 | PRECAST CONCRETE FLAGSTONES | 485 |  | 7263 | 1 |  |  |
| 860 | ASBESTOS CEMENT RAIN WATER GOODS | 19831 | 1-9 | 569 |  |  |  |
| 860 | ASBESTOS CEMENT RAIN WATER GOODS (CONT. 1) | 19841 | 1-6 |  |  |  |  |
| 860 | ASBESTOS CEMENT RAIN WATER GOODS (CONT. 2) | 19850 | 1 |  |  |  |  |
| 861 | LINTELS - PREFABRICATED |  |  | 5977 | 2 |  |  |
| 862 | uPVC SOIL AND VENT PIPES, FITTINGS, ETC. | 1187 |  | 4514 |  |  |  |
| 863 | STRUCTURAL STEEL IN BUILDINGS |  |  | 449 (5950) | 2 |  | BS 449 Part 2 Withdrawn  Replaced by BS 5950 Part 5 |
| 864 | PROTECTIVE BARRIERS IN AND ABOUT BUILDINGS |  |  | 6180 |  |  |  |
| 866 | BITUMENS FOR BUILDING & CIVIL ENGINEERING |  |  | 3690 | 1, 3 |  |  |
| 867 | SOLAR WATER HEATERS |  |  |  |  | AS 2813-85 |  |
| 868 | FLOORING - INITIAL TREAMENT MAINTENANCE |  |  | 6263 | 2 |  |  |
| 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 MIXIED OIL-BASED UNDERCOATING AND FINISHING PAINTS |  |  |  |  |  |  |
| 879 | COLD POURED SEALING MATEIALS FOR CONCRETE PAVEMENTS |  |  | 5212 |  |  |  |
| 880 | GULLY TOPS AND MANHOLE TOPS FOR VEHICULAR PEDESTRIAN AREAS. DESIGN REQUIREMENTS, TYPE TESTING, MARKING QUALITY CONTROL |  |  |  |  | BS EN 124 |  |
| 881 | STRUCTURAL TIMBER. STRENGTH CLASSES |  |  | 338 |  |  |  |
| 882 | CLAY ROOFING TILES AND FITTINGS |  |  | 402 | 1 |  | Part 1: Specification for plain tiles and fittings |
| 883 | BITUMEN ROAD EMULSIONS (ANIONIC AND CATIONIC) |  |  | 434 | 1 |  | Part 1: Bitumen road emulsions |
| 884 | DRESSED NATURAL STONE KERBS, CHANNELS, QUADRANTS AND SETTS |  |  | 435 |  |  |  |
| 885 | CONCRETE ROOFING TILES AND FITTINGS. PRODUCT SPECIFICATION |  |  |  |  | BS EN 490 |  |
| 886 | AIR BRICKS AND GRATINGS FOR WALL VENTILATION |  |  | 493 |  |  |  |
| 887 | EAVES GUTTERS AND FITTINGS MADE OF PVC-C |  |  |  |  | BS EN 607 |  |
| 888 | EAVES GUTTERS AND RAINWATER DOWN-PIPES OF METAL SHEET |  |  |  |  | BS EN 612 |  |
| 889 | PLYWOOD |  |  |  |  | BS EN 635 |  |
| 890 | TIMBER IN JOINERY |  |  |  |  | BS EN 942 |  |
| 891 | PRESSED STEEL GUTTERS, RAINWATER PIPES, FITTINGS AND ACCESSORIES |  |  | 1091 |  |  |  |
| 892 | WC FLUSHING CISTERNS (INCLUDING DUAL FLUSH CISTERNS AND FLUSH PIPES) |  |  | 1125 |  |  |  |
| 893 | NAILS |  |  | 1202 | 1, 2 & 3 |  | Part 1: Steel nails Part 2: Copper nails Part 3: Aluminium nails |
| 893 | FIXING ACCESSORIES FOR BUILDING PURPOSES |  |  | 1494 | 1 |  | Part 1 Fixings for sheet, roof and wall coverings |
| 894 | AUTOMATIC FLUSHING CISTERNS FOR URINALS |  |  | 1876 |  |  |  |
| 895 | WASTES (EXCLUDING SKELETON SINK WASTES) AND BATH OVERFLOWS |  |  | 3380 |  |  |  |
| 896 | LIGHTWEIGHT AGGREGATES FOR MASONRY UNITS AND STRUCTURAL CONCRETE |  |  | 3797 |  |  |  |
| 897 | TERRAZO TILES |  |  | 4131 |  |  |  |
| 898 | WELDABLE STRUCTURAL STEELS |  |  | 4360 |  |  |  |
| 899.1 | UNPLASTICIZED POLYVINYL CHLRIDE (PVC-U) RAINWATER 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 ½ AND 3/4) |  |  | 5412 |  |  |  |
|  | SUITABLE FOR OPERATION AT PN 10  MAX. AND A MINIMUM FLOW PRESSURE OF 0.01 MPa (0.1 BAR) |  |  |  |  |  |  |
| 899.17 | VITREOUS CHINA WASHDOWN WC PANS WITH HORIZONTAL OUTLET |  |  | 5503 | 1 & 2 |  | Part 1: Connecting dimensions  Part 2: Materials, quality, performance and dimensions other than connecting dimensions |
| 899.18 | VITREOUS CHINA BOWL URINALS (RIMLESS TYPE) |  |  | 5520 |  |  |  |
| 899.19 | PRESERVATION OF TIMBER |  |  | 5589 |  |  |  |
| 899.20 | PLASTIC CONNECTORS FOR USE WITH HORIZONTAL OUTLET VITREOUS CHINA WC PANS |  |  | 5627 |  |  |  |
| 899.21 | STILES, BRIDLE GATES AND KISSING GATES |  |  | 5709 |  |  |  |
| 899.22 | GLAZING FOR BUILDINGS |  |  | 6262 |  |  |  |
| 899.23 | MANUFACTURE OF GLUED STRUCTURAL COMPONENTS FOR TIMBER AND WOOD BASED PANEL PRODUCTS |  |  | 6446 |  |  |  |
| 899.24 | POLYETHYLENE DAMP-PROOF COURSES FOR MASONRY |  |  | 6515 |  |  |  |
| 899.25 | INSTALLATION OF CHMICAL DAMP- PROOF COURSES |  |  | 6576 |  |  |  |
| 899.26 | PORTLAND PULVERIZED-FUEL ASH CEMENTS |  |  | 6588 |  |  |  |
| 899.27 | PRECAST CONCRETE PAVING BLOCKS |  |  | 6717 | 1 |  | Part 1: Paving blocks |
| 899.28 | EXTERIOR WOOD COATING SYSTEMS |  |  | 6952 | 1 |  | Part 1: Guide to classification and selection |
| 899.29 | PRECAST CONCRETE FLAGS, KERBS, CHANNELS, EDGINGS AND QUADRANTS |  |  | 7263 | 1 & 2 |  | Part 1: Specification  Part 2: Code of practice for laying |
| 899.30 | 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 FRANSFORMERS |  |  | 7626 |  | IEC 60185 |  |
| 003 | VOLTAGE TRANSFORMERS |  |  | 7625 |  | IEC 60186/186A |  |
| 004 | CIRCUIT BREAKERS 1 kV A.C. |  |  | 5311 |  | IEC 60056/267 |  |
| 005 | CIRCUIT BREAKERS A.C. VOLT. OPERATED |  |  | 842 |  | BS EN 61008-1 |  |
| 006 | CIRCUIT A.C. CURRENT OPERATED |  |  | 4293 |  | BS IEC 1008-2-2 | BS 4293 Partially Replaced by  BS EN 61008-1 & BS IEC 1008-2-2 |
| 007 | FUSE SWITCHES (AIR BREAK) |  |  | 5419 |  | IEC 408 | BS 5419 Withdrawn  Replaced by BS EN 60947-3 |
| 008 | MOTOR STARTERS AND CONTROLLERS | 46062 |  | 587 |  |  | BS 587 Withdrawn  Replaced by BS EN 60947-4-1 and  BS 5856-1 |
| 009 | MOTOR STARTERS ABOVE 1000 V.A.C. |  |  | 5856 | 1 | IEC 60632-1 |  |
| 010 | ELECTRIC MOTOR DIMENSIONS | 42673 | BL. 1-4 | 4999 | 10 | IEC 60072, 72A |  |
| 011 | INDUCTION MOTORS FOR GENERAL PURPOSE | 42673 | BL. 1-4 | 5000 | 10 | IEC 60072 |  |
| 012 | ENCLOSURE PROTECTION SWITCH / CONTROL GEAR | 40050 | BL. 2, 6, 9, 10 | 5420 |  | IEC 60144 (IP32) | BS 5420 Withdrawn  Replaced by BS EN 60947-1 |
| 013 | MOTOR STARTERS NOT EXC. 1000 V.A.C. | 46062 |  | 4941 | 1, 3, 4 | IEC 292, 1, 2, 3, 4 | BS 4941 Withdrawn  Replaced by BS EN 60947-4-1 |
| 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 (15TH ED) |  |
| 019 | ELECTRICAL PROTECTIVE RELAYS |  |  | 142 |  |  | BS 142 Part 1 Section 1.5 Sub- Section 1.5.1 - 1.5.3 all renumbered as BS 60255-21-1, 2, 3 respectively |
| 020 | FACTORY BUILT SWITCHGEAR ASSEMBLIES | 57670 | TL. 6 | 5486 | 1, 2, 3, 13 | IEC 439-2 | BS 5486 Part 1 Withdrawn  Replaced by BS EN 60439-1 |
| 021 | RECIPROCATING INT/COMB. ENGINES |  |  | 5514 | 1, 2 | ISO 3046, PT. 1, 2 | BS 5541 Part 2 (1988) 'Test Methods' Withdrawn - Replaced by BS 5514 Part 1 (1996) |
| 022 | MACHINES FOR MISCELLANEOUS APPLICATIONS |  |  | 5000 | 99 |  |  |
| 023 | INSULATING MATERIALS FOR ELECTRICAL MACHINES |  |  | 2757 |  | IEC 85 |  |
| 024 | PCV INSULATED CABLES NOT EXCEEDING 1900 V.A.C. | 57207 | 4, 5 | 6346 |  |  |  |
| 025 | ROTATING ELECTRICAL MACHINES - GENERAL |  |  | 4999 | 1, 2, 3 | IEC 34-1, 34-8, 72,  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 |  |  |  |
| 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 | COMMISSIONIING, OPERATION AND MAINTENANCE OF STORAGE PUMPS |  |  |  |  | IEC 600805 |  |
| 047 | RUBBER INSULATED CABLES |  |  |  |  | IEC 600245 |  |
| 048 | VOLTAGE FLUCTUATION LIMITS - GUIDE |  |  |  |  | IEC 600827 |  |
| 049 | ELECTRIC CABLES - ARMOURING - WIRE FOR |  |  |  |  | KS 04-290 |  |
| 050 | ROTATING ELECTRICAL MACHINES FOR HARZARDOUS AREAS (“N”) |  |  | 5000 | 16 |  |  |
| 051 | POWER TRANSFORMERS - GENERAL |  |  |  |  | BS EN 60076-1 |  |
| 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 MISCELLLANEOUS**

| **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 STELLS (METAL ARC) (CONT 3) | 50120 | 1 |  |  |  |  |
| 920 | STEEL PLATE, SHEET AND STRIP |  |  | 1449 | 1 (Withdrawn) | ISO 3573 | BS 1499 Parts Withdrawn Replaced by BS EN 10111, 10209, BS EN 10149-2 & 3, 10051, 10131,10139, 10149-2 & 3, 10048, 10140, 10029, 10258 & 10259 |
|  |  |  |  | ISO 3574 |  |
| 1614 |  |  |  |  |  |
| 1632 | 2 |  |  |  |  |
|  |  | 1624 |  |  |  |  |  |

|  |  |  |  |  |  |  |  |
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| **SRN** | **SUBJECT** | **DIN** | **PART** | **BSS** | **PART** | **OTHER** | **REMARKS** |
| 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 ENGINEERING |  |  | 4320 |  | ASS 2602: 83  2603: 83 - ISO/12  887 |  |
| 926 | STEEL STRUCTURES - PAINTS FOR POLYURETHANE |  |  |  |  |  |  |
| 927 | SHEAR TEST FOR METALS | 50141 |  |  |  |  |  |
| 928 | WELDED STEEL TANKS FOR OIL STORAGE |  |  |  |  | APS 650 |  |
| 929 | LIFTING APPLIANCES - OVERHEAD TRAVELLING CRANES |  |  |  |  | ISO 7752/5 |  |
| 930 | HIGH STRENGTH FRICTION GRIP BOLTS |  |  | 4325 |  |  |  |
| 931 | ELECTRODES FOR MANUAL ARC WELDING |  |  | 639 |  | BS EN 499 | BS 639 Withdrawn  Replaced by BS EN 499 |
| 932 | BLACK CUP COUNTERSUNK BOLTS, SCREWS WITH NUTS |  |  | 4933 |  |  | BS 4933 Obsolescent |
| 933 | METAL LATHING |  |  | 1369 |  |  |  |
| 934 | ROLLED ASPHALT HOT PROCESS FOR ROADS |  |  | 594 |  |  |  |
| 935 | BINDER DIST. FOR ROAD SURFACE DRESSING |  |  | 1707 |  |  |  |
| 936 | BITUMINOUS ROOFING FELT |  |  | 747 |  | CP 114: 3 | CP 114:3 Withdrawn |
| 937 | GAS WELDING |  |  | 2640 |  |  |  |
| 938 | METALLIC COATINGS. HOT DIP GALVANISED COATINGS ON FERROUS MATERIALS |  |  |  |  | BS EN 1460 |  |
| 939 | METHOD FOR SPECIFYING ELECTROPLATED COATINGS OF ZINC AND CADMIUM ON IRON AND STEEL |  |  | 1706 |  |  |  |
| 940 | DIMENSIONS OF GASKETS FOR PIPE FLANGES TO BS 4504 |  |  | 4865 | 1 |  | Part 1: Non-metallic flat gaskets  (including gaskets for flanges to BS  4722) |
| 941 | BONDING AGENTS FOR USE WITH GYPSUM PLASTERS AND CEMENT |  |  | 5270 | 1 |  | Part 1: Polyvinyl acetate (PVAC) emulsion bonding agents for indoor use with gypsum building plasters |
| 942 | FALSEWORK |  |  | 5975 |  |  |  |
| 943 | TUBULAR POLYETHYLENE FILM FOR USE AS A PROTECTIVE SLEEVING FOR BURIED IRON PIPES AND FITTINGS |  |  | 6076 |  |  |  |
| 944 | FLEXIBLE JOINTS FOR GREY OR DUCTILE CAST IRON DRAINPIPES AND FITTINGS (BS 437) AND FOR DISCHARGE AND VIENTILATING PIPES AND FITTINGS (BS 416) |  |  | 6087 |  |  |  |
| 945 | HOT ROLLED PRODUCTS OF NON-ALLOY STRUCTURAL STEELS |  |  | 10025 |  |  |  |
| 946 | STAINLESS STEELS |  |  | 10088 | 2 |  | Part 2: Technical delivery conditions for sheet/plate and strip for general purposes |

**4.1 DIN**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **DIN** | **SRN** | **DIN** | **SRN** | **DIN** | **SRN** | **DIN** | **SRN** | **DIN** | **SRN** |
| 105 | 806 | 2000 | 651 | 2988 | 204 | 4279 | 405 | 19630 | 651 |
| 106 | 806 | 2403 | 700 | 2990 | 204 | 4279 | 602 | 19648 | 510 |
| 267 | 914 | 2406 | 701 | 2991 | 204 | 4281 | 845 | 19800 | 401 |
| 278 | 805 | 2410 | 213 | 2993 | 204 | 4325 | 017 | 19850 | 402 |
| 459 | 119 | 2413 | 210 | 2999 | 203 | 4325 | 016 | 19850 | 839 |
| 483 | 855 | 2413 | 228 | 2999 | 823 | 7572 | 832 | 19850 | 860 |
| 488 | 128 | 2425 | 708 | 3202 | 502 | 7865 | 138 | 22418 | 036 |
| 488 | 127 | 2425 | 651 | 3202 | 505 | 8061 | 305 | 28500 | 201 |
| 488 | 126 | 2429 | 701 | 3202 | 501 | 8061 | 314 | 28500 | 200 |
| 488 | 125 | 2440 | 203 | 3221 | 509 | 8061 | 313 | 28601 | 217 |
| 1025 | 905 | 2440 | 823 | 3230 | 501 | 8062 | 300 | 28602 | 218 |
| 1025 | 913 | 2441 | 203 | 3352 | 501 | 8062 | 305 | 28603 | 219 |
| 1045 | 108 | 2441 | 823 | 3352 | 502 | 8063 | 301 | 30670 | 227 |
| 1045 | 107 | 2442 | 203 | 3352 | 511 | 8072 | 825 | 30671 | 215 |
| 1045 | 110 | 2442 | 823 | 3354 | 506 | 8073 | 825 | 30672 | 221 |
| 1045 | 120 | 2444 | 225 | 3356 | 504 | 8074 | 825 | 30673 | 214 |
| 1045 | 111 | 2448 | 213 | 3357 | 514 | 8075 | 825 | 30673 | 908 |
| 1045 | 113 | 2458 | 213 | 3441 | 515 | 8528 | 919 | 30674 | 220 |
| 1045 | 112 | 2460 | 210 | 3620 | 847 | 8553 | 919 | 40050 | 012 |
| 1048 | 116 | 2460 | 213 | 4030 | 114 | 855 | 919 | 40050 | 030 |
| 1048 | 117 | 2460 | 824 | 4032 | 407 | 8564 | 600 | 42021 | 001 |
| 1060 | 801 | 2500 | 207 | 4032 | 409 | 8565 | 220 | 42673 | 010 |
| 1084 | 115 | 2501 | 207 | 4033 | 655 | 1045 | 100 | 42673 | 011 |
| 1084 | 121 | 2505 | 216 | 4034 | 854 | 16450 | 301 | 42961 | 029 |
| 1084 | 133 | 2519 | 207 | 4035 | 409 | 16451 | 301 | 46062 | 008 |
| 1101 | 815 | 2526 | 207 | 4035 | 408 | 16922 | 814 | 46062 | 013 |
| 1102 | 815 | 2559 | 210 | 4046 | 651 | 16928 | 302 | 50019 | 709 |
| 1164 | 103 | 2566 | 207 | 4060 | 222 | 16963 | 307 | 50120 | 600 |
| 1164 | 106 | 2605 | 226 | 4078 | 811 | 16970 | 304 | 50120 | 919 |
| 1164 | 105 | 2615 | 226 | 4085 | 667 | 18101 | 817 | 50141 | 927 |
| 1164 | 104 | 2615 | 216 | 4124 | 654 | 18195 | 668 | 50976 | 903 |
| 1187 | 862 | 2616 | 226 | 4126 | 145 | 18196 | 601 | 52128 | 856 |
| 1199 | 849 | 2616 | 216 | 4226 | 109 | 18196 | 650 | 52129 | 856 |
| 1211 | 845 | 2617 | 216 | 4226 | 110 | 18203 | 657 | 52130 | 856 |
| 1212 | 845 | 2617 | 226 | 4226 | 108 | 18301 | 822 | 53255 | 818 |
| 1229 | 846 | 2632 | 207 | 4226 | 107 | 18307 | 650 | 55928 | 900 |
| 1230 | 414 | 2633 | 207 | 4226 | 130 | 18330 | 656 | 55928 | 917 |
| 1249 | 822 | 2673 | 207 | 4226 | 111 | 18540 | 812 | 57207 | 024 |
| 1381 | 833 | 2693 | 208 | 4226 | 136 | 19522 | 829 | 57660 | 027 |
| 1387 | 833 | 2695 | 208 | 4226 | 114 | 19532 | 300 | 57670 | 020 |
| 1614 | 920 | 2696 | 208 | 4226 | 113 | 19532 | 305 | 68705 | 811 |
| 1623 | 920 | 2697 | 208 | 4226 | 112 | 19533 | 825 | 68706 | 817 |
| 1624 | 920 | 2873 | 221 | 4226 | 135 | 19593 | 846 | 68761 | 813 |
| 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 (15TH EDITION) | 018 | ISO 965/3, 262 | 923 |
| ISO 1106-3, 7438 | 924 | ISO DIS 4042 | 921 |
| ISO 1167 | 306 | UGANDA M.O.W. E 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 |  |  |
|  |  |  |  |