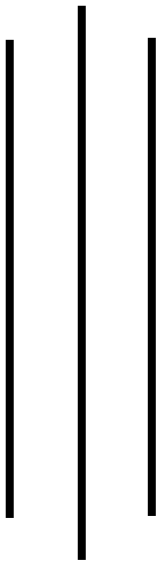
Government of Nepal
Ministry of Water Supply
Department of Water Supply and Sewerage Management

TECHNICAL SPECIFICATIONS



General Technical Specification

Contents

Government of Nepal 1

1 ITEMS OF GENERAL APPLICATION 1
1.1 General 1
1.2 Facilities for the Engineer 3
1.3 Access to and Possession of Site 5
1.4 Provision and Maintenance of Site Installations 6
1.5 Provision of Temporary Facilities 10
1.6 Coordination with Other Authorities 12
1.7 Submissions by the Contractor 13
1.8 Quality Control 16
1.9 Standards, Codes and Abbreviations 19
1.10 Securities and Insurances 22
1.11 Items Supplied by the Employer 23
2 CIVIL ENGINEERING WORK 24
2.1 Site Clearance 24
2.2 Earthworks 27
2.3 Cement Concrete 36
2.4 Brickworks 57
2.5 Stone Masonry Works 62
2.6 Cement Plaster Works 67
2.7 Other Finishes 72
2.8 Steel and Metalwork 77
2.9 Carpentry and Joinery Works 80
2.10 Roads and Parking Areas 84
3 PIPELINES AND RELATED WORKS 100
3.1 Pipe Trenches 100
3.2 Pipe Bedding and Fill 103
3.3 Supply, Delivery and Installation of Water pipelines 106
4 WATER METERS 141
4.1 Household Revenue Meters 141
4.2 Bulk Water Meters 143
5 ELECTRICAL INSTALLATIONS 147
5.1 Scope 147
5.2 Interpretations 147
5.3 Materials 148
5.4 Plant And Equipment 151
5.5 Construction and Workmanship 151
5.6 Test and Acceptance 156
5.7 Measurement and Payment 156
6 PLUMBING 157
6.1 Scope 157
6.2 Interpretations 157
6.3 General Requirements 158
6.4 Pipes and fittings 160
6.5 Material, fittings, appliances and structures for water supply 160
6.6 Sanitary fittings and appliances 162
7 FILTRATION MEDIA 167
7.1 Scope 167
7.2 Terminology 167
7.3 Filter Sand 167
7.4 Filter Gravel 167

8 SLOW SAND FILTERS AND ACCESSORIES 168
8.1 Slow Sand Filer 168
8.2 Air Blower and Motor 169
9 PUMPS AND RELATED ACCESSORIES 170
9.1 Pumps 170
9.2 Components of Submersible Pumps 170
9.3 Submersible Pumps 170
9.4 Submersible Motors 170
9.5 Bearings 170
9.6 Pump Set/Assembly Components 170
9.7 Pump Head Assembly 170
9.8 Riser Pipe and Fittings 171
9.9 Pump Bowl Assembly 171
9.10 Suction Case with Strainer 171
9.11 Submersible Motor 171
9.12 Submersible Cable (Cable for Submersible pumps) 172
9.13 Armoured Power Cable 172
9.14 Motor Control Panel 172
9.15 Documentation 174
9.16 Guarantee of Performance 174
9.17 Operation Maintenance Manual and Spare Part List 174
10 TRANSFORMERS, ELECTRICAL FEEDER LINES AND INSTALLATIONS 176
10.1 Transformer 176
10.2 Diesel Generator 177
10.3 Voltage Stabilizer 178
10.4 11 KV AAAC XLPE Insulated Covered Conductor 178
10.4.1 Scope 178
10.4.2 Service Conditions 178
10.4.3 Conductor Sizes 178
10.4.4 Application Standards: 178
10.4.5 Properties of Conductor 179
10.5 Disc Insulator Fittings 179
10.5.1 Scope 179
10.5.2 Description 179
10.5.3 Material 179
10.5.4 Galvanizing 179
10.5.5 Tests 179
10.5.6 Marking 180
10.6 Galvanised Steel Bolts, Nuts And Miscellaneous Fastening Components 180
10.6.1 Scope 180
10.6.2 Material 180
10.6.3 General 180
10.6.4 Machine Bolt and Nut 180
10.6.5 Double-Arming Bolt and Nut 180
10.6.6 Galvanizing 180
10.6.7 Tests 180
10.7 Crossarms And Bracing Angles 180
10.7.1 Scope 181
10.7.2 Material 181
10.7.3 Description 181
10.7.4 Galvanizing 181
10.7.5 Tests 181
10.8 Flat Crossarm Brace 181

10.8.1 Scope 181
10.8.2 Material 181
10.8.3 Description 182
10.8.4 Galvanizing 182
10.8.5 Tests 182
10.9 Pole Clamps 182
10.9.1 Scope 182
10.9.2 Material 182
10.9.3 Description 182
10.9.4 Galvanizing 182
10.9.5 Tests 182
10.10 Surge Arrester 183
10.10.1 Scope 183
10.10.2 System Parameters 183
10.10.3 Service Condition 183
10.10.4 Applicable Standards 183
10.10.5 Technical Parameters 183
10.10.6 Basic Features 184
10.10.7 Additional Requirements 185
10.10.8 Inspection And Testing 185
10.10.9 Bid Documentation 185
10.11 Distribution Cutout (Drop-Out Fuses) 186
10.11.1 Scope 186
10.11.2 System Parameters 186
10.11.3 Service Condition 186
10.11.4 Applicable Standards 186
10.11.5 Technical Parameters 187
10.11.6 Basic Features 187
10.11.7 Additional Requirements 188
10.11.8 Inspection And Testing 188
10.11.9 Bid Documentation 188
10.12 Fuse Link 189
10.12.1 Scope 189
10.12.2 Description 189
10.12.3 Tests 189
10.12.4 Bid Documentation 189
10.13 Distribution Panel Board 189
10.13.1 Scope 189
10.13.2 Description 189
10.13.3 Bid Documentation 191
10.14 Moulded-Case Circuit Breakers (MCCB) 191
10.14.1 Scope 191
10.14.2 System Parameters 191
10.14.3 Service Condition 191
10.14.4 Applicable Standards 192
10.14.5 Technical Parameters 192
10.15 Steel Tubular Pole 192
10.15.1 Scope 192
10.15.2 Description 192
10.15.3 Material 193
10.16 Pre-Stressed Concrete (PSC) Pole 195
10.16.1 Scope 195
10.16.2 Description 195

10.16.3 Load 196
10.16.4 Materials 196
10.16.5 Design 196
10.16.6 Tests 198
10.16.7 Marking 199
10.16.8 Bid Documentation 199
10.17 Porcelain Insulators and Fittings 199
10.17.1 Scope 199
10.17.2 General 199
10.17.3 Specific Requirements 200
10.17.4 Marking 201
10.17.5 Tests 201
10.17.6 Bid Documentation 201
10.18 Stay Sets 202
10.18.1 Scope 202
10.18.2 Description 202
10.18.3 Fabrication 202
10.18.4 Tests 202
10.18.5 Bid Documentation 202
10.19 Stay Wire 203
10.19.1 Scope 203
10.19.2 Description of Strands 203
10.19.3 Packing 203
10.19.4 Bid Documentation 203
10.19.5 Tests 203
10.20 11 kV Air Break Switch 203
10.20.1 Scope 203
10.20.2 AB Switches 203
10.20.3 Post Insulators 204
10.20.4 Temperature Rise 204
10.20.5 Main Contacts 204
10.20.6 Connectors 205
10.20.7 Operating Mechanism 205
10.20.8 Arcing Horns 205
10.20.9 Bush 205
10.20.10 Design, Materials And Workmanship 205
10.20.11 Dimension of 11 kV AB Switches in (Max.) Tolerance 5% 205
10.20.12 Terminal Connectors 206
10.20.13 Routine Test Certificate 206
10.20.14 Acceptance Test 206
10.20.15 Name Plate 206
10.21 LT Power Cable (PVC) 206
10.21.1 Scope 206
10.21.2 Rated Voltage 206
10.21.3 Service Condition 206
10.21.4 Applicable Standards 206
10.21.5 Technical Parameters 207
10.21.6 Basic Features 207
10.21.7 Cable Identification and Marking 208
10.21.8 Packaging 208
10.21.9 Inspection And Testing 208
10.21.10 Bid Documentation 208
11 OTHER ELECTRICAL INSTALLATIONS 209

11.1	Water Level Indicator	209
11.2	LT Voltage Stabilizer	209
12	ALUMINIUM DOORS, WINDOWS AND VENTILATORS	212
13	FRENCH SPIRIT POLISHING	214
14	MISCELLANEOUS	215
14.1	Surface Discharge Plate	215
14.2	Turfing	215
14.3	Sand Filling	215
14.4	Brick bat filling	215
14.5	Transportation of Surplus Materials	216
14.6	Geotextile	216
14.7	Gas Vents	216
14.8	Electro-fusion Welding Machine	216
14.14	Apparatus and Equipment for Water Quality Laboratory	218
14.15	Resilient Bearing Strip	1
14.16	Stainless Steel Strip	1
14.17	Specification for Single Dosing Chlorination Unit	2

1 ITEMS OF GENERAL APPLICATION

1.1 General

1.1.1 Scope

These Technical Specifications cover principles, responsibilities, and requirements for items that will be applicable to all works pertinent for laying of transmission pipe line, construction of intake, reservoir and other civil works including laying of pipelines, repair, rehabilitation, cleaning, other small works and operation and maintenance of the system.

These specifications shall be read in conjunction with the Conditions of Contract, The Agreement, the Bills of Quantities (BOQ) and the Drawings.

The specification provided cover the Works under the Contract, If the Contractor requires additional specifications for more explicit description of the Works or to supplement the existing specifications, or any other specifications to complete the Works, the Contractor shall submit such additional or supplementary specifications for the approval by the Engineer. All costs incurred for the additional specifications under the clause are deemed to be included in other unit rates quoted in the Bill of Quantities.

1.1.1.1 Scope of the Contract

This Contract includes but is not limited to the procurement and construction of:

- Construction of infiltration gallery.
- Construction of water treatment plant.
- Construction of RCC reservoir tanks
- Supply and laying of SS, DI, GI and PE pipes and fittings for proposed transmission and distribution lines
- Supply and erection of transmission lines and other electrical connections
- Construction of Water User Association's Office building, pump operation houses, Latrines, retaining wall and boundary wall.
- Construction of valve chamber, break pressure tank, air valve chamber, distribution chambers, thrust blocks, anchor blocks, gabion walls, and stream/river crossings.
- Supply and installation of pumps, generators, electrical panels, and it's all related accessories.
- Supply and installation of house connections.
- Rehabilitation works at the existing reservoir tank in the instructed area.

In order to complete above mentioned construction works the contractor shall carry out:

a) All temporary works and facilities including establishment and removal thereof support, supplement, or aid construction, access and other related works for the below.

b) Dismantling and removing of all damaged pipelines and civil structure as per the instructions of the Engineer including supply of all pipes, fittings, appurtenances, other specials and other construction materials required for the work.

c) Preparation of Site and storage-area/store-house for proper storage of the materials and goods to smooth implementation of the work.

d) Laying of High Tensile Steel (HTS), Ductile Iron (DI), Galvanized Iron (GI) and Polyethylene (PE) pipes for transmission and distribution with installation of fittings, appurtenances, and other specials.

e) Joining of old DI/GI/PE pipes with newly supplied HTS/DI/GI/PE pipes for all type of connection.

f) All necessary valve chambers (for air, pressure-relief, scour-washout and line control valves), special river/stream crossing, thrust block, anchor blocks, installation of all related pipe fittings and concrete works.

g) Supply of all necessary material and laying/installation for the complete work of reinstatement (water mains, sewer pipes, other utilities and associated civil works including road reinstatement) in service area.

h) Production of working and "as-built drawings and training of staff of the Employer in the installation of the pipelines and other related facilities.

i) Supply of all necessary material and installation to connect the communication pipe (House Connection) from where users can connect house connection pipe as per WUA instruction.

j) Operation of constructed system for one year after the completion.

1.1.2 Scope of Works

The activities to be undertaken by the Contractor within this Contract include the following: -

a) To carry out all necessary topographic surveys, soils investigations, laboratory analyses or related investigations where necessary to supplement the data provided by the employer. The Contractor's attention is drawn to:

- The need to carry out regular soil pH and resistivity measurement to determine the type of corrosion for ductile iron pipes.
- The need to determine the bearing pressure at the location of storage tank, water treatment plant, office buildings, in thrust block and other structures as per the recommended by the engineer.
- Hydrogeological investigation for infiltration gallery to confirm the design discharge.

b) To prepare working drawings for all elements of the works.

c) To undertake all steps necessary for temporary way, leave facilities and/or upgrading of roads and bridges, all related to access to the Site, or other related matters, where his opinion differ significantly from those produced by the Employer.

d) Setup/Preparation of stockyards and store house for pipes, valves fitting and other materials and equipment.

e) To take all steps necessary for the temporary or permanent diversion of services and the maintenance of services during the execution of the works, including diversion of overhead power lines, sewers and other underground services along the route of the pipelines.

f) To supply all pipes, valves, fittings, appurtenances and other materials and equipment required for construction of the works. The Contractor's supply items for the installation may include manufacture, testing, collection, transportation and delivery to Site. The Contractor will be responsible for ensuring that all procedures are adequately covered and that the materials fully conform to the Contract requirements. These responsibilities will include all necessary charges or dues related to insurance, freight, taxes (including customs and excise duties, surcharges etc.) and all testing and inspection for quality control.

g) To provide all necessary staff (including project manager, civil engineers, administrators, site supervision personnel) and workmen (including all necessary specialists, operators, tradesmen, artisans etc. in addition to semi-skilled and unskilled workers) necessary for execution of the works through to completion and for commissioning/trial run and defect liability period. Where appropriate, the contract shall provide all suitable facilities and accommodation for the staff and workmen and he/she shall make provision for all costs related to such provision and for medical, re-location, taxes or other expenses.

h) To provide all equipment, machinery, tools etc. and related spares for maintenance and consumables necessary for implementation of the works.

i) To provide all project offices, stores, workshops and facilities necessary for use by the Employer, Engineer and support staff and for the Contractor himself and his support staff.

j) To undertake all operations necessary to complete the works. These operations shall include: excavation, provision, haulage and installation of suitable bedding and backfill material and disposal of surplus excavated material; distribution, laying and jointing of pipes; installation of all special pipe work, valves etc. and construction of all related concrete or other activities together with all testing and disinfection of completed works. The Contractor's attention is drawn to the restricted working space in some of the stretches. In this stretches work in addition to that associated with the water main, will include but not be limited to, removal and replacement of existing sewer and water mains laid in the road.

k) To liaise with other contractors on the site and to ensure harmonious co-operation with them so that conflicts are avoided and areas of common interest, construction interface or potential overlaps are addressed without cost to the Employer or delays in completion.

l) To prepare documentary records of the works in the form of "as-built" drawings and GIS data, schedules etc., and to train staff of the Employer in the procedures for laying pipes, valves and fittings.

m) All the above activities shall be performed in a professional way and with good engineering and/or constructional practice. Upon completion of the works the scheme shall be fully operational with minimum disruption or inconvenience to interested parties, including landowners, and there shall be no outstanding matters requiring attention.

1.1.3 Definitions

1.1.3.1 General

Acceptable/Approved (Approval) - Acceptable to/approved (approval) by the Engineer in writing.

Agreed - Agreed in writing.

As detailed - As detailed on the drawings.

Authorized/ordered/rejected - Authorized/ordered/rejected by the Engineer in writing.

Designated - Shown on the drawings or otherwise specified by the Engineer or, in relation to an item scheduled in the Bill of Quantities, description of an item.

Indicated - Indicated in or reasonably to be inferred from the contract or indicated in writing by the Engineer.

Instructed/directed/permitted - Instructed/directed/ permitted by the Engineer.

Satisfactory - Capable of fulfilling or having fulfilled the intended function.

Service - Any pipeline, cable, duct etc. for conveying or transmitting any fluid, power, or other matter.

Submitted - Submitted to the Engineer.

Working easement – Area required by the Contractor for execution of the Works, including the permanent right of way obtained or land purchased by the Employer plus any temporary way leaves arranged by the Contractor.

Working strip - The working easement on the pipeline route.

1.1.3.2 Tolerances

Deviation - The difference between the actual (i.e., measured) size or position and the specified size or position.

Permissible deviation - The specified limit(s) of deviation.

Tolerance - The range between the limits within which a size or position must lie.

1.1.3.3 Measurement and Payment

Bill/schedule - The bill/schedule of quantities.

Billed/scheduled rate - The unit rate or price entered in the bill/schedule at which the Contractor undertakes to execute the particular work or to provide the required material, article or service, or to do any or all of these things, as set out in the item concerned.

Billed/scheduled - Listed in the bill/schedule of quantities.

1.1.4 Languages

All drawings, instructions, signs, notices, nameplates, etc. for use in the operation and maintenance of the completed works shall be in English.

1.2 Facilities for the Engineer

1.2.1 Engineering Laboratory

The Laboratory shall be at vicinity of the project site and provided to the dimensions herein after given and as directed by the Engineer to the full satisfaction of the Engineer. On completion of the project, the facilities and contents, equipment and furniture will become the property of the Contractor.

The laboratory building shall contain the following rooms and with net areas approximately as follows:

1. Laboratory	12 m2
2. Office	9 m2
3. Toilet with commode, washbasin, mirror, towels holder, etc.	4 m2
4. Storage room	9 m2

The Contractor shall provide sufficient water supply as well as power at all times for all lighting, other electrical appliances and apparatus. All power shall be 220 volts 50 cycles except as otherwise specified or directed by the Engineer or may be required for equipment contained in the laboratory or supplied by the Contractor. Room(s) shall be to the satisfaction of Engineer with acceptable finish.

1.2.1.1 Furniture for Engineering Laboratory

Following Furniture shall be supplied by the Contractor for the Laboratory: Worktables and shelves shall be provided as directed by the Engineer.

- 5 wooden chairs

- 2 wooden tables, 70x140cm
- 1 steel almirah (large) locking type

1.2.1.2 Laboratory Equipment and Testing

i. All equipment/ apparatus necessary for the regular testing of material and workmanship shall be provided by the Contractor in the field for the purposes of conducting the test of the works. The Contractor shall provide field laboratory testing apparatus required for tests such as moisture content. Sieve analysis, liquid limit, plastic limit, penetration permeability density, compaction, compression strength etc. Any off-site tests needed to be conducted outside the Contractor's laboratory has to be approved by the Engineer.
ii. The Contractor shall also be responsible for proper maintenance, lighting, power, water supply, and all consumables required for testing for the duration of the contract. Laboratory equipment shall be maintained and be in good working all the time.
iii. The laboratory shall be adequately staffed and equipped by the Contractor so that there shall never occur any interruption to construction activities resulting from the need to carry out tests required under the contract. All samples and records shall be preserved as per the instruction of the Engineer.

The Contractor shall make all arrangements for sampling, transportation, and preparations for regular site laboratory testing as well as off- site testing by the Engineer

1.2.2 Delay in provision of engineer's facilities

In the event the Contractor does not provide, or complete to the satisfaction of the Engineer, the required facilities outlined in the Clause 1.2 FACILITIES FOR ENGINEER, herein within the specified time limit of two weeks after award of the Contract then the Engineer may arrange to rent alternate equivalent facilities. This requirement will be related to the Contractor's own schedule and level of activity. The Contractor will be responsible for the cost of providing such temporary facilities as the engineer may deem necessary in this period. Furthermore, the Contractor's first monthly Payment Certificate may be submitted only after written acceptance by the Engineer of the facilities.

1.2.3 Cost for engineer facilities

The cost of the facilities for the Engineer as mentioned in the clause "1.2 Facilities for engineer, shall be covered under Contractor's overhead cost. The cost should compensate for furnishing all material, equipment, tools and incidental necessary to complete and maintain the facilities including all furniture, potable water, electricity, sanitary installations, expendables and providing support staff etc.

The following items shall also be provided by the Contractor at his own expenses until expiration of the Contract.

a) Building and accommodation for the Contractor's own and his workmen use.
b) Supply of water for Works and for drinking purposes by means of storage tanks and available at all times.
c) Supply of electricity at all times including standby generators to make the electricity available at all times.
d) Maintenance and replacement parts for repairs of the laboratory.
e) Unskilled labour at least (Six) for materials testing and field surveys.

All the laboratory equipment including all other additional purchase for laboratory provided by the Contractor will remain the property of the Contractor.

1.2.4 Provision of Vehicle Facility

The vehicle supplied for the use of Engineer (for construction supervision purpose) during the project period (max of 90 days) should be four-wheel drive with double cab.

1.2.5 Operation and Maintenance of Vehicle

The vehicle shall be licensed and insured for use on the public highway with comprehensive insurance cover for any qualified driver authorized by the Engineer, together with any authorized passengers and the carriage of good or samples. The Contractor shall provide a competent, qualified driver, subject to approval by Engineer, or Engineer's Representative, holding a valid driver's license as a driver of similar vehicle types. The Contractor shall provide fuel, oil and maintenance in conformity with the vehicle manufactures.

1.2.6 Survey Equipment and Field Assistance

The Contractor shall make available to the Engineer suitably educated and trained surveyors/ assistants and laborers for use on and about the Site in sufficient numbers and at all reasonable times.

The following set of survey equipment shall be provided in the project for the use of the Engineer's staff, and these equipment's shall be maintained in good condition throughout the Contract period:

a) 1 no electronic total station with optical plummet, automatic vertical index, data storage on memory card, single prism range 1 km, internal battery, down and uploading of data via memory card and serial port, internal programs for setting out, traverse and free stationing. Accuracy: Distance ± 2 mm + 2 ppm; Angle ± 3" include Accessories for total station as: Tripod, Tribrach, 2 internal batteries, 2 external batteries with cables, Charger with cables and Accessories for targets to include: 4 tripods, 4 targets (tribrach with optical plummet, adapter with 1 prism), adapter with 3 prisms, pole with adapter and 1 prism, pole extension;

b) 1 no. engineering levels - Wild NAKI with Tripod GST20 or equivalent,

c) 1 nos 100 m tapes (fibreglass) and 2 nos 30 m tapes (fibreglass)

d) 2 nos metric metal levelling staffs (3 packs of 4 pieces each) 3 meter long

e) 4 nos surveyors' umbrellas with accessories.

Other equipment such as ranging rods, survey pegs, light and heavy hammers, nails, chords, etc. required for setting out the Works, testing, inspection and any attendances shall be provided as and when required by the Engineer.

The above-mentioned equipment shall be the property of the Contractor upon the completion of the Contract.

1.2.7 Safety Equipment

The Contractor shall provide the Engineer with the safety equipment set as required in project office. The Contractor shall replace each item after it wears out and becomes unsuitable for use.

1.2.8 Testing of Material and Workmanship

Testing of material and workmanship which may be required upon instruction of the Engineer for the quality control of the Works shall be carried out by the Contractor at his own laboratory or laboratories acceptable to the Engineer. The Contractor shall be responsible for sampling, curing, and transport to laboratory for testing of materials and workmanship.

1.2.9 Measurement and Payment

No separate measurements and/or payment shall be made for all materials and works required under this Clause (1.2). All the cost associated with this Clause is deemed to be included in the item rates of the Bill of Quantities.

1.3 Access to and Possession of Site

The leaves, right-of-way, easement, and access to the site shall be governed by the rules of the country and by-laws of the local government.

1.3.1 The Site

The Site is:

a) That land purchased for the construction of water treatment plant, reservoirs, office buildings and other civil structures by the WUSC.

b) That land along pipeline alignments which are within the right-of-way of road.

c) That land under the ownership of WUSC or Nepal Government

d) As presented in the drawings.

Final Possession of the Site, or Parts thereof, for the purpose of carrying out the execution of the works to be given by the employer pursuant to Clause 2.1 of the Conditions of Contract shall be subject to any restrictions mentioned in the Contract.

The Contractor shall himself obtain temporary wayleaves on whatever additional lands or working easements are required by him to carry out the works.

1.3.2 Temporary Wayleaves and Access

The Contractor shall be responsible for obtaining temporary wayleaves.

The cost of obtaining wayleaves, including crop compensation, for temporary working areas, additional working easement and for any additional areas, required by the Contractor in connection with the Works as well as for the access to all of these shall be borne by the Contractor himself. The Contractor shall arrange for the serving of any Statutory Notices as per Clause 1.6 in connection with any temporary working area and shall give to the occupier of each such area seven day notice of his intention to enter and shall ensure that his methods of working cause the minimum of disturbance to the land and to its owners and occupiers.

The Contractor shall at all times provide proper facilities for access and inspection of the Works by the Engineer, his assistants, inspectors, agents and representatives of public agencies having jurisdiction.

The extent of each temporary working area and the period of time for its occupation shall be such as the Engineer considers necessary having regard to the Contractor's reasonable requirements which shall be submitted together with the Work Program to the Engineer.

The Contractor shall reinstate any temporary working areas to the condition prevailing prior to his initial entry as soon as possible after the work in those areas has been completed so as to keep the period of occupation to a minimum. The Contractor shall in any event restore the areas to a tidy and workmanlike condition. Boundary walls, fences and other structures that have been damaged, removed or otherwise interfered with by the Contractor shall be restored to a condition at least equivalent to their original condition.

1.3.3 Access to Adjoining Property

If the Contractor's work will cause unavoidable interference with access to adjoining property, the Contractor shall first give 7 days' notice to the occupier of such property and shall provide temporary means of access for vehicles, animals and pedestrians.

Convenient access to driveways, houses and buildings adjoining the work shall be maintained and temporary approaches to intersecting streets and alleys shall be provided and kept in good condition by the Contractor.

As soon as a section of surfacing, pavement, or a structure has been completed, it shall be opened for use by traffic at the request of the Engineer.

The Contractor shall not prevent the free access to public water valves, water hydrants, or utility valves.

1.3.4 Permanent Right-of-Way

The Employer will make all statutory arrangements necessary for obtaining the final possession of the Site and the permanent right-of-way in the shortest possible time.

1.3.5 Measurement and Payment

No separate measurements and/or payment shall be made for all materials and works required under this Clause (1.3). All the cost associated with this Clause is deemed to be included in the item rates of the Bill of Quantities.

1.4 Provision and Maintenance of Site Installations

1.4.1 Camp for Contractor's Staff

The Contractor shall provide adequate temporary accommodation with all necessary amenities and facilities for his staff and labor. The location and type of accommodation whether pre-fabricated or in-situ buildings or rental is the Contractor's choice.

During the whole period of existence, from setting up through operation to final removal upon completion of the Works, the Contractor shall be fully responsible for constantly carrying out all measures necessary for safeguarding the natural environment affected by his camp or camps.

He shall cause the least possible interference with existing amenities, whether man-made or natural. No trees shall be felled except as authorized by the Engineer

Latrine and ablution facilities and first-aid services shall be provided in sufficient type and numbers to the satisfaction of the Engineer and shall be maintained in a clean and sanitary condition at all times.

On completion of the Works or as soon as the facilities provided by the Contractor are no longer required, the Contractor shall remove such facilities and clear away all surface indications of their presence. Each camp area shall be reinstated to the satisfaction of the Engineer.

1.4.2 Contractor's Offices, Stores and Services

The Contractor shall provide, erect, construct, maintain, and subsequently remove proper offices, stores, workshops, laboratories, storage, and parking areas for his own use. Such facilities shall be sufficiently sized and equipped to enable him to manage his operations and those of his Subcontractors in a professional manner and to enable him to carry out all his obligations under the Contract.

Sheds for storage of materials that may deteriorate or corrode if exposed to the weather shall be weatherproof, adequately ventilated and provided with raised floors. No material or equipment shall be placed directly on the ground.

Within his offices, a meeting room shall be available for site meetings with the Engineer and the Employer.

These Contractor's facilities shall be subject to the same stipulations regarding sitting, interference with amenities and environmental protection as the Contractor's camp.

1.4.3 Preparation of the temporary Stockyard in the Site of Sub-project

The preparation of the stockyard for pipes valves and fittings shall include:

a) Clearance of the Site
b) Construction of side drains around the stockyards to avoid water logging
c) Construction of access tracks
d) Covering of pipe and fittings storage areas with a 150mm thick layer of granular material that will discourage the growth of vegetation
e) Provisions to carry the loads from the pipes and fittings.
f) Erection of a security fence
g) Construction of a guard house / store keepers office
h) Erection of stores for jointing material etc. including the provision of air-conditioning where necessary

1.4.4 Contractor's Construction Equipment

When working in built-up areas, the Contractor shall provide and use suitable and effective silencing devices for pneumatic tools and other Equipment that would otherwise cause a noise level exceeding 85 dB (A) during drilling, excavation and other work. Alternatively, he shall, by means of barriers, effectively isolate the source of any such noise in order to comply with above requirement.

1.4.5 Water Supply

The Contractor shall make his own arrangements for the supply of water for his camp, office and other temporary buildings as well as for the execution of the Works.

Temporary water connection may be arranged with nearby local system if any exist, at established rates.

When using other sources of water such as stone spouts, etc. the Contractor shall have due regard to and coordinate with other users, particularly with the local communities.

Water for drinking purposes shall be of drinking water quality, and shall be tested for proper disinfection.

1.4.6 Sanitation

The Contractor shall maintain the Site and all working areas in a hygienic condition. In all matters of health and sanitation he shall comply with the requirements of the local Health or other competent authority.

1.4.7 Sewage and Waste Disposal

The Contractor shall make provision for the discharge or disposal of from his camp, offices, and the Works of all wastewater as well as of all liquid and solid waste products however arising. The methods of disposal shall be to the satisfaction of the Engineer and of any authority or person having an interest in any land or watercourse over or in which water and waste products may be so discharged, and shall not in any manner be disposed of untreated to the environment.

1.4.8 Energy Supply

The Contractor shall install, operate, maintain and subsequently remove temporary supplies of electricity for power, heating, cooling, lighting and ventilation of all camps, offices, stores, laboratories and other temporary buildings used by the Contractor in addition to all electricity requirements in connection with the construction, testing and Defects Correction of the Works.

The Contractor shall ensure that all proposed electrical installations comply with the requirements of the Nepal Electricity Authority and shall be responsible for and shall bear all costs associated with obtaining the written approval of that authority for such installations and their operation.

Prior to placing orders for transformers, conductors, cables and associated equipment, the Contractor shall ensure by enquiry with the Nepal Electricity Authority that his proposed equipment is suitable for use with the existing or proposed medium/high tension electricity supply lines.

1.4.9 Pollution

The Contractor shall take all reasonable measures to minimize any dust nuisance, sound pollution, pollution of streams and inconvenience to or interference with the public (or others) as a result of the execution of the Works.

1.4.10 Supply of Fuel, Lubricants, etc.

The Contractor shall be responsible for arranging and ensuring that adequate supplies of petrol, diesel oil, motor oil, kerosene, lubricants and other petroleum products are available at all times to meet his requirements for the purpose of or in connection with the Contract; the Contractor's particular attention is drawn to this requirements as from time to time shortages and interruptions in the supply of fuel oils, etc., may occur.

The Contractor is required to store fuel to cover a minimum of 30 days of its requirements. It should provide additional stored fuel if supply conditions require so.

The Contractor is not allowed to purchase and use firewood.

With regard to the transportation, storage and handling of all his fuel requirements, including all electrical connections, he must strictly comply with all relevant safety codes and regulations.

Particular care is to be taken to avoid pollution due to spillage of fuel and oils. They shall be stored within a bunded area, all equipment drive by diesel or petrol engines shall be installed on a drip tray, waste oils shall be disposed of in a proper manner.

1.4.11 Temporary Telephone and Internet Connections

The Contractor shall arrange at his own cost for temporary telephone and internet connections to his offices and other installations.

He shall be responsible for all installations, connection and disconnection charges for his and his Representative's offices.

1.4.12 First Aid

The Contractor shall make his own arrangements for treatment of casualties on the Site. First-aid kits or units shall be provided. The Contractor shall be responsible for the construction of such first-aid units and their management and operation and rapid removal by ambulance of injured or sick employees to nearby hospitals. The first-aid service shall cover the Contractor's own personnel as well as that of the Employer, the Engineer, and all Subcontractors while working on the Site.

1.4.13 Fire Protection

No naked fire shall be used by the Contractor on or about the Site without the permission of the Engineer in writing. If in the Engineer's opinion the use of naked fire may cause a fire hazard, the Contractor shall at no extra cost to the Employer take such additional precautions and provide such additional firefighting equipment as the Engineer considers necessary.

The term "naked fire" shall be deemed to include electric arcs and oxyacetylene or other flames used in welding or cutting metals.

Compliance with the requirements of the Engineer shall not relieve the Contractor of any of his obligations under the Contract.

1.4.14 Contractor's Canteen

The Contractor shall provide adequate eating facilities for his employees and workmen.

1.4.15 Testing Facilities, Laboratory

The Contractor shall use an approved material testing laboratory for testing required by these specifications at his cost. An on-site laboratory staffed by qualified personnel may also be provided and used if allowed by the Engineer.

The name and qualifications of independent testing laboratories shall be submitted to Engineer for approval no less than thirty calendar days prior to the date the laboratories are to be used. Once approved, dismissal and replacement of the approved independent testing laboratory shall require written authorization by the Engineer.

The Contractor shall be responsible for the sampling, curing, and transport to the laboratories of all materials for testing, and all testing costs including laboratory fees, and/or all costs in running the on-site laboratory, i.e., chemicals, reagents, and other test consumables, staff, and utilities.

1.4.16 Site Safety

The Contractor shall at all times in the conduct of his work and that of his Subcontractors adhere to the established rules and regulations concerning all safety matters at Site such as the recommendations contained in the "Manual of Accident Prevention in Construction", published by the Associated General Contractors of America, Inc., or other internationally recognized recommendations to the extent that such provisions do not conflict with the applicable laws. This is especially important wherever it is necessary to enable the free passage of the public through the Site.

The Contractor's Safety Officer shall have the qualification and the authority to issue instructions to the Contractor's personnel regarding protection measures to prevent accidents.

The Contractor shall provide the public with adequate information on all risks with respect to the construction works. If the general public sustains any kind of bodily injury or death, the Contractor shall be responsible for providing all necessary medical care and compensation.

During construction the Contractor shall erect, maintain and subsequently remove sufficient barricades, guards, lighting, sheeting, shoring, temporary sidewalks and bridges, danger signals as well as temporary covering of potential accident areas.

If and where required the Contractor shall erect and maintain suitable and approved temporary fencing, to BS 1722 Part 1 Type PLC 180A or better, to enclose such areas of construction and areas of land occupied by the Contractor within the Site as may be necessary to implement his obligations under the Contract. Where temporary fencing has to be erected alongside a public road, foot-path, etc., it shall be of the type required by and shall be erected to the satisfaction of the authority concerned.

All open excavations along pipe lines shall be protected sufficiently to keep out livestock, and ensure the safety of workmen and members of the public and be in accordance with the directives of the police and the other local regulations.

The Contractor shall be responsible for ensuring that all persons working in the vicinity of power lines 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.

Where work is to be carried out in the proximity of buildings, bridges, tanks or other structures, the Contractor shall take all necessary precautions, including shoring and strutting, where necessary, to ensure the safety of the structures that are at risk.

The Contractor shall be responsible for all damages or injury which may be caused on any property by trespass by the Contractor's or his Subcontractor's employees in the course of their employment, whether the said trespass was committed with or without the consent or knowledge of the Contractor.

1.4.17 Protection of Overhead and Underground Services

The Contractor will be held responsible for any damage to known services (i.e. overhead services that are visible within the Site and underground services shown on the drawings) and he shall take all necessary measures to protect them. All work or protective measures shall be subject to approval of the Engineer. In the event of a service being damaged he shall inform the Engineer and the authority concerned, the Contractor shall not repair any such service unless instructed to do so.

Where no underground services are shown on the drawings or scheduled but the possibility of their presence can reasonably be inferred, the Contractor shall, in collaboration with the Engineer, ascertain whether any such services exist within the relevant section of the Site. The Contractor shall complete such an investigation well in advance of the start of construction work in the said section and he shall submit a report in good time to enable the Engineer to make whatever arrangements are necessary for the protection, removal or diversion of the services before any construction activities commences.

As soon as any underground service not shown on the drawings is discovered, it shall be deemed to be a known service and the Contractor will be held responsible for any subsequent damage to it. If such a service is damaged during the course of its discovery, the cost of making good such damage will be met by the Employer unless he establishes that the Contractor did not exercise reasonable diligence and that the damage was avoidable.

Where the authority concerned elects to carry out on its own account any alterations or protective measures, the Contractor shall co-operate with and allow such authority reasonable access and sufficient space and time to carry out the required work.

1.4.18 Signboards

Signboards shall be as per drawing. The signboards shall be placed at the project office and at main highway of the project town of the Contract, in English and Nepali, at least following information should be mentioned in each signboard:

(i) The name of the Project and section no.

(ii) The names and addresses of the Employer, the Contractor and the Engineer with contact number.

(iii) the name and short description of the Project

(iv) the amount of the Contract Price

(v) the starting and completion dates

They shall be of durable construction capable of withstanding the effects of the climate until the end of the Defects Liability Period.

The Contractor shall keep the signboards in good repair for the duration of the contract and shall remove them on completion of the Contract.

Besides these signboards the Contractor shall not, except with the written authority of the Engineer, exhibit or permit to be exhibited on the Site any other form of advertisement.

1.4.19 Site Roads, Loading and Turning Areas

The Contractor shall provide and maintain such access to the various sections of the Works as he requires for the proper execution of the work. Existing roads and bridges shall be upgraded for the construction transport purposes and site roads, loading and turning areas shall be so arranged as to minimize inconvenience to adjoining landowners or occupants and to the general public. The site roads shall be of gravel or equivalent material providing a hard surface for vehicles. Temporary roads, loading and turning areas shall be removed when they are no longer required and the location reinstated to the satisfaction of the Engineer, and damage to existing roads or bridges shall be repaired and reinstated to the satisfaction of the Engineer.

1.4.20 Site Drainage

The Contractor shall keep each Section of the Works well drained until the Engineer certifies that it is substantially complete and shall ensure that, so far as is practicable, all work is carried out in the dry. Site areas shall be kept well drained and free from standing water except where this is impracticable having regard to methods of Temporary Works properly adopted by the Contractor.

The Contractor shall provide, operate and maintain in sufficient quantity such pumping equipment, well points, pipes and other equipment as may be necessary to minimize damage, inconvenience and interference and shall construct, operate and maintain all temporary coffer-dams, sumps, ditches, drains and other temporary works as may be necessary to remove water from the Site while construction is in progress. Such Temporary Works and construction equipment shall not be removed without the approval of the Engineer.

Notwithstanding any approval by the Engineer of the Contractor's arrangements for the removal of water, the Contractor shall be responsible for the sufficiency thereof and for keeping the Works safe at all times and for making good at his own expense any damage to the Works.

The Contractor shall be responsible to keep the Site clear of water at whatever pump rate is found necessary.

The Contractor’s site drainage facilities shall not cause pollution in any local watercourses, he shall be responsible for any legal action resulting from pollution events.

1.4.21 Cleaning-up of Site

Before application is made for the Employer to accept any substantially completed Section of the Works, all items shall be complete, ready to operate and in a clean condition. All trash, debris, unused building materials and temporary facilities shall have been removed from the Site. Tools and construction equipment not needed during the subsequent Defects Liability Period for repair and adjustment shall not remain on the Site. The temporary walkways, parking areas and roadways shall be completely swept and broomed.

1.4.22 Measurement and Payment

No separate measurements and/or payment shall be made for all materials and works required under this Clause (1.4). All the cost associated with this Clause is deemed to be included in the item rates of the Bill of Quantities.

1.5 Provision of Temporary Facilities

1.5.1 Temporary Diversions of Utilities

If in the opinion of the Contractor it is necessary to make temporary diversions of services in connection with the Works, the Contractor shall arrange with the relevant authority for the construction of diversions.

The Contractor may at his own cost and subject to the approval of the authority concerned, make such temporary diversions as may facilitate the carrying out of the Works. These temporary diversions shall be reinstated to the full satisfaction of the Engineer and the relevant authority on completion of the Works.

1.5.2 Detours and Traffic Control

The Contractor shall program his work in such a way that, wherever the temporary closure of street sections to public thoroughfare cannot be avoided, the duration of traffic diversion can be kept as short as possible. No streets shall be closed and no detours shall be introduced and no traffic diverted until the Contractor's proposals have been approved by the Engineer and the appropriate Government authorities, such as the Roads Department.

Where work is to be carried out in public roads, the Contractor shall give notice to the Engineer sufficiently in advance of the date on which he wishes to commence such work.

The Contractor shall be responsible for obtaining the permission of the Engineer, Road Department and the Police for activities he intends to carry out in public roads. Two copies of the Contractor's proposals to the relevant authorities shall be submitted to the Engineer. One copy of all obtained approvals shall be submitted to the Engineer.

The Contractor's attention is drawn to the fact that processing of the documentation required by the local authorities prior to the cutting of existing public roads takes approximately 30 days. During the Monsoon period (June to August) no road cuttings are normally allowed.

Detours shall be selected in such a way that the inconvenience to the affected traffic as well as to the inhabitants of the affected areas is kept to a minimum.

The Contractor shall furnish, install and maintain at all times during the execution of the Works all necessary traffic signs, barricades, lights, signals and other traffic control devices, including flagging and other means of guiding traffic through the work zone. Traffic control shall be managed in accordance with prevailing rules and regulations, and with the approval and to the satisfaction of the Engineer.

All devices mentioned above shall be in conformity with the requirements of the Roads Department. All traffic signs and control devices to be furnished and installed by the Contractor shall be approved by the Engineer for their location, position, visibility, adequacy and manner of use under specific job conditions.

All traffic control devices necessary for the initial stage of construction shall be properly placed and operational before any construction is allowed to start. When work of a progressive nature is involved, the necessary signs shall be moved concurrently where they are needed.

If the Engineer determines that proper provisions for safe traffic control are not being provided or maintained, he may restrict construction operations affected by such defective signs or devices until such provisions are established or maintained, or may altogether order suspension of the Work until a proper traffic control is achieved. In case of serious or willful disregard by the Contractor of the safety of the public or his employees, the Engineer may take necessary steps to rectify the situation and deduct the cost thereof from monies due or becoming due to the Contractor. The Contractor shall be responsible for all resulting delays.

The Contractor shall designate or otherwise employ personnel to furnish continuous surveillance of the traffic control operations. The designated personnel shall be available day and night to respond to calls involving damage due to vandalism or traffic accidents.

At sections where traffic is in operation and when ordered by the Engineer, the movements of the Contractor's equipment from one place of work to another shall be subject to traffic control. During rush hours movement of larger vehicles, such as trucks, cranes, dumpers, etc. through main thoroughfare are not permitted by the police. Spillage resulting from hauling operations along or across the road way shall be removed immediately at the Contractor's expense.

The cost of detours and traffic control is deemed to be included in the rates for road reinstatement

1.5.3 Provision of Temporary Services

When the execution of the Works requires the temporary disconnection of existing public utilities, the Contractor shall provide the affected users with temporary services in at least the same standard as the original services.

For water supply he may install temporary lines or arrange for regular supply by tankers. The amount of water to be provided for the interruption period for a specific area shall be assessed by the Contractor. The Contractor shall submit to the Engineer, for its approval, the recommended volume of water to be provided.

When forced to disconnect existing sewers the Contractor shall install temporary pipes of adequate size to carry off sewage from any private sewer facilities cut off by construction work. Connections to temporary pipes shall be made immediately by the Contractor upon cutting off the existing facility. No sewage shall be allowed to flow from any severed facility upon the ground surface or into the trench excavation. Pipes used in temporary sewers may be plastic or approved flexible material.

When the Contractor is forced to disconnect power or telephone connections the relevant authority shall provide temporary connections at the Contractors expense.

Upon completion of work the Contractor shall replace all severed connections, with the assistance of the concerned authority where necessary, and restore to operating order the existing facilities.

No valve or other controls in public service facilities shall be operated by the Contractor without approval of the Engineer and the relevant authorities. All users affected by such operation shall be notified by the Contractor at least one hour before the operation and advised of the probable time when service will be restored.

1.5.4 Protection of Adjoining Property

1.5.4.1 Land

The Contractor shall control the movement of his crews and equipment on the working easement including access routes approved by the Engineer so as to minimize damage to crops and property and shall endeavor to avoid marring the lands. Ruts and scars shall be obliterated and damage to land shall be corrected and the land shall be restored as closely as possible to its original conditions before final taking-over of the Works.

The Contractor shall be responsible directly to the tenant / land owner for any excessive or avoidable damage to crops or lands resulting from his operations whether on lands adjacent to right-of-way or on approved access road and deductions will be made from payment due to the Contractor to cover the amount of such excessive or avoidable damage if adequate compensation is not paid by the Contractor, in the opinion of the Engineer.

1.5.4.2 Buildings and other Structures

The Contractor shall be responsible and take all measures in order to protect adjoining property including buildings, electrical and telephone poles, bridges and culverts, retaining walls, compound walls and fences, and other structures. Prior to the commencement of the activities, the Contractor shall assess the probability and extent of unavoidable damages, if any, to the building and properties and submit his assessment to the Engineer. The Engineer may make his own opinion and if required may order arrangements for protection or repair of such likely unavoidable damage in which event the Contractor shall complete the activities.

1.5.5 Reinstatement upon Completion

Temporary facilities shall be provided by the Contractor, only for as long as required after which he shall dismantle and remove the same from their place of use as speedily as possible. Re-usable components shall be safely stored by the Contractor in his yard.

The place of use shall be cleared and reinstated immediately to at least the condition existing before the temporary facilities were provided, and to the satisfaction of the Engineer.

1.5.6 Measurement and Payment

All temporary diversions of utilities and temporary services required for execution of the works shall be deemed to be included in other items of the BOQ and shall not be separately paid.

1.6 Coordination with Other Authorities

1.6.1 Statutory Services

As far as possible the Contractor shall acquaint himself with the actual location of all existing public utilities such as sewers, water mains, drains, cables for electricity, telephone lines, lighting poles, masts, etc., before commencing any activities likely to affect the existing utilities. The Contractor shall with the assistance of the Employer obtain such information directly from the responsible authorities as early as possible.

1.6.2 Notices, Permits

Well in advance of the programmed start of any work which may affect traffic or any existing utilities the Contractor shall give advance notice to the respective authority indicating the type, the exact location, the programmed starting time and the expected duration of the activities and shall provide whatever particulars may be required by the authorities to issue any required permits and make all necessary arrangements. The Employer will provide whatever assistance possible to the Contractor to facilitate the permit procedure which, however, will remain the sole responsibility of the Contractor.

1.6.3 Witnessing and Post-Construction Clearances

It is expected that the issue of these permits will be tied to the requirement that the work may only be carried out in the presence of authorized inspectors from the authorities concerned. Their job will be to witness and assess any damage or interference with their respective utility. Should such disturbances occur it will be at their discretion to authorize either the Contractor to correct them or to arrange for specialized repairs through their own personnel.

The Contractor shall be fully responsible for all costs whatever resulting from avoidable damages of or interference with other utilities.

As proof that the activities in question have been completed to the satisfaction of the authorities concerned the Contractor shall submit to the Engineer upon request official post-construction clearances issued by the respective authorities.

1.6.4 Measurement and Payment

No separate measurements and/or payment shall be made for all materials and works required under this Clause (Clause 1.6). All the cost associated with this clause is deemed to be included in the item rates of the Bill of Quantities.

1.7 Submissions by the Contractor

1.7.1 Pre-Construction Surveys and Setting Out

The Contractor shall verify all measurements and be responsible for their correctness. Any differences which may be found between actual measurements and the dimensions given in the Contract Documents shall be submitted to the Engineer, in writing, for consideration and directives before proceeding with the Works.

Site bench marks shall be accurately and safely established, maintained and removed upon completion of the Works, all to the satisfaction of the Engineer. The Engineer will indicate the position, co-ordinates and elevation of bench marks near the works, as shown on the Drawings.

The Contractor shall prepare a plan detailing the location of the bench marks and keep this up-to-date throughout the period of the Contract. Reproducible copies of the plan so prepared shall be supplied to the Engineer, as and when he may require.

The Engineer reserves the right to order levels, considered necessary for the full and proper supervision and measurement of the works, to be taken at any time.

Before the Works, or any part thereof, are commenced, the Contractor and the Engineer shall together make a complete survey, and take levels, of the Site and agree on the dimensions and elevations upon which setting out of the Works shall be based.

These levels shall be related to the bench marks and shall be plotted and drawn up by the Contractor. After agreement of the drawings, which shall be signed by the Engineer and the Contractor, these levels shall form the basis of setting out of the Works.
The Contractor shall submit the original of the drawings, and three copies, to the Engineer.

The Contractor shall be responsible for the true and proper setting out of the Works in relation to reference data given on the Drawings and shall accurately set out the positions, levels and dimensions of all parts of the Works. Any delay or loss resulting from errors in the setting out of the Works shall be the responsibility of the Contractor.

Setting out shall be reviewed by the Engineer before commencing the Works, but any approval shall, in no way, relieve the Contractor of his responsibility for the correct execution of the Work.

Setting out of the Works shall use methods and the necessary instruments described in BS 5606 "Code of Practice for Accuracy in Building". The Contractor shall maintain, in good working order at all times, the instruments provided by him for the setting out of the Works and shall make such instruments available to the Engineer as instructed for checking or taking measurements.

The Contractor shall provide all assistance which the Engineer may require for taking measurements of the Works, including labor, equipment and transportation.

1.7.2 Detailed Design of Temporary Works

The Contractor shall submit for approval full particulars, including drawings of any of the site installations and Temporary Works. If required the Contractor shall also submit calculations of the stresses, strains and deflections which will arise in false work or other Temporary Works and these calculations shall be accompanied by detailed Working Drawings to show the Contractor's proposals. Approval by the Engineer of the Contractor's proposals, calculations or drawings shall not relieve the Contractor of any of his duties or responsibilities under the Contract.

1.7.3 Working Drawings

The Drawings prepared by the Engineer, are called Engineer’s Drawings. They may be modified or added to as provided by the following clauses.

The proposals shown on the Engineer’s Drawings are based on information available prior to preparation of the Bid Documents. All levels indicated or proposed are based on survey information previously available but will need to be revised subject to the results of survey and site investigation carried out by the Contractor. Nevertheless, the Contractor shall follow such proposals in preparing his own proposals consistent with his own experience.

Working Drawings shall be submitted by the Contractor to the Engineer. Working Drawings shall include, but not be restricted to, pipeline plans and profiles, reinforcement detail drawings and bending schedules, shop drawings for structural steel and miscellaneous metal work, and drawings for other work for which the Engineer's approval is required.

It shall be the Contractor's own responsibility to prepare such Working Drawings as he may require for the proper setting out and construction of all structures and facilities. Work shall not commence on an individual structure or facilities until the relevant Working Drawings have been approved by the Engineer.

Within 28 days of the date of the Letter of Acceptance, the Contractor shall submit to the Engineer a Drawings Submittal Schedule for the Working Drawings listing the anticipated dates upon which they will be submitted for approval by the Engineer. The submission dates shall be spaced at reasonable intervals to allow at least 21 days for the Engineer to duly check and to either approve them or to request changes or modifications, as the case may be.

All dimensions shall be in metric units and each drawing shall be properly identified by a drawing head and a numbering code in the form prescribed by the Engineer upon commencement of the Works. ISO or DIN standard size sheets shall be used.

Drawings shall be scaled at A1 size, and plotted at A1 size and A3 size.

Prior to submittal, the Contractor shall also check the drawings prepared by his Subcontractors for accuracy and completeness, especially that the relation to adjoining work is accurately shown.

The Contractor shall submit 3 (three) copies of all drawings for approval.

Any changes or modifications to the Working Drawings that the Engineer considers necessary shall be made by the Contractor promptly and the drawings resubmitted for approval.

Approval of Working Drawings will be given by the Engineer in the form of a stamp "RELEASED FOR CONSTRUCTION" together with the date and the authorized signature. Only those Working Drawings carrying the signed and dated stamp shall be used for execution.

Copies of all such approved Working Drawings together with one unreduced transparency shall be supplied to the Engineer by the Contractor immediately after approval. The cost of preparing and providing all Working Drawings shall be included in the Contract Rates.

Should it be found at any time after approval has been given by the Engineer to a Working Drawing submitted by the Contractor that the said Working Drawing does not comply with the terms and conditions of the Contract or that the details do not agree with the Working Drawings previously approved, such alterations and additions as may be deemed necessary by the Engineer shall be made therein by the Contractor and the work carried out accordingly without entitling the Contractor to extra payment on account thereof, except where such alternations and additions are to be made in direct consequence of written order by the Engineer to vary the Works.

No examination by the Engineer of any document submitted by the Contractor or of the Contractor's Working Drawings, nor the approval expressed by the Engineer in regard thereto, either with or without modification, shall absolve the Contractor from any liability imposed upon him by any provision of the Contract. Notwithstanding the Engineer's approval of the Working Drawings the Contractor shall be responsible for any dimensional or other errors.

1.7.4 As-Built Drawings and GIS Data Creation

1.7.4.1 As-Built Drawings

Such approved Working Drawings as have been selected by the Engineer shall be correctly modified for inclusion in the As-Built Drawings incorporating such variations to the Works as have been ordered and executed. Such drawings shall show the actual arrangement of all structures and items of equipment installed under the Contract. The Contractor shall submit 1 (one) reproducible copy and 3 (three) prints of all As-Built Drawings clearly named as such to the Engineer for approval before applying for the Taking-Over Certificate for the respective Section of the Works.

In the as built drawings, for the major structures, the GPS control points should be always enlisted in the drawings. GPS format should be in MUTM projection (84 or 87) or WGS84 format (lat, lon).

After approval of the As Built Drawing the Contractor shall supply an electronic copy of the drawing in together with a licensed copy of the drafting software (at least AUTOCAD 2007). The software shall become the property of the Employer and shall be used to view the As Built Drawings.

During the course of the Works, the Contractor shall maintain a fully detailed record of all changes from the approval to facilitate easy and accurate preparation of the As-Built Drawing.

Irrespective of the other contractual prerequisites no Section of the Works will be considered substantially completed until the respective As-Built Drawings have been approved by the Engineer.

1.7.4.2 GIS Data Creation

In parallel with the preparation of as-built drawings, the Contractor shall produce GIS data of the constructed works. The

contractor conduct all necessary survey work, and shall ensure that vertical and horizontal measurements shall be captured at an accuracy of +/- 0.1m at a 95% confidence level, using the most suitable and cost-effective field data collection technology and methodology. All horizontal and vertical survey measurements will be referenced to the present GIS georeference based on MUTM projection with relevant meridian (84 or 87).

In case of pipe line or any linear installation or construction stretching more than 100 m, the Contractor will survey the three-dimensional position (x,y,z) of all point and line assets constructed under this project, (e.g., pipelines, approach road, longer span bridge crossing, etc.). In case of point installation or construction, the Contractor will survey the three-dimensional position (x,y,z) of all point assets constructed under this project, (e.g., small bridge crossings, manholes, chambers, valves, meters, hydrants, plugs, reducers, and tees). Nodes shall be created to clearly delineate different pipe sections in terms of material and/or diameter and to allow for future development of a hydraulic model in the GIS platform. Nodes shall also require a three-dimensional position, and through this, the position of the ends of a pipeline segment shall be defined. Point and line data should be consistent with the attributes of the existing GIS system, if any. However, the Engineer and the Employer may require the Contractor, at no additional cost, to create new attributes to include non-survey data, e.g., valve model, name of the manufacturer, images or plans, etc. Prior to the field survey, the Contractor shall submit to the Engineer, for approval, the GIS design in terms of themes, feature types and attributes.

The Contractor shall develop a checklist of QC checks for each type of deliverable and will be responsible for ensuring that these QC checks are performed. The Contractor shall assign a GIS quality officer to manage the quality review process. This officer shall be independent of the capture and production teams.

GIS data for the project will be delivered in an ESRI ArcGIS compliant file geo-database.

1.7.5 Construction Programme and Progress of Works

1.7.5.1 Construction Programme

In amplification of the requirements of the Conditions of Contract, the program shall be in the form of a Critical Path Method (CPM) Diagram showing, sequences, dependencies, durations and dates for execution of all major items following the sub-divisions in the Bills of Quantities for the execution of the Works within the periods stated in the Contract. It shall be supported by:

a) Data of the construction methods
b) Equipment Utilization Schedule
c) Manpower Utilization Schedule
d) Subcontracting Schedule
e) Mobilization/Demobilization Schedule

The CPM diagram incorporating the above mentioned schedules shall be prepared using Microsoft Project, or similar approved project management software, and shall be presented in hard copy and electronic form to the Engineer.

In carrying out the Works due attention shall be paid to all measures which can reasonably be taken in order to diminish the inconvenience which the work may cause to services and access to property.

1.7.5.2 Updating, Monitoring and Progress Reporting

The Contractor shall monitor the progress of the Works including information provided by his Sub-contractors and suppliers, as necessary, for purpose of network planning, scheduling and updating and shall confirm the actual progress on each current activity shown on applicable CPM networks. The CPM networks shall form part of the Monthly Progress Report and shall indicate changes of schedule, if any in network activity duration and start/finish imposed dates. It shall also be provided in electronic form.

The Contractor shall prepare written explanatory notes on the particular activities which are overrunning or going to overrun against the Master Schedule. If any such overrunning work is on the critical path, the Contractor shall state what corrective actions will be taken by him to bring it back on the schedule.

1.7.5.3 Detailed Fortnightly Programme

The contractor shall submit at the end of each working week a detailed bar chart program for the next fortnight. The program shall identify where further drawings or instructions are to be issued by the Engineer to avoid disruption to the progress of the Works.

1.7.5.4 Progress Reports

The Contractor shall furnish the Engineer with 5 copies of Progress Reports at regular monthly intervals in a form agreed with the Engineer, containing the following information:

a) Physical progress for the report month and estimated progress for the next month;
b) CPM networks and explanatory notices as described in Clause 1.7.5.2;
c) Updated S-curves for physical progress at different sections of the Works

d) Progress on Quality Control and Quality testing Plan

e) List of activities and obligations completed and planned for next month

f) Any report which may be specifically requested by the Employer and/or the Engineer.

These monthly progress reports shall be submitted not later than 7 days after the end of the reporting month.

1.7.6 Operation and Maintenance Manual

The contractor will submit an operation and maintenance manual, providing details of all the plant /mechanical facilities (valves, meters, etc.) he supplies and give details of recommended maintenance intervals and procedures.

1.7.7 Record / Progress Photographs

The Contractor shall arrange each month at least 12 Nos. of photographs to be taken by a professional photographer as Record Photographs and shall provide the electronic files and 6 color prints each on glossy paper unmounted and of a size not less than 210 mm x 297 mm (A4) in transparent plastic pockets contained in hard cover album. Each print shall contain upon its back the date and description of the view taken. The Contractor shall ensure that no use is made of any negative or print without permission from the Employer.

Out of these Record Photographs the Contractor shall select 6 characteristic ones as Progress Photographs, copies shall be made of these to be attached to the Progress Reports.

1.7.8 Measurement and Payment

Unless otherwise provided in the BoQ, no separate measurements and/or payment shall be made for all materials and works required under this Clause (Clause 1.7). All the cost associated under this clause is deemed to be included in the item rates of the Bill of Quantities.

1.8 Quality Control

1.8.1 Quality Control Plan and Procedures

The Contractor shall be responsible for establishing and maintaining procedures for quality control that will ensure that all aspects of the Works comply with the requirements of the Contract.

As soon as reasonably practicable prior to the commencement of Works the Contractor shall submit for approval a Quality Control Plan giving detailed proposals for control of quality of all aspects of work on the Site and at suppliers' workshops.

The Quality Control Plan shall include the following:

a) a list of the Contractor's staff engaged in quality control

b) a list of any outside testing agencies employed by the Contractor for work in connection with quality control

c) where a testing laboratory is to be established on Site under the Contract, a list of major items of equipment and a layout of the laboratory, together details of the tests which will be carried out there

d) a list of manufactured items and materials, obtained by the Contractor for the Works, which require inspection at the suppliers' premises, and the proposed procedures for ensuring quality control

e) a list of materials and operations to be inspected by the Contractor at the various stages of construction work on Site, together with inspection procedures, test types and frequencies

f) Sample of proposed quality control records, testing and reporting forms.

Unless the Engineer permits otherwise, the approved Quality Control Plan shall be followed throughout the construction of the Works. Any approval by the Engineer of the Contractor's plan and procedures shall not relieve the Contractor of his obligation to ensure that the Works comply with the requirements of the Contract.

The Contractor shall appoint a suitably qualified member of his staff to be responsible for all aspects of quality control and to maintain effective liaison with the Engineer.

Quality Assurance Plan (QAP) and third party inspection (TPI):

Before procurement of materials like SS pipes, DI pipes, DI fittings, CI Valves, submersible pumps, electrical panels, etc. Contractor shall have to submit manufacturer’s Quality Assurance plan (QAP) for review and approval of Engineer. QAP shall contain the quality control measures and quality checks/reviews at various stages of material production and shall comply as per latest international standards/codes of practice.

Such approved QAP shall be followed by Third party inspecting agencies at factory premises. No relaxation in QAP shall be done and followed either by the contractor or TPI agency without amendment to approved QAP by engineer. All such third party inspections and test results to be submitted as TPI tests reports in neat booklet FORM. After procurement

Following QAP norms, Contractor shall submit such TPI test reports along with interim payment BILLS claiming supply of items. No materials will be accepted for payment without necessary TPI, if deemed necessary by the client. Cost of Third party inspection will be paid as per provision in Bill of Quantity. If there is not any mention about TPI cost in BoQ, 50% of TPI cost will be shared by client and remaining 50% of such cost will be shared by contractor.

1.8.2 Sampling and Testing

The Contractor shall provide for the approval of the Engineer, samples of all construction materials and manufactured items required for the Permanent Works. All samples rejected by the Engineer shall be removed from Site. All approved samples shall be stored by the Contractor in a sample room, at a location approved by the Engineer, for the duration of the Contract, and any materials or manufactured items subsequently delivered to Site for incorporation in the Permanent Works shall be of a quality at least equal to the approved sample. The approved samples may only be disposed of with the Engineers approval.

Samples shall be submitted and tests carried out sufficiently early to enable further samples to be submitted and tested if required by the Engineer. Samples for testing will generally be selected by the Engineer from materials to be utilized in the project and all tests will be under the supervision of, and as directed by, and at such points as may be convenient to the Engineer.

Material requiring testing shall be furnished in sufficient time before intended use so as to allow for testing. No materials represented by tests may be used prior to receipt of written approval of said materials.

The Contractor shall give the Engineer at least 14 days' notice in writing of the date on which any of the materials will be ready for testing or inspection at the suppliers' premises or at a laboratory approved by the Engineer and unless the Engineer shall attend at the appointed place and time the test may proceed in his absence. The Contractor shall in any case submit to the Engineer within 7 (seven) days after every test such number of certified copies of the test readings as the Engineer may require.

Approval by the Engineer as to the placing of orders for materials or as to samples or tests shall not prejudice any of the Engineer's powers under the Contract.

The provisions of this Clause shall also apply to materials supplied under any nominated subcontract.

After all construction at each Section is completed and before applying for taking-over, the Contractor shall perform field tests as called for in the Specifications. The Contractor shall demonstrate to the Engineer the proper operation of the facilities and the satisfactory performance of the individual components. Any improper operation of the system or any improper or faulty construction shall be repaired or corrected to the satisfaction of the Engineer. The Contractor shall make such changes, adjustments or replacement of equipment as may be required to make the same comply with the Specifications, or replace any defective parts or materials.

In addition to any special provision made herein as to sampling and testing materials by particular methods, samples of materials and workmanship proposed to be employed in the execution of the Works may be called for at any time by the Engineer and these shall be furnished without delay by the Contractor at his own cost. Approved samples will be retained. The Engineer will be at liberty to reject all materials and workmanship that are not equal or better in quality and character than such approved samples.

The tests required for quality control shall include but not be limited to:

a) tests conducted at the premises of the Contractor, Subcontractor, manufacturer or supplier which are normally or customarily carried out at such premises for the items or materials being supplied for the Works
b) tests which are normally or customarily conducted on the items or materials being supplied for the Works by the Contractor, Subcontractor, supplier or manufacturer but which have to be conducted at an approved laboratory because the necessary testing facilities are not available on the premises of the Contractor, Sub-Contractor, supplier and manufacturer
c) tests on locally obtained materials or items either on the Site or at an approved laboratory for the purpose of obtaining the approval of the Engineer to the classification, use and compliance with the Specifications of such items or materials
d) routine quality control tests conducted by the Contractor to ensure compliance with the Specifications
e) regular testing of concrete and other materials as specified in the relevant Chapters of the Technical Specifications
f) Standard shop and Site acceptance tests, including trial assemblies, of Plant.

1.8.3 Inspection and Acceptance

The Engineer will not inspect any item of fabricated or finished work until such time as the Contractor shall have forwarded to the Engineer the approved Working Drawings covering the items to be inspected, together with four copies of the respective orders.

Manufactured items and materials delivered to the Site shall be inspected by the Contractor on arrival. Any defects shall be notified to the Engineer. Minor defects to surface finishes and the like in manufactured items shall be made good in an approved manner to the satisfaction of the Engineer. Items with more serious defects shall be returned to the Contractors for correction or replacement as appropriate.

1.8.4 Materials/Plant Certificates

Where certificates are required by the Specifications or relevant Reference Standard, the original and one copy of each such certificate shall be provided by the Contractor.

Certificates shall be clearly identified by serial or reference number and shall include information required by the relevant Reference Standard or Specification Clause.

The timing for submittal of certificates shall be as follows:

a) manufacturer's and Contractor's test certificates shall be submitted as soon as the tests have been completed and in any case not less than 7 calendar days prior to the time that the materials represented by such certificates are needed for incorporation into the Permanent Works

b) Certificates of tests carried out during the construction or on completion of parts of the Permanent Works shall be submitted within 7 days of the completion of the test.

No materials, articles or items of fabricated or finished work to be supplied by the Contractor or Subcontractors which have been inspected and tested by the Engineer or the inspecting Engineer shall be dispatched unless a Passing Certificate has been requested by the Contractor from the Engineer and subsequently been issued by the Engineer to the effect that the same are approved. Neither the Contractor nor Sub-Contractors shall make use of any materials or articles ordered by them for the purpose of fabrication until a Passing Certificate covering the said materials and articles shall have been issued by the Engineer or inspecting Engineer.

1.8.5 Site Records

Daily records of on-site testing and inspection shall be kept on forms of approved format. Test results shall be certified by the responsible member of the Contractor's staff. All test certificates and inspection records (including any from Contractors or other outside testing agencies) shall be clearly identified with the appropriate part of the Works to which they refer, and they shall be submitted to the Engineer together with the respective Passing Certificate.

Once each month, or at such other intervals as the Engineer may require, the Contractor shall submit in an approved form a summary of all quality control inspections and tests performed at Site and elsewhere in the intervening period.

Test results shall be summarized in tabular form or graphically or both in a way that best illustrates the trends, specific results, and specification requirements. Where the tests show that the specified requirements were not achieved, the report shall describe the action that was taken.

Each report shall also contain a forecast of quality control work likely to be carried out during the period to be covered by the succeeding report.

The Contractor shall keep detailed and up-to-date inventories in an approved form of goods and materials already approved by the Engineer for which Passing Certificates have been issued as well as of all other goods and materials subject to quality control which are on order, delivered, found faulty, lost during the work or found to be surplus to requirements. The Engineer shall have access to these records at all times.

1.8.6 Daily Logbook

The Contractor shall keep a Daily Logbook at each location where major construction activities are taking place. This Daily Logbook shall be in a form approved by the Engineer and shall contain, but not be limited to, the following major items of information:

a) Name of Contractor and Package No.

b) date

c) weather conditions (max./min. temperature, hours and intensity of rainfall, cloudy, sunny, windy)

d) work carried out during the day per Section (description, quantities)

e) major equipment used per section (on contractual work, on extra work ordered, approximate operating time on either)

f) strength of labour force per Section (on contractual work, on extra work ordered, hours worked on either)

g) Delays (cause, effects such as idle time etc.)

h) Unusual events (earthquakes, floods, fires, storms, accidents, strikes, agitation, rallies etc.)

i) visitors at Site

j) availability of required construction materials at site

Each daily log shall be signed by the responsible Site Manager of the Contractor and "noted" by the Engineer.

1.8.7 Operation and Maintenance for 1 year

After the installation of the pumps and its successful commencement, the contractor should operate the plant for at least 1 year, if provisioned in BoQ. The electrical cost of the pump operation and other electrical power consumption shall be recorded as per NEA format and should be reported in the log book.

Also for the disinfection of the treated water, the bleaching powder added should be reported in the logbook. The concentrations of the bleaching powder for chlorination is given in section 3.3.3.4.11.

This log book record of power consumption and chlorination will be used for the reimbursement for the contractor during first year of operation.

Personnel that should be employed for the one year maintenance of the system should be at least two assistant pump operator who will act as guard also for their pump station, one water supply and sanitation technician who will also act as plant operator and plumber for the system, and one general guard for the system.

Within a month after the start of the pipe laying works, the Contractor shall train the WUSC staff identified by the Employer who will be responsible for the operation and maintenance of the distribution system. The training shall include but not be limited to, cutting pipes of all diameters, installation of polyethylene sleeves, tape wrapping of pipes and fittings, repair of coatings, jointing of pipes of all diameters with all types of joint, including electro fusion joints, installation of valves and fittings and maintenance of valves and fittings.

Training shall be done for twelve (12) persons, and consist of at least 7 days of classroom-type training and a suitable period of field training to demonstrate and train the personnel of the Employer. The training personnel and program, and training materials shall be submitted prior for the approval of the Engineer.

1.8.8 Measurement and Payment

Measurements and/or payment shall be made for all materials and works required under this clause as provisioned in item rates of the Bill of Quantities.

1.9 Standards, Codes and Abbreviations

1.9.1 Reference Standards and Codes

The Works shall be carried out in accordance with the relevant quality standards, test procedures, or codes of practice, collectively referred to as Reference Standards, listed in the relevant parts of the Specifications. The applicable issue of any Reference Standard shall, unless otherwise stated in the Specification, be the issue current at the date two months preceding the date for submission of the Bids for the contract. The Contractor shall familiarize himself fully with the requirements of such standards. If no standard is indicated then the relevant ISO Standard or, in the absence of such standard, the relevant Indian Standards shall apply, or others, if so approved.

The Contractor shall obtain and keep on Site at least one copy of each approved Reference Standard and each Reference Standard referred to in the Specifications, and will make these accessible to the Engineer at any time upon request.

The Contractor shall obtain the Reference Standards from the addresses given below:

ISO	International Organization for STANDARDIZATION, Rue de Varembe, Geneva, Switzerland
DIN	Deutsche Industry Norm (German Industry Standard) from Deutsche Normenausschuss, Beuth-Vertrieb, P.O. Box 1045, W-1000, Berlin 30, Federal Republic of Germany
BSI	British Standards Institution, 389 Chiswick High Road, London W4 4BR, England
AASHTO	American Association of State Highway and Transportation Officials, Suite 341 National Press Building, Washington, D.C. 2004, U.S.A.
ACI	American Concrete Institute, P.O. Box 4754, Redford Station, Detroit, MI 48219, U.S.A.
AISC	American Institute of Steel Construction, 101 Park Avenue, New York, NY 10017, U.S.A.
ASTM	American Society for Testing and Materials, 2501 Race St., Philadelphia, PA 19103, U.S.A.
AWS	American Welding Society, Inc., 2501 N.W. 7th St., Miami, FL 33125, U.S.A.
AWWA	American Water Works Association, 6666 West Quincy Ave. Denver, Colorado 80235, U.S.A.
IS	Indian Standards, Manak Bhawan - 9, Bahadur Shah Jafar Marg, New Delhi, 11002
SIS	Swedish Standards
NS	Nepal Standards, Nepal Bureau of Standards and Metrology, Balaju, Kathmandu, Nepal

1.9.2 Metric Units

S.I. units of measurement shall be used throughout the Contract. All information and data originating in another system shall be transferred by the Contractor into the S.I. system.

1.9.3 Abbreviations

ACI	=	American Concrete Institute
AC	=	asbestos cement, alternating current
AASHTO	=	American Association of State Highway and Transportation Officials
ASTM	=	American Society for Testing and Materials

BOQ	=	Bill of Quantities, Schedule of Quantities
BS	=	British Standard
CBR	=	California Bearing Ratio
cm	=	centimeter
cm2/g	=	square centimeter per gram
CP	=	chromium plated
d	=	day(s)
dia	=	diameter
DIN	=	Deutsche Industry Norm (German Standard)
DN	=	diameter nominal (=ND)
GON	=	The Government of Nepal
g/cm3	=	gram per cubic centimeter
g/m2	=	gram per square meter
h	=	hour
ha	=	hectare
HDPE	=	high density polyethelene
GON	=	Government of Nepal
HP	=	horse power
IDA	=	International Development Association
IS	=	Indian Standard
ISO	=	International Standard Organization
kg	=	kilogram
kg/cm3	=	kilogram per cubic centimeter
kg/cm2	=	kilogram per square centimeter
km	=	kilometer
kN	=	kilo newton
kVA	=	kilo volt ampere
l	=	liter
m	=	meter
m2	=	square meter
m3	=	cubic meter
mg/l	=	milligram per liter
min	=	minute
mm	=	millimeter
m/min	=	meter per minute
m3/d	=	cubic meter per day
m3/min	=	cubic meter per minute
m/s	=	meter per second
mm/s	=	millimeter per second
N	=	Newton
ND	=	nominal diameter (=DN)
NEA	=	Nepal Electricity Authority
nm	=	nanometer
N/mm2	=	Newton per square millimeter
NS	=	Nepalese Standard
NWSC	=	Nepal Water Supply Corporation
OMC	=	Optimum moisture content
OPC	=	Ordinary Portland Cement

Pa	=	Pascal (1N/m2)
PC	=	personal computer
PCC	=	Plain Cement Concrete
PD	=	Permissible Deviation
PE	=	Polyethylene
pH	=	hydrogen ion concentration (acidity)
PI	=	Plasticity Index
ppm	=	parts per million
PVC	=	Poly Vinyl Chloride
RC or RCC	=	reinforced concrete
r/min	=	revolution per minute
s	=	second
SI	=	System International d'Unités
Si	=	silicon
SRPC	=	Sulphate Resisting Portland Cement
T	=	temperature
t	=	metric ton
uPVC	=	unplasticised polyvinyl chloride
V	=	Volt
W	=	Watt
WC	=	Water Closet
oC	=	degree centigrade
"	=	inch
%	=	percent
4WD	=	four wheel drive
<	=	smaller/less than
>	=	larger/more than

1.9.4 Measurement and Payment

No separate measurement and payment will be made for items provided under Clause 1.9, the cost of which shall be deemed to be included in the rates of the BOQ.

1.10 Securities and Insurances

1.10.1 Performance Security

The Contractor shall provide Performance Security in the required amount and currencies from an approved bank/financial institutions in accordance with relevant clause of the Conditions of Contract.

1.10.2 Insurance of Works and Contractor's Equipment

The Contractor shall also insure all his equipment against damages and losses with an approved insurance agency/institution as stipulated in relevant clause of the Conditions of Contract.

Insurance of Contractors Workmen And Employees

The Contractor shall insure all his employees and workmen against such liability as stipulated in Condition of Contract Clause 13 and submit the policy document to the Engineer within stipulated date.

1.10.3 Third Party Insurance Policy

The Contractor shall obtain a Third Party Insurance Policy as stipulated in the Conditions of Contract from an approved insurance agency/institution in the form acceptable to the Employer.

1.10.4 Insurance of Employer's Personnel

The Contractor shall insure all nominated personnel of the Employer including the Engineer's personnel against such liability as stipulated in the Conditions of Contract and submit the policy document to the Engineer within stipulated date.

1.10.5 Measurement and Payment

Only the cost of providing Insurance Policies as described above shall be paid to the Contractor amount against submission of required insurance policies with the appropriate payment receipts, in the form acceptable to the Employer, and made provision in the BOQ.

1.10.6 Other Provisional Items

All provisional items in the schedule shall be carried out at the discretion of the Engineer, and shall form part of the contract. In case, the provisional items are carried out by the Contractor, the rates shall be settled as for extra items as stated in the conditions of contract.

1.11 Items Supplied by the Employer

Items supplied by the Employer, if any, are described in Appendix a of Particular Technical Specification.

2 CIVIL ENGINEERING WORK

2.1 Site Clearance

2.1.1 Scope

This specification covers the removal of vegetation, boulders or concrete block of size up to 0.2 m^3, surface obstructions, and the demolition and removal of structures including their basements (if any) not directly associated with or incidental to any excavation.

2.1.2 Interpretations

2.1.2.1 Supporting Specifications

This specification contains stipulations that are generally and particularly applicable to site clearance

a) 1 General
b) 2.2 Earthworks, as applicable

2.1.2.2 Application

This specification contains stipulations that are generally and particularly applicable to site clearance.

2.1.2.3 Definitions

For the purpose of this specification the following definitions shall apply:

Cleared surface - The natural surface of the ground after clearing of surface vegetation has been completed.

Designated area - An area the position of which in relation to the work to be carried out is shown on the drawing or is described in the specification and is therefore known to the Contractor at the time of Bidding.

Finished level - The level of the finished earthworks as shown on the drawings or stated in the project specification.

Grubbing - The operation of digging out the roots of vegetation.

Original ground level - The level of the surface of an area before the commencement of clearing.

2.1.3 Materials

Material obtained from clearing and grubbing and from the demolition of structures shall be disposed of in tipping areas or other suitable places indicated by the Engineer and shall be covered with soil or gravel. Where no such place is indicated by the Engineer, the Contractor shall make his own arrangements for the provision of a suitable place. Such disposal places shall be subject to Environmental Mitigation Plan and approved by the engineer.

The Contractor shall not clear the Site of or damage any living tree having a girth more than 0.5 m (measured 1 m above the ground level) situated on the parts of the Site not subsequently to be occupied by the Works. All trunks and branches of cleared trees shall be stripped of secondary branches, sawn into transportable lengths and stacked at designated areas. Such timber shall be the property of the Employer and shall remain the property of the Employer.

Fencing wire shall be neatly wound into rolls or coils and all such wire, together with all fence posts and other re-usable material from walls, etc., shall be stacked at designated areas.

2.1.4 Construction Equipment

The Contractor shall provide saws for cutting of trees and branches as ordered, and plant that is suitable for grubbing roots and for digging out and removing other obstructions on the Site.

2.1.5 Construction and Workmanship

2.1.5.1 Areas to be Cleared and Grubbed

Prior to the start of any work, the Contractor should lay-out the right-of-way, working areas, clearing, and pavement cuts to insure a proper recognition and protection of the adjacent properties.

All lay-out work must be approved by the Engineer before any demolition, rehabilitation or construction begins.

The Contractor shall clear the parts of the Site subsequently to be occupied by the Works and shall maintain them clear of vegetation. Areas cleared shall include but not be limited to, portions of the Site where excavations are to be carried out and embankments and structures constructed, however, the Contractor shall not commence clearing and grubbing until the Engineer has designated, in writing and in detail, the exact areas to be cleared or grubbed and the time at which the work is to be started.

The Contractor shall ensure that the general shape, profile, and levels of the area are not materially altered during clearing and grubbing operations.

In order to avoid re-clearing or to control dust or erosion the Contractor may have to clear and grub at the latest practicable stage of construction.

2.1.5.2 Cutting of Trees

The Contractor shall take the necessary precautions to prevent injury to persons and animals and damage to structures and other private and public property. Where necessary, trees shall be cut in sections from the top downwards.

No tree shall be cut down until the Engineer has given written authorization for such work to commence.

If possible, trees shall be felled in such a manner as to allow removal of the root together with the trunk.

The Contractor shall be responsible for the disposal of cut trees. Prior to disposal, the Contractor shall identify the method of disposal and location of disposal sites if applicable, both of which shall be approved by the Engineer.

Individual trees indicated and marked by the Engineer as trees to be preserved shall be left standing and uninjured. An amount of NRs 100,000/- shall be deducted from monies due to the Contractor as a penalty in respect of every such tree that is damaged or removed unnecessarily or without the authorization of the Engineer.

2.1.5.3 Clearing

Clearing shall consist of:

a) the removal of all trees and bushes (complete with roots), other vegetation, rubbish, fences, and all other material that may interfere with the construction of the Works
b) the disposal of all materials resulting from the clearing
c) The removal of all rocks and boulders of size up to 0.2 m3 that are lying on the surface to be cleared or exposed during the clearing operation.
d) where fences have to take down, the sorting, coiling, and stacking of the material, and
e) The removal and stacking of other re-usable materials.

The moving of a certain amount of soil or gravel may be inherent in or unavoidable during the process of clearing. No extra payment will be made for the removal of such soil or gravel.

2.1.5.4 Grubbing

All stumps and roots larger than 75 mm in diameter shall be removed to a depth of at least 600 mm below original ground level. Where a road bed or other area has to be compacted, all stumps and roots included matted roots shall be removed to a depth of at least 200 mm below the cleared surface. The removal of stumps and roots shall be done in such a manner that the topsoil is least disturbed. Cavities resulting from grubbing shall be backfilled with approved material and compacted to a density at least equal to that of the surrounding ground.

2.1.5.5 Re-clearing of Vegetation

If during the contract period vegetation should again grow on any portion of the Site, or other areas that have been cleared in accordance with this specification, the Engineer may, if he considers it necessary, order that such area(s) be re-cleared.

Such re-clearing shall include the removal and disposal of grass, shrubs, and other vegetation, as in the first clearing operation.

2.1.5.6 Dismantling

Before moving equipment onto the Site and commencing operations the Contractor shall establish to the Engineer's satisfaction that the method of demolition proposed by the Contractor is such that he can keep any nuisance arising from dust, noise, and vibration to an acceptable level and ensure the safety of structures adjacent to those to be demolished.

The materials obtained from dismantling shall become the property of the Contractor. Serviceable materials shall be stacked neatly in such a manner as to avoid deterioration at site or at other places. Non-serviceable materials shall be disposed off by the Contractor without causing any inconvenience.

Dismantling of reinforced concrete structures shall be carried out using approved methods and in accordance with any safety regulations of the local municipality/VDC or relevant thereto. The Contractor should note that a Building Permit may be required for demolition work.

All rubbish shall be cleared off the site and the Ground let clean and clear and rubbish and non-serviceable materials shall be carted away in a manner acceptable to the local municipality up to a distance of 10kms as per the direction of the Engineer.

Underground structures shall be broken out to a depth of 1meter below original ground level. Sumps, pits, chambers and the like shall be properly cleaned out and filled with clean demolition hard-core, excluding any wood, plastic, sheet metal, loose reinforcement steel and the like.

The top surface of hardcore material shall be blinded with clean sand to a minimum thickness of 200mm.

Where directed by the Engineer, a reinforced concrete raft shall be cast over sumps, pits, etc. after filling.

The area shall be spread with approved fill material and graded to original levels, or such other levels as the Engineer may direct.

Dismantling of walls, tanks, plates inside building to be rehabilitated will be performed with the required care, without damaging the stability of the structure.

Where required or directed by the Engineer, the existing structure will be temporary reinforced to assure the stability. The Contractor will submit for the Engineer's approval the methods applied for demolishing and the proposed temporary safety measures. The Engineer's approval shall not relieve the Contractor of any of his responsibilities under the Contract.

2.1.5.7 Measurement and Payment

The items scheduled for clearance and demolition will be classified according to the nature of the materials involved and the methods of their disposal.

Only those areas designated to be cleared as indicated in BOQ will be measured for payment. The area of surfaced roads, structures, and paved areas falling within such designated areas will be deducted from such measurements.

2.2 Earthworks

2.2.1 Scope

This specification covers earthworks carried out with light or heavy equipment or by hand, for general excavations, terracing, landscaping etc. It covers the requirements for site-works, excavations for foundations for reservoirs, buildings, bridges and general structures and reinstatement of surfaces.

2.2.2 Interpretations

2.2.2.1 Supporting Specifications

The following specifications shall, inter alia, form part of and shall be read in conjunction with this specification:

a) 1 General
b) 2.1 Site Clearance
c) 3.1 Pipe Trenches, as applicable

2.2.2.2 Application

This specification contains Clauses that are generally applicable to earthworks. Interpretations, additions, and variations of this specification (if any) are set out in the Particular Specification.

2.2.2.3 Definitions

For the purpose of this specification the following definitions shall apply:

Backfill - Approved material placed in an excavation after specified operations have been performed and compacted to specified density.

Borrow - Material obtained from various sources such as borrow pits.

Borrow pit - An excavation made for the purpose of procurement of material.

Bulk Excavation – An excavation made from original ground level to reduced site or platform level.

Catch water drain - An open drain and/or berm intended to intercept water and to lead it to suitable discharge points.

Excavation - An excavation, to accommodate a structure or pipeline, made below the original ground level or reduced site/platform level as appropriate.

Over break - Excavation carried out in excess of the designated profile.

Pass - In regard to compaction, a movement of an approved compacting machine from one end of the layer being compacted to the other end.

Specified density - The ratio of field density to laboratory-determined modified AASHTO maximum density.

Spoil - Unsuitable or excess material removed to waste dumping sites or reclaimatiosites.

Stockpile - A pile of material that has been selected, loaded, transported and unloaded in a heap outside the confines of a borrow pit or of an excavation that forms part of the Works.

Suitable material - That material which is acceptable in accordance with the Contract for use in the Works and which is capable of being compacted, in the manner specified, to form a stable fill having side slopes as indicated on the Drawings.

Top Soil - The top layer of soil shall containing organic components that can support vegetation.

Unsuitable material - Unsuitable material shall mean other than suitable material and shall include:

a) material from swamps, marshes or bogs;
b) organic and perishable material;
c) material susceptible to spontaneous combustion;
d) Clay of liquid limit exceeding 80 and/or plasticity index exceeding 55.

2.2.3 Materials

2.2.3.1 Classification for Excavation Purposes

The Engineer will decide on the classification of the materials, which will be based on inspections and criteria given below.

The excavation of material will be classified as follows:

a) Normal excavation. Material that can be efficiently (i.e. in a manner that can reasonably be expected of an experienced contractor, having regard to the production achieved) removed or loaded, with normal mechanical means.

b) Rock excavation. Rock is defined as all materials which, in the opinion of the Engineer, require blasting, or the use of metal wedges and sledgehammers, or the use of compressed air drilling for its removal, and which cannot be extracted by ripping with a tractor of at least 110 kW with a single rear mounted heavy duty ripper.

2.2.3.2 Classification for Placing Purposes

a) Material for embankments, terraces, etc. Such materials shall, generally, have a CBR of at least 3% (compacted at OMC), a PI not exceeding 18, and a maximum dimension of 300 mm, unless otherwise specified in the Technical Specifications.

b) Material for backfill or fill against structures. Material placed as backfill or as fill within 500 mm of structures shall comply with requirements specified under a) above except that it shall not contain more than 10% rock or hard fragments retained on a sieve of nominal aperture size 50 mm.

c) Stone used for rock fill, gabions and stone pitching shall be hard, tough, sound, and clean and derived from a source approved by the Engineer.

2.2.3.3 Selection

Topsoil, if required for later use on the Site, as well as any other material excavated that is suitable for backfilling or for filling against the finished structures, shall be selected and stockpiled in the vicinity of the structures. Topsoil shall be stockpiled in a manner to prevent its deterioration.

The use of top soil shall be restricted to surface layers in positions not subject to loading pavements or structures.

No excavated suitable material other than surplus to requirements of the Contract shall be removed from the Site except on the direction or with the permission of the Engineer. Should the Contractor be permitted to remove suitable material from the Site to suit his operational procedure, then he shall make good at his own expense any consequent deficit of filling arising there from.

If any suitable material excavated from within the Site is, with the permission of the Engineer, taken by the Contractor for purposes other than the forming of embankments and other areas of fill, sufficient suitable filling material to occupy after full compaction, a volume corresponding to that which the excavated material occupied shall, unless otherwise directed by the Engineer, be provided by the Contractor from his own resources.

Suitable material surplus to the total requirements of the Works and all unsuitable material shall, unless the Engineer permits otherwise, be run to spoil in tips provided by the Contractor.

Where the excavation reveals a combination of suitable and unsuitable materials the Contractor shall, unless otherwise agreed by the Engineer, carry out the excavation in such a manner that the suitable materials are excavated separately for use in the Works without contamination by the unsuitable materials.

Any material that is below the finished level of an excavation and that the Engineer considers to be unsuitable, shall be excavated and disposed of as directed. The resultant space shall be refilled with backfill and compacted as specified

2.2.3.4 Explosives and Blasting

No explosives of any kind shall be used by the Contractor without the prior consent of the Engineer in writing.

The Contractor shall at all times maintain full liaison with and inform well in advance, and obtain such permission as is required from, all Government authorities, public bodies and private parties whatsoever concerned or affected, or likely to be concerned or affected by blasting operations.

The Contractor shall comply with all relevant ordinances, instructions and regulations which the Government, or other person or persons having due authority, may issue from time to time regarding the handling, transportation, storage and use of explosives.

The Contractor shall store explosives in a licensed store or magazine provided with a separate compartment for detonators. Explosives shall be handled only by currently licensed shot firers. The Contractor shall ensure that there is no unauthorized issue or improper use of explosives brought on the Site.

Explosives shall be used in the quantities and manner recommended by the manufacturers. The written permission of the Engineer shall be obtained for each and every location or series of locations where the Contractor wishes to use more than 10 kg of explosives in one blast. Such permission shall not in any way relieve the Contractor of his liabilities under the Contract.

When blasting is carried out, the Contractor shall ensure, by adherence to proper safety distances and by the use of heavy blasting mats where necessary to prevent the dispersal of material, that no damage is caused to persons or

Property on or off Site. Special care shall be taken when blasting to ensure that individual explosions are reduced to such a size as to preclude damage to any buildings or structures. Blasting will not be permitted within 400 meters of any building or structure.

Before the beginning of the defects liability period the Contractor shall account to the satisfaction of the Engineer for all explosives brought on to the Site during the continuance of the Contract and the Contractor shall immediately remove all unused explosives from the Site on completion of the Works when ordered by the Engineer.

2.2.3.5 Gabions

Gabions shall consist of steel wire mesh crates. The steel wire shall be mild steel wire complying with IS 280-1962. The standard size of mesh size shall be 100 x 120 mm hexagonal shape with 10 SWG thickness mesh wire, 10 SWG thick binding and connecting wire and 7 SWG thick selvedge wire. The weight of deposition of zinc shall be minimum of 250 gm. per square meter equivalent for all the gauges of wire specified. The height of boxes shall be maximum of 1.0 m and diaphragms shall be provided at 1.0 m interval. Maximum size of gabion box will be limited to 3.0 m x 1.0 m x 1.0 m.

2.2.4 Construction Equipment

Equipment shall be suitable for obtaining the end result required under the conditions applicable to the Site.

Compaction equipment used for applying the dynamic load, controlling the moisture content, and grading or mixing, shall be capable of achieving the compaction specified with the material available.

Any vehicle or item of equipment provided by the Contractor for the transport of materials shall conform to the requirements of the applicable road traffic ordinance if the vehicle or equipment is required to operate on any public road, street, or area that has been surfaced.

Where any of the Contractor's operations or the movement of any of the Contractor's vehicles or equipment has caused damage to the surface of any area normally open to the public, the Contractor shall repair such surface as a matter of urgency, and at his own expense.

The Contractor shall provide and use, where applicable, equipment that is suitable for the detection and location of underground service pipes and cables.

Construction traffic shall not use the surface of the bottom of mass excavations unless the excavation is in rock or the Contractor maintains the level of the bottom surface at least 30 cm from formation level. Any damage to the formation arising from such use of the surface shall be made good by the Contractor at his own expense, with material having the same characteristics as the material which has been damaged.

2.2.5 Construction and Workmanship

2.2.5.1 Precautions

2.2.5.1.1 Safety and safeguarding

Every excavation that is accessible to the public shall be adequately protected by barriers or fences, provided with lighting at night and watched to ensure that barricades and lights are effective at all times. Reference shall be made to Clause 1.4.16 of this specification.

The Contractor shall suitably safeguard excavations if the depth of an excavation or the nature of the material excavated renders the sides of the excavation liable to movement that might endanger the Works or the workmen engaged on the excavation.

This safeguarding may consist of supports by timber or sheeting adequately strutted and braced, or, if approved by the Engineer, by a reduction of the slope of the excavated face or faces so that any danger to the Works or the said workmen is eliminated.

The Contractor shall make good any fall of earth or rock due to insufficient safeguarding at his own expense, as directed and by approved means.

Without relieving the Contractor in any way of his responsibility, the Engineer may order additional lateral support for, or the sloping or reduction of the slope of, the sides of any excavation. During the progress of each excavation, the Contractor shall report to the Engineer the presence of bedding planes inclined towards the excavation, seepage water and any other feature that may affect the stability of the excavation, as soon as the presence of such feature or features is known. All timbering and sheeting shall be removed from the excavation at the completion of the work, unless the written permission of the Engineer allowing any portion to remain is obtained.

Should blasting be necessary, the Contractor shall obtain the permission from the Engineer and the local authority well in advance and in writing and shall take every precaution to protect the Works and persons, animals and property in the vicinity of the Site. The Contractor will be held responsible for any injury or damage caused by any blasting operations

And shall, at his own expense, make good such damage. A copy of the blasting permit(s) issued to the Contractor to cover the purchase, storage, and handling of explosives, shall be handed over to the Engineer.

When blasting to specified profiles, the Contractor shall so arrange the holes and charges that the resulting exposed surfaces are as sound and stable as the nature of the material permits. The Contractor shall make good at his own expense any additional excavation necessitated by the shattering of rock in excess of a 150mm over break allowance.

2.2.5.1.2 Existing services

The Engineer's Drawings as well as the Contractor's working drawings show positions of existing underground services based on the best information available.

The Contractor shall, before commencing work in any particular area, verify the position of all underground services and all other obstacles and existing construction on the Site.

The Contractor shall have equipment required for the detection and location of underground services available on the Site and in an operable condition for as long as is necessary to detect and locate such services and, if so ordered, he shall excavate by hand to expose such services in areas and in a manner and at a time agreed upon with the Engineer.

The Contractor shall advise the Engineer at least 7 days in advance of the actual date on which he proposes to excavate near any service. He shall not use mechanical equipment to excavate within 3 m of the assumed position of any service and shall, if necessary, expose the service by means of hand excavation carried out under proper supervision. When so ordered, the Contractor shall backfill such observation trenches with approved material to the compaction density ordered.

Once a service is exposed the Contractor shall take all measures necessary for the support and protection of the service.

Where a service is damaged because of the Contractor's negligence, he shall inform the Engineer and the authority concerned make good such damage or bear the cost of the repairs, as applicable

2.2.5.1.3 Storm water and groundwater

The Contractor's responsibility will include the provision of adequate protection against erosion and flooding by storm water, flow from springs, and seepage, and to include provision for repair, at his expense, of any damage to the Works that may arise as a result of the inadequacy of the protection provided by him.

2.2.5.1.4 Nuisance

Wherever dust from the activities, haul roads, borrow pits or road deviations becomes a nuisance to the public the Contractor shall, when so ordered by the Engineer, apply sufficient water or take other measures to lay the dust, oil shall not be used.

All excavated material shall be so deposited as not to interfere with or endanger the Works, other property, or traffic. The Engineer may order the Contractor to remove, at his expense, any material that the Engineer considers liable to endanger or to interfere with the Works, private property, traffic, or pedestrians, and to place such material at some other approved location.

2.2.5.1.5 Roads

The Contractor shall reinstate and maintain the surfaces of all roadways through which trenches or other excavations have been made. Should any subsidence occur at the location of such trench or excavation, the Contractor shall immediately restore the road surface to its correct level. Where immediate restoration is impracticable, the Contractor shall provide adequate protection. The Contractor shall follow the Standard Specification for Roads & Bridges, 2001, published by the Department of Roads and its requirement to fulfill the above works.

2.2.5.1.6 Traffic control

Where work affects the operation or safety of public road traffic, the Contractor shall, comply with the requirements of the Clause 1.5.2 of the Specification.

2.2.5.2 Methods and Procedures

2.2.5.2.1 Site preparation

Before carrying out any work at any location, the location shall be inspected where necessary together with the Engineer.

The Contractor shall request in writing such inspections where in his opinion the situation shown in the Drawings has changed and/or is different from actual conditions.

After clearing, the location shall be surveyed in conjunction with the Engineer's representative to establish original ground levels, and these agreed ground levels shall form the basis for the calculation of quantities of any subsequent excavation and filling.

Should work commence in the absence of this joint survey, the Engineer's statement shall be final.

Prior to the start of excavation proper, if and as scheduled, all areas in which excavation is to take place or that are to be covered by banks, structures etc., shall be cleared as specified or directed by the Engineer.

Where so ordered, the Contractor shall remove and conserve the topsoil for later use in a manner approved by the Engineer. The Contractor will not be required to remove topsoil from any area in which the average depth of topsoil is less than 150 mm.

The Contractor is responsible for the transfer of line and grade from control points established by the Engineer. The preservation of stakes or other line and grade references provided by the Engineer is the responsibility of the Contractor.

The Contractor's method for setting the line and grade for the activities shall be approved by the Engineer.

2.2.5.2.2 Excavation

Excavation shall be carried out to the depth indicated or to such greater depths as may be required by the Engineer to ensure a satisfactory foundation.

Except where otherwise specified, shown on the Drawings, ordered or dictated by the requirements for safeguarding, excavation shall be so carried out and so trimmed to the outline of the concrete work shown on the Drawings that the excavated surfaces will act as forms for the concrete works. Such surfaces as well as the bottom of excavations shall be cleaned by hand, air or other effective means to remove all loose, soft or otherwise unsuitable material and as required by the Engineer.

Should the Contractor excavate to dimensions in excess of those stipulated or permitted, he shall fill in the excess at his own expense in the manner specified or approved by the Engineer. Excavated surfaces that will remain permanently exposed shall be finished off in a neat and workmanlike manner and shall be graded to provide adequate drainage.

When the Contractor is required by the Engineer to open up borrow pits, he shall maintain them so that they do not become a danger to persons and livestock. On completion of borrowing, the sides of the pits, if not filled with unused material, shall be graded 1V:2H, or as the Engineer may direct. The Contractor shall not spoil, stockpile, or waste any material without approval. He shall dispose of surplus and unsuitable material in areas designated by him and approved by the Engineer. Spoil heaps shall be flattened to present a neat level or graded surface with no danger of erosion.

All excavations in driveways, gardens and the like, private and/or enclosed lands, and premises shall be made by hand unless the consent of the owner to the use of (small) mechanical plant has been obtained by the Contractor.

The Contractor shall not sell any materials arising from excavations, demolitions and the like carried out on the Site unless permission is obtained from the Engineer.

2.2.5.2.2.1 Excavation of Foundation Pits & Trenches

Excavations shall be taken out to the least dimensions required to accommodate the several parts of the Works and shall provide any working space necessary for their excavation.

Excavations shall be carried out in such lengths, widths and depth at one time and in the sequence as approved by the Engineer and in such manner as to avoid any damage to the ground and adjacent property.

Excavations shall be timbered, sheeted and piled or otherwise supported to the extent necessary to support the surrounding ground and to ensure the safety of the Works and adjacent structures. Alternatively where specifically permitted they may be suitably battered.

Unless otherwise required by the Contract no timber or other supports shall be left in excavations without consent of the Engineer.

All proposed measures for the shoring and supporting of excavations or trenches shall be to the approval of the Engineer. Calculations showing the adequacy of any temporary works shall when required be submitted to the Engineer for approval.

2.2.5.2.2.2 Excavations to be Kept Free of Water

The Contractor shall provide and maintain and operate dewatering or other pumping equipment, and shall construct such drains, sumps and catch waters as may be necessary to remove water from the excavations or to prevent its entrance thereto. Water in the excavations shall be dealt with in such manner as will prevent the surfaces on or against which foundations or other work will be constructed from any deterioration of their natural condition, or from such condition as improved by work executed under the Contract.

The arrangement made for dewatering the ground, diverting water or removing water entering the excavations shall be to the satisfaction of the Engineer. Arrangements for removing water shall ensure that the dewatering of excavations can continue during the placing of concrete or execution of any other activities which could be adversely affected by water in or entering excavations. (The Contractor shall ensure that disposal of water does not create a nuisance or cause damage).

Precautions shall be taken especially when ground dewatering equipment is used, to ensure that the lowering of the ground water table in the vicinity of excavations or the removal of fine particles of soil from the ground surrounding the excavations causes no damage to sources of water supply, the adjoining Works or property, or the ground consolidated previously by others.

The Contractor shall take all necessary precautions to ensure the stability of any of the Works against floating or displacement during construction due to high sub-soil water level, flood or other causes.

The method of disposal of drainage water from dewatering operations shall be to the approval of the Engineer and the Employer. Drainage water shall be caught where necessary in holding lagoons which shall be constructed by the Contractor for the purpose or piped to approve disposal points as directed. The Contractor shall obtain all necessary approvals and No Objection Certificates for his disposal method.

Crossings of existing road corridors in disposal systems for drainage water from dewatering systems shall be laid as permanent structures to an acceptable standard of construction. Depth of cover to drainage pipes shall not be less than 1.5 Meters. Pipes shall be PVC or reinforced concrete with appropriate joints. Pipes shall be laid, bedded and backfilled to the approval of the Engineer.

Applications for approval for disposal of drainage water shall be made to the Engineer and Employer in the form of Method Statements giving the following information:

a) Routes, diameters, depths and materials of proposed pipelines.
b) Design of proposed holding lagoons.
c) Proposed daily average, and maximum pumping/discharge rates.
d) Effect on any existing disposal systems proposed to be used.
e) Any other information required by the Engineer or Employer.

2.2.5.2.2.3 Foundation Levels and Preparation of Foundations

Formation levels shall be at the levels shown in the Drawings or at such other levels as may be directed.

When approaching foundation levels in excavations in material other than rock, the final trimming to these levels, whether for actual foundations or for any blinding concrete required by the Contract shall not take place until placing of the blinding concrete or of concrete in the foundation is about to commence.

In the event of the Contractor requiring trimming the foundations in advance of readiness to place concrete, the trimmed foundations shall be protected against the ingress of moisture or the evaporation of soil moisture.

In the case where blinding concrete is required by the Contract no trimming of side faces of excavations shall be carried out for 24 hours after the placing thereof.

Where foundations are in rock, as the excavations approach finished level, the Contractor may be directed to continue excavating without the use of explosives or with limited use thereof by shallow holes and light charges. The final trimming of the foundations shall be executed without explosives by approved hand tools.

Immediately before placing concrete against rock surface, all loose and soft material shall be removed from surface by the use of stiff brooms, hammers, picks and air/water jets. Before the placing of concrete all water shall be removed from depressions and the Contractor shall take all measures necessary to keep all rock faces, against which concrete is to be deposited, dry and properly drained.

2.2.5.2.2.4 Protection of Slopes during Contract Period

The Contractor shall be responsible for the protection of slopes formed during the initial earthmoving stage, from subsequent erosion or damage throughout the period of the Contract, caused either by natural means or as a result of subsequent construction operations, or by construction traffic or any traffic.

The form of protection to be used shall be to the approval of the Engineer. During or after the initial earthmoving, the Contractor shall submit his proposals for the protection of the formed slopes. No subsequent construction activity will be permitted until the approved form of slope protection has been carried out.

The permanent form of protection of slopes shall be as described elsewhere in the Specification.

2.2.5.2.3 Placing and compaction

Where approved material from excavations is insufficient to form designated embankments, terraces etc., the Contractor shall, unless otherwise ordered, obtain the additional material, as directed, from borrow pits at locations approved by the Engineer.

2.2.5.2.3.1 Fill in embankments terraces etc.

The fill material shall be free from vegetable matter and shall contain no debris or deleterious matter. The embankment area shall be stripped, grubbed, and cleared prior to placing of embankment fill. The level shall be taken after the stripping and grubbing to arrive at the actual height of fill involved. Nothing extra shall be paid for stripping grubbing etc. Work shall be in good workmanlike manner.

The material of each embankment shall be deposited in layers of thickness, before compaction, not exceeding 300 mm. The material shall be spread to form a layer that is of approximately uniform thickness, and graded over the whole area of the embankment. Each layer shall be compacted at OMC to a density of at least 90 % of modified AASHTO maximum density in the case of cohesive soil or 98 % in the case of non-cohesive soil, unless indicated otherwise on the Drawings.

Should the material be too wet, owing to rain or any other cause, it shall be harrowed and allow to dry out to the correct moisture content before compaction is undertaken. The Contractor shall ensure that storm water will at all times be discharged uniformly over the full area of each embankment or through specially prepared and protected drainage ditches to prevent scouring of the slopes. Where it is necessary to use clay or clayey material in embankments, such material shall be placed not less than 1 m and not more than 5 m below the finished surface.

Where hand-compacting is employed in no case shall the number of men filling-in be more than half the number of men compacting.

Watering-in of backfill will not be allowed, except in some special cases, and if directed or approved by the Engineer.

The Contractor shall be responsible for the suitability of all embankment materials under the Contract until final acceptance of the work. The Contractor shall replace any portions which have become displaced due to carelessness and negligence on his part or to damage resulting from natural causes not attributable, in the opinion of the Engineer, to unavoidable movements of the ground up to which the embankment is made.

2.2.5.2.3.2 Backfilling and Filling

Where backfilling or filling around or against structures has been authorized by the Engineer, such filling shall be placed, and shall be compacted approximately simultaneously on both sides of the structure to minimize unequal loading. All excavations shall be carefully refilled with approved material in layers of thickness not exceeding 200 mm. Each layer shall be compacted, using power rammers or vibrating plate compactors, to a density equal or better than that of the adjoining undisturbed material. Each layer shall be completed before the next is added. Except with the consent of the Engineer, filling shall not be deposited in water.

Timber sheeting and other excavation supports shall be carefully removed as the filling proceeds except where they are required by the Contract, or directed by the Engineer to be left in position, but removal of such supports will not relieve the Contractor of his responsibilities for the stability of the Works.

No filling shall take place around any structure until the Engineer's approval to backfill has been obtained and no backfilling shall take place around sumps, tanks or any other water retaining structures until the structure has been tested and a certificate of compliance with the specified test issued

2.2.5.2.4 Rubble Masonry, Stone Paving & Pitching

In rubble masonry walls the joints shall be broken vertically and staggered bond stones shall be provided to the full wall thickness. More than one meter high wall shall not be allowed and constructed at a time. Each stone shall be 150 mm to 250 mm high, 200 mm to 300 mm long and 100 mm to 150 mm wide and the whole masonry work shall be well bonded by cement mortar as mentioned in the Drawings. The faces of all stones showing externally shall be rough hammer dressed to a convex surface. The mortar joints shall be 15 to 20 mm thick. Finished rubble masonry works shall be wetted by water and prevented from drying out for at least seven days after construction.

Stone paving shall be pitched by hand and set in places in such a manner as to secure the greatest possible compactness and solidity; the smaller interstices shall be filled in with stone chips firmly wedged in with hammers. Rubble for paving is to be carefully bedded and grouted in cement mortar (1:3) to form an even surface.

Stone pitching shall be laid on a filter layer of gravel. The stones shall be pitched by hand to provide a dense uniform surface with even joints.

2.2.5.2.5 Gabion works

Gabion crates shall be filled with large stones with minimum voids between the stones.

2.2.5.2.6 Landscaping

On completion of earthworks to the finished level, the whole surface shall be graded, shaped and compacted to final grades and levels. The surface shall be lightly watered as the Engineer may direct.

If ordered by the Engineer, topsoil shall be placed on level and slightly graded areas and shall be lightly compacted by tamping, and trimmed neatly to required lines, grades, and levels. The final thickness of topsoil after compaction shall be at least 200 mm.

If ordered by the Engineer, grass or other vegetation shall be planted after top soiling has been completed. Such planted areas shall be neatly trimmed and well-watered, and the Contractor shall ensure that planted areas are not permitted to dry out. Any grass or vegetation planted that fails to grow shall be replaced by the Contractor, at his expense.

All land drains, like irrigation channels, culverts, etc. which have been severed during excavation work shall be carefully reinstated by the Contractor at his cost in either similar or approved equivalent material or construction.

Particular attention shall be paid to the support of reinstated drains in filled ground.

2.2.6 Tolerances

2.2.6.1 Positions, dimensions, levels, etc.

The work shall be finished to and within the limits (permissible deviation = PD) given below:

a) Excavations
   - (i) position on plan, i.e. PD in plan of any point measured from nearest grid line: ±35 mm
   - (ii) dimensions on plan, i.e. PD from the designed dimensions: -10 to +50 mm
   - (iii) foundation level, i.e. PD in level of surface of excavation trimmed to receive blinding concrete: ±50 mm
   - (iv) Level (other than foundation level), i.e. PD from designed levels with reference to nearest transferred bench-mark: ±15 mm

b) Embankments, terraces, etc.
   - (i) position of top edge, i.e. PD from designated position of any point, measured from nearest grid line: ±300 mm
   - (ii) alignment of top edge, i.e. PD from a line joining any two points 30 m apart on top edge of embankment: ±100 mm
   - (iii) finished levels, i.e. PD from designated levels with reference to nearest transferred bench-mark: ± 50 mm
   - (iv) slopes of top surfaces, i.e. PD from rate of fall: ± 5 % i.e. if fall 10% tolerance 9.5 to 10.5%

2.2.6.2 Moisture content and density

The permissible deviations (PD) shall be as given below:

a) OMC in field during compaction: +1% and -2%
b) specified density: +(no top limit) and -0

2.2.7 Testing and Acceptance

To determine founding conditions or for other purposes, the Engineer may require the Contractor to drill, auger or excavate bore holes in advance of the start of construction. When so requested by the Engineer, the Contractor shall provide labour, tools, machinery and equipment for sinking such exploratory holes and for refilling them. Such operations will be paid as day work.

The Contractor shall carry out sufficient tests to satisfy himself about the consistency of material placed in embankments and as backfill, and submit a test report to the Engineer.

The Engineer may carry out check tests as he deems necessary, at any depth or at any layer. Where these tests reveal that the material used does not comply with the applicable requirements of the specification, or that the compaction specified has not been attained, the Contractor shall rectify the work to the satisfaction of the Engineer.

2.2.8 Measurement and Payment

Rates for excavation shall cover the cost of excavating, forming excavated material embankments, terraces, shoring and supporting excavations, protection of structures, provision for existing services, dealing with storm and ground water, protection of slopes, and the cost of disposal of any surplus and unsuitable material to a tip identified by the Contractor and approved by the Engineer.

The Contractor shall be responsible for making all arrangements for the disposal of surplus excavated material up to a distance upto10kms at no extra cost. The cost for all lift, disposal including transportation shall be included in unit rate of excavation.

Rates for excavation shall cover the cost of excavating and proper placing of material for re-use. Excavation shall be restricted to limits of excavation as provided in drawings.

Rates for filling shall cover the cost of the provision of suitable material from any lead distance, placing in layers, and compacting as specified. Filling quantity will be restricted to quantity excavated till limits of excavation only. Extra excavations beyond limits of excavation, as shown in drawing, to be filled up with suitable material as directed by engineer at contractor's cost.

The Contractor shall be responsible for making all arrangements for the disposal of surplus filling material up to a distance up to 1 km at no extra cost. The cost for all lift, disposal including transportation shall be included in unit rate of filling.

Rates for landscaping shall include trimming the earthworks to final grades and levels, disposal of surplus materials, planting and seeding, reinstatement of land drains.

Excavations which are required to be backfilled will be measured as if taken out with vertical sides regardless of whether they have been taken out with sloping sides. They will be measured from the net plan of the finished concrete footing, foundation, building or concrete structure except that, in the case of conical-bottomed tanks or other such structures, the volume will be measured from the finished outline of the concrete as shown on the drawings.

Fill is measured as the volume between ground levels before and after the filling and the rate will include forming embankments, terraces, etc.

Landscaping is measured as the area over which finishing is required; it shall exclude areas covered by structures, roads and pavements.

2.3 Cement Concrete

2.3.1 Scope

This specification covers the requirements for plain and reinforced concrete, either cast-in-situ or precast, for civil engineering and building construction applicable to this project.

2.3.2 Interpretations

2.3.2.1 Supporting specifications

The following specifications shall, inter alia, form part of and be read in conjunction with this specification:

a) 1 Item of General Application
b) 2.2 Earthworks, as applicable

2.3.2.2 Application

This specification contains clauses that are generally applicable to concrete and structural precast concrete work.

2.3.2.3 Definitions

For the purpose of this specification the following definitions shall apply:

a) General

Adverse weather. Cold weather, or weather in which the ambient temperature is above 25^{o}C, or the relative humidity is low, or the wind velocity is high, or weather in which any combination of the latter three conditions occurs, and which tends to impair the quality of fresh or hardened concrete or otherwise causes concrete to have abnormal properties.

Approved laboratory - A laboratory suitably equipped and staffed for purposes of concrete testing and as such approved by the Engineer.

Cold weather - Weather conditions in which the ambient temperature is 5^{o}C or less.

Concrete cover - The thickness of concrete between the face of the concrete and the outside of reinforcing steel nearest this face as cast.

Cool weather - Weather conditions in which the ambient temperature is higher than 5^{o}C but not higher than 15^{o}C.

Fixture - An item such as a bolt, anchorage, bearing, or the like that is cast or grouted into concrete.

Formwork - Temporary work that is required to support and shape the concrete for a structure.

Hot weather - Weather conditions in which the ambient temperature is higher than 25^{o}C.

Normal weather - Weather conditions in which the ambient temperature is higher than 15^{o}C and less than 25^{o}C.

b) Quality

Class of concrete - See grade of concrete.

Consistency - The extent, as measured by the slump test, to which fresh concrete resists flow or deformation.

Designed Mix – A mix specified by its required performance in terms of strength.

Grade of concrete - An identification number for the concrete, the number being numerically equal to the characteristic compressive strength at 28 d expressed in MPa.

Prescribed mix - Concrete for which the Engineer has prescribed the mix proportions.

Ready-mixed concrete - Concrete complying with the relevant requirements of the specification and delivered to the Site in a plastic state.

Target slump - The average value for the slump of concrete aimed at ensuring compliance with the slump required in terms of the specification.

Workability - The property of fresh concrete that determines the ease with which it can be placed and compacted without segregation of the constituent materials.

c) Strength

Characteristic compressive strength - See specified strength.

Specified strength - The required concrete strength (or the strength corresponding to the required concrete grade) stated on the Drawings or in the Technical Specification and which in all cases represents the strength below which not more than 5 % of valid 28 d test results obtained on cubes of concrete of the same grade can be expected to fall.

Designed Mix - The mix shall be designed to produce the grade of concrete having the required workability and a characteristic strength.

Target strength - An average value of the strength of concrete that is higher than the characteristic strength and is aimed at to ensure that the characteristic strength is attained. (Note: If the standard deviation can be determined, the value of the target strength is at least equal to the specified strength plus 1.64 times the standard deviation of valid 28 d test results.)

Valid test result – The average result obtained from the testing of cubes of concrete as defined in IS: 4634-1968 or equivalent BS 5328 Part 4.

d) Joints

The location of joints is controlled by design requirements and construction limitations. Joints shown on the Engineer's Drawings are "designated construction joints" and are required for design requirements and cover "movement joints", "contraction joints" and "expansion joints". The Engineer may, at the request of the Contractor, give his consent to further joints before the casting of concrete to suit the Contractor's method of construction. These shall be defined as "construction joints". In the event that the placing of concrete has to be halted due to equipment failure, inclement weather, movement of shutters or some other event, which are not the Employer's risk, which requires the halting of concreting, and "unforeseen construction joint" shall be formed. Where they are to the Employer's risk they shall be defined as "unforeseen designated joints"

2.3.2.4 Abbreviations

For the purpose of this specification, the abbreviation for reinforced concrete shall be RCC and the abbreviation for plain concrete shall be PCC.

2.3.3 Materials

2.3.3.1 Approval of materials

The Contractor shall supply in good time to the Engineer for his approval, samples of the aggregates and, if so ordered, of the water, that he proposes to use for the concrete and shall furnish evidence that the water and aggregates comply with the requirements of the Contract. Evidence shall be in the form of a statement from an approved laboratory of the results of tests, or an authoritative report or record of previous experience.

2.3.3.2 Cement

Unless otherwise specified the cement used in the Works shall be rapid hardening cement confirming to IS 8041-1990 or high strength ordinary Portland cement (OPC) complying with IS 8112-1989 or related equivalent BS and Nepalese Standards. The use of high-alumina cement (IS-6452-1972) or supersulphated cement (IS 6909-1990) will not be allowed.

The Contractor shall require the manufacturer to provide a certificate for each consignment of cement received at the Site. The Contractor shall maintain a record available for inspection by the Engineer of the locations of concrete from each consignment.

Within eight weeks of the award of the Contract a report on proposed cement sources shall be submitted to the Engineer. The report shall propose primary and secondary sources of supply and shall give each manufacturer's full analysis of chemical composition and physical properties.

The report on cement sources shall be submitted at least four weeks in advance of the commencement of work on trial concrete mixes.

The Contractor shall supply samples of cement, when requested by the Engineer both from any store on Site and the place of manufacture.

If required by the Engineer the Contractor shall ascertain whether the alkali content of cement is greater than 0.6% calculated as Na2O + 0.658 K2O. For alkali contents greater than 0.6% the Engineer may require tests in accordance with BS EN 196 to determine the alkali content of the cement.

The Contractor shall conduct preliminary and works tests as required by the Engineer to determine fineness, compressive strength (mortar cube) at 7 days and 28 days, initial and final setting time and soundness of the cement, as described in IS/BS/NS.

Separate storage facilities shall be provided on the Site for each type of cement used. Cement shall be fresh when delivered to Site and the consignments shall be used in the order of their delivery. The Contractor shall mark the date of delivery on each consignment and each consignment shall be stored separately in such manner as to be easily accessible and identifiable. No cement in bags or other container shall be used unless these and the manufacturer's seals are intact at the time of mixing. If the cement is delivered in bags it shall be stored under cover and on elevated floors that provide proper protection against moisture and other factors that may promote deterioration. Bulk cement may be used providing it is stored in approved weather-proof silos or similar containers provided that the cement drawn for use is measured by mass and not by volume.

The Contractor shall not use cement, which has hardened into lumps, but subject to removal of the lumps by screening, the Engineer may allow such cement to be used in non-structural concrete mixes.

2.3.3.3 Water

The water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that maybe deleterious to concrete or steel. Portable water shall be generally considered satisfactory for mixing concrete. The quality of water shall correspond to IS: 456-2000 (Clause 5.4).

Regular tests of the water shall be made by the Contractor during construction of the Works as instructed by the Engineer. The water shall be sampled at the point of discharge into the mix. The Contractor shall supply two copies of each test result to the Engineer.

2.3.3.4 Aggregates

Aggregate shall consist of naturally occurring (crushed or uncrushed) stones, gravel and sand or combination thereof. They shall be hard, strong, dense, durable, clear and free from veins and adherent coating; free from injurious amounts of disintegrated pieces, alkali, vegetable matter and other deleterious substances. As far as possible, flaky, scoriaceous and elongated pieces should be avoided.

Aggregates shall not contain any harmful material described in Clause 3.21, IS: 383-1970, such as pyrites, coal, lignite, mica, shall or similar laminated material, clay, alkali, soft fragments, sea shells and organic impurities in such quantity as to affect the strength or durability of the concrete. Aggregates to be used for reinforced concrete shall not contain any material liable to attach the steel reinforcement. The maximum quantity of deleterious materials shall not exceed the limits set in Clause 3.21, IS: 383-1970.

The contractors should supply samples of the aggregates for the purpose of making preliminary tests for concrete. Method of sampling of aggregate or concrete shall be as per IS: 2430-1986 and method of test for aggregate for concrete shall be as per IS: 2386.

Graded or Single-Sized Coarse Aggregates shall be supplied in the nominal sizes as per clause 4.1 and 4.2 of IS: 383-1970. The proportion of sizes and shapes of the aggregates shall be determined by the method described in IS: 2386 (Part I) -1963.

The grading of fine aggregates for concreting shall be within the limits given in Clause 4.3 of IS: 383-1970 and shall be described as fine aggregates with grading zones of I, II, III, and IV.

Immediately after commencement of the Works, the Contractor shall supply samples of proposed aggregates and also carry out preliminary testing on proposed aggregates for compliance with the Specification. The results of such tests shall be to the satisfaction of the Engineer before the Engineer will give approval to the source of aggregates proposed by the Contractor. Alternatively, and subject to the approval of the Engineer, the Contractor may submit certified results of tests on the aggregate carried out by an independent laboratory for the Engineer's approval of the source of aggregate.

During the performance of the Contract, the Contractor shall supply samples of aggregates when required by the Engineer for testing. The method of sampling shall be done in accordance with IS: 2430-1986. The amount of material required for each test shall be as specified in the relevant method of test given in IS: 2386 (Part I) -1963 to IS: 2386 (Part VIII) -1963.

All the tests shall be carried out as described in IS: 2386 (Part I) -1963 to IS: 2386 (Part VIII) -1963. When tests are necessary for combined aggregates, the aggregates shall be separated into two fractions, one finer than 4.75 mm IS Sieve and the other coarser than 4.75 mm IS Sieve. Appropriate tests shall be made on samples from each component, the former being tested as fine aggregate and the latter as coarse aggregate.

The contractor shall provide samples or perform any tests as required by the engineer and shall allow access to and provide attendance to enable the engineer to inspect and sample the sources of all materials in quarries, pits, river beds or other sources.

Any rejected aggregate shall be promptly removed from Site within 24 hours.

2.3.3.5 All-In-Aggregates (Combined Aggregates)

If the combined aggregates are available, they do not have to be separated into fine and coarse aggregates but necessary adjustments can be made (with the instructions of the engineer) in the grading by the addition of Single-Sized aggregates. The grading of combined aggregates shall be done in accordance with Table 5 of IS 383 -1970. (Clause 4.44),

2.3.3.6 Admixtures

Admixtures shall not be used in any way in trying to replace any quantity of cement and shall conform to IS: 9103 -1999. Admixtures shall not be used in any concrete without the approval of the Engineer. Admixtures may require tests to be made before they are used. To facilitate approval, the Contractor shall provide the following information:

a) the trade name of the admixture, its source, and the manufacturer's recommended method of use
b) typical dosage rates and possible detrimental effects of under-dosage and over-dosage
c) whether compounds (such as those containing chloride in any form as an active ingredient) likely to cause corrosion of the reinforcing steel or deterioration of the concrete are present, and, if so, the chloride content (expressed as chloride ions or as anhydrous chloride) by mass of admixture
d) The average expected air content of freshly mixed concrete containing an admixture which causes air to be entrained when used at the manufacturer's recommended rate of dosage.

If the use of air-entraining agent is permitted by the Engineer, test measurements shall be carried out on Site by the Contractor, as and when required by the Engineer, to determine

a) the percentage of air entrained in the concrete, and
b) The density of concrete.

The Contractor shall provide equipment to permit measurement of entrained air at such frequencies as are required by the Engineer.

2.3.3.7 Reinforcement

This work shall consist of the supply of all reinforcing bars and fabric of the type, shape, size, and grade required for concrete structures and placing them in accordance with this specification, as shown on the drawings or as directed by the engineer.

The contractor shall supply the reinforcing steel necessary for the completion of the work. The reinforcing steel shall be any of the following if not mentioned on the drawings:

a) Mild steel and medium tensile steel bars conforming to IS: 432 (Part I) -1982 or equivalent of Nepalese Standard.
b) Hot-rolled deformed bars conforming to IS: 1139 -1966 or equivalent of Nepalese Standard.
c) Cold-twisted bars conforming to IS: 1786 - 2008.
d) The modulus of elasticity of steel shall be taken as 200 KN/sq.m.

If the contractor can produce a manufacturer's certificate which can be identified with the reinforcing steel by numbers or identification marks, it shall be accepted as evidence that the steel complies with the relevant specification. If the contractor cannot produce such certificates and if the engineer requires tests to be performed to satisfy himself that the steel complies with this specification, then the contractor shall supply a certificate of compliance with this specification or send for testing one test piece in each size of reinforcing steel with each batch of steel delivered to the site at least three weeks before the steel is due to be incorporated in the works. In case of each test piece that fails, the steel represented by such test pieces shall be rejected.

All hard drawn steel wire fabric shall confirm to IS: 1566-1982 and rolled steel made from structural steel shall confirm to BIS: 226-1975.

Steel reinforcement shall be protected at all times from injury. It shall be stacked in racks above the ground and shall at all times kept clear of mud. Reinforcement steel which is free from dirt, detrimental scale, paint, oil, loose rust or other foreign substance can only be placed in the work.

2.3.3.8 Storage capacity

The storage capacity provided and the amount of material stored (whether cement, aggregates, steel, or water) shall be sufficient to ensure that no interruption to the progress of the work is occasioned by lack of materials.

2.3.3.9 Deteriorated material

Material that has deteriorated, or that has been contaminated or otherwise damaged, shall not be used in the concrete. Such material shall be removed from the Site without delay.

2.3.3.10 Water stops

The Contractor shall supply and fix Water stops in all joints in members which are to be water-retaining and where shown on the Drawings.

Water stops built into joints shall be made of PVC, rubber, GI Sheet or similar approved material. They shall be obtained from manufactures approved by the Engineer and shall be stored, fixed and jointed in accordance with the manufacture's instruction. They shall be fabricated into the longest practicable units complete with angles and junctions at the

Manufacture's works and shall be made continuous throughout the structure below highest water level and where shown on the Drawings. The number of joints in the Water stop made on Site shall be kept to a minimum.

Where water stop joints are vulcanized or welded on site, jointing shall be performed strictly in accordance with the supplier's instructions and recommendations. The tensile strength of the spliced water stop at a factory-made splice shall be at least 90% of the water stop's tensile strength. The tensile strength of a water stops spliced at the site shall be 80% of the original strength of the water stop.

The Contractor shall supply the manufacturer's test certificates for each consignment of Water stops delivered to Site and shall, in addition, supply to the Engineer sufficient of each type and consignment for confirmatory tests to be carried out in accordance with the appropriate standard test procedure, if ordered.

2.3.3.11 Joint filler

Unless otherwise specified in the Contract, the joint filler shall be of expanded polystyrene, resin or bituminous bonded cork, or similar type (e.g. "FL excel"). The filler shall be obtained from a manufacturer approved by the Engineer and shall be stored and fixed in accordance with the manufacturer's instructions. The Contractor shall supply the manufacturer's certificate for each consignment of joint filler delivered to Site and shall, in addition, supply to the Engineer sufficient of each consignment for confirmatory tests to be carried out in accordance with the appropriate standard test procedure, if ordered.

2.3.3.12 Joint sealant

Unless otherwise shown on the drawings or ordered by the Engineer, an elastomeric two-part polysulphide or polyurethane sealer shall be used. Such joint sealers and the requisite priming materials shall be obtained only from manufacturers that have been approved by the Engineer. They shall be stored in accordance with the manufacturer's instructions and recommendations

The Contractor shall supply the manufacturer's test certificate for each consignment of each type of joint sealer delivered to Site and shall, in addition, supply to the Engineer sufficient of each type and consignment for confirmatory tests to be carried out in accordance with the appropriate test procedure, if ordered.

2.3.3.13 Waterproof Membrane

Unless and otherwise mentioned elsewhere, the waterproof membrane shall be combination of heavy polythene film and a thick self-adhesive rubber/bitumen compound of 1.5 mm thickness or alternatively a 1.5 mm butyl rubber membrane. A compatible solar protection material shall be used at the exposed perimeter of the membrane. Such waterproof membranes, solar protection material, and the requisite priming materials shall be obtained only from manufacturers which have been approved by the Engineer. They shall be stored in accordance with the manufacturer's instructions and recommendations.

The Contractor shall supply the manufacturer's test certificate for each consignment of waterproof membrane materials.

2.3.3.14 Concrete Curing Compound

Concrete curing compound for structures shall be a liquid resin or wax resin base membrane curing compound of a proprietary brand and shall contain a fugitive dye.

Test certificates, prepared by an approved testing laboratory, shall be supplied by the Contractor to show that the performance of the curing compound complies with the curing efficiency.

2.3.3.15 Premixed Grout

The grout used to secure holding down bolts or to fill under structural steelwork shall be premixed and with properties applicable to the application. All premixed grout shall be kept in conditions recommended by the manufacturer and shall not be used after the expiry date.

2.3.3.16 Bituminous Paint

Bituminous paint shall comply with BS 3416 or equivalent IS Standard, Type II for materials in contact with raw or treated water and Type I for all other cases as per BS.

2.3.4 Construction Equipment

2.3.4.1 General

All Construction Equipment shall be maintained in good working order at all times during concrete work.

2.3.4.2 Mixing equipment

The type and capacity of mixing machines shall be such that the rate of output of concrete is suitable for the rate of concreting. Each machine shall be capable of producing a uniform distribution of the ingredients throughout the batch and shall comply with the specification to which the manufacturer claims it has been manufactured. Worn or bend blades

And paddles shall be replaced. The inner surfaces of the mixer shall be clean and free from hardened concrete. The mixers used shall be specially suited to the production of low slump concrete.

2.3.4.3 Vibrators

Vibrators shall be capable of fully compacting each layer of concrete. At least one standby vibrator shall be available at all times during concreting for every three vibrators necessary to maintain the rate of placing.

Vibrating equipment used for the production of precast elements, whether in the form of a vibrating table, an external vibrator attached to the mould, or an immersion vibrator, shall have the frequency that is suitable for the compaction of low slump concrete.

The concrete that is to be compacted by vibration should appear anything from earth dry to slightly glistening. The mix should have the appearance of lacking in fines.

Segregation is likely to take place when the concrete is tipped into the formwork and this should be avoided. The concrete mix should not contain surplus water and sand which will develop segregation under influence of vibrator compaction. The distribution of new concrete should be uniform for the whole section and the surface kept horizontal for the whole section all the time thus ensuring the movement of concrete is downward only. Vibrators shall not be used as a spreading or distributing agent.

The vibrators shall be of rotary out of balance immersion type or the electro-magnetic type and operate at a frequency of not less than 4,000 cycles per minute. The vibration shall be of such a power input as to produce an acceleration of 1 to 3 m/sec in the mass of the compacted concrete. The vibrators shall be provided for continuous operation.

Internal vibrators shall be disposed within the mix, when placed, so as to maintain the whole of the concrete under treatment in adequate state of agitation such that de-aeration and effective compaction may be achieved at a rate commensurate with the supply of concrete from the mixers. Insertion of vibrators at about 450 mm center is considered sufficient.

Vibration shall continue during the whole period occupied by placing the concrete, the vibration being adjusted so that the center of vibration approximates to center of the mass being compacted at the time of placing. The concrete should not be over vibrated and the period of insertion of internal vibration should be about 15 seconds at any point.

The concrete shall be considered fully compacted when the mortar fills the spaces between the coarse aggregate so as to form a glistening and even surface except for slight irregularities where the coarse aggregate breaks this smooth surface. When this condition has been attained the vibrators shall be withdrawn slowly.

The vibrator must not be placed against the steel or the formwork. The minimum distance shall be 8 mm. The compactor must be placed in such a position that formwork, reinforcement, and recently laid concrete may be subjected to the minimum amount of vibration.

2.3.4.4 Formwork

Formwork shall be so designed and constructed that the concrete can be properly placed and compacted and that, subject to the tolerances specified, the required shapes, finishes, positions, levels, and dimensions shown on the drawings are maintained. The formwork and joints shall be capable of resisting the dead load, including the pressure exerted by the wet concrete, wind forces, and all other superimposed loads and forces. If not otherwise directed, forms shall be made of timber where practicable.

The types of ties used and their position shall be such that the required finish is achieved and will not be marred by subsequent corrosion of the ties.

Unless otherwise shown or directed, formwork shall be such that exterior corners of finished concrete are provided with 25-mm chamfers and re-entrant corners without fillets.

2.3.4.5 Scaffolding and ladders

The Contractor is responsible for providing, erecting, dismantling, and removing safe and adequate lifting equipment and scaffolding where required at his own cost.

2.3.4.6 Casting beds and moulds

All casting beds for precast concrete shall be properly aligned and levelled. Adequate weather protection shall be provided should this be necessary to achieve the standards specified below.

2.3.4.7 Construction Equipment for handling, lifting, and stacking

The Contractor shall provide adequate equipment for handling, lifting, and stacking precast units that they do not become discolored and are protected from permanent damage due to stresses induced during handling or stacking or due to the use of slings, chains, and hooks.

2.3.5 Construction and Workmanship

2.3.5.1 Reinforcement

Reinforcement Bars shall be straightened to eliminate any bends or kinks developed during delivery to the site. Bars shall be cut into the length and hooked and bent in accordance with the drawings. Bars shall not be straightened or bent in any way that may be injurious to the material.

Unless otherwise stated reinforcement shall be Fe 415 high strength deformed steel bar confirming to IS 1786 or equivalent to NS 191-2046.

Bent bar reinforcement shall be cold bent to the shapes shown on the drawings. Bending of bars shall confirm to IS: 2502-1963.

After cutting and bending, the bars shall be bundled or stocked according to their respective marks as shown in the bending schedule.

All steel reinforcement shall be accurately placed in the positions shown in the drawings and firmly held during placing and setting of the concrete.

Bars shall be held in position be wiring at all intersections with annealed wire not less than 1.25 mm diameter (preferably 16 gauge).

Distances from the forms shall be maintained by precast mortar blocks, plastic tipped metal chairs, metal hangers, plastic chairs, or other approved devices. Metal supports and tie wires which extend to the surface of the concrete shall not be permitted. Stirrups and distribution bars shall pass around the main bars and shall be securely wired thereto.

Layers of bars shall be separated by precast mortar blocks or by other equally suitable devices. The use of pebbles, pieces of broken stones or brick, metal pipe and wooden blocks shall not be permitted.

In case concrete blocks are used, they shall be cured by immersion in water for at least 7 days until 24 hours before the blocks are to be used.

Reinforcement in any member shall be placed and then inspected and approved by the engineer before the placing of the concrete begins. Concrete placed in violation of this provision shall be rejected and removal may be required.

Substitutions of different size bars will not be permitted unless written application, stating special reasons, is made at least 4 weeks before the reinforcing steel is to be placed. Such permission will not be guaranteed and will be subject to the approval of the engineer. Such permission may, however, be granted if the structure is not adversely affected and no additional payment will be made on account of these alterations.

All reinforcement shall be furnished in the full lengths indicated on the drawings and bar bending schedules. Splicing of bars except where shown on the drawing will not be permitted without the written approval of the engineer.

2.3.5.2 Splicing of Reinforcement

Splicing of reinforcing bars shall be either by lapping, or mechanical butt splicing at the option of the Contractor. Bars in excess of 44 mm diameter shall not be spliced by lapping. The location of splices, except where shown on the Drawings, shall be determined by the Contractor based upon using available commercial lengths where practicable. Unless otherwise shown on the Drawings or approved by the Engineer, splices in adjacent reinforcing bars shall be staggered. The minimum distance between staggered splices for reinforcing bars 25 mm diameter or smaller shall be the length required for a lapped splice in the bar. The minimum distance between the staggered butt splices for reinforcing bars 44 mm and larger shall be 1500 mm. Completed welded butt splices and mechanical butt splices shall develop not less than 90 percent of the specified minimum ultimate tensile strength of the un-splice reinforcing bar. Acceptance of welded butt splices and mechanical butt splices of approved design shall be based on qualification tests performed prior to making splices to be used in the work upon job control tests made during the progress of the work. Such tests shall consist of the fabrication and testing by the Contractor of sample splices and shall include testing satisfactory to the Engineer on all or any splices. Acceptable sample splices shall conform to the splicing requirements in this Clause. Splices made by lapping shall consist of placing the reinforcing bars in contact and wiring them together in such a manner as to maintain the alignment of the bars and to provide the minimum specified clearances. The length of lapped splices shall be as shown in Table 2-1 unless otherwise specified in the Drawing or ordered by the Engineer.

Table 2-1: LENGTH OF LAPPED SPLICES FOR REINFORCING BARS

Type of Bar	Diameter of Bar	Length of Lapped Splice in Diameter
Mild Steel Fe-250	Up to 32 mm	50 diameter of smaller bar
Tor Steel Fe-415	25mm or Less	55 diameter of Smaller Bar
Tor Steel Fe-415	More than 25 mm	55 diameter of Smaller bar
Steel >Fe-415	More than 25 mm	60 diameter of Smaller bar

2.3.5.3 Placing of Reinforcement

Reinforcement shall be placed in position as given on the detailed design drawing and shall be secured at that position. In case of delay occurring between fixing of reinforcement shall be checked prior to concreting.

All bars are to be lapped for at least fifty-five (55) diameters except where otherwise shown on the plan or indicated in the reinforcement bar schedule. The least distance between parallel bars is to be 25 mm or one diameter whichever is greater. The positions of the laps are to be staggered throughout unless shown otherwise.

2.3.5.4 Cover of the Reinforcement

Unless otherwise shown on the drawings or directed by the Engineer, reinforcement shall have concrete cover and the thickness of such cover shall be:

a) At each end of the reinforcing bars not less than 25 mm nor less than twice the diameter of such bar;

b) For a longitudinal reinforcing bar in a column not less than 40 mm nor less than the diameter of such bar. In case of columns of minimum dimension of 200 mm or under, whose reinforcing bars do not exceed 12 mm, a cover of 25 mm shall be used;

c) For longitudinal reinforcing bar in a beam not less than 25 mm nor less than the diameter of such bar;

d) For tensile, compressive, shear or other reinforcement in a slab, not less than the diameter of such bar;

e) For any other reinforcement, not less than 15 mm, nor less than the diameter of such bar.

f) For reinforced concrete members immersed in water, concrete cover over reinforcement shall be minimum 50 mm.

g) The maximum cover for reinforcement shall not be more than 75 mm.

Unless otherwise specified by the engineer, tolerances for placing of reinforcement shall be within the following tolerances:

a) For effective depth 200 mm or less + (-) 10 mm

b) For effective depth more than 200 mm + (-) 15 mm

The cover shall in no case be reduced by more than one third of the specified cover or 5 mm whichever is less.

2.3.5.5 Formwork

Formwork will be classified in accordance with the surface conditions required on the finished concrete, as shown on the drawings or as directed. Such finishes will be as follows:

a) Class F1 Rough. No treatment of the surface of the concrete will be required after the striking of the formwork. The finish of the concrete need not be more accurate than Degree of Accuracy U3 as defined in terms of Clause 2.3.6.14.

b) Class F2 Smooth. Imperfections such as small fins, bulges, irregularities, surface honeycombing, and slight surface discolorations shall be made good and repaired by approved methods. The finish of the concrete shall be accurate to Degree of Accuracy U2 as defined in terms of Clause 2.3.6.14

c) Class F3 Special. Special finishes shall be as indicated on the drawings and BOQ.

If no Class of Finishes is specified in the BOQ or Technical Drawing, Class of finishes Class F2 shall apply.

Forms shall be erected with joints tight enough to prevent leakage of cement mortar.

Surfaces of forms (regardless of the material of which they are made) that are to be in contact with fresh (wet) concrete shall be treated with a coat of non-staining mineral oil or other approved material, or, in the case of timber forms, by thorough wetting of the surfaces with water, so as to ensure easy release and prevent adhesion of the formwork during stripping.

Before re-use, all formwork shall be reconditioned, and all form surfaces that are to be in contact with the concrete shall be thoroughly cleaned.

Where necessary for the proper placing of the concrete, temporary openings for cleaning, inspection, or placing and compaction purposes shall be provided and, subsequently, so closed as to provide the finish specified and to conform to the applicable tolerances specified.

Formwork shall not be removed before the concrete has attained sufficient strength to support its own weight and any loads that may be imposed on it. The Engineer's approval shall be obtained before formwork is removed. As a guide, the formwork shall remain in place, after placing of the concrete, as follows:

a) Concrete cast with OPC or SRPC, in hot or normal weather

   (i) Beam sides, walls, and unloaded columns 1 d

   (ii) Slabs with props left underneath 4 d

(iii) Beam soffits with props left under 7 d

(iv) Slab props, including cantilevers 10 d

(v) Beam props, including cantilevers 14 d

b) Concrete cast with OPC or SRPC, in cold weather

(i) Beam sides, walls, and unloaded columns 1.5 d

(ii) Slabs with props left underneath 7 d

(iii) Beam soffits with props left under12 d

(iv) Slab props, including cantilevers 17 d

(v) Beam props, including cantilevers 21 d

In cool weather, stripping times shall be determined by interpolation between the periods specified for normal and cold weather.

If the Contractor can prove to the satisfaction of the Engineer that a period shorter than the appropriate minimum given above is sufficient to enable the concrete to comply with its requirements, the formwork may be removed after such shorter period.

Formwork shall be removed carefully so that shock and damage to the concrete are avoided.

Notwithstanding the provisions above, the Contractor shall be responsible for making good any damage to the concrete arising from the removal of formwork and its supports.

2.3.5.6 Holes, chases, and fixing blocks

No holes or chases, other than those shown on the drawings or approved by the Engineer, shall be cut or otherwise formed in the concrete. The manner of attaching fixtures to be embedded in the concrete shall be subject to approval by the Engineer.

Boxes for forming holes shall be constructed so as to be easily removable without damaging the concrete during removal. They shall be properly vented to permit the escape of entrapped air and shall be capable of being sealed, subsequently, to prevent the loss of grout.

2.3.5.7 Pipes and conduits

No pipes or conduits, other than those shown on the drawings or approved by the Engineer, shall be permanently embedded in the concrete.

2.3.6 Concrete

2.3.6.1 Quality

Concrete shall comply with the requirements for a designed mix to in Accordance to Clauses 5.1, 5.2.1, 8.2.1, 14.1.1, 35.1 of IS:456 -2000 or relevant BS Standard (BS 8110 and BS 8007).

The Contractor shall determine to the approval of the Engineer the actual proportions of ingredients for each class of concrete to be used in the Permanent Works.

The concrete shall meet the requirements given in the Table 2-2 the designation of the concrete mix, letter M refers to the mix and the number to the specified characteri4stic compressive strength of 15 cm cube at 28 days and is expressed in N/sq. m.

Table 2-2: GRADES OF CONCRETE

(In Accordance to Clauses 5.1, 5.2.1, 8.2.1, 14.1.1, 35.1 of IS: 456-2000)

Grade Designation	**Specified Characteristic Compressive Strength at 28 days (N/sq. mm.)**
M10	10
M15	15
M20	20
M25	25
M30	30

2.3.6.2 Grades of Concrete

Grades of concrete to be used shall be as specified in the drawings or as directed by the engineer. In any case Grade of Concrete is not mentioned in drawing, grades of concrete lower than M15 shall not be used in reinforced concrete.

2.3.6.3 Mix Proportion

The mix proportions shall be selected to ensure that the workability of the fresh concrete is suitable for the conditions of handling and placing, so that after compaction it surrounds all reinforcements and completely fills the formwork. When concrete is hardened, it shall have the required strength, durability, and surface finish.

The determination of the proportions of cement, aggregates, and water to attain the required strengths shall be made as follows:

a) by designing the concrete mix,
b) By adopting nominal concrete mix.

Design mix concrete shall be preferred to the nominal concrete mix. If design mix concrete cannot be used for any reason on the work for grades of M20 or lower, nominal mixes may be used with the permission of the engineer.

2.3.6.4 Design Mix Concrete

The mix shall be designed to produce the grade of concrete having the required workability and a characteristic strength not less than the appropriate values given in Table 2-2.

When the results of sufficient number of tests (at least 30) are not available, then depending upon the degree of quality control expected to be exercised at the site, the value of standard deviation of the compressive strength of concrete given in Table 2-3 can be adopted for guidance but only if approved by the engineer.

Table 2-3: SUGGESTED VALUES OF STANDARD DEVIATION

Grade of Concrete	**Standard Deviation for Different Degree of Control in N/sq. mm.**		
	Very Good	**Good**	**Fair**
M10	2.0	2.3	5.3
M15	2.5	3.5	4.5
M20	3.6	4.6	5.6
M25	4.3	5.3	6.3
M30	5.0	6.0	7.0

The target strength for mix design and the selection of the water cement ratio shall be done according to IS: 10262-2009.

2.3.6.5 Selection of Water Content and Fine Aggregates Ratio

For the desired workability, the quantity of mixing water per unit volume of concrete and the ratio of fine aggregate to the total aggregate by absolute volume shall be estimated according to Table 2-4 depending upon the nominal maximum size and type of aggregates. The water content corresponds to the saturated surface dry aggregate.

Table 2-4: SAND AND WATER CONTENTS PER CUBIC METER FOR GRADES UPTO M35

Nominal Maximum Size of Aggregate per cubic meter (mm)	**Water Content of Total of Concrete (kg)**	**Sand as Percent Aggregate**
10	208	40
20	186	35
40	165	30

The water content corresponds to the saturated surface dry aggregate.

2.3.6.6 Nominal Mix Concrete

Nominal mix concrete may be used for concrete of grades M10, M15, and M20. The proportions of materials for nominal mix concrete shall be in accordance with Table 2-5.

Table 2-5 PROPORTIONS FOR NOMINAL MIX CONCRETE

Grades of Concrete	**Total Quantity of Dry Aggregate by mass per 50 kg of Cement (kgs)**	**Proportion of fine Aggregate to Coarse Aggregate by mass**	**Maximum Quantity of Water per 50 kg of Cement**
M10	480	Generally 1:2 but subject to an upper limit of 1:1.5 and a lower limit of 1:2.5	34
M15	350		32
M20	250		30

The proportions of fine to coarse aggregates should be adjusted from upper limit to lower limit progressively as the grading of fine aggregates becomes finer and the maximum size of coarse aggregates becomes larger.

The cement content of the mix specified in Table 2-5 for any nominal mix shall be proportionately increased if the quantity of water in a mix has to be increased to overcome the difficulties of placement and compaction, so that the water cement ratio as specified is not exceeded.

2.3.6.7 Mixing of Concrete

a) Unless otherwise agreed by the Engineer concrete shall be mixed in a batch type mixer which shall comply with IS: 1791 -1985 or such other type as the Engineer may approve. When swing-type weight batchers are used they shall comply with IS: 2722-1964. Batch mixers will be tested and perform in accordance with IS: 4634-1968 or such other tests as the Engineer may require. Mixers which have been out of use for is mixed. Concrete shall not be mixed when the air temperature in the shade is Below $3^{o}C$ ($38^{o}F$) unless special precautions are taken which have been approved by the Engineer. During hot weather the Contractor shall ensure that the constituent materials are sufficiently cool to prevent the concrete from stiffening in the interval between its discharge from the mixer and its final position. Concrete shall be mixed for not less than 90 seconds nor more than 5 minutes from the time all constituents have been introduced into the mixer.

b) Hand mixed concrete shall only be used when specified or authorized in writing by the Engineer. It shall be made in batches of not more than 0.25 cubic meters and shall be mixed on a water tight level platform. The proper amount of coarse aggregate shall be measured in measuring boxes and spread on the platform and the fine aggregate spread over this layer, the two layers being not more than 300 mm in total depth. On this mixture will be spread the dry cement and the whole mass turned not less than 2 times dry; then sufficient clean water shall be added, evenly distributed and the whole mass again turned not less than 3 times, not including placing in the carriers or forms.

c) Ready mixed concrete batched off the site may be used only with the approval of the Engineer and shall comply with the requirements of IS: 4926 - 2003.

2.3.6.8 Control Over Production of Concrete

The Engineer shall be afforded all opportunity and facility to inspect the materials and manufacture of concrete and to take any samples or to make any tests. All such inspection, sampling and testing shall be carried out with the minimum of interference with the process of manufacture and delivery.

2.3.6.9 Batching of Concrete

a) Weight Batching: In normal circumstances weight batching shall be used. The mass of cement supplied in a standard sack shall not be less than 50 kg. All cement taken from bulk storage containers and from partly used sacks shall be batched by mass with additional 2 % of mass required.

   Mixing water for each batch shall be measured. The amount of water measured shall be adjusted to allow for the moisture content of the aggregates.

   The mass of the aggregate of each size shall be determined and a correction made for the moisture content of the aggregates.

b) Volume Batching: In special circumstances, and at the sole discretion of the Engineer, proportioning of materials by volume may be approved. If batching is by volume, the fine and the coarse aggregates shall be measured separately in suitable measuring boxes of known volume and of such capacity that the quantities of aggregates for each batch are suitable for direct transfer into the mixer. Bulking tests on the fine aggregate shall be conducted regularly and the results used for adjustment of the batch volume of the fine aggregate to give the true volume required.

2.3.6.10 Transportation and Placing of Concrete

No concrete shall be placed at any time without at least one day's notice being given to the engineer, and concrete shall be placed only in the presence of the engineer.

Before any concrete is placed, forms must be inspected to see if thoroughly clean, and all sawdust, shavings, nails, dirt and rubbish of any description must be removed from within the forms. Temporary openings shall be provided where necessary to facilitate cleaning and inspection immediately before depositing concrete.

Where concrete is to be placed on a rock foundation the surface shall be washed down with streams of water under sufficient pressure, and scarified with wire brush of by other effective means, to thoroughly cleanse the rock surface and to remove all dirt, gravel, scale, debris, rock fragments or other loose material. Where concrete is to be placed on other concrete including inclined and vertical surfaces, which has taken its final set, the forms shall be retightened and the concrete shall satisfactorily roughened with pick or other means if required, and shall be cleansed in a similar manner. All objectionable substance shall be removed from the surface of concrete at such times depending on weather conditions and rate of hardening, as the engineer may direct. When such area is cleansed and wetted, but free from surplus water, a wash of neat cement grout shall be scrubbed into the contact surface of the old concrete or rock with brooms and shall

Be thoroughly worked into all crevices and depressions. When required by the engineer, a coat of mortar shall be spread over the contact surfaces thus prepared, after which the concrete may be put in position and well rammed, and worked so as to make a thoroughly bonded and water-tight joint.

No concrete shall be placed in position until the reinforcement, forms and supports or the foundation, as the case may be, have been inspected and passed by the engineer.

Concrete shall be placed only in the presence of the engineer.

Concrete shall be handled from the mixer to the place of final deposit as rapidly as practicable by methods which prevent the separation or loss of ingredients. Mixing and transporting equipment shall be free from hardened concrete and foreign materials on the inner surface. The concrete shall be deposited in the forms are near as practicable in its final position to avoid re-handling. It shall be so deposited as to maintain until the completion of the unit, a plastic surface approximately horizontal. Forms for walls or other thin sections of a considerable height shall be provided with openings, or other thin sections of a considerable height shall be provided with openings, or other devices, that will permit the concrete to be placed in a manner that will avoid accumulation of hardened concrete on the forms or metal reinforcement. Under no circumstances shall concrete which has partly hardened be deposited in the work.

When concrete is conveyed by chutes, the plant shall be of such size and design as to ensure a practically continuous flow in the chute. The angle of the chute shall be such as to allow the concrete to flow without separation of the ingredients. The delivery end of the chute shall be as close as possible to the point of deposit. When the operation is intermittent, the spout shall discharge into the hopper. The chute shall be thoroughly flushed with water before and after each run; the water used for this purpose shall be discharged outside the forms.

Concrete shall be deposited continuously and as rapidly as practicable unit the unit of operation approved by the engineer is completed. Any concrete which has taken its initial set will be rejected and under no circumstances shall concrete remain longer than twenty (20) minutes after mixing before being used, or such other time as may be determined by the engineer, to suit the setting properties of the cement, the position in the work and the weather conditions at the time of placing.

Cement shall not be placed in running water. No concrete shall be placed in water without the permission of the engineer, and the method of depositing shall be such as to minimize loss of cement, and subject to his approval. Care shall be taken that no water interferes in any way with the proper placing of concrete, and the Contractor shall not allow water to rise in any concrete until in the opinion of the engineer it has set sufficiently. Water shall be removed from excavation before concrete is deposited unless otherwise directed by the engineer. Any flow of water into the excavation shall be diverted through proper side drains to a sump, or be removed by other approved methods which will avoid washing the freshly deposited concrete. Water vent pipes and drains used for constructional purposes shall be filled by grouting or otherwise after the concrete has thoroughly hardened. Springs encountered in the foundation shall be plugged, piped or otherwise satisfactorily disposed off.

Concrete shall be gently placed into position and is not to be poured from a greater height than 1200 mm into the forms unless suitable chutes are specially provided for. It is to be placed and punned in layers not thicker than 150 mm and the section of the works undertaken shall be such that the next layer of concrete 150 mm thick will be placed on top of the first within twenty (20) minutes of placing the first layer, or such time as to preclude any danger of disturbing the first layer once it has taken its initial set. It is to be well worked and consolidated around the reinforcement and embedded fixtures and into corners of forms by means of suitable tools in such a manner as to prevent the formation of any void spaces and to ensure the most thorough compacting to obtain density and water tightness. At the same time by spading just inside the face of the forms, a good smooth and regular face is to be ensured when the forms are stripped. Concrete is also to be assisted into place by tapping the outside of the forms opposite the newly-placed concrete.

All concrete shall be done in as large sections as possible without a break, to ensure a minimum number of joints. In mass work, the masses of concrete laid at different times shall break joints both horizontally and vertically. Whenever required, the work shall be so prosecuted that construction joints will occur only at designated places and when so directed, the Contractor shall complete by continuous depositing of concrete, sections of the work bounded by such joints. Joints not indicated on the plans shall be so designed and located to the approval of the engineer.

When placing of concrete is to be interrupted long enough for the concrete to take its final set, provision for bonding will be made by leaving the surface rough by the use of forms of such styles and dimensions as to properly form the concrete joints into steps, dovetails, grooves or other ordered shapes. In the case of walls, the bond is to be helped by the formation of a continuous tapered tongue or key whose base width shall be approximately one-third of the thickness of the wall, and whose height shall be 75 mm. No concrete shall be placed on old work, which has taken its initial set, unless work is at least three (3) days old.

In the case of floor slabs, construction joints transversely to the span shall be made at the center of the span unless directed otherwise by the engineer. Longitudinal construction joints shall be made where shown on the plan or as directed by the Engineer.

Columns are to be placed in accordance with the instructions above, but in certain cases for long columns the engineer may allow the use of a "Tremie" pipe. Columns shall be poured up to the underside of the haunches of beams. The haunches are to be formed and poured with the beam.

Beams and slabs shall be poured together so that there is no break between the two, unless the Drawings expressly show such a break.

At the discretion of the engineer, concreting operations may be suspended during excessively hot weather.

The Contractor shall not permit walking over or upon finished surfaces of concrete until sufficiently hardened or until at least three (3) days after placing. While setting, the concrete must not be disturbed or subjected to vibration or interference of any kind.

Should concreting be stopped for any reason, the work is to be left protected, and is to be cleaned down before operations are resumed.

At all times, great care shall be exercised to prevent injury to concrete surfaces and the Contractor may be required to clean same before the completion of the contract.

The Contractor is to note particularly that adequate numbers and the very best class of workmanship will be insisted on. This will necessitate especially the conformation with this specification with regard to the amount of water used in mixing, the thorough tamping while placing, and the through cleansing of all surfaces from laitance or other matter on which concrete is to be placed.

2.3.6.11 Compaction of Concrete

The Contractor shall regard the compaction of the concrete as work of fundamental importance and shall produce a watertight concrete of maximum density compatible with the approved mix. Unless otherwise specified by the engineer, concrete shall be compacted with the use of mechanical vibrators of the type complying IS: 2505 - 1992, IS: 2506-1985 and IS: 2514-1963.

Compaction shall be assisted by the use of mechanical vibrators of the immersion type, but shall not involve the vibration of reinforcement or shutters except that vibration of shutters may be allowed, with the approval of the Engineer. Vibrators shall be inserted at least to the full depth of the newly deposited concrete and then slowly withdrawn to prevent the formation of voids. The procedure shall be continuous with points of insertion 150 to 225 mm apart. The number and type of vibrators available for use during each period of concreting shall be to the approval of the Engineer, which will not be given if sufficient stand-by vibrators in good working order are not readily available. If concreting is in the dark, ample lighting shall be provided at the mixing stations and at every place where concrete is being deposited.

Compaction shall be carried out by mechanical vibration or (if approved) by spading, rodding, or forking.

Over-vibration resulting in segregation, surface laitance, or leakage, or any combination of these, shall not be permitted. The rate of concrete placing shall be commensurate with the available compaction equipment and only skilled operators shall be permitted to undertake compaction by vibration.

Concrete for precast elements shall be so placed in moulds and vibrated that concrete surfaces are smooth and even and all arrises are true and clean.

Where precast units having architectural finishes are required, the Contractor shall ensure that duplicate samples are submitted to and approved by the Engineer with regard to both colour and quality before full scale production is commenced. One sample will be retained by the Engineer and the other shall be retained by the Contractor at the place of manufacture. The Contractor shall not commence manufacture until acceptable samples have been lodged.

Vibration shall not be applied by way of reinforcement. Therefore contact with the reinforcements and all inserts shall be avoided as far as possible.

2.3.6.12 Construction Joints in Concrete

Concreting shall be carried out continuously up to the locations where joints are shown on the Contractor's working drawings or up to approved or directed locations. The method adopted for forming such joints and unforeseen joints shall be one of the following:

General Preparation: Joints when concrete is less than 24 h old. The surface of the concrete shall be water jetted to expose the aggregate.

Joints when concrete are more than 24 h but not more than 3 d old. The surface of the concrete shall be sandblasted or chipped with a light hammer to expose the aggregate.

Joints when concrete are more than 3 d old. The procedure specified in (b) below shall be followed.

Preparation before placing concrete:

a) Joints when concrete are less than 24 h old. The surface of the concrete shall be swept clean and immediately before placing the concrete wetted but without pools of water.

b) Joints when concrete are more than 24 h but not more than 3 d old. The surface of the concrete shall be swept clean, and thoroughly wetted but without pools of water.

c) Joints when concrete are more than 3 d old. The procedure specified in (b) above shall be followed, except that the old surface shall be kept continuously wet for at least 24 h before the new concrete is placed.

2.3.6.13 Curing and Protection of Concrete

The Contractor shall, until it has thoroughly hardened and for not less than 7 days, protect the concrete from the harmful effects of frosts, wind, sun, high or low temperature, variation or reversal of temperature gradient, premature loading, deflection or impact, and aggressive groundwater. The protruding steel shall be kept cool.

Unless otherwise approved by the Engineer, exposed concrete surfaces shall be kept continuously moist for not less than 7 days after casting in the case of Portland and sulphate resisting cement concretes. Immediately upon exposure, surfaces shall be covered with a thick layer of hessian or sand or other material as may be approved by the Engineer, which shall be in continuous contact with the concrete and kept wet to the satisfaction of the Engineer; the Contractor shall make special provision to the satisfaction of the Engineer for the supervision of wetting concrete which incorporates other authorised types of cement.

If curing membranes are proposed by the Contractor and approved by the Engineer, they shall be applied in conformity with the manufacturer's instructions. They shall be applied to unshuttered surfaces within one hour of concrete deposition and shall incorporate aluminum or other approved reflecting agent. Surfaces with applied curing membrane shall be shaded from the sun, unless otherwise approved.

Curing membranes shall not be applied to construction joints.

Concrete curing compound for structures shall be a liquid resin or wax resin base membrane curing compound of a proprietary brand and shall contain a fugitive dye.

Test certificates, prepared by an approved testing laboratory, shall be supplied by the Contractor to show that the compound complies with the curing efficiency.

2.3.6.14 Concrete surfaces

Surfaces of concrete not finished against forms or ground surfaces shall be finished to the following classes.

Type Ul - This finish is for surfaces where a superior finish is not required. It is also the first stage for finishes U2 and U3. The finishing operations shall consist of grading, tamping, and screening the concrete to produce a uniform, plain, or ridged surface.

Type U2 - This is a smooth matt finish such as may be achieved by a wood trowel, as required, inter alia, to receive mastic paving, block or tile paving bedded in mastic or screeds. Smoothing shall be done only after the concrete has hardened sufficiently, and may be by hand or machine. Care shall be taken that the concrete is worked no more than is necessary to produce a uniform surface free from marks.

Type U3 - This is a smooth steel-trowelled finish for surfaces of concrete pavings, tops of walls, copings and other members exposed to weathering or water, surfaces to receive thin flexible sheet, tile paving bedded in adhesive, and seatings for bearing plates and the like where the metal is in direct contact with the concrete. Trowelling shall not commence until the moisture film has disappeared and the concrete hardened sufficiently to prevent excess laitance from being worked to the surface. The surfaces shall be trowelled by hand or machine under firm pressure and left free from trowel marks.

If no Class of Finishes has been specified in the BOQ or Technical Drawing, Class of finishes U2 shall apply.

2.3.6.15 Watertight concrete

Each section of the Works that is required, to hold or exclude water shall be watertight, and special care, particularly at construction joints, shall be taken by the Contractor to ensure water tightness. Should any such section of the Works fail to pass the tests for water tightness as required as per the Technical Specification or as ordered, or show any sign of water leakage or penetration after being taken into use shall be repaired as per the instruction of the Engineer at the cost of the Contractor. If the problem persists, the structure shall be deemed defective and demolished and replaced with proper one.

2.3.6.16 Concrete in wet ground

The Contractor is to provide a dewatering system on own cost, which ensures when concrete is placed there is not surface water and the ground provides suitable working condition.

2.3.6.17 Grouting

Where it is required to grout holding-down bolts, or to place grout under column bases or bedplates for equipment, the Contractor shall first prepare the relevant concrete surfaces by scrabbling and cleaning them. The grout shall consist of an approved premixed grout mixture of cement, sand, water, and admixture, and shall be so rammed into each HD-bolt pocket or under each base or bedplate (as applicable) that all voids and pockets are completely filled around the bolt or between the top of the concrete and the underside of the metalwork, and, in the case of a base or a bedplate, that the grout projects beyond the base or bedplate. After the void has been completely filled, the edges of the mortar grout shall Be trimmed at an angle of 45^0 outward from the bottom edges of each base or bedplate and the trimmed edge wood-floated to a neat finish.

2.3.6.18 Concrete pumping

Where approved by the Engineer, the Contractor may use a suitable concrete pump for transporting the concrete from the batching equipment or transport vehicle to the point where it is to be deposited, in which case the specified mix proportions shall be adjusted and agreed with the Engineer at the time of submission of the relevant method statement. The concrete shall be fed directly from the batching equipment or transport vehicle into the hopper of the pump. Once concreting has commenced the rate of the flow and mixing must be such as to ensure continuous movement of the concrete in the pipe work, which shall have as few bends as possible. Frequent slump tests (e.g. in accordance with BS 1881) shall be carried out at the delivery end to ensure the consistency and workability at the point of placing. All equipment must be thoroughly cleaned at the end of each operation.

2.3.6.19 Defects

The concrete shall be homogeneous and free from honeycombing, interstices, and planes of weakness. If, after removal of the forms, the concrete shows any defect, the Contractor shall immediately report such defect to the Engineer, and he shall not carry out any patching or remedial work until authorized to do so by the Engineer.

After thorough inspection and investigation of the quality and strength of the defective work and after due consideration of the possible consequences of such defect, the Engineer will either specify the extent and method of repair or order the demolition and reconstruction of the whole of the defective work to the extent that he considers necessary.

The cost of all such investigation, repair, and remedial work and of any demolition and reconstruction of defective work shall be borne by the Contractor and all repair, remedial, and reconstruction work shall be executed to the satisfaction of the Engineer.

Finished concrete shall have a neat, smooth, even, and uniform finish free from any honeycombing. If the finish of any formed or floated concrete surface is, to the opinion of the Engineer, unsatisfactory and does not conform to that specified, the Contractor will be required, at his own expense, to rub down such surface while it is still green, or, alternatively, to grind it down with Carborundum or other suitable material when it has hardened or to take other approved measures to give the specified finish.

For precast elements, moulds shall be removed without any shock or vibration that might damage the concrete or have any other detrimental effect on the units and on their surfaces.

2.3.6.20 Handling and erection of precast units

The Contractor shall ensure that lugs, slots, holes, etc., provided for handling units and moving them from the point of manufacture to the place where they are erected, are adequate, and are so arranged that excessive stresses do not occur in any unit during handling, movement, or erection. Without the Contractor's responsibility being limited in any respect, the position of lifting and supporting points, the method of lifting, and the type of equipment and transport used shall be subject to approval by the Engineer.

The Contractor shall place indelible identity, location, and orientation marks on each unit, as and where necessary.

Packing pieces shall be such that they do not discolour or otherwise permanently damage the units.

Precast units shall be so stacked that the accumulation of trapped water and dirt is prevented, that, in the case of small units, deformation is minimized during the curing process, and that large units have complete freedom of movement during the curing process.

The method of assembly and erection agreed to with the Engineer shall be adhered to on the Site. Immediately after the unit is in position and before the lifting equipment is removed temporary supports or temporary connections between units shall be provided as necessary. The final structural connections shall be completed as soon as is practicable.

2.3.6.21 Joint Sealers

The Contractor shall construct recesses at all joints and on both faces of the concrete work except on the underside of ground slabs. The recesses shall be accurately formed to the lines and dimensions shown on the Drawings or as agreed with the Engineer.

The Contractor shall prepare the surfaces of the recess, prime if necessary and shall apply a joint sealer and fill or caulk the recess completely with it.

Joint sealing shall not be commenced without the approval of the Engineer. In reservoir joints the sealer shall be applied after the construction of the reservoir roof.

Sealants shall be installed in strict accordance with the manufacturer's instructions. De-bonding strip shall be used in conjunction with the sealers as indicated on the Drawings. The de-bonding strip shall be compatible with the joint sealer and shall be resistant to attack from the primer used to bond the sealer to the concrete.

Polysulphide and polyurethane sealers shall not abut bituminous sealers. Surfaces to receive polysulphide and polyurethane sealers shall be kept free from bituminous paints.

All sealers shall be appropriate for the prevailing climatic conditions.

2.3.6.22 Concrete for benching

Concrete for benching in manholes and similar structures shall consist of Grade M15 concrete unless otherwise specified. It shall be placed with low workability to the approximate shape required, and, while still green, shall be finished with not less than an average of 20 mm of cement screed to a steel trowelled finish and to the contours indicated on the drawings.

2.3.6.23 Records

The Contractor shall maintain written records that provide the following information:

a) the date on which each section was concreted
b) the position of the section within the Works
c) the time taken to place the concrete
d) the daily weather conditions
e) the nature of samples taken and the dates they were taken
f) the curing history
g) the date of removal of formwork
h) the grade of concrete

A written record of the concrete works shall be made each day by the Contractor and kept available for inspection by the Engineer. The diary shall contain notes and records of:

(a) The names of the Contractor's engineers who are responsible for the different phases of the concrete work, and also the names of their assistants.
(b) The temperatures of air, water, cement, aggregates and concrete, together with the air humidity and type of weather.
(c) Deliveries to the Site of concrete materials (quantity, brand of cement, etc.).
(d) Inspections carried out, tests performed, etc. and their results.
(e) Times of commencement and completion of different parts of the concrete works, and times of erection and striking of forms.
(f) Quantity of cement, fine and coarse aggregate and admixture used for each section of work, and the number and kind of test samples taken on these ingredients and water.

2.3.7 Tolerances

2.3.7.1 General

Permissible deviations (PD) appropriate to the degree of accuracy will be applied to linear dimensions, position, plumb (verticality), level, squareness, and bow.

Where precast units are to fit on between cast-in-situ concrete units, the tolerances applicable to the cast-in-situ concrete shall be compatible with the tolerances applicable to the precast units.

The Degree of Accuracy may be one of the following:

a) Degree of Accuracy III for use where a high degree of accuracy is unnecessary, e.g. mass foundations, Finish classes F1 and U1.

b) Degree of Accuracy II for what is normally considered "good work" Finishes F2 and U2.

c) Degree of Accuracy I where the use of special, as opposed to normal, methods or materials (or both) is warranted, e.g. prefabricated units or where such are to fit in. Finishes class F3 and U3.

Deviations will be measured as set out below:

a) Any deviation from flatness of a plane surface will be measured as the maximum deviation of the surface from any straight line of length 3 m joining two points on the surface, determined by means of a straight-edge the ends of which are supported on identical blocks of suitable thickness placed over each of the points.

b) Any abrupt change in a continuous surface, including a local depression or peak in a floor or wall and any abrupt change caused by a joint in formwork will be measured as specified in (a) above.

c) Out-of-squareness of a corner or an opening or an element such as a column will be measured by taking the longer of two adjacent sides as the base line, and determining any departure from the perpendicular of the side at either end of the base line.

2.3.7.2 Permissible Deviations

If no Degree of Accuracy is specified in the BOQ or Technical Drawing or Technical Specification, Degree of Accuracy II shall apply.

The Permissible Deviations are:

a) for the Degree of Accuracy III:

(i) reinforcement

Spacing between two adjacent bars ± 25 mm
location of ends of bars± 40 mm
Cover to reinforcement- 0, + 20 mm

(ii) foundations

position in plan from grid or center line± 50 mm
linear dimension in plan cast against excav.± 60 mm
linear dimension in plan cast against formw.± 30 mm
level of underside of concrete - 40,+ 20 mm
surface level- 30, +15 mm

(iii) elements above foundation

Position in plan from grid or centre line± 25 mm
linear dimensions± 30 mm
Cross-section dimension- 10, + 20 mm
Level of any element or component- 20, + 10 mm
plumb, per meter of height5 mm
plumb, maximum of any point, at any height70 mm
out-of-squareness, for short sides <0.5 m ± 10 mm
out-of-squareness, for short sides < 2.0 m± 20 mm
out-of-squareness, for short sides < 4.0 m± 25 mm
flatness of or abrupt changes in exp. surface 10 mm
flatness of surface to be plastered15 mm
abrupt changes in surfaces to be plastered 10 mm
cover to reinforcement0 mm
location in plan or elev. of HD-bolts± 5 mm
constituents in the concrete mix± 5 %

b) for the Degree of Accuracy II:

(i) reinforcement

spacing between two adjacent bars± 20 mm
location of ends of bars± 30 mm
cover to reinforcement- 0,+ 15 mm

(ii) foundations

position in plan from grid or centre line± 35 mm
linear dimension in plan cast against excav.± 40 mm

linear dimension in plan cast against formw.± 20 mm
level of underside of concrete- 30,+ 15 mm
surface level- 20,+ 10 mm

(iii) elements above foundation

position in plan from grid or centre line± 15 mm
linear dimensions± 20 mm
cross-section dimension- 5, + 10 mm
level of any element or component- 15, + 5 mm
plumb, per metre of height4 mm
plumb, maximum of any point, at any height50 mm
out-of-squareness, for short sides <0.5 m± 5 mm
out-of-squareness, for short sides <2.0 m± 15 mm
out-of-squareness, for short sides <4.0 m± 20 mm
flatness of or abrupt changes in exp. surface 5 mm
flatness of surface to be plastered10 mm
abrupt changes in surfaces to be plastered 5 mm
cover to reinforcement0 mm
location in plan or elev. of HD-bolts± 3 mm
constituents in the concrete mix± 5 %

c) for the Degree of Accuracy I:

(i) reinforcement

spacing between two adjacent bars± 15 mm
location of ends of bars± 20 mm
cover to reinforcement- 0,+ 10 mm

(ii) foundations

position in plan from grid or centre line± 20 mm
linear dimension in plan cast against excav.± 20 mm
linear dimension in plan cast against formw.± 10 mm
level of underside of concrete- 20,+ 10 mm
surface level- 10, + 5 mm

(iii) elements above foundation

position in plan from grid or centre line± 5 mm
linear dimensions± 10 mm
cross-section dimension± 5 mm
level of any element or component- 10,+ 0 mm
plumb, per metre of height2 mm
plumb, maximum of any point, at any height30 mm
out-of-squareness, for short sides <0.5 m ± 3 mm
out-of- squareness, for short sides <2.0 m± 10 mm
out-of-squareness, for short sides <4.0 m± 15 mm
flatness of or abrupt changes in exp. surface 30 mm
flatness of surface to be plastered5 mm
abrupt changes in surfaces to be plastered3 mm
cover to reinforcement0 mm
location in plan or elev. of HD-bolts± 1.5 mm
constituents in the concrete mix± 5 %

d) for precast beams the deviation from the intended line measured on a part of or on the overall length of the beam shall not exceed 3 mm for the length of up to 3 m, and for each additional meter in length a deviation of 1 mm will be allowed up to a maximum of 10 mm. In addition, the rate of deviation from the intended line shall not exceed 1:300.

2.3.8 Tests and Acceptance

2.3.8.1 Facilities and frequencies of sampling

For the purposes of taking samples and carrying out tests, the Engineer shall have free access to the Works and the Contractor shall provide all equipment required for the sampling (e.g. cones, moulds) as specified and render any assistance necessary. If so required, the Contractor shall provide storage and protection for such samples on the Site.

While concrete of a particular grade is being placed under the same conditions, sets of samples (each sample being sufficient for 3 cubes) shall be taken.

The sets of samples shall be taken as close as is practicable to the start of placing and at appropriate intervals thereafter, or from one particular batch and then from subsequent batches chosen at appropriate intervals.

At least one set of samples shall be taken from each day's casting and from at least every 90 m3 of concrete of each grade placed.

Only one sample shall be drawn from any one batch of concrete, and, except where otherwise ordered, no sample shall be taken of any grade until at least 3 batches of such grade have been mixed and discharged.

2.3.8.2 Testing

All testing shall be carried out in accordance with the relevant applicable standards or as directed by the Engineer.

The Contractor shall ensure that Site testing is carried out by a competent technician or by a person deemed by the Engineer to be sufficiently experienced.

The Contractor shall ensure that laboratory testing is carried out by a recognized testing institution or an approved laboratory or a firm approved by the Engineer.

Where early-strength testing is desired by the Contractor (e.g. for determination of the seven day strength), plans for such testing and interpretation of results shall be as agreed between the Contractor and the Engineer. As a general guide the seven day strength may be considered to be the 28 day strength divided by 1.4.

2.3.8.3 Acceptance criteria for designed mix concrete

Of the three cubes made from each sample of fresh concrete in accordance to IS: 516 -1959 or BS 1881, one will be crushed at 7 days and the other two at 28 days. The average of the two 28-day strengths will be taken as the test result. Compliance with the specified strength requirements shall always be judged on the 28-days' test results.

Concrete shall be considered to have failed to comply with the Specification:

(a) if a test result is less than the minimum specified in to IS: 516 -1959 or BS 5328 for that class of concrete, in which case the concrete which it represents shall be broken out and disposed of away from the Site by the Contractor unless at his sole discretion the Engineer approves otherwise .

(b) if the average of four consecutive test results for that class of concrete shall have failed to exceed the minimum mean of 4 as specified in to IS: 516-1959 or BS 5328 in which case no further concrete of that class shall be placed in the Permanent Works until the Contractor shall have discovered the cause of such failure and rectified it to the satisfaction of the Engineer.

If a mix fails to achieve the requirements for fresh concrete the batch shall be rejected and no further concrete of that class shall be placed in the Permanent Works until the cause of failure has been rectified.

If test results for strength of concrete of any class are consistently and significantly in excess of the target mean strength the Engineer may on the application of the Contractor agree to a reduction in the cement content in the mix for that class, provided the cement content is not lowered below the minimum specified for that class, nor the maximum water/cement ratio exceeded.

If, after evaluation of the test results an examination of the concrete in the structure is indicated, one or more of the procedures in the sequence given below may be adopted at the discretion of the Engineer to determine the acceptability or otherwise of concrete in particular sections of the structure:

a) An assessment of the stress level in the structure concerned in relation to the test result obtained

b) non-destructive testing, subject to similar concrete of proved acceptable quality being available in comparable members in the same construction as a reference (impact hammers and ultrasonic testing are two examples of such test techniques that may be used, provided the apparatus has been previously calibrated)

c) the testing of drilled cores in accordance with relevant applicable standards under terms and conditions agreed upon between the Engineer and the Contractor.

Where load tests are, in the opinion of the Engineer, unsuitable or impractical, and if an examination described above does not show the concrete strength to be acceptable, or if a portion of the structure fails to pass the test, the Contractor

shall, on the instructions and directions of the Engineer, either replace or strengthen by approved means: each section of the structure that failed or contains concrete that failed, as relevant; and any section, irrespective of strength, the functional purpose of which is affected by the a failed section or failed concrete.

The Contractor shall bear the cost of any replacement or strengthening referred to above as well as any other remedial measures that may be ordered to restore the durability of the concrete to that achievable by concrete of the strength required in terms of the specification.

2.3.8.4 Individual Load Tests on Precast Units

If so directed by the Engineer, the unit to be tested shall be supported at its designed points of support and loaded for 5 min with a load equal to the sum of the characteristic dead load plus 1.25 times the characteristic imposed load, and the deflection shall then be recorded. The maximum deflection measured after application of the load shall be checked for compliance with the applicable requirements of the relevant applicable standards.

The recovery shall be measured 5 min after the removal of the applied load and the load shall then be re-imposed. The percentage recovery after the second loading shall be at least equal to that determined after the first loading and at least 90 % of the deflection recorded during the second loading. At no time during the test shall there be, in the opinion of the Engineer and in the light of a reasonable interpretation of the relevant data, any sign of weakness or faulty construction in the unit under test.

If destructive tests for beam units are ordered, the unit to be tested shall be supported at its design points of support, and loaded to its ultimate design load. The unit shall not fail within 15 min after the application of the test load. A deflection exceeding 1/40 of the span shall be regarded as failure of the unit.

For units not amenable to the tests described above, details of the testing arrangements shall be agreed between the Engineer and the Contractor before such units are cast.

2.3.9 Measurement and Payment if not otherwise specified in the BOQ.

2.3.9.1 Formwork

Formwork will be measured as the net area of the face of the concrete. No deduction will be made for fillets and splays of size up to 100 x 100 mm or for openings of diameter up to 0.7 m or of area up to 0.5 m2.

Formwork in continuous lengths of narrow width of up to 300 mm will be measured by length, the width, or range of width being stated in the schedule.

Separate items will be scheduled

a) for each class of finish required
b) for the different angles of inclination of formwork as given below:
    (i) horizontal: $>85^0$ up to 95^0
    (ii) sloping: $>10^0$ up to 85^0
    (iii) battered up to 10^0
    (iv) vertical: 0^0
c) for each type of structural element, such as walls, beams, slab, etc.
d) for formwork to curved surfaces

No payment will be made for formwork used in forming designated and construction joints.

2.3.9.2 Reinforcement

Steel for reinforcement will be measured net by mass of all bars, including supporting steel detailed on the bending schedules. No allowance will be made for cutting, waste, spacer devices, or binding wire.

Welded mesh will be measured by area to be reinforced by means of mesh, no allowance being made for cutting, waste, laps, or deductions for end cover.

Steel offcuts resulting from the cutting and bending of reinforcing steel in accordance with the bending schedule shall be deemed to be the property of the Contractor.

2.3.9.3 Concrete

The volume or area of concrete, in which unit the payment is intended, will be computed from the measurements net to the dimensions shown on the drawings or to the dimensions cast, whichever is the smaller. Structural elements that are undersized will be measured for payment only if they are accepted by the Engineer.

No allowance will be made for concrete required to make up overbreak in soft excavation, but payment will be made for additional concrete or formwork, ordered in writing by the Engineer to replace unsuitable material or overbreak in hard rock or in intermediate excavation.

Sub-foundation carpets and blinding layers will be measured to the plan size of the concrete structure resting on it and the thickness shown on the drawings, and measured on the mean thickness as cast, provided that the Engineer is satisfied that the excavation has not at any point been taken deeper or wider than necessary.

Separate items will be scheduled, as applicable, for each type and each grade of concrete, for each unit or element in the structure (where these would materially influence the pricing), such as

a) slabs that are horizontal, sloping, conical or of different thickness
b) concrete deposited under water
c) small quantities each less than 0.20 m3 of formed surfaces, and
d) different surface finishes, other than just striking-off and levelling.

No separate payment will be made for curing, sampling of testing.

2.3.9.4 Miscellaneous Items

Only designated joints shall be measured. Unless otherwise provided in the Contract, joints will be measured per linear m for joints in slabs and horizontal and vertical joints in walls. The rate shall include waterstops, formwork to form the joint, forming a recess for the joint sealer and application of the joint sealer.

Waterproof membrane and rubber gasket shall be measured as the plan area of the roof slab covered with the membrane. The rate shall include upstands at the perimeter and solar protection of the perimeter.

Bitumen painting is measured as the surface area covered by the painting.

2.4 Brickworks

2.4.1 Scope

This specification covers the general construction requirements for brickwork in general Masonry, Pavement, Drain Section, Manholes, Chambers, Buildings, Reinstate of Brickwork, Walls, and other brick related structures.

2.4.2 Interpretations

2.4.2.1 Supporting Specifications

The following specifications shall, inter alia, form part of and shall be read in conjunction with this specification:

a) 1 General
b) 2.1 Site Clearance
c) 2.2 Earthworks
d) 2.3 Concrete Works, as applicable

2.4.2.2 Application

This specification contains clauses that are generally applicable to brickwork construction and associated work.

2.4.3 Materials

2.4.3.1 Bricks

Unless otherwise specified, burnt-clay bricks shall confirm to the requirement of IS: 1077-1992. Specification for common Burnt Clay Building Bricks, and shall be first class quality (Class `A').

Bricks should be obtained from an approved manufacturer and should be approved by the Engineer. The Contractor shall submit to the Engineer samples of the bricks that he intends using in the construction of the different sections of the Works. The samples of the bricks that are approved will be retained by the Engineer.

Bricks shall be free from defects affecting strength and durability. The amount and extent of manufacture cracks or cracks and chips due to handling shall not be to such a degree as to give an unsightly appearance to exposed brick surfaces and all face brick to be used on the Work shall match with the samples approved by the Engineer.

All bricks shall be machine made, of good quality brick earth and thoroughly burnt, and shall be of deep cherry red or copper color. The bricks when dried shall emit a clear ringing sound when struck together and shall not break when thrown on the ground or against other bricks from a height of 1 m. The bricks shall not absorb water more than one sixth of their weight after one hour of soaking by immersion in water. The bricks shall be wholly clean and free from flaws, cracks, and under-burnt lumps of any kind. They shall be uniform in size and regular in shape and have square, straight, and sharp edges and even surfaces.

Bricks shall be carefully handled at all stages in delivery, stockpiling, transportation on Site and construction to prevent breakage or surface damage. Bricks shall be carefully unloaded by hand and shall not be dumped or thrown. They shall be stocked in regular layers even as they are unloaded. The supply of bricks shall be arranged so that at least one weeks requirement of bricks are available at the site at any time.

2.4.3.2 Hollow concrete blocks

The hollow concrete blocks for masonry works shall be machine made and thoroughly compacted in the moulds by external form vibrators or vibrating tables.

Unless otherwise specified in drawing and BOQ, the hollow concrete blocks shall be made of 1 part of cement, to 4 parts of well graded fine and coarse aggregates mechanically mixed into a very dense and dry consistency with very low water cement ratio.

The hollow concrete blocks shall comply with NS 119-2042 and shall have following physical properties.

a)	Compressive Strength	70 kg/cm2
b)	Drying Shrinkage	0.04%
c)	Moisture Movement	0.03%
d)	Water absorption	240 kg/m3
e)	Moisture content	40%

2.4.3.3 Cement for mortar

Cement for masonry mortar and grout shall be ordinary Portland cement in accordance with the requirements of Clause 2.3.3.2. All cement for mortar for exposed face work shall be of a uniform color as approved by the Engineer.

2.4.3.4 Sand for mortar

Sand (fine aggregate) for masonry mortar and grout shall be in accordance with the requirements of IS 460-1962. For exposed face work shall be of a uniform color as approved by the Engineer. The particle size grading of sand for use in mortars for masonry work shall be within the limits specified in Table 2.8.

Table 2-6: Requirement of Grading of Sands for Masonry Work

IS Sieve Designation (IS 460-1962)	Percentage of Weight Passing IS Sieve
4.75mm	100
2.36 mm	90-100
1.18 mm	70-100
600 Micron	40-100
300 micron	5-70
150 Micron	0-15

Sand shall be clean pit sand and shall be free from clay and other impurities and, if so directed, shall be properly screened and washed.

2.4.3.5 Water for mortar

The water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that maybe deleterious to concrete or steel. Portable water shall be generally considered satisfactory for mixing of mortars. The quality of water shall correspond to IS: 456 - 2000 (Clause 5.4).

2.4.3.6 Construction Equipment

The Contractor is responsible for providing, erecting, dismantling, and removing safe and adequate lifting equipment and scaffolding where required.

The type and capacity of mixing machines shall be such that the rate of output of mortar is suitable for the rate of brickwork. Each machine shall be capable of producing a uniform distribution of the ingredients throughout the batch and shall comply with the specification to which the manufacturer claims it has been manufactured. Worn or bend blades and paddles shall be replaced. The inner surfaces of the mixer shall be clean and free from hardened mortars. The mixers used shall be specially suited to the production of low slump mortars.

The Contractor is responsible for providing, erecting, dismantling, and removing safe and adequate lifting equipment and scaffolding where required at his own cost.

2.4.4 Construction and Workmanship

2.4.4.1 Mortar

Cement and sand shall be mixed in specified proportions given on the drawings or BOQ. Cement shall be proportioned only by weight, by taking its unit weight as 1440 kg per cubic meter and the sand shall be proportioned by volume after making due allowance for bulking. The required quantity of water shall then be added and the mortar mixed to produce workable consistency.

Necessary tests to determine compressive strength of the mortar, for consistency of the mortar and its water retentivity shall be carried out in accordance with IS: 2250 -1981. The frequency of testing shall be one cube for every 2 cubic meter of mortar prepared subject to a minimum of 3 cubes for a day's work.

2.4.4.2 Workability of mortar

The mortar shall be of a readily workable consistency with only enough water to obtain a plastic condition suitable for troweling.

2.4.4.3 Workability of grout

Grout shall be of pourable consistency with a slump of 120 mm when tested in accordance with the standard slump test for mortar and grout.

2.4.4.4 Cement mortar mixing and using period

All cementing material and aggregates shall be mixed for a minimum of 2 min in a mechanical batch mixer. Only so much water shall be added as is compatible with convenience in using the mortar. If mortar begins to stiffen from evaporation or absorption of a part of the mixing water, the mortar shall be re-tempered by adding water and remixed. All mortar and grout shall be used within 2.5 h of the initial mixing and no mortar or grout shall be used after it has begun to set.

2.4.4.5 Mixing of mortar

The mixing shall be done intimately in a mechanical mixer unless hand-mixing is specifically permitted by the Engineer. If hand-mixing is done, the operation shall be carried out on a clean watertight platform, and cement and sand shall be first

mixed dry in the required proportion to obtain a uniform color and then the mortar shall be mixed for at least two minutes after addition of water.

In case of cement mortar, that has stiffened because of evaporation of water, it shall re-tempered by adding water as frequently as needed to restore the requisite consistency but this retempering shall be permitted only within thirty minutes from the time of addition of water at the time of initial mixing.

Necessary tests to determine compressive strength of the mortar, for consistency of the mortar and its water retentivity shall be carried out in accordance with IS: 2250. The frequency of testing shall be one cube for every 2 cubic meter of mortar prepared subject to a minimum of 3 cubes for a day's work.

2.4.4.6 Brick laying

All brickwork shall be placed only after the foundation surfaces have been prepared to the satisfaction of the Engineer.

Bricks shall be well soaked in water for a minimum of 3 h immediately before being laid or as required so that the rate of absorption when laid does not exceed acceptable limits approved by the Engineer. The method of wetting shall be such that each brick shall be nearly saturated but the surface appears dry when laid.

Bricks shall be laid in running bond with head joints in each course centered over the bricks in the course below and shall be plumb, level & true to line with full head and bed joints. The ends of brick shall be buttered with sufficient mortar to fill the head joints.

Joints in brickwork shall be uniform and generally 10 mm thick for horizontal and 6 mm wide for vertical joints. Joints shall be tooled to produce a dense V-shaped joint or as otherwise ordered by the Engineer or shown on the drawings. Defective joints shall be cut out and repointed with mortar as directed by the Engineer.

The color and texture of all exposed mortar joints shall be subject to the approval of the Engineer and shall be kept uniform throughout the particular contract by strict adherence to the approved mixes and samples.

Extreme care shall be taken to prevent any concrete, grout, or mortar from staining the face of masonry. If any grout or mortar does contact the face it shall be immediately removed and the surface cleaned with clean water. Masonry work shall be protected against staining, tops of walls shall be covered with waterproof coverings as required, and when work is interrupted.

All walls shall, to the extent possible and as practicable, be built up at the same time. In no case shall any walls be advanced more than 1.5 m above another. If it is necessary to stop off a horizontal run of masonry, the end shall be stepped or as otherwise approved by the Engineer.

Where mortar on joints has partially or totally set, the exposed surface shall be cleaned and thoroughly wetted so as to obtain the best possible bond with the new work. All loose masonry and mortar shall be removed prior to the commencement of the work.

Brickwork shall be taken up truly plumb and each set of four bricklayers shall be provided with a plumb bob and straight edge.

Bricks on the 'fair face' shall be the best available, care being taken that they are not chipped or stained as work proceeds. Bricks shall be laid so as to give a perfectly flat face as tested with a straight edge, and no chipping or rubbing back will be permitted to remedy bad laying.

In the event of fair faced brickwork not being finished with struck joints whilst the mortar is still damp, pointing may be carried out with the approval of the Engineer. In this case all joints shall be raked out to a depth of 20 mm, cleaned free from all loose material and any putlogs filled in. The area to be pointed shall then be thoroughly soaked before pointing takes place, the mortar used being to the satisfaction of the Engineer.

Care shall be taken to keep all brickwork free from mud splashing, mortar, bitumen droppings, etc., and it shall be well cleaned down before being handed over.

If, after the completion of brickwork construction, any of it is found to be out of alignment or level or otherwise not conforming with the permissible deviations specified or otherwise defective, it shall be removed and replaced or repaired by the Contractor, at his own expense, and to the satisfaction of the Engineer.

2.4.4.7 Half brick thick wall and Curtain Walls

Two bars of 6 mm diameter shall be used longitudinally at every 5th course of half brick thick wall brick work. The first reinforcement shall be placed on the top of the bottommost course. The bars shall be fully embedded in the mortar and the ends shall be properly bonded in the vertical joints of brick work or to the main wall as directed by the Engineer. Laps for the reinforcement shall be provided of minimum length of 45 times the diameter of bar.

Top and ends of full height partition walls (half brick or single brick) shall be securely fastened to beams, slabs, columns, and walls, as applicable, with pre-fixed metal fasteners or holdfasts spaced not greater than 75cm apart unless otherwise

indicated. Clearance between top and ends of partition wall and beams, slabs, columns, and walls shall be caulked as indicated or as directed by the Engineer to form a closed continuous joint.

2.4.4.8 Exposed Brick Work

a) The exposed brick work shall be specially selected for uniformity of size, color, and shape. All faces of the bricks shall be truly plane and rectangular all corners exactly 900 and all bricks identical in size. There shall be no cracks or flaws in the bricks. The finished surface shall give a uniform and pleasant appearance. The exposed brick work shall have 8 mm deep recessed pointing at joints.

b) The brick walls for exposed brick work shall be of composite bricks with selected bricks for exposed face and routing bricks for inner face. This shall be done in a proper way to ensure proper bond. Mortar, etc. shall be the same as specified for brick work.

c) All exposed brick work, at the final completion or when it is so directed by the Engineer shall be rubbed with carborundum stone, washed down, cleaned, in extreme cases, a 5% solution of neurotic acid may be used for cleaning of exposed brick work, but it shall be proceeded and followed by a copious bath of fresh, clean water.

d) Exposed faces of brick masonry shall be kept moist for 10 d after laying

2.4.4.9 Brick manholes / Chambers

Brick walls for manholes or chambers shall be constructed in an approved bond comprising header and stretcher courses with the fair face on the inside. No false headers shall be built in and only whole bricks shall be used except where closures are required to form bond.

Joints shall be flushed up solid at every course throughout the whole width of each course, which shall be laid on a solid bed of mortar of thickness not exceeding 10 mm, and, if plaster is required, the joints shall be raked out to form a key as the work proceeds for the extent of the area to be plastered.

The walls of a manhole, if so required in terms of the Drawings shall be plastered internally and steel-trowelled to a smooth and true surface free of sharp edges and corners. The thickness of plaster shall be not less than 12.5 mm and not more than 15 mm. All salient angles and arises shall be slightly rounded, and all internal angles shall be finished true, square, and smooth.

2.4.4.10 HONEY COMB BRICK WORK

The honeycomb brick work shall be done with specified class of brick, laid in specified mortar. All joints and edges shall be struck flush to give an even surface. The thickness of the brick honeycomb work shall be half-brick only, unless otherwise specified.

Openings shall be equal and alternate with half brick laid with a bearing of 2 cm on either side.

2.4.4.11 Brick Work in Arches

The detailed specifications for brick work mentioned in earlier sub clauses of 2.4.3 shall apply, in so far as these are applicable. Arch work shall include masonry for both gauged as well as plain arches. In gauged arches, cut or moulded bricks shall be used. In plain arches, uncut bricks shall be used.

Brick forming skew-backs shall be dressed or cut so as to give proper radial bearing to the end voussiors. Defects in dressing of bricks shall not be covered by extravagant use of mortar, nor shall the use of chips or bats etc. be permitted.

2.4.4.12 Brick Pavement

The brickwork in paving shall be laid in 1:4 cement mortar and be made with machine made bricks, and shall be laid to the specified slopes, levels, dimensions, pattern, and bonds as shown in the drawing or as directed by the Engineer.

The widths of mortar joints shall not exceed 12 mm and shall be fully packed with mortar. The brick pavement shall be laid over a layer of mortar of 12 mm thickness, and shall not be disturbed at least for 7 d after it has been laid and shall be kept wet for at least 10 days.

2.4.4.13 Brick Soling

All the excavated materials shall be cleaned out properly and the base shall be rammed properly before the soling work is proceeded. Foundation shall be checked so that it is in exact line and dimensions.

Unless specified elsewhere or otherwise directed, dry brick soling in foundations and under flooring shall be laid flat or edge over a compacted surface as required, and be made of machine made bricks as specified above. The dry brick soling shall be laid over a cushion of sand of 25 mm thickness unless otherwise shown on the drawings or directed by the Engineer. All joints shall be completely filled with fine sand.

2.4.5 Tolerances

The dimensions of brickwork walls and structures such as manholes shall conform to the tolerances laid down for concrete structures (as per Clause 2.3.7), as applicable, or as directed by the Engineer.

2.4.6 Measurement and Payment

All Brickwork (half or full brick) will be measured as the net volume, for the different types and thickness applicable. No deductions will be made for openings of area up to 0.2 m^2.

Unless and otherwise mentioned in BOQ, Brick soling and Brick pavement works will be measured as the net area.

In case of honey combed wall, the length, width and height shall be measured correct to a cm. Volume of wall shall be calculated in cubic metres correct to two places of decimal. Honeycomb openings shall not be deducted.

2.5 Stone Masonry Works

2.5.1 Scope

This specification covers the general construction requirements for Stone masonry Work, Stone Pitching work, reinstate of Stone Work, Walls and other stone masonry related works.

2.5.2 Interpretations

2.5.2.1 Supporting Specifications

The following specifications shall, inter alia, form part of and shall be read in conjunction with this specification:

a) 1 General
b) 2.1 Site Clearance
c) 2.2 Earthworks
d) 2.3 Concrete Works, as applicable

2.5.2.2 Application

This specification contains clauses that are generally applicable to stonework construction and associated work.

2.5.3 Materials

2.5.3.1 Stone

Building stones to be used in the masonry shall be granite, quartize, gneiss laterite or any other type of good stones that may be specified in the item. In the absence of mention of a special type in the item or the special provision, good granite, quartize or gneiss stones in that order available and known to be satisfactory in use, in view shall be used. The stone shall stand weathering well and when immersed in water for 24 hours shall not absorb water more than 5 percent of its dry weight, when tested according to IS:1124-1974. The stone of the required quality shall be obtained from the quarries approved by the Engineer. All stones shall generally be freshly quarried.

Rubble stones for hearting shall be of approved quality, sound, hard, dense and durable, free from segregation, seams, srams, cracks, weathered- portion and other structural defects or imperfections tending to affect their soundness and strength. Stones shall be freshly quarried with sharp edges and clean faces. They shall be free from rounded, worn or weathered surfaces or skin or coating which prevents the adherence of mortar. Size and shape of stones shall be as per requirements of each item.

Stones to be used as headers, pin headers, quoin, copings etc. shall comply with the requirements of facing and hearting stones as may be relevant and shall further comply with the requirements of size and shape stipulated under the relevant item.

Samples of the stone intended for use in the work shall be submitted for the Engineer's prior approval.

Mortar: Mortar shall comply with IS 2250-1965 Code of Practice for Preparation and Use of Masonry Mortars.

2.5.3.2 Cement for mortar

Cement for masonry mortar shall be ordinary Portland cement in accordance with the requirements of Clause 2.3.3.2. All cement for mortar for exposed face work shall be of a uniform colour as approved by the Engineer.

2.5.3.3 Sand for mortar

Sand shall be in accordance with the Clause 2.4.3.4.

2.5.3.4 Water for mortar

The water used for mixing and curing shall be according to Clause 2.4.3.5.

2.5.3.5 Construction Equipment

The Contractor is responsible for providing, erecting, dismantling, and removing safe and adequate lifting equipment and scaffolding where required. The type and capacity of mixing machines shall be such that the rate of output of mortar is suitable for the rate of stone masonry work and should be as per the Clause 2.4.3.6.

The Contractor is responsible for providing, erecting, dismantling, and removing safe and adequate lifting equipment and scaffolding where required at his own cost.

2.5.4 General Construction and Workmanship

The dressing of stone shall be as specified for individual type of masonry work and it shall also conform to the general requirements for dressing of stone covered in IS: 1129 - 1972. Other specific requirements are covered separately with respect to particular types of rubble stone work.

Stones shall be sufficiently wetted before laying to prevent absorption of water from mortar. The bed which is to receive the stones shall be cleaned, wetted, and covered with layer of fresh mortar. All stones shall be laid full in mortar both in bed and in vertical joints and settled carefully in place with a wooden mallet immediately on placement so that it is solidly bedded in mortar before the has set. Clean ships and spalls shall be wedged into the mortar joints and beds wherever necessary, to avoid thick beds or joints of mortar. Whenever foundation masonry is laid directly on rock, the face stones of the first course shall be dressed to fit into the rock snugly when pressed down in the mortar bedding over the rock. No dry or hollow space shall be left anywhere in the masonry and each stone shall have all the embedded faces completely covered with mortar.

Courses of the masonry shall ordinarily be predetermined. They shall generally be of the same height. Where there is variation in the height of courses, larger courses shall be placed at lower levels, with height of courses decreasing gradually towards the top.

Vertical joints shall be staggered as far as possible.

All necessary chases for joggles, dowels and cramps shall be formed in the stones beforehand.

Sufficient transverse bond shall be provided by the use of bond stones extending from the front to the back of the masonry. In case of thick walls bond stones shall overlap each other in their arrangement.

Bell shaped bond stones or headers shall not be used.

At all angular junctions stones at each alternate course shall be well bonded into the respective course of the adjacent wall.

All connected masonry in structure shall be carried up at one uniform level throughout as far as possible, but when breaks, are unavoidable, the masonry shall be raked in sufficient long steps to facilitate jointing of new work with old. The stepping of ranking shall not be more than 45^{o} with the horizontal. Wing walls, abutments are piers, etc., shall be carried up truly plumb or to the specified batter.

Face work and hearing shall be brought up evenly. The top of each course, however, shall not be leveled up by use of flat chips.

2.5.5 Random Rubble Masonry (Un-coursed and Coursed)

2.5.5.1 Dressing:

Stone shall be hammer dressed on the face, the sides, and beds to enable it to come in proximity with the neighboring stone. The bushing on the face shall not be more than 4 cm on exposed face.

2.5.5.2 Insertion of Chips

Chips and spalls of stone may be used wherever necessary to avoid thick mortar beds or joints and it shall also be ensured that no hollow spaces are left anywhere in the masonry. The chips shall not be used below hearting stones to bring these upto the level of face stones. Use of chips shall be restricted to filling of interstices between the adjacent stones in hearting and they shall not exceed 20 percent of the quantity of stone masonry.

2.5.5.3 Hearting Stones:

The hearting or interior filling of wall face shall consist of rubble stones not less than 15 cm in any direction, carefully laid, hammered down with a wooden mallet into position, and solidly bedded in mortar. The hearting should be laid nearly level with facing and backing.

2.5.5.4 Bond Stones

Through bond stones shall be provided in masonry upto 60 cm thickness and in case of masonry above 60 cm thickness, a set of two or more stones overlapping each other at least by 15 cm shall be provided in a line from face to back. In case of highly absorbent types of stones (porous limestone and sandstones, etc.) the bond stone shall extend only about two-third into the wall, as through stones in such cases may give rise to penetration of dampness and, therefore, for all thicknesses of such masonry a set of two or more bond stones overlapping each other by at least 15 cm shall be provided. One bond stone or a set of bond stones shall be provided for every 0.50 square metres of the masonry surface.

2.5.5.5 Quoin Stone

Quoin stone, i.e., the stone specially selected and neatly dressed for forming an internal angle in masonry work, shall not be less than 0.03 cubic meters in volume.

2.5.5.6 Plum Stone

The plum stones are selected long stones embedded vertically in the interior of masonry to form a bond between successive courses and shall be provided at about 90 cm intervals.

2.5.5.7 Wet Foundation

In wet foundation, or other situation where water is met with the work space shall be kept free of water by the Contractor while the masonry is in progress and until the Engineer consider the mortar has sufficiently set. Dewatering shall be carried out in such a way as not to injure the concrete or masonry in any way. Dewatering shall also be done when required for taking/checking measurements, approved foundations etc. Dewatering shall be included in the rate of masonry unless separate provision is made in the contract.

2.5.5.8 Laying

The masonry shall be laid to lines, levels, curves, and shapes shown in the drawing. Fixtures, plugs, frames etc. if any shall be built in at places shown on the drawing or directed by the Engineer while laying the masonry and not later by removing the stones already laid.

a) Stones in the hearting shall be laid on their broadest face which gives better opportunity to fill the space between stones.

b) Stratified stones must be laid on their natural beds. All bed joints shall be normal to the pressure upon them.

c) In weathered walls, the beds of stone and the plane of course should be at right angles to the latter.

d) The courses of masonry shall ordinarily be predetermined. They shall generally be of the same height. Where there is to be variation in height of courses, larger courses are to be placed at the lower levels, the height of courses decreasing gradually towards the top of the wall, unless to architectural requirements.

e) The stones shall be wetted before laying in mortar. Each mason shall be supplied by the Contractor with a vessel full of water and a tumbler for wetting stones, care being taken not to spill any water on green masonry. The bed which is to receive the stone shall be cleaned, wetted and covered with layer of fresh mortar. All stones shall be laid full in mortar both in place with a wooden mallet immediately on placement and solidly bedded in mortar before it has set. Clean chips and spalls, carefully selected to fit in the spaces shall be wedged into the mortar joints and beds wherever necessary to avoid thick beds or joints of mortar. When the foundation masonry is laid directly on rock the face stones of the first course shall be dressed to fit into the rock snugly when pressed down in the mortar bedding over the rock. No dry or hollow space shall be left anywhere in the masonry and each stone shall have all the embedded faces completely covered with mortar. If a portion of masonry is dismantled, every stone must be found with mortar adhering fast to all its embedded surfaces and there shall be no hollows. This will be one of the tests in deciding if the masonry is good or bad if need arises. Where hollows or other defects are suspected a stone here there may be removed for confirmation. If these are confirmed such portion shall be dismantled and rebuilt at the cost of the Contractor.

f) Face work and hearting shall be brought up evenly but the top of each course shall not be leveled up by use of flat chips.

g) In case any stone already set in mortar is disturbed or the joint broken, the stone shall be taken out without disturbing the adjoining stones and joints, the mortar thoroughly cleaned from the joints and the stone reset in fresh mortar. Attempts must never be made to slide one stone over another already laid.

h) Shaping and dressing shall be done before the stone is laid in the work. No dressing and hammering which will loosen the masonry shall be permitted after it is once placed.

i) There shall be an adequate collection of stones and spalls within easy reach of the mason to enable proper selection of stones for individual location while laying. The stones shall be continuously replenished.

j) Bond

- To give sufficient lateral bond, a stone in any course shall break joint with the stone in the course below or above about half the height of the course and generally not less than 7.5 cms.
- To give sufficient transverse bond, the prescribed number of headers shall extend from front to back of thin walls up to a width of 60 cms or prescribed number of lines of overlapping headers from face to back of walls over 60 cms thick. Over laps shall be 15 cms at each end. To ensure provision of full number of headers of the required size, they shall be kept at specified intervals in each course in advance of starting masonry and then embedded in mortar. Their position in each course shall be staggered, so that each will be near about the middle of the two in the courses below and above. Their faces shall be marked with a distinguishing sign to identify them.
- To bond work at all angle junctions of walls, the stones at each alternate course shall be so carried into each of the respective walls as to join the work thoroughly. Quoin shall be laid header and stretch wise when seen on each side of the wall.

- When new work has to be started on the old or one completed a long while ago or in the previous working season, the surface shall be roughened and cleaned satisfactorily without disturbing the masonry before laying the new. It shall be wetted before laying the bedding mortar.
- Where practicable the whole of the masonry in any structure shall be carried upto a uniform level throughout. But where breaks are unavoidable in carrying up the work continuously in horizontal courses, sufficiently long step shall be left to join the courses to be laid later. All junctions of walls shall be formed at the time the walls are being built; cross-walls should be carefully bonded into the main walls.
- The practice of building two thin faces tied with occasional through-stones and filling up middle with dry packing and putting mortar on top must be strictly guarded against putting dry chips in the joints of stones before filling them with mortar shall not be allowed.
- For ensuring good bond masonry shall be left uneven at the top of each course.

k) The face stones shall be laid absolutely without any pinnings on the exposed faces. In each course the headers or lines of headers as the case may be, shall be kept in position at specified intervals and with specified laps where such laps are required before the masonry of the layer is commenced to ensure that they are being laid properly and in required numbers and intervals. They shall be embedded in mortar as masonry in that layer progresses.

l) Joints: No face joints shall exceed 8 mm in thickness. Stones shall be arranged to break joint as much as possible and long vertical lines of jointing shall be avoided.

m) Striking Joints: The face joints should be properly struck while the mortar is fresh. Joints which cannot be struck at the time of laying, shall be prepared for it by raking joints to a depth of not less than 6 mm when the mortar is fresh. These joints should be properly cleaned of loose particles, wetted thoroughly and filled with good fresh cement mortar 1:3 and finished off by being troweled smooth.

n) Rate of raising masonry: The rate of raising random rubble masonry brought up in uniform levels may be limited to a height of 60 cm per day in cement mortar. No fresh course shall be laid over masonry previously laid within 4 hours of its laying for cement mortar.

2.5.5.9 Items to Include in the unit rate

a) Masonry built in any position to any height or depth and to lines, levels, curves and batters, shown on drawing as ordered by the Engineer with headers, quoin etc. including striking joints and curing, cutting, grooves holes etc. for fixing frames, fixtures etc. are also included in the rate.

b) Erecting and removing all scaffolding, ladders and use of plant required for execution of the item, safety of the labour and inspection of the work including compensation for any injury, damage etc.

c) Watering to allow construction in the dry and proper setting of masonry unless separately provided in the contract.

d) Clearing the site round the masonry and back filling so as to restore it to the original condition.

e) All labour, use of tools, materials and other items incidental to satisfactory completion of the item.

f) Curing of the work and protection of fresh work from dust, rain etc.

2.5.5.10 Joints

The face joints shall not be more than 20 mm thick, but shall be sufficiently thick to prevent stone-to-stone contact and shall be completely filled with mortar.

2.5.6 Dry Rubble Masonry for Retaining structures

This work shall conform to Clause 2.5.5 of Random Masonry (Un-coursed) except that:

a) the masonry shall be dry without mortar;

b) the spaces between large stones shall be filled with spalls at tightly as possible; and

c) the foundations shall be excavated at right angles to the face batter and not horizontally. The beds of the stones shall be laid at right angles to the face better.

2.5.7 Dry Stone Pitching/Dry Rubble masonry

Stone Pitching/Dry Rubble masonry shall be constructed generally to the requirements of un-coursed random rubble masonry as specified in elsewhere in this document but with the omission of mortar. All stones shall be carefully shaped to obtain as close as fit as possible at all beds and joints, any interstices between the stones being fitted with selected stone spalls. The exposed tops or cropping of dry rubble structures shall be formed as described in the Contract.

Activities involved will be supply of stones, dressed bond stone, cement, sand, water, tools, machine, preparation of mortar, placing and joining stones dry/with mortar, control, and removal of water, curing, collection, & testing of specimens etc. complete.

2.5.8 Stone Soling Work Blinding in Floor

The ground or earth shall be thoroughly consolidated with a 25 mm layer of coarse sand so that there is no loose pockets left anywhere in the whole area. Over such consolidated surface a layer of stone soling shall be made. Care should be taken that all stones are placed vertically. No smaller stones than 80 mm shall be provided for such work. The stone shall be thoroughly rammed as closely packed in position and interstices blinded with course sand, if necessary, so that a solid hard core of desired thickness is formed in position.

2.5.9 Measurement and Payment

Unless and otherwise mentioned in BOQ, measurement shall be made to cubic meters of any type of masonry made in accordance with authorial dimensions.

Stone soling works will be measured as the net volume.

Stone pitching works will be measured as the net area.

2.6 Cement Plaster Works

2.6.1 Scope

This specification covers the general construction requirements for finishing works in any structure on exterior and interior surfaces including bed and side slopes of specified surfaces of stone pitching, brick wall, stone walls, reinstate work, and other surfaces.

2.6.2 Interpretations

2.6.2.1 Supporting Specifications

The following specifications shall, inter alia, form part of and shall be read in conjunction with this specification:

a) 1 General
b) 2.2 Earthworks, as applicable
c) 2.3 Concrete Works
d) 2.4 Brickwork
e) 2.5 Stonework

2.6.2.2 Application

This specification contains clauses that are generally applicable to finishing work and associated work.

2.6.3 Materials

2.6.3.1 Cement

Cement for finish work shall be ordinary Portland cement or Portland pozzolana cement (incase of plaster work only) as per engineer's instruction in accordance with the requirements of Clause 2.3.3.2. All cement for mortar for exposed face work shall be of a uniform color as approved by the Engineer.

2.6.3.2 Sand

The particle size grading of sand for plaster work for internal as well as external walls and ceiling as analyzed by the method described in IS: 2386 (Part I) -1963 shall be as specified in Table 2-7. Where the grading falls outside the limits of the grading zones of sieves other than 600 micron IS Sieve by a total amount not exceeding 5 percent, it shall be regarded as falling within the grading. This tolerance shall not be applied to percentage passing the 600 micron IS Sieve or to percentage passing any other sieve size on the finer limit. The various sizes of particles of which the sand is composed shall be uniformly distributed throughout the mass. The required grading may often be obtained by screening and or by blending together either natural sands or crushed stone screening which are by themselves unsuitable grading.

Table 2-7: GRADING OF SAND FOR FINISHING WORK

(Clause 4.1 of IS: 2386 -1963)

IS Sieve Designation (IS 460-1962)	Percentage of Weight Passing IS Sieve
10.0mm	100
4.75mm	95-100
2.36 mm	95-100
1.18 mm	90-100
600 Micron	80-100
300 micron	20-65
150 Micron	0-50

Notes:

1 For crushed stone sands, the permissible limit on 150 micron IS Sieve is increased to 20 percent. This does not affect the 5 percent allowance permitted in 4.1 applying to other Sieve sizes.

2.6.3.3 Water for mortar

The water used for mixing and curing shall be according to Clause 2.4.3.5.

2.6.3.4 Scaffolding and ladders

The Contractor is responsible for providing, erecting, dismantling, and removing safe and adequate lifting equipment and scaffolding where required at his own cost.

2.6.3.5 Care of Tools and Accessories

All tools shall be cleaned by scraping and washing at the end each day's work, or after use with different materials. Metal tools shall be cleaned and greased after each operation. The tools shall be examined and thoroughly cleaned before

plastering is begun. Cleanliness is particularly important with cement plasters, where contamination with set material may seriously affect the performance as well as reduce the effective life of the tools.

2.6.3.6 Plastering

The surface to be plastered shall be brushed clean. Mortar joints of brick masonry or concrete walls to be plastered shall be raked to a depth of approximately 12mm, and the surface brushed down with a stiff brush and thoroughly wetted. The surface shall be free of all dust, loose materials, grease, etc.

Before starting plasterwork, the contractor shall prepare a sample panel of plastering of a size at least 1 m^2 for the approval of the Engineer. The sample shall be prepared in an area designated by the Engineer. The Contractor shall obtain approval before starting work and preserve the approved sample intact until all plastering is completed.

Plaster shall be applied in two coats. The thickness of the first coat shall be just sufficient to fill all unevenness of the surface. The first coat shall be applied with even, firm pressure to ensure good bond, shall be cross scratched and shall be moist cured. After the first coat has properly cured, and been allowed to dry thoroughly, the surface shall be dampened before applying the finish coat. The finish coat shall be steel trowel finished to a smooth, even, burnished surface, completely free from defects or trowel marks.

Unless specified elsewhere or otherwise directed, the thickness of plaster in total shall not be less than 12.5 mm. Wall plastering shall be started from top and work down to the floor. Ceiling plastering shall be completed before starting the wall plastering. To ensure uniform thickness and vertical plaster face, plumb guider strips may be applied as required.

If required to achieve the smooth, burnished finish, the surface shall be finished with lime putty of just sufficient thickness to fill in uneven surface or defects due to coarse sand in the plaster mix. Lime mortar finish shall be applied immediately after the finish has set sufficiently firm.

In order to obtain additional strength at external angled corners, the corners shall be dusted with cement during the steel trowel finishing of the finish coat.

Care shall be taken to ensure that finished plaster surfaces shall be plumb, square, straight, and true to line. All arises and corners shall be straight, clean, and sharp.

2.6.4 Preparation of Plaster

2.6.4.1 Proportioning

The material used in the preparation of plastering mixes may be measured by volume using gauge boxes.

Cement shall be measured by weight. For the purpose of proportioning one cubic meter of cement shall be taken to weight 1,440 kg approximately.

2.6.4.2 Quantity of Water

For general cement plaster work with 1:3 proportion the quantity of water required is about 70 percent by weight of cement. This may, however, vary depending on the following factors, and adjustment shall be done as explained in IS: 2250-1981.

a) The nature and condition of the fine aggregate.
b) The temperature and humidity at the time of working;
c) Richness of the mix, namely, whether rich or leaner than 1:3;
d) The varying quantities of lime in composite mortars; and
e) The use of admixtures added for improving the workability.

2.6.4.3 Mixing

Cement and sand shall be mixed dry in the required proportions to obtain a uniform colour. Water shall then be added to get the required consistency for the plaster.

Cement lime plaster shall be used within two hours after the addition of water to cement provided it is kept agitated or turned over at intervals of at least 20 min. Cement plasters shall be used within half an hour after the addition of water. Any mortar or plaster which is partially set shall be rejected and removed forthwith from the site.

Mixing may be done either manually or mechanically. "Hand mixing" shall be carried out on a clean, water tight platform. During mixing, the mortar shall be heed back and forth for 10 to 15 min after the water is added. In "machine mixing" the mixer shall run at least 5 min after placing all the ingredients in the drum.

Machine mixing is preferable to hand mixing for all mortars.

2.6.5 General Precaution in Plastering

2.6.5.1 Cleanliness and Protection of Existing Work

Cleanliness is essential in carrying out plaster work. Adequate protection shall be given to all existing work and fittings which are liable to be damaged, not only in the area of plastering operation, but also in the approaches thereto by covering up with boards, dust sheets, etc, as necessary.

2.6.5.2 Cleaning off on Completion

On completion, all work affected by plastering operations shall be left clean. Special care is necessary when removing set plaster from glass to avoid damaging its surface.

2.6.5.3 Suction Adjustment

The careful adjustment of suction is very necessary for good plastering, and may be done either by wetting the backing suitably if it is dry, or by sprinkling with a cement-mix as in the case of a concrete surface with low suction. Without the aid of suction, plaster would creep and slide down due to its own weight. On the other hand, high rate of suction withdraws all moisture from the plaster and makes it weak porous and friable. Too much water makes it impossible to keep the mortar in position till it sets. A failure in bond due to excessive water leads to further failure as the pocket formed may hold water and break up the plaster when the water freezes; or if the water is salt laden, the same results will be produced on evaporation by crystal formation.

The wall shall not be soaked but only damped evenly before applying the plaster. If the surface becomes dry in spots, such areas shall be moistened again to restore uniform suction. A for-spray is recommended for this work.

2.6.5.4 Adjustment of Working to the Setting Properties of Plaster

Cement plasters contain materials which set when brought into contact with water, and the fullest use of their strength producing properties is not made unless the mix is applied before the setting process has started. If retampering of such mixes is carried out after the set has commenced an inevitable loss in strength and efficiency will result.

The commencement of the set is accompanied by a noticeable stiffening of the mix. It is essential, therefore, that mixes shall be used as soon as possible after water has been added and that working periods recommended in this code shall not be exceeded.

2.6.5.5 Control of Cracking

This is normally a structural problem, but the plaster will be able to reduce the effects of structural cracking by making a trowel cut between adjacent surfaces.

2.6.5.6 Maintenance of Proper Time Intervals

Shrinkage, partly irreversible, occurs on drying, causing stresses to be set up both in the applied coat and in the undercoat or background, and in order to avoid break down of adhesion between successive coats, it is very important that the drying shrinkage of the first coat should be materially complete before a subsequent coat is applied. The rate of drying will vary widely with conditions of temperature, humidity, and ventilation. Proper time interval serves to diminish the possibility of efflorescent salts finding their way to the final plaster surface, and also of the drying and naturing shrinkage (map crazing) of the undercoat reaching the finished plaster surface over a period of time. The surface then shall be allowed to set for at least a day or two depending upon the weather (one day in summer and two days in winter). During this period the surface of this coat shall be kept damp and shall not be allowed to dry.

2.6.6 Preliminary Programming of Work

All materials necessary for plastering shall be kept readily available at the site. An adequate supply of water suitable for mixing the plaster and for curing purposes shall be available.

In building operations, such as construction of brick and block walls, the encasement of steel walls, columns and beams with concrete, etc, requiring plastering shall be so programmed that they are sufficiently matured to receive the plaster without subsequent damage to plaster or decoration. Careful programming and avoidance of last minute alterations in the design or in the sequence of work can avoid serious damage to the plaster finish. Where such alterations are unavoidable the permanent decoration shall be postponed.

Plastering operations shall not be started until all necessary fixing, such as door and window frames, mantle pieces are completed and all pipes and conducts to be embedded in the wall or plaster are installed.

A preliminary inspection shall be made to ensure that the surfaces are in a suitable condition for plastering, particularly as regards their planeness and dryness. If dubbing out is necessary, it should be done in advance, so that an adequate time interval may be permitted before the application of the first undercoat. Plastering operations shall be so scheduled as to allow sufficient interval between undercoats and finishing coats.

2.6.7 Sequence of operations

The surfaces to be plastered shall first be prepared as indicated in the sub-section "General precaution of plastering".

When the preparation has been done, arrangements may be made for a constant supply of plastering material prepared as described in 2.6.4. The plaster coat is then applied rendering surfaces.

Sometimes, ends of scaffolding BALLIES have to be housed in the wall which is being treated with plaster. In such cases after the BALLIES are taken out, the hole or holes left in the wall shall be filled up with brick and mortar, and the patch plastered up true, even and smooth in conformity with the rest of the wall, so that no sign of any patch work shows out.

Where corners and edges have to be rounded off, such rounding off shall be completed along with the plaster finishing to prevent any joint marks showing out later.

2.6.8 Special Finishing Textures

Various types of special textures for rendered surfaces may be obtained by using special tools for the application of the final coat. The special finishes shall be applied in accordance with the details given in IS: 2402-1963.

2.6.9 Trueness of Plaster System

The finished plaster surface shall not show any deviation more than 4 mm when checked with a straight edge of 2 m length placed against the surface.

2.6.10 Curing

To develop maximum strength and density in the plaster, it is necessary to cure cement plasters properly. The plaster coat shall be kept damp continuously for a maximum period of 7 days. Moistening shall commence as soon as the plaster has hardened sufficiently and is not susceptible to injury. The water shall be applied by using a fine fog-spray. Soaking of wall shall be avoided and only as much water as can be readily absorbed shall be used. Excessive evaporation on the sunny or windward sides of buildings in hot dry weather may be prevented by hanging mattings or gunny bags on the outside of the plaster and keeping them wet.

After the completion of the finishing coat, the plaster shall be kept wet for at least seven days, and shall be protected during that period from extremes of temperature and weather.

2.6.11 Approval by the Engineer of plaster work

All plaster work shall be subject to approval of the Engineer, and work failing to meet the requirements of the specifications or not being to the satisfaction of the Engineer shall be removed and reapplied at the Contractor's expense.

2.6.12 Inspection and Diagnosis –Applicable Only if the Engineer Deems it Necessary

It is essential to determine the cause of any defects of plaster work before any attempt is made to remedy or repair them and unless the cause is properly dealt with, the majority of defects will continue to recur after repair. The interpretation of defects of plasterwork and the determination of their causes can only be done by approaching the subject in a systematic and logical manner.

Since it is the final plaster finish which claims the attention of the casual observer, it is a common error to blame only the plastering materials or workmanship for all defects. Actually, these, although perhaps the most important, are not the only factors that may influence the final result.

Every defect in a plastering is more or less connected with the whole history and treatment of the background. Consideration shall be given not only to the plastering material used and to the quality of workmanship, but also the climatic conditions prior to, during and after the plastering process, and to the correct choice of the plastering system.

Detailed consideration has already been made in Clause 2.6.4 and 2.6.5 or several factors in this connection such as:

a) the possible causes for lack of bond between successive coats of plaster and between the first undercoat and the background concerned,

b) the possible effect of inadequate time intervals in promoting severe efflorescence or `map crizing' on the finished surface, and

c) the effect of climatic conditions in causing or aggravating the above as well as other troubles.

Besides, the active influences of the various atmospheric conditions, the effect of the physical properties of the building surface prior to plastering shall also receive due consideration.

2.6.13 Plastering Defects & Remedies – Applicable Only If the Engineer Deems It Necessary

It is not possible to give simple rules for the correction of all plastering defects or failures. Many serious defects may be shown to have causes outside the materials or techniques used in the plastering operations and it is often useless to repair or even replace the plaster without first having discovered and corrected the primary fault.

Thus, penetration of moisture through an external wall may cause blistering, efflorescence, flaking or complete disintegration of the plaster. To patch or to re-plaster such a wall without first taking steps to prevent further damp penetration would be useless. Again, plastered ceilings may develop cracks because the ceiling construction permits excessive deflection, and no plaster repair could be expected to be effective in preventing it. Recurrent surface dampness may be associated with the presence of deliquescent salts in the plasterwork, but it would not necessarily be effective to renew the plaster. The salts may also be in the background and would probably migrate into the new plaster and bring about a renewal of the trouble. This type of defect usually traced to the use of an unwashed estuarine or sea sand, is best corrected by battening out and erecting a new plaster base out of capillary contact with the affected area.

Defects caused by the use of unsuitable plastering material or by faulty technique may be corrected by means of an appropriate repair.

2.6.14 Measurement and Payment

All Plaster work will be measured as the net area, for the different types and thickness applicable. No deductions will be made for openings of area up to 0.2 m^2.

2.7 Other Finishes

2.7.1 Scope

This specification covers the general construction requirements for finishes (except cement plaster work), such as flooring, painting, roofing, water proofing, etc., required in surface finishes of general civil construction (eg building, chambers, walls, manhole, etc.).

2.7.2 Interpretations

2.7.2.1 Supporting Specifications

The following specifications shall, inter alia, form part of and shall be read in conjunction with this specification:

a) 1 General
b) 2.3 Concrete Works
c) 2.4 Brickwork
d) 2.5 Stonework
e) 2.6 Cement Plaster Works

2.7.2.2 Application

This specification contains clauses that are generally applicable to finishes on walls, floors, ceiling of cast in situ and pre cast structure and associated work.

2.7.3 Materials

Cement Concrete Floor: All the materials to be used such as cement, sand, aggregates, water, and other materials shall be as have been described in the Clauses 2.3.3 and 2.4.3 or as directed by the Engineer. Unless specified elsewhere or otherwise directed, the thickness of cement concrete floor should be of 1:2:4 proportion (Cement: Sand: Aggregate) and shall not be less than 50mm thick.

Cement Floor (Cement Screed): All the materials to be used such as cement, sand, water and other materials shall be as have been described in the Clauses 2.3.3 and 2.4.3 or as directed by the Engineer. Unless specified elsewhere or otherwise directed, the thickness of cement screed floor should be of 1:6 proportion (Cement: Sand) and shall not be less than 12.5mm thick.

Cement Punning Finishing: All the materials to be used such as cement, sand, water and other materials shall be as have been described in the Clauses 2.3.3 and 2.4.3 or as directed by the Engineer. Color pigment shall be of superior quality conforming IS standards and as approved by the Engineer. Unless specified elsewhere or otherwise directed, the thickness of cement the finishing layer shall not less than 3mm and consist of cement-sand (Cement Punning) mixed at 1:1 (cement: fine sand). Cement punning should be also used as skirting purposes.

Pointing: All materials to be used such as cement, sand, water, and other materials shall be as have been described in the Clauses 2.3.3 and 2.4.3 or as directed by the Engineer. If not specified, it shall be carried out in cement mortar not leaner than 1:3.

Terrazzo Floor Finish: Terrazzo tiles shall be not less than 250 x 250 x 20 mm size unless otherwise shown or specified on the drawings or directed by the Engineer. Terrazzo tiles shall be free from cracks, chips, flaws, stones or lumps of any kind. Their granulity of embedded color chips should be regular and uniform in order to add aesthetic purpose. These tiles shall sound hard, homogeneous texture and water absorption shall be minimum during soaking. All terrazzo tiles shall have to be approved by the Engineer and any terrazzo tiles not up to the specification must be removed from the site immediately at Contractor's own cost. Representative samples of the tiles to be used shall be submitted to the Engineer and his approval taken before bulk purchase. The samples shall be kept with the Engineer for future reference and comparison. All tiles supplied shall conform to these approved samples in all respects.

Ceramic Tiles: Ceramic tiles shall be not less than 200 x 200 x 6 mm size unless otherwise shown or specified on the drawings or directed by the Engineer. They shall be either ceramic vitreous tiles, with colours as selected by the Engineer, or approved glazed tiles conforming to IS 777 or equivalent. Cement, sand, and water used for tiling work shall be in accordance with the requirements of Clause 2.4.Granular material (e.g. marble chips) for in-situ flooring, screeds, and skirting shall be as approved by the Engineer. The Contractor shall submit samples of tiles for selection and approval by the Engineer, and all tiles used shall conform to the approved samples with regard to size, quality, texture, and color.

Painting: The materials for painting and color washing of internal and external walls and similar surfaces shall conform to the requirements of the relevant applicable standards (e.g. IS 5410 or equivalent) and shall be approved by Engineer.

Waterproofing materials: Unless and otherwise mentioned in BOQ, waterproofing material, such as waterproofing bituminous felt, other bituminous materials, specified thickness of concrete band or layer and cement sand plaster with

waterproofing concrete admixture @ 2% by weight of cement or its equivalent shall be in accordance with the relevant applicable standards (e.g. IS 1322, IS 1580, IS 2645-1975 and IS 9103-1979 or equivalent).

Other items: Pigments and other necessary additives to produce colored plasters and mortars shall conform to the relevant applicable standards (e.g. IS 57 or equivalent) and shall be applied the rate of 1% by weight of cement or to produce a color and texture indicated on the drawings or as directed by the Engineer. The sample of such color plaster shall be subjected to approval of the Engineer before applying in the work.

Caulking compounds shall be of approved manufacture such as to provide a continuous waterproof barrier installed with exposed caulking smoothly recessed from the finished steel or brick surface.

The Contractor is responsible for providing, erecting, dismantling, and removing safe and adequate lifting equipment and scaffolding where required in order execute the finishes Work at his own cost.

2.7.4 Construction Equipment

Construction Equipment shall be suitable for applying the specified flooring and coating systems and for obtaining the specified results. If, however, consistent and satisfactory results are not achieved with the equipment used by the Contractor, the Engineer may order the Contractor to obtain and use such Construction Equipment as may be necessary to achieve the required results.

2.7.5 Construction and Workmanship

Special care should be taken for draining out the water while laying the floor finishes. The slopes and position of drains shall be as shown in the detailed drawings or as directed by the engineer.

2.7.5.1 Cement Concrete Floor

In the ground floor, the cement concrete floor shall be laid on a hard surface of either cement concrete or brick soiling. If the base is made of cement concrete, the flooring work shall commence within 48 hours of laying the base. If the base consists of brick soling, the surface shall be leveled with the used of brick ballast or concrete mixture before the concrete flooring is laid. The base shall be cleaned with brushes and wetted properly before the concrete flooring is laid.

In the first floor or upper floors where cement concrete floor is to be laid on R.C.C. slabs, the surface of the R.C.C. slab shall be made rough with brushes while the concrete of the slab is still green. The bases shall be provided with the slope required for the flooring as indicated in the drawings or as directed by the engineer.

2.7.5.2 Cement Floor (Cement Screed)

In the ground floor, the cement screed floor shall be laid on a hard surface of either cement concrete or brick soiling. If the base is made of cement concrete, the flooring work shall commence within 48 hours of laying the base. If the base consists of brick soling, the surface shall be levelled with the used of brick ballast or concrete mixture before the concrete flooring is laid. The base shall be cleaned with brushes and wetted properly before the cement screed flooring is laid.

In the first floor or upper floors where cement screed floor is to be laid on R.C.C. slabs, the surface of the R.C.C. slab shall be made rough with brushes while the concrete of the slab is still green.

The bases shall be provided with the slope required for the flooring as indicated in the drawings or as directed by the engineer.

2.7.5.3 Cement Floor Finishing (Cement Punning)

One layer of at least 12.5 mm thick cement sand plaster of the specified proportion shall be applied onto the surface of the cement concrete floors before cement punning. The cement plaster shall be laid according to the dimensions of the concrete floor panels and keeping the joints above the joints between the concrete floor panels. Such plaster shall be followed by a thin layer of at least 3.5 mm thick cement punning finishes of specified mix (1:1 cement sand mixture) and shall be finished with wooden or steel floats.

After laying the cement concrete floor, the surface shall be left undisturbed for about 2 hours after which it shall be covered with wet jute bags. Curing of the concrete by flooding water on the surface for at least 7 days shall commence only after 24 hours of laying the concrete.

The same brand of cement shall be used throughout and the same proportion is maintained strictly to have a uniform color. Junctions of the floor with wall plaster, dado and skirting shall be rounded of neatly.

Skirting work shall be of same mix and thickness of cement punning. Skirting work shall be done simultaneously with flooring work or as directed. Skirting work shall include racking, cleaning and wetting of the base as well as applying cement plaster and cement punning. The top edge of the skirting shall be champhered to prevent dust collection.

Curing and protection of cast in situ floor shall be in accordance with the requirements of Clauses 2.3.6.13 and 2.6.10.

2.7.5.4 Pointing

Pointing, if specified, shall be carried out in cement mortar not leaner than 1:3. The thickness of joints shall not exceed what is prescribed for each type of masonry. In the face works, the raked out joints up to a depth of at least 20 mm shall be filled with mortar of specified mix and of required consistency and then shall be well pressed and rubbed smooth.

2.7.5.5 Terrazzo Tiles

The tiles shall be socked in water for at least 2 hours before laying. Tiles which are to be fixed in the floor adjoining the wall shall be arranged so that the surface of the round edge tiles shall correspond to the skirting or dado. Neat cement grant of honey like consistency shall be spread over the bedding mortar just to cover so much area as can be tiled within half an hour. The edges of the tiles shall be smeared with neat white cement slurry and fixed in this grout one after the other, each tile being well pressed and gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. There shall be no hollows in the bed or joints. The joints shall be kept as close as possible and in straight lines. The joints between the tiles shall not exceed 4.50 mm wide. The joints shall be grouted with slurry of white cement.

Finishing of the skirting shall be in same material or different as specified in the specification and as directed by the engineer. All the top lines shall be in perfect line and level (if sloped regular). The vertical joints of the skirting in case the tiles are provided shall be in the regular pattern corresponding to the joints of floor. The parts of the walls where the tiles are to be provided shall be chiseled, rocked, brushed, and cleaned properly and cement mortar of the specified proportion is then provided. Other method of laying may also be used but only with the permission of the engineer.

Rubbing by carborendem stone at least three phase shall be carried out to give perfect finishes. The joints should be leveled and smooth as the terrazzo tiles.

Where full size tiles cannot be laid, they shall be cut (sawn) to the required size and the edges rubbed smooth to ensure a true and straight joint.

Joints in tile work shall be accurately aligned with horizontal joints level and vertical joints plumb. The joints shall be maintained uniformly wide by aligning spacer lugs on tile edges if tiles are so manufactured or by use of wetted strings.

The layout of tile work shall be so that no tile less than half size occurs. Where tiles must be cut at edges or penetrations, the cut edges shall be carefully fitted and neatly ground. No chipped, cracked, or broken tile shall be used and all defective work shall be replaced and repaired to the satisfaction of the Engineer and at the Contractor's expense.

After tiles have been set firm and joint strings removed, tiles shall be dampened and joints grouted full with a plastic mix of neat cement by trowel, brush, or finger application. Unless otherwise directed, grout shall be made with white cement. During grouting all excess grout shall be cleaned off the tile surface with damp cloth sponges.

Where the setting bed is applied directly to a concrete slab, the slab surface shall be thoroughly wetted, with no free water left standing, and sprinkled with dry cement. The setting bed shall be 1:4 cement mortar and shall be placed to the required level, grade and slope and tamped firmly.

All finishing tile work shall be adequately protected from damage during the progress of construction and any damage shall be repaired to the satisfaction of the Engineer at the Contractor's expense.

2.7.5.6 Ceramic Tiles

Wall and floor surface shall be brushed clean, wetted, and fitted with an approximately 12.5 mm thick level and plumb scratch coat of cement mortar 1:3 applied in accordance with Clause 2.6. The scratch coat shall be moist cured for at least 24 h before the application of a floating coat. Before applying this floating coat, the scratch coat shall be thoroughly wetted. The floating coat, a plastic mix of neat cement of approximately 3 mm thickness shall be applied even, and with screed to true plane. The floating coat shall be applied over areas no larger than can be covered with tiles while the mortar is still plastic (half set). Glazed tiles shall be soaked, completely immersed in clean water, at least 30 minimum and drained.

Tiles shall be installed by applying a skin coat of a plastic mix of neat cement to backs of tiles and firmly pressing them into the floating coat to true plane and position. White cement shall be used for the skin coat where white joints are required.

Tiles shall be installed by dusting a thin layer of dry cement over the setting bed worked lightly with trowel or brush until damp, and tiles shall than be set with straight uniform joints 1 mm or less in width, accurately aligned in both directions and tamped solidly to the bed.

During the process of setting tiles, continuous horizontal and vertical cuts every 40 to 60 cm shall be made through the floating coat while plastic, using the point of a trowel turned edge wise. Care shall be taken to prevent cutting into the scratch coat.

Where full size tiles cannot be laid, they shall be cut (sawn) to the required size and the edges rubbed smooth to ensure a true and straight joint.

Joints in tile work shall be accurately aligned with horizontal joints level and vertical joints plumb. The joints shall be maintained uniformly wide by aligning spacer lugs on tile edges if tiles are so manufactured or by use of wetted strings.

The layout of tile work shall be so that no tile less than half size occurs. Where tiles must be cut at edges or penetrations, the cut edges shall be carefully fitted and neatly ground. No chipped, cracked, or broken tile shall be used and all defective work shall be replaced and repaired to the satisfaction of the Engineer and at the Contractor's expense.

After tiles have been set firm and joint strings removed, tiles shall be dampened and joints grouted full with a plastic mix of neat cement by trowel, brush or finger application. Unless otherwise directed, grout shall be made with white cement. During grouting all excess grout shall be cleaned off the tile surface with damp cloth sponges.

Where the setting bed is applied directly to a concrete slab, the slab surface shall be thoroughly wetted, with no free water left standing, and sprinkled with dry cement. The setting bed shall be 1:5 cement mortars and shall be placed to the required level, grade, and slope and tamped firmly. Cement mortar at a rate of 4.4 kg per square meter shall then be spread. The floor tiles shall then be placed in position and tapped with a wooden mallet until the tiles are properly bedded in line and level.

Where the setting bed is applied over a waterproofing membrane, metal reinforcing wire mesh shall be installed lapped at least one full mesh at edges and supported so as to be located approximately mid-height of setting bed. At edges where wall tiles are foreseen, the mesh shall be turned up at least 80 mm.

All finishing tile work shall be adequately protected from damage during the progress of construction and any damage shall be repaired to the satisfaction of the Engineer at the Contractor's expense.

2.7.5.7 Waterproof Cement Paint

The contents of each fresh container of the paint shall be loosened by rolling or shaking the container before opening for the first time. To one volume of water in a clean container, an equal volume of cement paint shall be added and stirred well to achieve a uniform consistency. No further dilution will be permitted.

The cement paint powder shall be kept secured from exposure to atmosphere by properly tying up the polythene liner in the container and keeping the lid firmly closed.

The cement paint shall be used within two hours of mixing and shall be kept stirring during use.

For application, the base surface shall be cleaned by use of a stiff brush to remove loose dust and dirt. The base surface shall be thoroughly wetted and water allowed to run off.

The first coat shall be well brushed in a manner to give a good bond of the paint with the surface. The second and subsequent coats shall be brushed or sprayed as approved. The cement paint shall be applied at the following rate:

a) on brickwork	2 kg/m²
b) on in situ concrete	3.5 kg/m²
c) on concrete blocks	2 kg/m²
d) on cement sand rendering	3.2 kg/m²

The curing of the waterproof cement paint shall be carried out by application of fine water spray at an interval of 6 to 8 h after the application of the paint for duration of at least 7d.

The finished surface shall be protected from any damages, staining, etc., by approved means.

2.7.5.8 Oil bound distemper

All plaster surfaces shall be thoroughly cleaned and shall receive 3 or more coats. The first coat shall be a prime coat. The second and third coats shall be of oil bound distemper of approved colour, shade, and quality, and shall be mixed in accordance with the manufacturer's recommendations.

After these operations, if the work is not to the satisfaction of the Engineer, one or more coats shall be applied without extra cost to the Employer until a smooth and even surface is achieved and approved by the Engineer.

2.7.5.9 Distempering

Distemper shall be dry distemper as approved by the Engineer. The distemper shall be mixed with clean water as recommended by the manufacturer and shall be stirred until the mixture attains an even consistency.

The surface shall be cleaned, cracks and holes repaired, all irregularities and inequalities sand papered smooth and wiped clean to present a fine smooth surface which shall be completely dry before distempering is started.

The mixture shall be applied evenly with a brush in long parallel strokes evenly so as not to leave any visible brush marks.

The surface of this first application shall be allowed to dry and harden. Then the second coat shall be applied on the first coat. If a uniform surface is not achieved, a third coat shall be applied.

2.7.5.10 Plastic Emulsion Paint

The surface shall be prepared as specified for oil paints. First, a priming coat of primer as specified by the manufacturer shall be applied.

The second and third coats of plastic emulsion paint of approved shade and manufacture shall be applied to achieve an even surface. If the finish is not to the satisfaction of the Engineer, more coats shall be applied at no cost to the Employer to achieve a smooth and even surface.

2.7.5.11 Ready-mixed Enamel Paint

Surfaces to be painted shall be dry, free from dust and dirt, and rubbed smooth by means of sand paper or pumice stone to the satisfaction of the Engineer.

The paint shall be ready-mixed synthetic enamel or oil paint of approved make and manufacture. The primary coat (primer) shall be applied evenly with a brush. After the primary coat is applied and perfectly dried, all holes, cracks etc. shall be filled with putty and the surfaces sand papered (finishing touch in primary coat). A first coat of paint of approved shade and manufacture shall then be evenly applied and allowed to dry (after giving finishing touch to primer). The second coat shall be carefully applied as and when required, to achieve a smooth and even surface.

2.7.5.12 French Polish

The work shall be first cleaned and sandpapered thoroughly. It then will be painted with a `filler', composed of methylated spirit, and sandpapered.

A thin coat of French Polish shall then be applied and sand papered. Subsequent coats of French Polish shall be applied till the proper finishing is achieved to the satisfaction of the Engineer.

2.7.5.13 Roofing

A water proofing coating on bare reinforced concrete roofs shall be bitumen based and shall be applied in two layers of primer and one layer of finishing coat in accordance with the manufacturer's instructions and recommendations.

Such coating shall be applied by brushing, spraying, or roller application and shall be placed on concrete which has been cured and has reached an age of not less than 3 months.

If not otherwise shown on the drawings or directed by the Engineer, the prime coats shall be applied at a rate of approximately 0.85 l/m² and the final coat at a rate of about 1.2 l/m².

Care shall be taken in connection with drains, gutters, etc. to achieve proper flashing and lapping with the bitumen coating.

2.7.6 Tolerances

The tolerances for flooring work shall be as described in Clause 2.3.7, as applicable, unless otherwise agreed between the Contractor and the Engineer prior to the commencement of the work.

2.7.7 Measurement and Payment

Finishing work will be measured as the net areas covered and no deductions made for openings of area up to 0.10 m² or else unit as mentioned in BOQ. Separate items will be scheduled for each type of finish, and for different location of application, if such location will substantially effect the pricing.

2.8 Steel and Metalwork

2.8.1 Scope

This specification covers metalwork for structural steelwork, buildings, and other structures, it includes sundry items such as metal doors, and windows, ladders, stairs, handrails, open grid flooring, fences, railings, grills, gates etc.

2.8.2 Structural Steel Work

Structural steel work shall conform to the requirements of BS 449; steel shall comply with BS 15, BS 548, BS 968 whichever is appropriate and steel tubes for structural purposes shall comply with BS 1775 and shall be obtained from a manufacturer to the prior approval of the Engineer

Steelwork shall be thoroughly de-scaled to BS 4232 second quality and shall be painted with two coats of two pack epoxy based red lead primer before leaving the manufacturer's works. Any damage to this coating shall be repainted before erection.

2.8.3 Bolts and Nuts

Bolts, ragbolts, nuts and washers shall conform to BS 15 as regards material and BS 916 as regards dimensions. Each bolt shall be provided with two washers and bolts shall be long enough to show a full thread through the nut after fixing. All bolts, ragbolts, nuts and washers shall be hot-dip galvanized in accordance with BS 729.

2.8.4 Steel Chequered Plate

Chequer plating shall be mild steel and shall have a non-slip pattern on its upper face.

Chequer plates shall be securely bolted with countersunk screw studs to frames set in the edges of and spanning the ducts or opening. Chequer plates for use in valve chambers or manholes shall be hinged to one side of the frames unless otherwise specified.

The sizes of chequer plates shall be such that no discernible deflection occurs under the weights of a man standing upon it. Where it is not practicable to provide individual frames to each plate, the plates shall be stiffened by welding steel angles on their underside to eliminate discernible deflection. The plate panel sizes shall be such that they can be lifted by two men easily and each panel shall be provided with suitable sized lifting holes.

The edges of all chequer plates shall be finished straight or to the outline of obstructions and shall be free of burn marks or irregularities. Chequer plating which has been cut with a torch shall afterwards be ground to present a straight edge.

Chequer plating shall be thoroughly wire brushed and painted with two coats of two pack epoxy based red lead primer before delivery. After installation on Site chequer plates sued in valve chambers shall be painted with a further two

coats of two pack coal tar epoxy paint. Chequer plates used elsewhere shall be painted on the lower (hidden) upper (exposed) surfaces with one undercoat, two coats of semi-gloss high finishing paint of approved quality and colour.

2.8.5 Handrailing

Handrailings shall be made from hot-dip galvanized mild steel hollow sections and flats. After cleaning with lithoform, it shall be painted with two coats of two pack epoxy red lead primer, an undercoat and a further 2 coats of an approved gloss paint after installation. Expansion units shall be provided where the handrailings are more than 15 metre long.

Where safety chains are required, they are to be galvanised mild steel 10mm nominal size, short links, smooth welded chains in accordance with BS 4942 Part 2. Each length of chain shall be fitted with a shackle at one end and a nap fastening at the other.

The rates for handrailing shall include for painting and formation and subsequent grouting up of pockets in the concrete for stanchions.

2.8.6 Ladder

Mild steel ladders shall be hot-dip galvanised in accordance with BS 729. After cleaning with lithoform it shall be painted with two coats of approved two pack coal tar epoxy paint which shall be obtained from an approved manufacturer. Unless detailed on the Drawings, the Contractor shall submit to the Engineer detailed drawings of the ladder for approval before placing any orders.

Steel ladders shall be 450mm wide, of welded construction and shall not have an unsupported length of more than 2 metre. Intermediate support between the ends of the ladder shall be by means of stays securely fixed to the nearest part of the structure.

The steel ladders shall be galvanised before leaving the manufacturers' premises and the Contract Rates for supplying and fixing steel ladders shall include for painting as specified, and for all nuts, bolts, stays and other things necessary for fixing the ladders securely in place.

2.8.7 Step Irons

Steel irons for use in chambers shall unless otherwise specified be bent from 25mm diameter mild steel bars to the shape and dimensions shown on the Drawings and shall be hot-dip galvanised after bending. Step irons shall be measured by number and the Contract Rates for step irons shall include for the supply and all necessary fixing work galvanising and painting with 2 coats of approved two pack coal tar epoxy paint.

2.8.8 Fencing

Fencing shall be as detailed on the Drawings. If it is not mentioned in the drawings the Fencing shall be:

Chain link for fencing shall be PVC coated and consist of hot dipped galvanised 3.7mm wire of 50mm square mesh reinforced with 3 nos. 4.1 mm hot dipped galvanised line wires. Barbed wires shall be galvanised two ply 2.64 mm with 4 point barbs spaced at 75 mm interval.

Fence posts shall be of 64mm x 64mm x 9.4mm hot dipped galvanised mild steel angles spaced at 3.0 metre intervals with straining posts at all corners and at intervals of 15 metre. Stays for straining posts shall be 51mm x 51mm x 6.3mm hot dipped galvanised mild steel angles raked at 45. All mild steel angles shall be galvanised and painted in accordance with BS 5493. All fence posts and struts shall be sunk into post holes 300mm x 300mm x 750mm deep, and filled in with Grade 20 concrete to be flushed with ground level.

Suitable gate as shown in the drawings shall be provided to match the fencing. This gate shall be complete with lock gears and a 75mm lock of approved brand. Four (4) keys shall be provided for the locks.

The Contract Rates for fencing and gate shall include for the supply of all materials, galvanising, excavation, erection of the fencing complete painting with 2 coats of approved paint, fence posts, stays corner posts, concrete support and dwarf walls. Payment will be made for the net length of fencing and number of gate erected.

2.8.9 Aluminium Structures and Sections

Aluminium structures shall be constructed in alloy NE8M to BS 1474. Cold working shall be avoided. All hollow boxed and pressed sections shall be extruded from fully heat treated aluminium alloy and etched and anodised in bronze colour to BS 1615. Recesses on internal faces of boxed sections shall be finished with a strip of 13mm x 6.5mm black vinyl glued on. Where aluminium members are in contact with other non-aluminium structures the contact faces shall be protected by insulating pads of neoprene bitumen alloy.

2.8.10 Galvanized Metals

All metals to be galvanized shall be of the full dimensions shown or specified and all punching, cutting, drilling, screw tapping, welding and the removal of burrs shall be completed before the galvanising process commences.

All galvanizing shall be done by the hot-dip process with spilter, not less than 98% of which shall be pure zinc. Bolts, nuts and washers shall be completely galvanized including the threads but galvanizing removed in the course of nut fixing may be replaced with an approved zinc rich paint.

The galvanizing shall be uniform, clean, smooth and as free from spangle as possible. It shall weigh not less than 6.00 grams per square meter of area covered and be not less than 0.1mm thick.

All galvanized metal parts shall be protected from damage due to electrolytic action, white rust and abrasion during delivery, storage and erection. Minor damage shall be touched up with an approved zinc chromate or other approved metallic compound but if, in the opinion of the Engineer the damage to the galvanizing is too severe or extensive the part shall be removed and be re-galvanized.

2.8.11 Dissimilar Metals

The Contractor shall not use fixtures and fittings for metalwork including pipe-work in which dissimilar metals likely to lead to galvanic action are placed in permanent contact with each other.

2.8.12 Manhole Covers, Surface Boxes, etc.

Ductile iron manhole and access covers, surface boxes, gulley grating and frames shall be obtained from an approved manufacturer and shall comply generally with BS 497. Items not covered by this standard shall be of a quality equal to the first grade available in the country.

Access covers and surface boxes exposed to the weather shall incorporate a waterproof seal.

Frames shall be firmly bedded in 1:3 cement/sand mortar and the tops of all covers and gratings shall be flush with the finished surface of the surrounding floor, ground for pavement. Four sets of each type of lifting key shall be supplied by the Contractor.

2.8.12.1 Metal Doors, Windows, Ventilators, Glazed Shutters etc.

Glazed units shall be made from galvanized steel folded sheets sections, anodised extruded aluminium sections, or approved equivalent free from rolling defects.

All steel doors, windows and glazing shall conform to IS 4351 or equal approved with electro galvanized finish conforming IS 1570 unless otherwise directed. The doors, window and ventilation frame section are made of folded plate as per manufacturer's specification to conform to the drawings.

2.8.12.2 Window grills, fences, railing and gates.

Mild steel grill, fences, railing and gates of approved pattern and manufacture, all complete, shall be as shown on the drawings or as directed and shall comply with the requirements of IS 800 or equal approved.

2.8.12.3 Collapsible gates and rolling shutters.

These shall be double or single collapsible gates depending upon the size of the opening. The collapsible gates shall consist of vertical channels 20 x 5 mm and top and bottom rails of T-iron 40 x 40 x 6 mm with 38 mm dia. steel pulleys or ball bearings in every 4th double channels, unless otherwise specified. Where a collapsible gate is provided with the opening and is fixed along the outer surface the T-iron at the top may be replaced by flat iron 40 x 10 mm. The collapsible gate shall be provided with necessary bolts and nuts, locking arrangement, stoppers, and handles.

Unless otherwise ordered, the rolling shutters shall conform to IS 6248 and be suitable for fixing in the position ordered i.e. outside, inside, on or below lintel or between jambs. Shutters up to 12 m² in area shall be manually operated or push up type while bigger sizes shall be of reduction gear type mechanically operated by chain or handles. Laths shall be of 18 gauge best quality mild steel 75 mm wide strips interlocking, rolling centres, machine rolled and straightened with an effective bridge depth of 16 mm. Side guides and bottom rails shall be built up mild steel rolled sections. The spring assembly shall be supported on strong mild steel or malleable cast iron brackets shaped to fit the lintel. The rolling springs shall be from tested unbreakable high tensile steel wire or strip of adequate strength to balance the shutter in all positions. The shutter shall be complete with door suspension shafts, locking arrangement, pulling hooks, handles and other accessories.

2.8.12.4 Welding Consumables

Welding electrodes shall comply with, and shall be stored and handled in accordance with, the requirements set out in the relevant applicable standards (e.g. BS 639, IS 814). Welding consumables shall be such that they produce weld metal that has a minimum yield stress and minimum tensile strength at least equal to those of the parent metals.

2.8.12.5 Coating Materials

All coating materials and constituents shall be delivered in the manufacturer's original sealed containers which bear the manufacturer's labels. Each label shall display all the information necessary to ensure correct storage and traceability, and instructions for the application of the contents of the containers. Any container showing traces of leakage shall, before use, be rejected together with its contents.

The Engineer may require that the contents of any container be subjected to sample testing. All coating materials held in storage prior to use shall be kept in an approved store which shall be dry and enclosed. Care shall be taken to avoid the accumulation of old stock.

All Site stores used for the storage of coating material shall be provided with adequate fire extinguishers placed in a prominent and accessible position outside the entrances. "No smoking" signs shall be placed inside and outside such stores. No naked flames shall be permitted inside such stores.

Stores for coating materials shall not, at any time, be used for the accommodation of personnel.

2.8.13 Measurement and Payment

Work involving metalwork will be measured as specified relevant section of the specification or in BOQ, which will include all materials, fabrication, corrosion protection, and installation.

2.9 Carpentry and Joinery Works

2.9.1 Scope

This specification covers the general construction requirements for timber work, carpentry and joinery, required in general building construction (e.g. office building, guardhouse and operator's quarter at reservoir sites, etc.).

2.9.2 Interpretations

2.9.2.1 Supporting Specifications

The following specifications shall, inter alia, form part of and shall be read in conjunction with this specification:

a) 1 Item of General Application
b) 2.3 Cement Concrete
c) 2.4 Brickwork
d) 2.5 Stone Masonry Work, as applicable
e) 2.6 Cement plaster Works, as applicable

2.9.2.2 Application

This specification contains clauses that are generally applicable to timber works, carpentry and joinery for buildings and associated work.

2.9.3 Materials

Woodwork in doors & windows frames and shutters with good finish including fixing with necessary fixtures all complete as per drawing and instruction.

2.9.3.1 Timber

Timber for general purposes shall be approved hardwood of the best quality generally complying with IS: 1326, Grade1, or similar and planed on all sides. The timbers shall be impregnated with an odourless wood preservative. It shall be uniform in substance, straight in fiber, free from large, loose, dead and cluster knots, flaws, shakes, wasp, cup spring, twist, bends, saps and defects of any kind. It should be free from spongy, brittle, flaky or brushy condition, sapwood and bore holes.

All timber shall be seasoned and be free from decay, and harmful fungi and insect attacks and from any other damage or harmful nature which will affect the strength, durability, appearances or its usefulness for the purpose for which it is required.

The timber shall be of best quality timbers specified in the item. The samples of the timber to be used shall be submitted for the approval of the Engineer. The samples of the approved timber to be used shall be deposited in the office of Engineer for the purpose of comparison.

Treated lumber shall be accompanied by a certificate from a recognized lumber treating company, certifying the amount of treatment and the percentage of moisture after drying.

For the structural components which will be concealed after installation, e.g., in the case of built-in cupboards, wardrobes or wall linings, either the type of wood specified for the unconcealed structural components (spruce, fir, pine or a wood of at least equal quality) or an equally suitable material may be used at the Contractor's own choice, unless otherwise specified.

The timber shall be in a suitable condition so that the components made of it will neither crack, warp nor twist. The moisture content of timber assemblies when leaving the manufacturer's works shall be as follows (referred to the oven-dry weight):

a) 8 to 12% for interior finish components
b) 10 to 15% for structural parts in permanent connection with the outside air.

Proof of this moisture content shall be furnished to the Engineer.

For plywood and wood chip boards, all surfaces to be veneered or seal coated shall be adequately closed.

Wooden fiber boards, veneers, coating slabs and coating foils of plastics shall be suitable for their intended applications.

All coating materials shall form a good bond with the base. Their surface shall be readily brushable and insensitive to wiping contact.

All polish (polishing varnish) shall be fast to light and unsuitable condition so that it provides a surface which is elastic to the greatest possible extent and resistant to scratches, water, acid and heat.

2.9.3.2 Preservatives

All timber for carpentry and joinery placed in contact with masonry or concrete shall be given a coating of coaltar or cresote before being fixed in position. Wood preservatives shall be of an officially approved type. Where subsequent painting of the timber is required, the wood preservative shall be compatible with the paint. In interior applications, the wood preservative shall be odourless. The rates quoted for woodwork shall provide for such treatments.

2.9.3.3 Cover Moulds

In areas where the door or window frame are fixed flush with wall or plaster surface, teakwoods cover moulds of size 40 x 12mm shall be provided all round without an extra charge. The cover mould shall be given the same finish as the main frame, and overlap the masonry / plaster by at least 25mm.

2.9.3.4 Rebates

All door and window frames shall have cut rebates as per the drawings. Planted rebates shall not be allowed. The unrebated edges of the frames shall be rounded or chamfered as may be shown on the drawings. When not indicated on the drawings, they shall be beaded uniformly.

2.9.3.5 Post Keys

The vertical post of doorframes in the ground floor shall be embedded 25mm. On upper floors they shall be embedded in the floor slab by chiping a receptacle 12mm deep. The frames shall be installed in position and held plumb and level with strong supports from both sides as masonry works proceed.

2.9.3.6 Hold Fast

These shall be of M.S. flat with one end split into two and turned for anchorage into cement concrete blocks 1:2:4, the holdfasts shall be fixed to an adequately sized recess in the door frames with 30mm screws. There shall be one such holdfast on each side of frames of up 76 cm height, 2 on each side of frames upto 152 cm height. The position of the holdfasts shall be as shown on the drawings with minor adjustment to suit brick coursed or as directed by the Engineer. All holdfasts with concrete blocks shall be laid as the masonry work proceeds and not fixed afterwards. This concrete block shall neither be measured separately nor any deduction is made in brick work for these blocks.

Door frames when abutting on RCC member shall be fixed to RCC members with rawl plugs 50mm long and wooden screws of required sizes. Screws heads shall be sunk into frame and plugged properly.

2.9.3.7 Panelled Shutter

The shutter shall be paneled single, double, triple or more. The design, panels and the number of panels to be used shall be as per drawing or as per the direction of the Engineer. The styles shall be continuous from top to bottom. The top, freize, muntins or mullions shall be jointed to the styles and their muntins shall be jointed to the rail with wooden or bamboo pins or as directed by the Engineer. The thickness of the frame for the shutter varies depending upon the size of the door, situation and thickness of the panel as shown in the drawings or as directed by the Engineer. Grooves shall be made on all the inside faces of the frames to receive panels. Before fixing the panels in the grooves of styles, rails etc. plaster of white zinc shall be treated on the panel for proper adhesion.

Mortice and tenon joints between the styles and the top frienze, the muntins and rails shall be to the full width of the member. The tenon shall not be less than 12mm thick and shall be glued into the mortices inaddition to being pinned with wood dowels of not less than mm diameter. If mortices are tapered, the tenons may be wedged into them.

Each panel shall be in a single width piece, the contractor shall endure that the solid panels shall have their grains running along the layer dimensions.

Grooves in stile for panel fixing shall be 12mm wide and at least 20mm deep, panel edges shall be coated with and approved glue prior to insertion into the groove. Care shall be taken to see that there is no gap between the panel face and the sides of the groove.

The clearances between the finished shutter and the door frames and between the shutters themselves (when couble leafed) shall not exceed 3 mm unless otherwise specified in the drawings.

2.9.3.8 Flush Door Shutter

Unless specified elsewhere or otherwise directed, door shutters shall be of veneered plywood of thickness not less than 4.5mm or plain galvanized sheet of 18 standard wire gauge. The thickness of the frame for the shutter varies depending upon the size of the door, situation and thickness of the panel as shown in the drawings or as directed by the Engineer. Sheets shall be flushed on both sides of wooden frame as per drawings. The beading shall be of solid timber of any of the species mentioned in Table 3 of IS: 2202 (Part I) -1966. The beading shall be to the full thickness of the door. The depth of beading all round shall be not less than 25 mm excluding the tongue and brew joint using BWR type adhesives conforming to IS:848-1956, and the beading shall be further secured by additional screws of adequate length. The tongue shall not be less than 12 mm deep and its width shall not be less than 1/3 of the finished thickness of the shutter.

The timber used for beading for flush doors with decorative face shall preferably be of the same species as the face veneers unless otherwise mentioned. Samples of such shutters shall be submitted for approval.

Each sheet on the flush door shall be in a single width piece. The clearances between the finished shutter and the door frames and between the shutters themselves (when couble leafed) shall not exceed 3 mm unless otherwise specified in the drawings.

2.9.3.9 Fixtures & Fastening

Unless specified elsewhere or otherwise directed, every leaf of door and window shutter should provided and find fixed in position with following fixtures & fastening. All fittings shall be submitted to the Engineer in good time for approval.

Description of Fixtures	Door Leaf	Window Leaf
Brass or mortise lock of approved size and quality	1 No.	Nil
Hinges, 150mm long with screw	3 Nos. (150 mm long)	(2 Nos. 100 mm long)
Aluminum tower bolt with screw	2 Nos. (300 mm long)	2 Nos. (200 mm long)
Brass handle with screws	2 Nos (150 mm long)	1 Nos (100 mm long)
Rubber buffer stops with screws	2 Nos	Not Necessary
Aluminum locking pin (restricting window leaf movement during wind)	Not Necessary	1 No. (125 mm long)

All fixtures shall be fixed to the jointing in a secure and efficient manner. Any of the fixtures damaged during fixing shall be removed and new ones fixed in their place and the surface of the joinery made good where affected at the Contractor's expenses. When the type is not mentioned on the drawing it shall be as directed by the Engineer.

If detailed drawing specifies different types of fixture, the work shall be carried out according to the drawing. Screw shall be suitable length & cover diameter & shall be fixed with screws driven & not by hammers.

2.9.4 Construction Equipment

Equipment and tools for the execution of timber work, carpentry and joinery shall be sufficient in number and capacity, in good working order, and in accordance with the requirements of the applicable safety regulations.

2.9.5 Construction and Workmanship

If not otherwise shown on the drawings, or directed by the Engineer, DIN 18334 shall be binding for the execution of the Works as well as the other DIN Standards as follow:

a) DIN 1052 Timber Structures
b) DIN 68365 Timber for Carpenters' Work, Quality Specifications
c) DIN 4074 Timber for Wood Building Components
d) DIN 68800 Timber Protection in Building Construction
e) DIN 17440 Stainless Steel; Quality Specification
f) DIN 18202 Dimensional Tolerances in Building Construction,

Timber as specified shall be jointed and erected in accordance with DIN 1052 and the drawings, including the required wind bracing. Posts shall be fixed to the concrete slab by means of bearing plates, straps and angles according to the structural calculations. Only non-rusting steel according to DIN 17440, Material No. 1.4571 shall be used for fixing components.

The Contractor shall supply to the Engineer shop drawings in accordance with the architectural design and Contractor's static analysis, which are subject to approval before any execution starts.

All structural components shall not warp or crack under any circumstances including stresses due to temperature and humidity that will have to be expected.

All timber connections and metres shall be accurately fitted. The surface exposed to view shall be trimmed, eg by planing and grinding. There shall be no plane cutting marks.

Solid timbers shall be joined in such a way that in the event of variations of air humidity, the wood is free to swell and shrink without affecting the joint.

Framing timbers shall not be butted. Dovetailing may be used subject to the Engineer's consent.

All edge surfaces of plywood, plain galvanized sheets and composite shutter exposed to view shall be veneered or provided with banding (insets or strips). On sealed, veneered and coated surfaces joints and irregularities of the base shall not show even after final drying.

All grained veneers and Plain Galvanized sheets shutter shall be protected against tearing. All timbers ultimately in contact with outside air, or permanently in contact with particularly humid air, or connected to masonry or concrete, shall be treated on all sides with suitable wood preservative before being inserted. The manufacturer's instructions shall be observed.

2.9.6 Test and Acceptance

A selection of samples for visual inspection and dimensional checks on material and fittings may be made by the Engineer. Supplier's material and test certificates pertaining to the material to be used shall be supplied to the Engineer by the Contractor. The Engineer shall have access at all reasonable times to all places where the work is being carried out and shall be provided with all the necessary facilities for inspection during all stages of manufacture or construction.

2.9.7 Measurement and Payment

Generally, the items shall be measured in-situ. The method of measurement shall be based on the following:

Unless stated otherwise in the BOQ, payment for windows and doors shall be made by number for each type and size. If items scheduled call for measurement by area, architraves linings, sills etc. shall not be measured separately but shall be considered as being included in the area of the opening closed by the window, door, shuttering or any other specified closure.

Wall panels or linings will be paid for by area. The unit rate shall include all substructure, fasteners, doweling etc.

Built-in cupboards, cabinets and wardrobes will be paid for separately according to types and dimensions, by covered rear wall area.

Surface treatment will be paid separately at the area treated.

All costs for hardware and iron ironmongery shall be included in the unit rate of the relevant bill item.

2.10 Roads and Parking Areas

2.10.1 Scope

This specification covers the construction of new roads, parking areas and reinstatement of Roads, Bridges and Culverts.

2.10.2 Interpretations

2.10.2.1 Supporting Specifications

The following specifications shall, inter alia, form part of and shall be read in conjunction with this specification:

a) 1.1 General
b) 2.1 Site Clearance
c) 2.2 Earthworks

2.10.2.2 Application

This specification contains clauses that are generally applicable to construction of new roads, parking areas and reinstatement of Roads, Culverts, and Bridges.

2.10.3 Materials

2.10.3.1 Classification for excavation purposes

All excavations for new roads and parking areas will be classified as set out in Clause 2.2.3.1.

2.10.3.2 Classification for placing purposes

All materials for new roads and parking areas will be classified as set out in Sub-section below:

2.10.3.2.1 Fill for Embankments

Fill for embankments shall comply with the provisions of Clause 2.2.3.2.

2.10.3.2.2 Sub-base and Gravelling

The grading of material shall be a smooth curve within and approximately parallel to the envelope given in table 2. 10.

The plasticity index shall not exceed 6.

The minimum 4 day soaked CBR of the material shall be 30% at the specified in situ density.

Table 2-8: Grading Envelope

Sieve Size (mm)	**Percentage by weight passing**	
	Type A	**Type B**
63	100	-
50	-	100
37.5	65 – 95	80 – 100
20	50 – 85	60 – 100
10	40 – 75	-
5	30 – 60	30 – 100
2.36	20 – 45	-
1.18	15 – 37	17 – 7
0.3	-	9 – 50
0.075	4 – 15	5 – 25

2.10.3.2.3 Water Bound Macadam

Coarse aggregates - Coarse aggregates shall be crushed or broken stone. The aggregates shall conform to the physical requirements set forth in Table 2.11.

Table 2-9: Physical requirements of Coarse Aggregates for Water Bound Macadam for Base Course

Los Angeles Abrasion Max	45
Flakiness Index Max.	35
Aggregate Impact Value Max	35

The crushed or broken stone shall be hard, durable, and free from excess flat, elongated, soft, and disintegrated graded particles, dirt, and other deleterious material.

The coarse aggregate shall conform to the gradings given in Table 2.12.

Table 2-10: Grading Requirements of Coarse Aggregates

Sieve Size (mm)	Per cent Passing by Weight		
	Grading 1	**Grading 2**	**Grading 3**
125	100	-	-
90	90 – 100	100	-
63	25 – 60	90 – 100	100
53	-	25 – 75	95 – 100
45	0 – 15	0 – 15	65 – 90
22.4	0 – 5	0 – 5	0 – 10
11.2	-	-	0 – 5

Screenings - Screenings to fill voids in the coarse aggregate shall generally consist of the same material as the coarse aggregate. However, predominantly non-plastic crushed rock fines or natural angular pit sand may also be used for this purpose provided the liquid limit and plasticity index of such material are below 20 and 6 respectively and the fraction passing 0.075 mm sieve does not exceed 10 percent.

Screenings shall conform to the grading set forth in Table 2.13. Type A screening shall be used with Grading 1 and 2 coarse aggregates. Type B screening shall be used with Grading 2 and 3 coarse aggregates.

Table 2-11: Grading for Screenings

Sieve Size (mm)	Per cent Passing by Weight	
	Type A	**Type B**
13.2	100	-
11.2	95 – 100	100
5.6	15 – 35	90 – 100
0.180	0 – 10	15 – 35

2.10.3.2.4 Prime Coat

The prime coat shall consist of a medium curing cut-back bitumen complying with IS 217-1961 from a source approved by the Engineer.

2.10.3.2.5 Asphaltic Concrete

(a) Coarse Aggregate

Coarse Aggregate is defined as all material retained on a No. 12 U.S. Sieve (No. 10 B. S. 1.68 mm). It shall consist of broken stones or crushed gravel. It shall be of reasonably uniform quality throughout, clean, free from dust, and flat or elongated pieces. Rock and gravel shall have a per cent of wear in the Los Angeles Abrasion Test (500 revolutions) not exceeding 50 for base or intermediate coarse material or 40 for surface coarse material. The aggregate shall fall within the grading limits set out in Table 2.14. Material passing the No. 10 U. S. Sieve and retained on a No. 200 U. S. Sieve shall in laboratory tests and for the purpose of proportioning the mixture be treated as Fine Aggregate. In a like manner, material passing the No. 200 Sieve shall be considered as mineral filler. Should the coarse aggregate material and the fine aggregate material contain so little material between the No. 4 and No. 10 sieve that upon combination of the two the resulting percentage of this fraction is less than the minimum specified Table 2.15 such deficiency shall be made up by the addition of stone screenings or coarse sand of the appropriate particle size.

Table 2-12: Asphaltic Concrete, Grading Limits of Coarse Aggregate

U.S. Sieve Size		Mix Number and Percent Passing by Weight				
Inches	**mm. Approx.**	**I**	**II**	**III**	**IV**	**V**
2 ½"	63.5	100				
2"	51	95-100	100			
1½"	48	-	95-100	100		
1"	25	25-70	-	90-100	100	
¾"	19	-	35-70	-	90-100	100
½"	13	10-30	-	25-60	-	90-100
3/8"	9.5	-	10-30	-	20-55	40-75
No. 4	6.5	0.15	0.15	0.15	0.15	0.15
No. 10	1.5	0-5	0-5	0-5	0-5	0-5

(b) Fine Aggregate

Fine aggregate is defined as all material passing the No. 10 and retained on the No. 200 sieve. It shall consist of sand or stone screenings, or a mixture of the two, composed of clean tough rough surfaced grains, free from clay, loam and other foreign matter, together with particles which pass a No. 10 sieve which may be contained in the Coarse Aggregate material. As delivered to the mixer it shall be free of lumps or loosely bonded aggregations. The grading shall fall within the limits set out in Table below.

Table 2-13: Asphaltic Concrete, Grading Limits of Fine Aggregate.

U.S. Sieve Size		**Percent by Weight**
PASSING	**RETAINED**	
No. 4	-	98-100
No. 4	No. 10	0-15
No. 10	No. 40	15-50
No. 40	No. 80	30-60
No. 80	No. 200	15-40
No. 200	-	0-5

(c) Mineral Filler

Mineral filler is defined as all material passing the No. 200 sieve. It shall consist of thoroughly dry limestone dust, cement or other mineral dust approved by the Engineer. As delivered to the mixer it shall be free from lumps and loosely bonded aggregations. The grading shall fall within the limits set out in Table 2.16.

Table 2-14: Asphaltic Concrete, Grading Limits of Mineral Filler

U.S. Sieve Size	Percent Passing by Weight
No. 30	100
No. 100	Not less than 85
No. 200	Not less than 65

Material retained on the No. 200 sieve shall be considered as Fine Aggregate for the purposes of grading analysis and mix proportioning.

(d) Binder

The Binder shall be straight run bitumen of 80-100 penetration complying with IS 73-1961.

Samples of the bituminous materials that the Contractor proposes to use, together with a statement as to their source and character shall be submitted and approved before use of such material. The Contractor shall require the manufacturer or producer of the bituminous materials to furnish material subject to this and all other pertinent requirements of the Contract. Only satisfactory materials, so demonstrated by service tests, shall be acceptable.

The Contractor shall furnish vendor's certified test reports for each load of bituminous material shipped to the Project. The report shall be delivered to the Engineer before permission is granted for use of the material. The furnishing of the vendor's certified test report for the bituminous material shall not be interpreted as basis for final acceptance. All such test report shall be subject to verification by testing samples of materials received for use on the Project.

2.10.3.2.6 Chippings

Chippings/Cover aggregate for surface dressing specified in the relevant items of the Bill of Quantities shall be obtained from a source approved by the Engineer and shall be natural screened gravel or crushed hard rock/stone, clean and free from adhering dust, achieved by washing and drying, or any other detrimental substance that could impair the adhesion of bitumen. The size of the chippings shall be as specified in the relevant item in the Bill of Quantities.

The flakiness index and elongation index of the chippings, when tested in accordance with B.S. 812, shall not exceed 40. The aggregate crushing value (ACV), when tested in accordance with B.S. 812, shall not exceed 35. The Los Angeles abrasion value (LAV) of the chippings shall not exceed 40.

Cover aggregates/Chippings shall be stockpiled in their separate sizes on a clear hard well drained area. The stockpiles shall be covered with tarpaulins or other suitable cover during periods when rain is expected. Grading of the chippings shall be as specified in the Table 2.17.

Table 2-15: Grading Requirements of Chippings

Sieve Size	Percentage Passing for nominal chippings size			
mm	20 mm	14 mm	10 mm	6 mm
28	100	-	-	-
20	85 – 100	100	-	-
14	0 - 25	85 - 100	100	-
10	0 - 7	0 - 25	85 - 100	100
6.3	-	0 - 7	0 - 20	85 - 100
4.75	-	-	0 - 10	-
4.0	-	-	-	0 - 20
2.80	0 - 2	0 - 2	0 - 2	0 - 10
0.075	0 - 1.5	0 - 1.5	0 - 1.5	0 - 1.5

2.10.4 Construction Equipment

2.10.4.1 General

The relevant requirements of Clause 2.2.4 shall apply.

2.10.4.2 Mixing Equipment

The mixing equipment to be used for asphaltic concrete shall be approved by the Engineer. The Contractor shall provide such attendance, access to the equipment and testing facilities as the Engineer may require at any time for the verification of the weights or proportions, character of materials and determination of temperatures used in the preparation of the mixture. The binder shall be heated to a temperature of 150ºC (302ºF) at the equipment.

2.10.4.3 Binder Distributors

Distributors shall be of constant volume or preferably constant pressure type, self-propelled, equipped with pneumatic tyres and have a minimum binder capacity of 4000 litres and each machine shall require the approval in writing of the Engineer for use in constructing the Works.

Distributors shall be equipped with low range speedometer (fifth wheel) in good working condition, so located to be visible to the driver to enable him to maintain accurately the constant speed for spraying binder at the uniform specified rate. They shall be fitted with either a calibrated pressure gauge which accurately records the pressure of the bitumen at the spray bar for constant pressure distributors, or a binder pump delivery meter for constant volume distributors. Binder pumps shall be capable of maintaining constant pressure or constant volume during spray runs.

Distributors shall be fitted with burners in combination with a circulating pump capable of maintaining the bitumen without overheating within the specified temperature range and an accurately calibrated thermometer for indicating the spraying temperature of the bitumen.

The spray bar shall be capable of applying bitumen binder to a minimum width of 2.30 meters with provision for application of lesser widths by closing jets. The spray bar shall have the capability of being raised and lowered to specified heights above the road and of being adjusted so that it is parallel with the road surface. The distributors shall be so designed to allow the circulation of hot binder through the spray bar when not spraying.

Spray bars shall be fitted with either slotted spray jets or preferably whirling spray jets, whose essential features are the ability to spray binder uniformly at the specified rate of spray, such that the speed of the distributor can be matched by the following chipping spreader during its normal chip spreading operation. If whirling spray jets are fitted the spray bar shall be protected by a hood to reduce wind interference. Distributors shall be fitted with hand-lances with nozzle spray attachments for spraying small, inaccessible areas and to correct deficiencies in the spray rate.

Prior to surface dressing operations, distributors shall be checked for leakages from spray jets and any other sources and these shall be eliminated. Distributors shall then be calibrated by a method approved by the Engineer and under his supervision, to establish uniformity of lateral spray of bitumen to within ±10% permitted variation at any point on the surface from the mean spray rate. This calibration includes setting the spray bar height above the surface to be sprayed, in accordance with the manufacture's instructions, so as to ensure that the designed overlap of jets is achieved. All spray jets shall be functioning so that each jet requirement has been achieved. Calibration shall be undertaken in accordance with the manufacturer's instructions or in accordance with TRRL-ORN 3 - Section 6.3 Distributor Speed Control and Calibration - to establish the relationship between spray rate and road speed for constant pressure distributors and in addition, bitumen pump delivery rate and spray bar width for constant volume distributors. The distributors shall be

capable of achieving a mean spray rate measured by the TRRL-ORN 3 Method B, which shall not vary by more than 5% from the specified spray rate.

Chip-spreaders: Mechanical chip-spreaders shall be capable of spreading the chippings uniformly over variable widths, from 0.5 to 3.5 m, at the rates specified.

The number and output of chip-spreaders shall be sufficient to ensure that chippings are spread immediately after the bituminous binder has been applied. Chip-spreaders shall be checked and calibrated before starting any work or when required by the Engineer.

Rollers: The main rolling shall be carried out with self-propelled pneumatic tyred rollers, having a wheel-load of more than 2 tonnes. The tyres shall be smooth and their pressure shall be more than 0.4 N/mm2.

The number and output of rollers shall be sufficient to ensure that rolling does not lag behind spreading. To the extent possible, at least two pneumatic tyred rollers shall be used for each chip-spreader.

Miscellaneous Equipment: Sufficient trucks and loading machinery shall be employed to ensure an adequate, prompt and continuous supply of chippings. Rubber tyred mechanical rotary brooms towed by or mounted on rubber tyred vehicles shall be provided. Tractor toed air compressor with sufficient length of hose pipes and air jet nozzle shall be provided to ensure sufficient cleaning of surface to be sprayed with bituminous layers

2.10.5 Construction and Workmanship

2.10.5.1 General

With regard to safety, existing services, nuisance, dealing with traffic etc., the relevant requirements of Clause 2.2.5 shall apply. With regard to site clearance and stripping of site, the relevant requirements of Clauses 2.1 and 2.2 shall apply.

The subgrade and sub-base shall be kept continuously drained and any damage caused by water accumulating on or running off the surface shall be made good at the Contractor's expense.

Should water accumulate on any part of the subgrade or subbase, the Contractor shall remove and dispose of any material which becomes saturated, or cannot then be compacted to the required density, and shall replace it to specification, all at his own expense.

2.10.5.2 Compaction

Before commencing construction and from time to time as may be considered necessary by the Engineer, the Contractor shall carry out compaction trials in the presence of the Engineer on each main type of materials to be compacted in the Works. He shall carry out all necessary laboratory and field tests and supply the Engineer with full copies of the results of all tests.

Following completion of the compaction trials, the Contractor shall submit to the Engineer, for his approval, proposals for the compaction of each main type of material. The Contractor's proposals shall include reference to the type of equipment, the operating weights, and the method of adjusting moisture content.

If, in the opinion of the Engineer, the results of the compaction trials indicate that the Contractor's proposed equipment and methods will achieve the densities specified, the Engineer will approve the same. Otherwise the Contractor shall submit in writing proposals for modifying the equipment and/or methods and shall, if the Engineer so requires, compact further trials in accordance with these modified proposals until the Engineer approves the Contractor's proposals.

2.10.5.3 Cut and Borrow

Cut and borrow shall be carried out in accordance with Clause 2.2.5.2

All cuts carried below the designated level or the bottom of the subbase shall be backfilled with suitable material that has a CBR of at least 7% and compacted at the Contractor's own expense. The Contractor shall conserve all suitable material and shall not borrow, spoil, or waste any material without approval of the engineer.

2.10.5.4 Formation of Embankment

This work shall consist of the construction of embankment and other areas of fill and backfill not specified elsewhere by providing, placing, compacting and shaping suitable material of acceptable quality obtained from approved sources and to the lines, levels, grades, dimensions and cross-sections on the drawings or as required by the Engineer.

Prior to placing any embankment upon any area all clearing and grubbing activities shall be completed in accordance with Clause 2.1. Topsoil shall be removed and stockpiled for later use. Prior to the placing of any materials for formation of the embankment, the sub-grade after removal of top soil shall be leveled to a specified grade as per the drawing or the engineers instructions and the top 15 cm shall be watered if necessary and compacted to 93% of the modified AASHTO maximum dry density.

All earthwork material placed in or below embankments, below formation level in cuttings or elsewhere in the Works shall be deposited and compacted in layers of thickness appropriate to the compaction equipment and confirmed by the compaction tests. The embankment materials shall be compacted to a minimum 93% of modified AASHTO maximum dry density and to 95% in the top 30 cm below formation or sub-grade level.

Isolated boulders each within the range 0.05 cubic meter to 0.1 cubic meter in size may be incorporated in embankments not of rock fill at the discretion of Engineer provided that the specified compaction requirements are met and no stone exceeding 0.05 cubic meter shall be placed less than 1 meter below formation level of carriageway or hard shoulder.

Rock used in rock fill embankments shall except for any specified external cover to slopes or near formation level, be of such size that it can be deposited in horizontal layers each not exceeding 450 mm in loose depth and extending over the full width of the embankment. Material shall be spread and levelled by a crawler tractor weighing not less than 15 tonnes and compacted as specified above. Each layer shall consist of reasonably graded rock and all surface voids shall be filled with broken fragments before the next layer is placed. The top surface and side slopes of embankments so formed shall be thoroughly blinded with approved fine graded material to seal the surface. Such material on side slopes and verges shall be top soil.

All materials used in embankment and filling elsewhere shall be compacted as soon as practical after deposition

Hand compaction shall be allowed only on restricted areas.

2.10.5.5 Sub-base and Gravelling

The material shall be deposited in such quantity and spread in a uniform layer across the full width required, so that the final compacted thickness is nowhere less than shown on the Drawings or instructed by the Engineer. Every reasonable effort shall be made to prevent segregation after mixing and during the dumping, spreading, trimming, and compacting operation.

The compacted thickness of any layer laid, processed, and compacted at one time shall not exceed 150 mm and where a greater compacted thickness is required, the material shall be laid and processed in two or more layers. The minimum layer thickness shall be 80 mm.

The material shall be broken down to the grading specified in Table 2.10. Any oversize material which cannot be broken down to the required size shall be removed and disposed of.

The material shall be scarified and the moisture content adjusted by either uniformly mixing in water or drying out the material such that the moisture content during compaction is between 95% and 100% of the Optimum Moisture Content. It shall be graded and trimmed to final line and level. Light compaction may be applied before the final trim is carried out but once 25% of the compaction has been applied no further trimming or correction of surface irregularities will be allowed.

The final trim shall be in cut and the Contractor shall ensure that material from the trim is neither deposited in low areas nor spread across the section but graded clear of the Works. Following the final trim the material shall be compacted to a dry density of at least 95% of modified AASHTO maximum dry density. During the grading, trimming and compaction of the material the Contractor shall ensure that the surface and/or the material does not dry out by applying fog sprays of water or other approved means sufficient to maintain the surface and/or material within the specified limits of moisture content.

On completion of compaction, the surface shall be well closed, free from movement under compaction equipment, and free from compaction planes, ridges, cracks, loose or segregated material.

2.10.5.6 Water Bound Macadam Base

2.10.5.6.1 General

This Clause covers the construction of base course from clean, crushed aggregates mechanically interlocked by rolling and bonded together with screening material and water laid on a properly prepared sub-base and finished in accordance with the requirements of these specifications and in close conformity with the lines, grades, cross sections and thickness as per approved plans or as directed by the Engineer.

2.10.5.6.2 Preparation of Base

The surface of the sub-base base to receive the water bound macadam course shall be prepared to the specified lines and crossfall and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm surface is achieved. Sub-base/base surface irregularities, where predominant, shall be made good by providing appropriate type of profile corrective course.

2.10.5.6.3 Spreading Coarse Aggregates

The coarse aggregates shall be spread uniformly and evenly upon the prepared sub-base to proper profile by using templates placed across the road about 6 m apart, in such quantities that the thickness of each compacted layer is not

greater than 100 mm for Grading 1 coarse aggregate and 75 mm for Grading 2 and 3 coarse aggregates (Table 2.12). Aggregates placed at locations which are inaccessible to the spreading equipment, may be spread in one or more layers by any approved means so as to achieve the specified results.

The spreading shall be done from stockpiles along the side of the roadway or directly from vehicles. In no case shall the aggregates be dumped in heaps directly on the surface prepared to receive the aggregates nor shall hauling over uncompacted or partially compacted base be permitted. No segregation of large or fine particles shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pockets of fine material.

The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregates as may be required. The surface shall be checked frequently with a straight edge while spreading and rolling so as to ensure a finished surface as per approved plan.

The compacted thickness of any layer laid, processed and compacted at one time shall not exceed 150 mm and when a greater compacted thickness is required, the material shall be laid and processed in two or more layers. The minimum layer thickness shall be 80 mm.

2.10.5.6.4 Rolling

Immediately following the spreading of the coarse aggregate, rolling shall be started with vibrator rollers of 12 to 20 ton capacity of approved type.

Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the center. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to the centerline of the road, in successive passes uniformly lapping preceding tracks by at least one half widths.

Rolling shall be discontinued when the aggregates are partially compacted with sufficient void space in them to permit application of screenings. During rolling, slight sprinkling of water may be done, if necessary. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wave-like motion in the sub-grade or sub-base course.

The rolled surface shall be checked transversely and longitudinally, with templates and any irregularities corrected by loosening the surface, adding or removing necessary amount of aggregates and re-rolling until the entire surface conforms to desired crossfall and grade. In no case shall the use of screenings be permitted to make up depressions.

Material which is crushed excessively during compaction or becomes segregated shall be removed and replaced with suitable aggregates.

The minimum dry density to be achieved as a percentage of the Maximum Dry Density (MDD) determined in accordance with IS 2720 Part 8 shall be 98% of MDD.

2.10.5.6.5 Application of Screenings

After the coarse aggregate has been rolled as above, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregate. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motions of hand shovels or by mechanical spreaders, or directly from tipper with suitable grit spreading arrangement. Tipper operating for spreading the screenings shall be so driven as not to disturb the coarse aggregate.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms, hand-brooms or both. In no case shall the screenings be applied so fast and thick as to form cakes of ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregate.

The spreading, rolling, and brooming of screenings shall be carried out in only such lengths of the road which could be completed within one day's operation.

The final trim shall be in cut and the Contractor shall ensure that material from the trim is neither deposited in low areas nor spread across the section but graded clear of the Works. During the grading, trimming and compaction of the material the Contractor shall ensure that the surface and/or the material does not dry out by applying fog sprays of water or other approved means sufficient to maintain the surface and/or material within the specified limits of moisture content.

2.10.5.6.6 Sprinkling of Water Grouting

After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screenings into voids and to distribute them evenly. The sprinkling, sweeping and rolling operation shall be continued, with additional screenings applied as necessary until the coarse aggregate has been thoroughly keyed, well-bonded and firmly set in its full depth and a grout has been formed of screenings. Care shall be

taken to see that the base or sub-grade does not get damaged due to the addition of excessive quantities of water during construction.

2.10.5.6.7 Setting and Drying

After the final compaction of water bound macadam course, the pavement shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam has set. The Engineer shall have the discretion to stop hauling traffic from using the completed water bound macadam course, if in his opinion it would cause excessive damage to the surface.

The compacted water bound macadam course should be allowed to completely dry and set before the next pavement course is laid over it.

2.10.5.7 Prime Coat

2.10.5.7.1 General

A Bituminous Prime Coat shall consist of an application of bituminous material on the prepared non-bituminous surface like base course, shoulder, before any further bituminous layers are applied in accordance with this specification, applied at the rate specified below or any modification instructed by the Engineer.

2.10.5.7.2 Weather

The prime coat shall be applied only when the existing surface is dry or sufficiently low in moisture to assure uniform distribution of the bituminous material, when the atmospheric temperature is above 15ºC, and when the weather is not foggy or rainy. The temperature requirements may be waived, but only when so directed by the Engineer.

2.10.5.7.3 Application

The amount of bituminous material for the prime coat shall be 1.0 kg/m2 (net bitumen) or as directed by the Engineer. Prior to the application of prime coat to any area of the Permanent Works, the Contractor shall carry out trials to determine the rates of spread of binder. In the course of such trials by the Contractor the Engineer may amend the rate of spread of binder.

Immediately before applying the prime coat, the full width of the surface to be primed shall be swept with a power broom or other method approved by the Engineer to remove all loose dirt and other objectionable materials.

The application of the bituminous material shall be made by means of a pressure distributor at the temperature, pressure and in the amount directed by the Engineer. The application temperature shall be generally in the range of 50-60º C for MC-30 and 65-80º C for MC-70.

Following the application, the primed surface unblinded shall be allowed to cure, as agreed with the Engineer, without being disturbed. If after 24 hours the asphalt prime is not absorbed, sand shall be applied to blot up excess asphalt until the primed surface will not be picked up by traffic or equipment. Blotting material, where required, shall be to the approval of the Engineer and shall consist of clean, dry sand free from cohesive material and containing no organic matter. Blotting material shall not be paid for as a separate item. This period shall be determined by the Engineer. The surface shall then be maintained by the Contractor until the surfacing has been placed. Prime coated surfaces damaged by traffic shall be repaired by the Contractor without additional payment, in a manner instructed by the Engineer. Suitable precautions shall be taken by the Contractor to protect the primed surface against damage during this interval, including supplying and spreading any sand necessary to blot up excess bituminous material.

The depth of penetration shall be about 3 – 10 mm and the quantity sprayed shall be such that the surface is dry within a few hours.

For minor activities or small areas of surfacing failures where the size of the activities does not justify using a bitumen distributor, manual application of binder using watering cans, hand pumps and lances shall be used with the approval of the Engineer.

2.10.5.8 Asphaltic Concrete

2.10.5.8.1 Characteristics of Asphaltic Concrete Mixtures

The mixture of mixes to be used shall meet the requirements set out in Table 2.18 for proportions of coarse aggregate, fine aggregate, mineral filler and binder. The mix property shall meet the requirements set in Table 2.19. The Contractor shall carry out such tests of mix composition as the Engineer shall require to determine the precise proportions of the various materials to be used in the mix. After completion of these tests the Engineer shall specify or approve a job mix coming within the limits in Table 2.18 for each type of mix selected, which in his judgment will be suitable. Unless specifically permitted by the Engineer in writing the maximum permissible variations from the job mix shall be as set out in the Table 2.20.

2.10.5.8.2 Approval of Materials

Prior to use the Contractor shall supply the Engineer with samples of all materials proposed to be used. He shall carry out such tests as the Engineer may require satisfying himself that the materials and proportions satisfy this Specification. No materials shall be used nor job mix adopted until approved in writing by the Engineer.

2.10.5.8.3 Mixing

The aggregate shall be dried and heated at the equipment so that when delivered to the mixer it shall be at as low a temperature as is consistent with proper mixing, transport without binder segregation, and proper laying and in no case will exceed 163ºC (325ºF).

2.10.5.8.4 Transporting, Laying and Compacting

The mixture shall be transported, laid and compacted to the satisfaction of the Engineer. The temperature of the mixture at the time of rolling shall be not less than 90ºC.

Table 2-16: Asphaltic Concrete, Mix Proportions

Courses for which recommended		Base or Intermediate		Intermediate Surface			
Mix Number		I	II	III	IV	V	
Minimum Thickness		75 mm	63 mm	50 mm	38 mm	25 mm	
Maximum Thickness		90 mm	90 mm	76 mm	63 mm	51 mm	
Aggregate and Filler Combination							
	Passing U. S. Sieve	Retained U. S. Sieve	Percent by Weight				
Coarse Aggregate	2”	1”	15-45	-	-	-	-
	1½”	¾”	-	14-48	-	-	-
	1”	½”	3-45	-	17-52	-	-
	¾”	3/8”	-	3-45	-	18-50	-
	½”	No. 4	-	-	6-42	-	-
	3/8”	No. 4	-	-	-	3-36	8-45
	No. 4	No. 10	5-15	5-15	5-15	9-22	9-27
Sub Total	-	No. 10		60-80	55-70	50-65	50-65
Fine Aggregate	No. 10	No. 40	3-19	3-21	4-20	5-22	5-22
	No. 40	No. 80	5-22	6-25	8-25	9-27	9-27
	No. 80	No. 200	3-15	3-16	4-16	5-18	5-18
Filler	No. 200	-	3-5	4-6	4-7	5-8	5-8
Sub Total	No. 10	-	20-40	25-45	30-45	35-50	35-50
Total Aggregate and Filler			100	100	100	100	100
Total Mix							
Total Aggregate and Filler			93.5	93.0	93.0	92.0	92.0
			95.5	95.0	95.0	94	94
Binder			4.5-6.5	5.0-7.0	5.0-7.0	6.0-8.0	6.0-8.0
Total Mix			100	100	100	100	100

Table 2-17: Mix Property Requirements

Mix Property	Property Limits
Effective Bitumen Content Absorbed Bitumen Content Total Actual Bitumen Content	Min. 6.8% Min 0%; Max. 1.7% Min 7.3%
Air Void Content	Min 3%; Max 6%
Bitumen Film Thickness	Min 8 micron
Marshall Quotient (AASHTO T 245-78)	Min 1.0 kN/mm; Max 4.0kN/mm
Marshall Stability (AASHTO T 245-78)	Min 450 kg; Max 850 kg
Retained Marshall Stability after soaking 24 hours at 60°C	Min 75%

Table 2-18: Asphaltic Concrete, Permissible Variations from Job Mix

U. S. Sieve Size		Mix Number				
Passing	Retained	Percentage variation by weight plus or minus				
		I	II	III	IV	V
2”	1”	5	-	-	-	-
1½”	¾”	-	5	-	-	-
1”	½”	5	-	5	-	-
¾”	3/8”	-	5	-	5	-
½”	3/8”	-	-	-	-	5
½”	No. 4	5	-	5	-	-
3/8”	No. 4	-	3	-	5	5
No. 4	No. 10	3	3	3	3	3
No. 10	No. 200	2	2	2	2	2
No. 200	-	1	1	1	1	1
Binder	-	0.3	0.3	0.3	0.3	0.3

2.10.5.9 Surface Dressing Work

2.10.5.9.1 Rate of Application of Binder

The rate of spray of binder and the size and rate of spread of chippings shall be as specified in clause no. 2.10.5.9.4 below or as instructed by the Engineer.

Tray tests shall be carried out at least twice per run during surface dressing operations to check spray and spread rates calculated from spray truck chippings and chip-spreader coverage, and more frequently when a number of short lengths are being surface dressed. Spray truck dipping and chip-spreader coverage shall be checked for each length sprayed.

2.10.5.9.2 Safety and Maintenance

Bitumen heating, pumping and spraying operations shall be entrusted only to personnel who have been adequately trained and who are competent in the use of the equipment. Unauthorized personnel shall not be allowed to remain in the vicinity during the above operations. Authorized personnel shall be provided with, and be required to wear, suitable protective clothing, i.e. overalls, heat-proof gloves, boots, helmets and goggles.

Special care is needed when changing the type of binder being used in the distributor. When changing from hot binders to bitumen emulsions, all residual binder in the tank and spraying system shall be drained completely and the spraying system flushed using diesel. When changing from emulsions to hot binders, all emulsion shall be drained/flushed from the distributor in order to avoid foaming when hot binder is loaded. When it is necessary to load hot binder after using the distributor for spraying cutback bitumen, the cutback bitumen shall be drained completely and the manhole left open for some time to allow solvent vapour to escape.

The spray bar shall be emptied of binder by blowing with air, or by diesel flushing when spraying is suspended for lengthy periods and at the end of each day’s work.

The binder shall be introduced into the distributor at a temperature equal to or just above the spraying temperature after preheating in separate tanks fitted with burners and circulating pumps for this purpose. The capacity of the decanters/preheating tank shall be sufficient to preheat the binder required for the full day’s work.

The distributor burners shall be used only to make relatively small adjustments to the binder temperature and shall not be used to raise the binder from ambient to spraying temperature. Under no circumstances shall distributor burners be operated during the spraying operation, or when the level of binder in the tank is less than 150 mm over the top of the flues, or when the distributor is moving. The need for end of day maintenance of the distributor is emphasised to reduce fire risk and to ensure its adequate performance when next used for binder application.

Maintenance of all equipment for the surface dressing operation shall be under the control of a competent senior mechanic, approved by the Engineer and fully experienced in the maintenance of all equipment and in the calibration of the bitumen distributor.

The Contractor shall provide all necessary traffic control equipment and shall inform the engineer at least 14 days before commencing the surface dressing Work, of his detailed arrangements for traffic control. After review the Engineer will

inform the Contractor in writing of his approval, subject to any modifications to the Contractor's arrangements which he requires for traffic and convenience of the public.

2.10.5.9.3 Preparation of Surface

If the surface to be treated contains holes or depressions, which in the opinion of the Engineer require treatment such irregularities shall be repaired by removal of all loose and defective material and replacement with a patching mixture compatible with the surrounding surface or other material approved by the Engineer, which shall be compacted to produce a right surface conforming with the adjacent area. Irregularities which impair the riding qualities of the underlying surface shall be corrected as instructed by the Engineer.

Immediately before spraying, all loose material and foreign matter shall be removed by thorough brushing with mechanical brooms and/or washing or by use of compressors or by other methods acceptable to the Engineer. All hardened mud or other foreign matter shall be loosened by scraping before sweeping. The debris shall be deposited well clear of the surface to be sprayed. Road furniture (manholes covers etc.) shall be covered with adhesive paper or similar materials. Kerb stones, roadside, and any other objects what shall not benefit from binder spray shall be protected in a manner approved by the Engineer.

2.10.5.9.4 Application of Surface Dressing

a) Application of Binder

The specified bitumen binder, cut back if instructed by the Engineer, its application rate and spraying temperature shall be instructed by the Engineer on Site after design of the surface dressing, in accordance with the procedures set out in Chapter 5 of TRRL-ORN 3. The range of spraying temperature for binders is given in TRRL-ORN 3, and is normally within the range 140°C to 200°C.

The Contractor shall present his detailed programme and arrangements and methods for the planning and execution of the surface dressing process to the Engineer for approval at least 28 days before he intends to commence this Work. The Contractor's authorized representative shall be responsible for preparation of the programmes and arrangements and the Contractor shall not commence surface dressing until the Engineer has approved his programme.

The Contractor shall base his programme on TRRL-ORN 3 - Section 7. The Surface Dressing Process, Sub-Section 7.1 Planning and 7.2 The Surface Dressing Operation - by selecting the activities appropriate to his particular Work Programme. The Contractor shall appoint a surface dressing overseer approved by the Engineer who shall be fully competent to organize and implement the surface dressing operation with experience in operating all essential equipment.

All operations associated with the surface dressing process shall be described in the Contractor's arrangements and shall include but not be limited to:

- method of bitumen supply, decanting, cutting back where required, heating and storing, transfer to distributor including lists of equipment and capacities;
- location and method of production of cover aggregates and pre-coating with type and output of equipment, including crushers where appropriate; and.
- method of performing the surface dressing process including type and capacity/weight of all main and ancillary items of equipment along with workforce details.

The Contractor shall provide, one day in advance, his following day's surface dressing Work Programme, including his expected spray lengths and widths for each run with details of the quantity of cover aggregate available in approved chip spreaders standing by at the commencement of the spray run. Spraying shall not commence until sufficient cover aggregate is in this position to cover the area programmed for spraying.

The distributor shall be filled with preheated bitumen binder on the same day, shortly before start of binder application. The distributor spray bar and jets shall be preheated by circulating hot binder and the jets operated for at least 10 seconds for testing. This operation shall be carried out before each spray run, off-road onto trays, or at a location where no environmental damage will be created. Jets shall be inspected by the Engineer for shape, direction, blockage or any other defects which shall be corrected before spraying is permitted. At the end of each spray run the distributor shall be driven off-road to avoid binder drippage on the pavement surface. Binder drippage from any location which may contaminate the road surface shall be sufficient for the Engineer to order removal of the offending source from the roadway until repairs are completed.

As emergency/temporary measures, drip protection of the pavement surface shall be provided by use of buckets/trays etc. These shall be available for use at all times, along with equipment for removal of binder spillages on the pavement surface, to the approval of the Engineer.

The Contractor shall carry out a trial section of surface dressing at a location instructed by the Engineer to demonstrate to the Engineer that his surface dressing operation is capable of constructing the surface dressing in accordance with the

Specification. The trial length shall be minimum 200 meters using full spray bar width with full width application of cover aggregate. If the trial section of surface dressing complies with the Specification, the Contractor shall receive payment for the Work in accordance with the Contract as if it were Permanent Work. If the trial section of surface dressing fails to comply with the Specification, the Contractor shall carry out further trials until his surface dressing operation complies with the Specification. No payment will be made for trial sections that do not comply with the Specification.

When the Engineer is satisfied that the Contractor is capable of constructing surface dressing that complies with the Specification after trial section or sections, the Contractor will receive permission to commence surface dressing as permanent Work on the road pavement.

Application of binder shall only be undertaken when the surface is dry or slightly damp, but in no circumstances when wet. If in the opinion of the Engineer rainfall is likely before the application of binder or cover aggregate or the temperature or the pavement surface has time to fall below the specified minimum temperature of 15°C, the Engineer will instruct the Contractor to delay surface dressing work until weather conditions are satisfactory. Areas damaged by rainfall shall be rectified by the Contractor without additional payment, in a manner instructed by the Engineer.

If in the opinion of the Engineer the ambient temperature is too cold for surface dressing, the Contractor shall delay this operation until the temperature increases to the specified minimum level of 15°C.

Building paper or other approved protective material shall be used at the start and finish of each spray run of sufficient width (not less than 600mm) to enable the distributor to reach its calibrated road speed with spray jets open before discharging binder onto the pavement under treatment. Ends of previous surface treatment runs shall be trimmed back to clean, straight transverse edges and these shall form the start point for subsequent runs, with completed work suitably protected as described above. Spray runs will be limited to 300 metres length initially until the Contractor demonstrates his ability to plan and execute longer lengths. Spray widths shall be calculated allowing for 150mm longitudinal overlap with adjoining passes and for the width that the following chipping spreader is able to cover. Longitudinal sprayed butt joints will not be permitted. The Contractor shall submit his spray width and length proposals to the Engineer for approval.

During spraying all passing traffic shall be stopped. If spray jets block, or the chipping spreader stops, or any other event occurs which may affect the surface treatment process, then the spray bar operator immediately shall stop spraying. When the defective equipment or operation is rectified, spraying may restart with the Engineer's approval.

To ensure that the spray runs are parallel with the road pavement the road centerline or edgeline shall be marked every 25 meters and a string line laid out for the distributor driver to follow with the guide bar attached to his side of the cab.

Where a second surface dressing is specified, the first surface dressing shall be left open to traffic for a minimum period of 21 days and preferably a longer period before applying the second surface dressing unless special approval is obtained from the Engineer for a shorter period. Surplus chippings shall be removed by firm hand-brooming or power-brooming before applying the second surface dressing.

The spraying widths shall be so selected that the centerline joint of the second surface dressing is offset from that in the first surface dressing by a minimum 300 mm.

Hand-pouring pots or hand-lances shall be used to touch up carefully any parts of the first surface missed by the distributor/chipping spreader, or for the treatment of areas in which the distributor cannot operate and in this case only, chippings may be applied by an approved manual method.

Areas damaged by excess bitumen or spillages of diesel or other deleterious material shall be repaired by careful cutting out and removal followed by careful hand-poured or hand-lance application of binder and chipping in a manner approved by the Engineer.

The second surface dressing shall be undertaken when the first surface has been approved by the Engineer after all surplus chippings are removed, repairs carried out and the surface thoroughly cleaned as specified. The procedures to be followed are those specified for Surface Dressing in this Specification.

b) Application of Cover Aggregate

The cover aggregate shall be applied at the rate instructed by the Engineer on Site in square metres of coverage per cubic metre of loose aggregate after design of the surface dressing, in accordance with procedures set out in Chapter 5 of TRRL-ORN 3.

The cover aggregate shall be applied immediately after the binder is applied and with the approval of the Engineer may be applied slightly damp if not pre-coated to depress dust and help adhesion. Aggregate applied to sprayed bitumen emulsion shall, however, be dry.

The cover aggregate shall be applied using approved mechanical spreaders, which shall be tailgate mounted on tipper trucks, pushed spreaders or self-propelled spreaders, specifically manufactured for the purpose and they shall preferably

be metered. They shall be capable of uniformly spreading cover aggregate at the instructed rate such that they can deliver the rate specified whilst travelling at the same speed as the binder distributors during spraying.

The bitumen binder surface shall be covered with cover aggregate closely packed in one layer so that adjacent chippings are touching and no bitumen binder is left uncovered.

A sufficient number of loaded spreaders shall be available at the start of binder application to provide cover aggregate over the whole area programmed for spraying. The Contractor shall not commence spraying unless sufficient loaded spreaders are in place. Aggregate spreading by manual methods will not be permitted except in circumstances where:

- mechanical spreaders cannot operate effectively or safely;
- additional aggregate (back-up work) is required;
- breakdown of mechanical spreaders occurs during the spreading operations before stoppage of spraying;
- minor surface repairs are instructed.

The spreader shall follow the distributor at an interval not exceeding 10m for hot binder work and not exceeding 5m when using bitumen emulsion binder. A back-up vehicle or other approved means shall be constantly in attendance during surface dressing, from which additional aggregate may be hand-applied to ensure complete and rapid coverage.

Where an adjoining pass of the distributor is required, no aggregate shall be applied to the binder over a 150 - 200 mm strip so as to permit subsequent overlap.

Under no circumstances will general brooming of the chipped surface be permitted. Aggregate spillage shall be removed with care and excess aggregates may be brushed off carefully after a minimum of 3 days under traffic, after approval of the Engineer.

The cover aggregate shall be rolled with pneumatic multi - tyred power rollers. Tyre pressures and sizes shall be in accordance with the manufacture's recommendations and shall be the same on each axle and tyres shall be smooth and in good condition to provide uniform rolling of chippings. The roller shall follow directly behind the spreader and shall continue to roll at a speed of approximately 8-10kph, so as to provide minimum 10 passes over the entire treated area. Excessive rolling, resulting the crushing of chippings, shall be avoided. Each pass shall overlap the previous pass by minimum half width of roller rolling shall be continued until all cover aggregate particles are firmly bedded. Tyres shall be in good condition and be kept clean and smooth to avoid pick-up of bitumen and chippings.

2.10.5.9.5 Aftercare and Control of Traffic

The road shall not be opened to traffic until the binder has attained sufficient viscosity to prevent the stones being whipped off.

The Contractor shall erect temporary traffic restriction signs, barriers and any other device, as instructed by the Engineer, to prevent vehicles traveling too fast over the newly laid surface dressing. Vehicle speed shall be restricted to a maximum of 30 km/h, until there is sufficient adhesion to ensure that the chippings shall not be dislodged by faster vehicles.

Where possible, the traffic shall be distributed across the road so as to obtain uniform polishing of the road surface.

After traffic has been permitted to run on the surface dressing for a period of at least two weeks and when instructed by the Engineer, all loose chippings shall be swept and taken away. Windrows of loose chipping shall not be allowed to accumulate at the sides of the road.

2.10.6 Tolerances

2.10.6.1 Embankments

The surface of the fill and selected layer shall be finished true to line and level to within the tolerances +10 mm and –30 mm.

The slopes of cuttings shall be trimmed to neat lines and to a standard that is generally attainable with proper care and workmanship in the type of material concerned. Fill slopes shall be finished to neat lines and all loose rocks and uncompacted material shall be removed. The finish shall be as smooth as is consistent with the nature of the material and good workmanship.

The degree of finish required for all earthfill slopes and for earthcut slopes of gradient less than 1:4 shall be that normally obtainable by motor grader or hand-shovel operations.

2.10.6.2 Sub base and Gravelling

The layer shall be set out and constructed to tolerances of +10 mm and –30 mm in surface level, ±25mm in thickness and ±200mm in width.

2.10.6.3 Waterbound Macadam

Water bound macadam base shall be constructed to construction tolerances of ± 10 mm in surface level, ±25mm in thickness and ±200mm in width..

2.10.6.4 Prime Coat

The actual spray rate shall not deviate from the specified spray rate by more than 5 percent.

2.10.6.5 Asphaltic Concrete

On completion the surface level shall not deviate vertically from the true pavement surface by more than ± 8 mm.

2.10.7 Tests and Acceptance

Any materials or workmanship that do not comply with the specified requirements shall be removed and replaced with materials and workmanship complying with the specified requirements, or be repaired so that after being repaired it will comply with the specified requirements.

2.10.7.1 Embankments

Tests shall comply with Clause 2.2.6.

2.10.7.2 Sub Base and Gravelling

The minimum testing frequency that will be required for the purpose of process control shall be the following:

Tests	Testing Frequency	
	One Test Every	Min. No of Tests per km Or Specific Area
Materials:		
Gradation	200 m3	2
Plasticity Index	200 m3	2
Maximum Dry Density and Optimum Moisture Content	1000 m3 or every change in source	2
Field Density and Moisture Content	500 m3	2
CBR	1000 m3 or every change in source	2

Additional routine inspection and testing will be carried out to test the quality of materials and workmanship for compliance with the requirements of this section.

2.10.7.3 Waterbound Macadam

The minimum testing frequency that will be required for the purpose of process control shall be the following:

Tests	Testing Frequency	
	One test every	Min. No of Tests per km Or Specific Area
Materials:		
Plasticity Index	1000 m3	2
Gradation	200 m3	2
Flakiness Index	200 m3	2
Los Angeles Abrasion	1000 m3	-
Aggregate Impact Value	1000 m3	-

In addition routine inspection and testing will be carried out to test the quality of materials and workmanship for compliance with the requirements of this section.

2.10.7.4 Prime Coat

The actual spray rate shall be tested before the start of application of the prime coat and when required by the Engineer.

2.10.7.5 Asphaltic Concrete

The tests that will be required for purpose of process control shall be following:

a) Sieve analyses (wash method) for at least two samples of aggregate from each hot bin.
b) Sieve analyses (wash method) for at least two samples of the combined hot aggregate.
c) Temperature of mix when sampled at the mixing equipment and on the road (once per hour).

d) Density of Laboratory-compacted mix (Marshall Density) for at least two samples.

e) Compacted density and percentage compaction of the mix relative to the laboratory Marshall Density for at least two samples.

f) Marshall Stability and Flow and calculated Marshall Quotient, as defined in Table 2.18, for at least two samples.

g) Asphalt content and aggregate grading of mix as determined by bitumen extraction testing for at least two samples. When the centrifuge extraction method is used an ash correction shall be applied as required by AASHTO T 164 Cl 8.6.

h) Air voids in mix, as calculated on the basis of the Maximum Specific Gravity of Bituminous Paving Mixtures (AASHTO T 209-74).

i) The bitumen absorbed by the aggregates, as calculated on the basis of the Maximum Specific Gravity of Bituminous Paving Mixtures (AASHTO T 209-74).

From time to time, as directed by the Engineer, the Contractor shall also submit test results for the penetration and softening point (Ring and Ball) of samples of the bitumen extracted from the finished mix.

2.10.8 Measurement and Payment

2.10.8.1 Excavation and Fill

Excavation and fill shall be measured in accordance with Clause 2.2.8.

2.10.8.2 Subbase and Gravelling

Unless otherwise mention in the BOQ gravel for subbase shall be measured by cubic meter placed and compacted upon the road calculated as the product of the compacted sectional area specified to be laid and the length instructed.

The rates for gravel for subbase shall include for the cost of opening up the borrow area, excavation and selection of material, removing and spoiling of oversize material, screening or breaking, stockpiling, transportation, spreading, compacting, rolling, making good defective areas and maintenance of the surface and all incidentals in accordance with the requirements of these specifications.

2.10.8.3 Water Bound Macadam for Base

Unless otherwise mention in the BOQ water bound macadam for base shall be measured by the cubic meter placed and compacted upon the road calculated as the product of the compacted sectional area specified to be laid and the length instructed.

The rates for water bound macadam for base shall include for the cost of opening up the borrow area, excavation and selection of material, removing and spoiling of oversize material, screening or breaking, stockpiling, transportation, spreading, compacting, rolling, application of screening, watering, making good defective areas and maintenance of the surface and all incidental in accordance with the requirements of these specifications.

2.10.8.4 Prime Coat

2.10.8.4.1 Basic Cost

The basic prime coat shall be measured in square meters in the accepted work as instructed by the Engineer on Site. The application rate for measurement shall be 1.0 kg/m2 (net bitumen). Cutter shall not be measured and shall be deemed included along with other associated costs shall be included in the item rate of prime coat. The measured quantity shall be the area instructed and accepted by the Engineer. The binder application rate shall be corrected to 15.6ºC.

The contract unit rates for prime coat shall be payment in full for carrying out the required operations including full compensation for:

a) Providing all materials for all preparation, delivering and application and

b) Providing all labor, tools, equipment, and incidentals necessary to complete the work.

2.10.8.4.2 Variation in application rate

Measurement of variation of binder application shall be by litre calculated as the difference between the above specified binder application rate and the binder application rate (net bitumen) instructed by the Engineer, corrected to 15.6ºC. Adjustment of compensation to the Contractor shall be as follows:

As a payment to the Contractor where the binder application rate is increased above the specified rate, but only where such increase has been instructed in writing by the Engineer.

As a refund to the Employer where the application rate is reduced below the specified rate of application. The binder application rate shall be reduced if the Engineer so instructed in writing.

2.10.8.5 Asphaltic Concrete

Asphaltic concrete shall be measured by cubic meter placed and compacted upon the road calculated as the product of the compacted sectional area specified to be laid and the length instructed.

The rates for asphaltic concrete shall include for the cost of opening up the borrow area, excavation and selection of material, removing and spoiling of oversize material, screening or breaking, stockpiling, provision of binder, mixing, transportation, spreading, compacting, rolling, making good defective areas and maintenance of the surface and all incidentals in accordance with the requirements of these specifications.

2.10.8.6 Surface Dressing

The distributor shall be dipped and the binder temperature recorded before and after each spray run and spray length and width recorded on approved Record Sheets. The hot application rate shall be calculated and recorded and checked against the specified rate. The calculated actual rate shall not vary by more than ± 5% from the specified rate. The actual quantity of binder sprayed corrected to 15.6°C shall be calculated.

At least eight clean pre-weighed metal spray trays shall be available for sampling the spray rate for each spray run, to be used in accordance with TRRL-ORN 3 - Section 6.3 Method B - if so instructed by the Engineer.

Binding material bitumen and cutter shall be measured separately in litre. For computation of the quantity the following methods shall be adopted.

(a) Design/instructed rate of application times specified area sprayed computed in litres corrected to 15.6°C.

(b) Actual rate of application measured through tray tests times specified area sprayed, computed in litres corrected to 15.6°C.

(c) Actual consumption in specified area sprayed measured in litres corrected to 15.6°C by dip stick feading of the distribution.

The lowest value of the above three methods shall be adopted for payment. However, if the rate of actual spray of binder is much less or more than the designed/ instructed rate of spray so as to impair quality of surface dressing, the Engineer shall reject the work or shall ask for appropriate rectification which the contractor shall execute at his own cost.

Bitumen and cutter shall be computed on the basis of percentage actually used in the work.

Chipping of each nominal size shall be measured in cubic metre. For computation of quantity the following methods shall be adopted.

(a) Design/instructed rate of application of chippings times specified area applied.

(b) Actual rate of application of chippings times' specified area of application.

The lower of these two values shall be adopted for payment. However rate of application shall not vary with designed/instructed rate of application to impair quality of surface dressing. In such event the Engineer shall reject the work or ask the Contractor to rectify at his own

3 PIPELINES AND RELATED WORKS

3.1 Pipe Trenches

3.1.1 Scope

This specification covers earthworks in trenches for all types and sizes of pipes. It covers excavation, the preparation of a trench bottom, bedding for pipe laying, backfilling and the reinstatement of surfaces.

3.1.2 Interpretations

3.1.2.1 Supporting Specifications

The following specifications shall, inter alia, form part of and shall be read in conjunction with this specification:

a) 1 General
b) 2.1 Site Clearance
c) 2.2 Earthworks
d) 2.10 Roads and Parking Areas

3.1.2.2 Application

This specification contains clauses that are applicable to earthworks for pipe trenches associated with Water mains, water distribution mains, and sewerage and drainage systems.

3.1.2.3 Definitions

For the purpose of this specification the following definitions shall apply:

Backfill - The approved filling material placed in a pipe trench after the pipe has been laid, bedded and surrounded by the blanket that has been compacted at the sides and over the top of the pipe.

Bedding - The material, and the operation of placing it, of the bedding cradle and blanket, up to the underside of the backfill.

Blanket - The bedding zone in which material is placed and compacted on or from the top of the cradle up the sides and over the top of the pipe in such a manner that the barrel of the pipe is supported continuously and firmly on the sides and protected over the top by a dense cushion of material.

Cradle - The bedding zone in which material is placed firmly and without voids under and up the sides of a pipe in such a manner that for all practical purposes the pipe cannot move or deflect.

3.1.3 Materials

The material encountered in excavation will be classified as Normal or Rock in the manner described in the Section Earthworks (Clause 2.2.3.1)

For selected fill material, the requirements given in Clause 3.2 shall apply.

Backfill material shall be material excavated from trenches, provided only that it contains no organic material, that it excludes stones of average dimension exceeding 150 mm, and that its moisture content will allow it to be compacted to 95% of the Modified Proctor Density to avoid significant settlement, and shall have a PI not exceeding 12. Backfill material in road or traffic areas shall in addition have a minimum CBR of 15% at specified density if placed in the upper 200 mm of the subgrade, and a minimum CBR of 7% if the backfill is to be placed lower in the subgrade. Material containing more than 10% of rock or hard fragments that are retained at a sieve of nominal aperture size 50 mm, and material containing large clay lumps that do not break up under the action of the compaction equipment being used, will be regarded as unsuitable for use in backfilling.

If the Contractor allows material which, when excavated was suitable for re-use, to become unsuitable when required for backfilling, he shall make good by running it to spoil and replacing with suitable material.

Where trenches cross or run along surfaced roads and paved areas of which the surfaces are ordered by the Engineer to be reinstated, the Contractor shall obtain prior approval for subbase and base materials that may be required to supplement such materials lost during excavation. Materials for bituminous or asphalt construction shall comply with the applicable standards of the Roads Department of the Ministry of Transport.

The Contractor is not required to use selective methods of excavation but may, if he so wishes, screen, wash or otherwise treat excavated material in order to produce material suitable for the bedding. He shall take positive steps to avoid burying or contaminating materials which otherwise would be suitable for use as different types of fill, topsoil, or road material, as applicable.

3.1.4 Construction Equipment

The Contractor shall use trenching equipment that will excavate to a width such that the side allowance does not exceed the appropriate values specified in Clause 3.1.5.2 below by more than 50 %.

The Contractor shall use appropriate techniques or provide equipment such as pumps, well points and sheeting or close timbering for keeping the trenches sufficiently free from water to enable him to lay pipes true to line and level and to bed them soundly.

The Contractor may use mechanical compaction equipment but he shall select such equipment and operate it in such a manner that the pipeline is not stressed or damaged. Machine compaction shall not be used directly above the pipe until sufficient backfill has been placed to ensure that machine compaction loads transmitted to the top of the pipe are not greater than would be imposed by normal road traffic over a pipeline with cover of depth 600 mm.

3.1.5 Construction and Workmanship

3.1.5.1 Precautions

With regard to dealing with water, the requirements of Clause 2.2.5.2.2 -b shall apply in addition to the stipulations below.

In the case of a trench on sloping ground, the Contractor shall take approved measures (such as the construction of cross-embankments) to minimize erosion in the trench and adjacent ground.

With regard to accommodation of traffic and access to properties, the Contractor shall, in addition to the requirements of Clauses 1.5.2, construct or put in order such bypass(es) as may be required to deviate traffic from portions of the road that are to be affected by the construction; or where half-width construction is ordered or approved, so arrange his work that the traffic will at all times have free one-lane access to at least half the width of the roadway; or ensure, wherever possible, that the whole road is open at night and left in a trafficable condition, complete with traffic signs and protection facilities as specified.

He shall also ensure, wherever possible, that the usable width of the road is at least 3.5 m and he shall provide and allow reasonable access to persons occupying properties that fall within or adjoin the area over which he is working. If, for any reason, such access has to be closed during the construction period, the persons affected shall be given reasonable notice for each such period of closing.

With regard to existing services that intersect or adjoin trenches, the requirements of Clause 2.2.5.1.2 shall apply.

Special precautions may be necessary when buildings are close to the edge of the trench. Throughout the duration of such activities the Contractor will be fully responsible for the safety of all adjacent property. Wherever the minimum clearances cannot be complied with, e.g. in certain urban areas, the Contractor shall provide adequate temporary protective support by struts, bracing, etc. for adjacent structures and such support must be capable of safeguarding the buildings from structural damages resulting from the execution of the Works. Prior to installation the Contractor in consultation with the effected person or owner of the effected properties shall submit to the Engineer his proposed system of support for approval. Irrespective of the Engineer's approval sufficiency and suitability of the support will remain the sole responsibility of the Contractor. The support shall remain in place until such time as the Contractor is sufficiently convinced that there is no more imminent risk of damage of any kind to the adjacent buildings resulting from the activities. Upon removal of the support any damages caused by the attachment of the support itself shall be repaired to the satisfaction of the Engineer.

3.1.5.2 Maximum base width

The base width of a trench shall be not more than the value shown in drawing.

Where two or more pipes are to be placed in one trench, the base width of the trench shall be no less than the sum of the external diameters of the pipe barrels plus the side allowance for each outer pipe plus, between each pair of adjacent pipes, the average of the side allowance for each pipe.

3.1.5.3 Maximum Length of open Trench per Gang

Except by special permission of the Engineer, only that length of trench excavation shall be permitted in advance of the pipe jointing, such that laying and jointing of pipes can reasonably be expected to be completed and the trench refilled not later than 7 days after excavation of trench. The contractor will not permitted to keep trenches open for unduly long period, creating public hazards. The Engineer's decision in this respect shall be final.

3.1.5.4 Site clearance

The Contractor shall clear the working strip, in accordance with Clause 2.1. The working strip shall be an area of sufficient width along the route of the pipeline to ensure that his construction operations are not hampered and damage to buildings and the environment is minimized.

3.1.5.5 Excavation

The length of pipe trench excavated by a gang shall be as per the Clause 3.1.5.3. The width of the trench shall provide at least the appropriate side allowance (within trench supports, if any) as specified in Clause 3.1.5.2 above, and such that half of the base width is on either side of the designated centre-line of the pipe.

The sides of each trench from the bottom up shall be vertical as possible.

When cutting through bituminous surfaces, the edges of the existing bitumen base and/or wearing courses shall be cut back vertically to straight lines.

All trenches shall be braced and strutted to the satisfaction of the Engineer, if they are;

a) so close to a building or structure, that a line between the corner of the trench bottom nearest to the building and the underside of the foundation of the building or structure would be steeper than 45^0 ·
b) if the soil conditions are not providing sufficient stability to the side walls.

The Contractor will be responsible for any damage resulting from trench instability and insufficient bracing and strutting.

During the course of the Works the Contractor shall clean road surfaces and other paved areas used by his vehicles and employees to minimize disturbance to residents and road users, cleaning shall be to the satisfaction of the Engineer.

3.1.5.6 Widening Trench at Joints Etc.

Any widening or deepening of the trench, whether in ordinary soil or rock, necessary to accommodate curves, joints or bends as shown on the drawings or ordered by the Engineer shall be carried out by the Contractor, after taking all the necessary safety measures.

3.1.5.7 Over-Excavation of Trench Bottoms

All excavation carried below the grades shown on drawings or bottom (limit depth of excavation) of the bedding shall be refilled with sand / concrete at the Contractor's expense

3.1.5.8 Trench bottom

Material that the Engineer considers to be unsuitable at the bottom of the trench shall be excavated to the depths directed and disposed of in the manner described. The resulting space shall be refilled, as ordered, with approved material and compacted as directed.

Where the bottom of the trench has been loosened during excavation, it shall be compacted at OMC to 90 % of modified AASHTO maximum density prior to bedding and pipelaying.

Bottoms of the excavated trenches shall be trimmed flat and leveled to provide an even base for the pipeline or pipe bedding; rocks, debris or other extraneous matter that may damage the pipes shall be removed.

Where pipes are to be laid on formation made in undisturbed ground (i.e. without bedding), the Contractor shall ensure that excavation in the first instance is stopped 75 mm above formation level and the trimming the formation shall be done by hand immediately prior to starting the laying of the pipes.

Where granular or concrete beddings are required, bottoms of trenches shall be excavated to a depth below the proposed level of the pipe over the full width of the trench as shown in the Drawings.

The depth of the trench shall be such that the depth of the cradle can be placed under the pipeline, and the trimming and grading of the bottom of the trench shall be such that the barrel of each length of pipe can be uniformly supported over its full length, free at the joints, and at the correct grades and levels.

The bottom of pipe trenches shall be sufficiently straight to enable the pipe to be laid without reduction of the trench width given in Clause 3.1.5.2 above and in conformity with the applicable tolerances specified.

3.1.5.9 Backfilling

Backfilling of pipe trenches shall commence as soon as possible after the pipe has been laid and firmly bedded in the specified cradle and the blanket has been placed over the top of the pipe to the height of blanket cover specified.

Backfilling shall be carried out as described below and over the full extent of the actual trench excavation and to original ground level, except where otherwise directed.

Unless the Contractor is authorized by the Engineer to use other material, the material for backfilling above the bedding (cradle and blanket) shall be obtained from trench excavations.

Unless prior approval has been obtained, no filling shall be placed in water.

Hard and rock material shall be incorporated in the backfill above the bedding only to the extent approved. Depending on the quality of the material, the Engineer may direct that it shall be suitably mixed with other backfill material.

Excavated material from the trench, which is unsuitable or has become surplus because of bulking, displacement by the pipe and importation, shall be disposed of as approved by the Engineer.

Any deficiency of backfill material from trench excavations because of removal of organic or other unsuitable material shall be made up from suitable surplus material from other excavations on the Site. If, insufficient or no suitable material is available for this purpose from such excavations, the Contractor shall import sufficient suitable material. The Contractor shall so arrange his work that the importation of backfill material is kept to a minimum.

The Contractor shall complete backfilling of trenches expeditiously and in reasonable lengths.

3.1.5.10 Compaction

In normal areas backfill shall be in accordance with Clause 2.2.5.2.3.

In areas subject to traffic loads, trenches shall be backfilled with selected fill material in layers of thickness (after compaction) not exceeding 150 mm and the material shall be compacted to at least 95 % of modified AASHTO maximum density up to the top of the subgrade level.

3.1.5.11 Reinstatement of surfaces

In all cases, the Contractor shall, if ordered, reinstate surfaces over the full extent of the top of the actual excavation.

On private properties or other unsurfaced areas, the top 100 mm layer of each trench that will not be subject to road traffic loads shall be of such topsoil as is available in addition to soft material from excavations. The finished surface of backfilling, after appropriate compaction and that is left raised of the surrounding ground to allow for initial settlement, shall not be more than 150 mm above the surrounding ground.

In case of gravel roads or similar surfaced areas, the Contractor shall, immediately after completion of the backfilling to the top of the subgrade level, reinstate the road surface by filling the reminder of the trench with a well-graded and approved hard-wearing gravel surface of thickness at least 200 mm, and of quality equal to that of the existing road surface compacted to at least 95% modified AASHTO density. The gravel layer shall be finished with a slight camber in order to allow for initial settlement but shall not be shaped such as to cause excessive jolting of any vehicle proceeding with normal speed.

If the surface of a road with a stabilized base has been disturbed, the base shall be replaced with crusher run base compacted with sufficient moisture to give a density of at least 98 % modified AASHTO maximum density.

Except if otherwise ordered by the Engineer, the surface of a bitumen road shall be reinstated with asphalt of at least the thickness used in the original state. The base material shall be graded to a level sufficiently below the final road surface to allow the bitumen surfacing to be accommodated, and the edges of the existing bitumen wearing course shall be cut back vertically to a straight line. Before the bituminous construction is commenced, all loose materials and dust shall be removed and after approval, the surface shall be prime coated at the rate of 1.0 l/m^2 of MC30 cutback bitumen. The bituminous surface will have a tolerance of ±6 mm after compaction.

The Contractor shall maintain the reinstated surfaces and shall make good, at his own expense, any damage due to any subsidence, pothole or any other unevenness during the period of the contract or during the defects liability period.

Where, during the execution of the activities, if any other road or paved surface (other than the right-of way or road in which the pipeline is laid) has been damaged in any way whatsoever by the Contractor's equipment, he shall, at his own expense and as soon as is practicable, repair and restore such surface to a condition at least equivalent to that previously existing, and to the satisfaction of the Engineer and the concerned authority.

3.1.6 Tolerances

3.1.6.1 Alignment and grade

The deviation from the specified level of the invert and the specified dimensions of a trench and (for a height equal to at least the diameter of the pipe) of the lower part of the sides of the trench shall be such that the pipe may be laid and bedded in the trench within the tolerances specified for the pipeline.

3.1.6.2 Moisture content and density

The requirements for moisture content and density given in Clause 2.2.6.2 shall apply.

3.1.7 Testing and Acceptance

The Contractor shall provide: the optimum moisture content, the maximum dry density, the CBR, Marshall and the specified properties of reinstatement and backfill materials before use at a rate of one test per 200 m^3 of material. In-situ density test of non-bituminous materials, and Marshall compaction/in-situ coring of bituminous materials will be carried out on each layer for every 200 linear meter of trench or part thereof by the Contractor in the presence of the Engineer, or by an independent laboratory approved by the Engineer. The cost of all testing will be included in the Contractor's

rates. In the event of failure results, the Engineer will order removal of such defective work or carry out remedial works at the Contractor's expense.

3.1.8 Measurement and Payment

The items scheduled for clearance and demolition will be classified according to the nature of the materials involved and the methods of their disposal. The item for clearance shall include the removal of topsoil and storing for reuse.

Clearance of the working strip shall be measured as the length of pipeline with no deduction for chambers.

Dismantling and Demolition of structures, buildings etc, shall be measured as a sum for demolition of the identified structure as per BOQ.

The Item rates for reinstatement of the Site shall include preparing the working strip to receive topsoil, placing topsoil, disposal of surplus materials, planting and seeding, watering, providing fertilizer and reinstatement of land drains.

Unless and otherwise mentioned in BOQ, reinstatement of work in roads shall be measured in square meter.

The rates for trench excavation and preparation of bedding shall cover the cost of excavating and re-use of the excavated material. Additional payments will be made for bedding of selected type.

Trench excavation and bedding will be measured as the Volume of excavation.

Excavation for chambers, abutments, columns, thrust blocks, and anchors shall be measured as the volume of excavation, on accordance with Clause 2.2.8, outside the nominal trench dimension.

Excavation in rock shall be measured extra over normal excavation and measured as a volume.

3.2 Pipe Bedding and Fill

3.2.1 Scope

This specification covers the bedding, consisting of the bedding cradle and the selected fill blanket, for buried pipes for carrying fluids under pressure or gravity.

3.2.2 Interpretations

3.2.2.1 Supporting Specifications

The following specifications shall, inter alia, form part of and shall be read in conjunction with this specification:

a) 1 General
b) 2.1 Site Clearance
c) 2.2 Earthworks, as applicable
d) 3.1 Pipe Trenches

3.2.2.2 Application

This specification contains clauses that are generally applicable to the bedding of pipes.

3.2.2.3 Definitions

For the purpose of this specification the following definitions shall apply:

Bedding - The material in the bedding cradle and fill blanket up to the underside of the main fill, and the operation of placing and compacting bedding in the manner specified.

Bedding cradle - The zone in which bedding is placed firmly and without voids under and up the sides of a pipe in such a manner that for all practical purposes the pipe cannot move or deflect.

Expansion joint - A joint in concrete bedding in which two concrete surfaces are separated by resilient filler of thickness at least 15 mm.

Flexible pipe –A pipe whose properties are such that the first limit state reached is either excessive deformation, or buckling collapse. Plastic pipes, UPVC etc, are examples of flexible pipes.

Joint hole - A depression formed in the bedding cradle to accommodate a joint in a pipeline.

Main fill - The approved filling material placed in a pipe trench after the pipe has been laid, bedded, and surrounded by selected fill blanket up to 300 mm cover above the top of the pipe.

Rigid pipe – A pipe whose properties are such that the first limit state reached is fracture of the pipe walls due to bending stress. Concrete pipes are an example of rigid pipes.

Selected fill blanket - Material placed and compacted to form a blanket on or from the top of the bedding cradle up the sides and over the top of the pipe in such a manner that the barrel of the pipe is supported continuously and firmly on the sides and is protected over the top by a dense cushion of material.

Selected fill material - Material that complies with the requirements of Clause 3.2.3.2 below.

Selected granular material - Material that complies with the requirements of Clause 3.2.3.1 below.

Semi-rigid pipe - A pipe that can deform enough to redistribute some of the overburden pressure to the sidefills, but which is stiff enough to rule out the possibility of buckling. The first limit state reached may be either excessive deformation, or excessive wall bending stresses. Ductile iron pipes are considered as semi-rigid pipes.

3.2.3 Materials

3.2.3.1 Imported selected granular material

Selected granular material shall be material of a granular, non-cohesive nature, free draining, a pH>6 and the following grading.

Sieve Size (mm)	% Passing Sieve
40	100
20	100
5	60-100
2.5	20-80
0.6	0-25
0.315	0-20
0.075	0-5

3.2.3.2 Imported selected fill material

Selected fill material shall be material that has a pH>6 and the following grading.

Sieve Size (mm)	% Passing Sieve
40	100
20	80-100
5	60-100
2.5	20-100
0.6	5-100
0.315	0-70
0.075	0-10

3.2.3.3 Bedding

Bedding for all pipelines shall be as shown on the Drawings. The Blanket/Cradle (Pipe zone) shall be of selected granular or sand material while material for the main fill shall be selected fill material.

3.2.3.4 Selection

The Contractor may screen, wash, or otherwise treat excavated material from pipe trenches or other excavations in order to produce material suitable for covering the pipeline. The Contractor shall take every reasonable precaution to avoid burying or contaminating material that is suitable and is required for bedding or covering the pipeline.

When material suitable for use as selected fill material or selected granular material is not readily available from trench or other excavation within a reasonable distance, the Contractor shall, subject to the Engineer's approval for each material, obtain suitable material to replace the shortfall by opening up borrow pits at approved areas located at intervals along the route of the pipeline or by importing from commercial or other sources.

3.2.4 Construction Equipment

Adequate equipment shall be provided by the Contractor for the placing and compacting of bedding as specified in Clause 3.2.5 below.

The Contractor shall also provide the necessary test equipment for performing on Site tests referred to in Clause 3.2.7 below.

3.2.5 Construction and Workmanship

3.2.5.1 General

No bedding shall be laid until the Engineer has approved the trench, measured the depth if necessary, and authorized pipelaying to proceed.

The anchoring of pressure pipes shall be as shown in the Drawings.

The bedding requirements for ductile iron and HDPE pipes shall be as shown in the drawings.

A cavity of adequate size shall be excavated in the sides and bottom of the trench or left in the pipe bed at each joint and at each sling position.

The preparation of the trench bottom or surface of the bed shall be completed for at least one full pipe length in advance of the pipe laying, except where in exceptional circumstances another arrangement is approved.

No bedding material shall be placed in trenches containing water.

Where bedding other than concrete is to be used, stones, bricks or similar materials shall not be used below or against the pipes to locate them in position in the trench or to level the pipes.

Except in the case of concrete surround, the joint holes shall be refilled with fine granular material and lightly compacted to prevent the migration of adjacent pipe bedding material into the holes and to obviate the forming of hard spots under joints.

In the placing of bedding, all voids under the overhang of the pipes shall be filled and the compaction shall be carried out uniformly on each site of the pipes so as not to cause any lateral or vertical displacement of the pipe.

Bedding shall be carried out as pipelaying proceeds, and shall be completed before the acceptance test is carried out.

The degree of compaction attained for bedding (other than concrete) shall be 90% modified AASHTO maximum density.

3.2.5.2 Placing and compacting of bedding for rigid pipes

In addition to complying with the requirements of Clause 3.2.5.1 above, the Contractor shall construct the bedding for flexible and semi-rigid pipes in accordance with the following requirements:

Pipes shall be supported on a cradle as indicated on the engineer's drawings. Initially continuous bed of selected granular or sandy material of compacted depth indicated shall be placed in 100 mm layers and covering the full width of the trench. The granular material shall be compacted to the density specified in Clause 3.2.5.1. After laying of the pipeline, additional selected granular material shall than be placed carefully and evenly between the sides of the trench and the pipeline, in layers of uncompacted thickness approximately 100 mm and in accordance with the construction details. Each layer shall be compacted individually to the density specified in Clause 3.2.5.1.

After completion of the bedding blanket and cradle (pipe zone), selected fill shall be placed carefully in layers of 100 mm uncompacted thickness over the full width of the trench and shall be compacted to the density specified in Clause 3.2.5.1 up to a height above the crown of the pipeline, as shown in the drawings.

When placing and compacting the bedding particular care shall be exercised to prevent damage, deflection, or displacement of the pipeline and the polyethylene sleeving, if any.

3.2.5.3 Concrete surround

In special cases, and where ordered by the Engineer, pipes shall be surrounded in concrete of the specified grade, generally of at least 20 MPa. The lower part of the encasement shall be constructed in the manner specified for Class A bedding. Once the pipeline has been tested and approved, the pipes shall be covered with concrete to the specified depth and expansion joints shall be cut or constructed in the upper part to coincide with those in the lower part. No earthfilling over the concrete shall be commenced until at least 5 d after the concrete has been placed or until the concrete has attained strength of at least 15 MPa.

3.2.6 Tolerances

The permissible deviations shall be as follows:

(i)	Moisture Content in field during compaction	OMC -2, +1 %
(ii)	Density when bedding rigid pipes	-0, +5 %
(iii)	Density when bedding flexible and semi-rigid pipes	-0, +3 %

3.2.7 Testing and Acceptance

The Engineer may order density tests to be carried out to determine the density and grading of the bedding. Tests will be carried out for every 200 linear meter of trench or part thereof by the Contractor in the presence of the Engineer, or by an independent laboratory approved by the Engineer. The cost of all testing will be included in the Contractor's rates. If the density is found to be below the specified value, the Engineer may order removal and re-compaction at the Contractor's expense, and the cost of retesting shall be borne by the Contractor.

The tests may be carried out by the sand replacement method or, where the grading of the bedding is such that the particle size is not less than 0.075 and not more than 2 mm, by use of a dynamic cone penetrometer.

3.2.8 Measurement and Payment

These shall be made according to Clause 3.1.8.

3.3 Supply, Delivery and Installation of Water pipelines

3.3.1 Overall Scope

Supplying Ductile Iron pipes from 80 mm to 400 mm diameter, conforming to ISO 2531:2009 with latest amendments and conveying to worksite, rolling and lowering into trenches, laying true to line, level and perfect linking at joints, testing and commissioning, including loading and unloading at both destinations and cuts of pipes wherever necessary including jointing of pipes and specials, (excluding cost of specials) with rubber gaskets including cleaning the socket and spigot ends with soap solution and applying soft soap to the spigot and socket ends before insertion of rubber gaskets, jacking and fixing in perfect conditions including cost of soap solution, soft soap, waste etc. and giving necessary hydraulic test to the required pressure as per specification mentioned in clause 3.3.3.6 with all lead and lift including cost of jointing materials. (Contractor will make his own arrangements for procuring water for testing).

This specification covers the supply, transportation to Site of all pipe, fittings, appurtenances and other specials for installation and testing of water supply pipe lines, valves, fittings and other specials. The first part of this section describes requirement for supply and delivery of the pipe, fittings, appurtenances and other specials. The second part is specification for the installation, testing and disinfection of pipelines, fittings, appurtenances and other specials

3.3.2 Supply and Delivery of DI Pipe, Fittings, Appurtenances and Other Specials

3.3.2.1 General and Storage

3.3.2.1.1 Scope

The Contract shall include but not be limited to: provision of guards and storekeeper until completion of the works; supply of items; transport to Site; insurance; unloading and storing at Site in an acceptable manner (in air-conditioned stores if necessary); repair of any damage during transportation; provision of operations and maintenance instructions; provision of spares; making records of storage, stock control program; and provision of special tools, provision of a warranty against manufacturer's defects for the items supplied for a defect liability period (except where otherwise indicated for specific items). During the delivery of items train the Employer's staff in the store keeping system, methods of handling pipes and fittings.

3.3.2.1.2 Definitions

For the purpose of this specification the following definitions shall apply:

Materials - All materials and articles of every kind, raw, processed or manufactured, which are used in the manufacture of goods to b supplied under the Contract.

Fittings - A special or a valve, or joint adaptors, or couplings or a process of jointing (except welding) straight pipes to one another and to specials and valves.

Pressure Pipelines – A pipeline in which the normal internal working pressure exceeds 3 metres of water (0.3 Bar) and such other pipework as may be so designated

Special - Any pipe other than straight pipe, such as bends, tees, reducers, etc.

Straight pipe - A straight pipe of uniform bore and of standard or non-standard length.

Valves - A flow control equipment which are not joints or fittings.

Internal - Those parts of pipes or fittings which are to be in contact with the liquid being conveyed.

External - Those parts of the pipes or fitting which are not to be in contact with the liquid being conveyed and which are likely to be in contact with pipe bedding or native soil.

Flexible joints - joints made with factory made jointing materials, loose collars, rubber joint rings and the like which permit angular deflections between adjacent pipes.

Meters - shall mean water revenue meters.

3.3.2.1.3 Abbreviations

For the purpose of this specification the following abbreviations shall apply:

a)	CI	Cast Iron
b)	DI or DCI	Ductile iron
c)	DN or ND	Nominal Diameter
d)	EPDM rubber	Ethylene propylene diene Monomer rubber
e)	GI	Galvanized Iron
f)	GS	Galvanized Steel
g)	PE	Polyethylene pipe

h)	IRHD	International rubber hardness degree
i)	PN	Nominal Pressure
j)	PVC	Polyvinyl Chloride
k)	PTFE	Polytetrafluor ethylene
l)	NBR	Nitrile butadiene rubber, a family of unsaturated copolymer rubbers
j)	NR	Natural Rubbers
k)	SS	Stainless Steel
l)	ST	Steel
m)	UPVC	Unplasticized Polyvinyl Chloride
n)	HTS	High Tensile Steel (Seamless)

3.3.2.1.4 Site

The Site for the purposes of the supply of pipes, fittings, appurtenances, and specials in this contract is store in stockyard or covered store facilities established and maintained by the Contractor.

The Contractor shall not use the Site for any purpose not required by the Contract. The Contractor shall prepare the storage area and store to receive Goods.

3.3.2.1.5 Climatic condition and Tropicalization

In choosing materials and their finishes, due regard shall be given to the humid tropical conditions to which they will be subjected when installed in the transmission and distribution system. The Contractor shall submit details of his practices that have proven satisfactory and he recommends for application on the parts of the supplied items which may be affected by the tropical conditions.

All items of materials shall be in every respect suitable for storage, installation, use and operation in the conditions of temperature and humidity appertaining in project area.

The annual monthly minimum and maximum average temperature is 13.8°C and 28.9 C, respectively, while extreme temperate ranges from -3.3°C (in month of January) to 36°C in May, Annual average raninfall is 1465mm per year and the 80 to 90% rainfall occurs in 4 months (June to September), while the average relative humidity varies generally from 37% to 84%.

3.3.2.1.6 Suitability for Potable Water

Pipes and pipeline components, including their protective coatings and joint materials, that will or may come into contact with potable water shall not constitute a toxic hazard; shall not support microbial growth; shall not cause taste or odour, cloudiness or discolouration of the water.

3.3.2.1.7 Drawings

The drawings issued to the Contractor show details of the pipes, fitting, and valves assumed during the design of the civil works, the Contractor should take note of these drawings and notify the Engineer if any of the dimensions of the items he supplies are different to those indicated on the drawings.

3.3.2.1.8 Languages

All drawings, instructions, signs, notices, name-plates, etc for use in the operation and maintenance of the supplied Goods shall be in English.

3.3.2.1.9 Non-metallic Materials

All non-metallic materials supplied shall be listed in the current "Water Fittings and Materials Directory" published by the Water Research Centre, UK, or approved equivalent publication, as a recognized certifying authority having passed full tests of effect on water quality under the requirements for the testing of non-metallic materials for use in contact with potable water.

3.3.2.1.10 Transport and Handling of Materials

Any vehicle on which pipes, valves, or fittings are transported shall have a body of such length that the items do not overhang. Coated pipes, valves and fittings, not in crates, shall be transported on trucks or trailers fitted with approved padded timber cradles shaped to fit the curvature of the pipes, valves or fittings and of adequate dimensions so as to prevent any damage to the coating. Successive tiers of coated pipes valves or fittings shall be separated by similar suitable shaped timber cradles. Pillows shall be provided between securing chains or lashings when load are being transported.

Particular care shall be taken during unloading, loading, handling and transportation to avoid distortion, flattening, denting, scaring or any other damage to the pipes, valves or fittings and any damage to the external or internal coating or

lining of the items etc. Under no circumstances shall pipes, valves or fittings be dropped, be allowed to strike on another, be rolled freely or dragged along the ground.

Loading, unloading and handling shall be carried out using special hooks, well padded, with a curved plate to fit the curvature of the pipes, valves or fittings or webbing slings not less than 300 mm wide or other means approved by the Engineer. Steadying ropes shall be employed. The positions of lifting slings shall ensure that stresses and tendency towards deformation in the pipes, valves and fittings are kept at a minimum. Handling equipment shall be maintained in good repair and any equipment, which in the opinion of the Engineer may cause damage to the pipes, valves or fittings shall be discarded.

Additional precautions shall be taken to avoid deformation of the flexible or large items. To maintain their dimensions struts and supports shall be fitted to the items and shall be retained in position until laying and jointing have been completed. Struts shall be adjustable in length having the ends suitably shaped. Where pipes or fittings are cement mortar lined struts shall be fitted after curing. At least two struts shall be used in each full length of pipe.

Details of the proposed strutting and support system shall be submitted to the Engineer for approval and if required by the Engineer, the method of strutting shall be demonstrated and tested on Site. End covers and protection shall not be removed until incorporation of the pipes and fittings into the Works.

Care shall be taken during loading, transporting, and unloading to prevent damage to the pipes, valves and fittings. After unloading all items will be examined, any defects or damage to the pipe, valve, fitting, lining or coating, shall be noted and reported to the Engineer. Any damage shall be repaired in a manner recommended by the manufacturer with the approval of the Engineer. Any pipe or fitting not considered by the Engineer to be of an acceptable quality after repair will not be accepted.

Any items which, in the opinion of the Engineer are delivered damaged or are damaged by the Contractor in the process of stockpiling at Site shall be promptly removed from the Site. The Contractor shall receive no compensation for the damaged material or its removal until it is either repaired to the satisfaction of the Engineer or replaced.

3.3.2.1.11 Storage of Materials

Pipes, valves and fittings shall be unloaded and stocked by the Contractor at the store/stockyard.

Pipes shall be stored in piles only up to such height as recommended by the manufacturer. The first layer will be placed on beams, large enough to distribute the pipe loads on the ground and to give sufficient clearance from the ground; the pipes will be secured by wedges. Each layer will be separated from the next by an adequate number of beams (at least two).

All meters, valves and fittings shall be securely packed in crates and boxes to prevent damage during delivery and storage as recommended by the manufacturer and shall be adequately supported clear of the ground on timbers all to the Engineer's approval. The cost of packing shall be deemed to be included in the Contract Rates and crates will not be returned.

Crated small items shall be delivered and stored in their original containers. Each crate, box and other packing shall be clearly labeled with weatherproof marking identifying the quantity and exact nature of the contents thereof, such that materials may be readily identified without opening of the crates.

Until required for incorporation in a joint, each rubber ring or gasket shall be stored in the dark, free from the deleterious effects of heat or cold, and kept flat so as to prevent any part of the rubber being in tension.

Where items to be stored have a limited shelf life or require special storage arrangements, the method of storage shall be to the approval of the Engineer and in accordance with the manufacturer's instructions.

Storage areas shall be set out to facilitate unloading, loading and checking of materials. Different consignments shall be stacked or stored separately with identification marks clearly visible. All areas and sub-areas should be clearly sign posted and marked out.

3.3.2.1.12 Standard of Storage

The standard of storage to be provided by the Contractor shall be as follows:

All items; pipes, fittings etc. shall be stored by the Contractor in a secure stockyard at a site approved by the Engineer and cleared, prepared for storage and fenced by the Contractor at his own expense. Such items shall be protected as appropriate to prevent its deterioration while in store. While the items are in store the Contractor shall make all necessary precautions to maintain the items in a serviceable condition and these precautions shall be to the approval of the Engineer.

All other items which require a stable environment, gaskets, joint materials, lubricants, paints, oils etc. shall be stored by the Contractor in suitable wind and watertight stores to be provided by the Contractor in the stockyard. The stores shall be dust free and shall be adequately ventilated and temperature controlled, to prevent condensation and deterioration of

the stored items. The temperature control shall be provided by a thermostatically controlled air conditioning system. The stores shall also be adequately lit. The storage facility shall be to the approval of the Engineer and be provided at the Contractor's expense.

3.3.2.1.13 Store Records

The Contractor shall prepare records which will include but not be limited to, lists and drawings giving details of each item delivered to site and its storage location. The lists shall be in the form of a computer program that can be used for stock control during the execution of the civil works.

3.3.2.2 Materials and Packing

3.3.2.2.1 General

Before manufacturing items of any description intended for supply, the Contactor shall submit for the approval of the Engineer the names and locations of the factories proposed. No manufacture shall start before the factory and the proposed items to be manufactured in the factory are approved.

In order to ensure watertightness between DI pipes, fittings and valves, all ductile iron products are preferably to be manufactured and supplied from the same manufacturer. And the manufacturer should demonstrate its capacity to produce Di pipes and Fittings from same material.

All item supplied under this contract must ne new.

Materials used in the supplied items which are, or can be in contact with the untreated or treated water shall not contain any matter which could impart taste, odour or toxicity or otherwise be harmful to health or adversely affect the water conveyed. Listing by the UK Water Fittings Bye-laws Scheme as operated by the UK Water Research Centre will generally be regarded as satisfactory evidence of suitability.

3.3.2.2.2 Sample

Unless expressly stated, the Contractor shall provide samples of all manufactured items required for the supply, or alternatively the Contractor shall submit trade literature where the provision of samples, in the first instance and as agreed by the Employer, is impracticable.

All samples shall be provided free of cost and samples rejected by the Engineer shall be removed.

All approved samples shall be stored, at a location approved by the Engineer, by the Contractor for the duration of the Contract, and any items subsequently supplied shall be of a quality at least equal to the approved sample.

3.3.2.2.3 Samples and Tests

The Contractor shall provide to the Engineer three certified copies of the results of any routine analyses or tests carried out by him or his manufacturer on materials used in the manufacture of the Goods when and if asked by the Engineer.

In addition, when and if required by the Engineer, the Contractor shall provide samples of all or any materials used in the manufacture of the Goods and shall carry out any specified test on the said materials as may be required the Engineer at the place of manufacture or at a laboratory approved by the Engineer and shall provide to the Engineer within seven days of each such test three certified copies of the results of the analysis or test.

Samples shall be submitted and tests carried out sufficiently early to enable further samples to be submitted and tested if required by the Engineer. The Contractor or his manufacturer shall prepare the necessary test pieces and supply all labor, appliances, testing apparatus and everything necessary for carrying out all specified tests.

The Contractor shall give the Engineer 14 days notice in writing of the date on which any of the samples will be ready for testing or inspection and unless the Engineer shall attend at the appointed place within the said 14 days, the test may proceed in his absence.

Approval by the Engineer as to the placing of orders for materials or as to samples or tests shall not prejudice any of the Engineer's rights under the Contract.

3.3.2.2.4 Test Certificates

Test certificates in triplicate shall be provided by the Contractor for each consignment of pipe supplied, giving the process of manufacture and the results of the specified tests.

Similar certificates in triplicate shall be provided by the Contractor in respect of materials to be used in the manufacture of the pipes giving the process of manufacture, chemical analysis (where relevant) and the results of the specified tests. The material shall be suitably marked to enable it to be identified from references on the certificates.

Any materials subject to test incorporated in the manufacture of the pipes and fittings before the Engineer has received a satisfactory Test Certificate shall be at the Contractor's risk.

3.3.2.2.5 Independent Tests

The Engineer reserves the right to carry out any independent tests he may deem fit on the completed pipes or on any material to be used in the Contract at any stage of manufacture or delivery, in addition to those tests specified to be made by the manufacturer.

Any samples of materials which may be required for such tests shall be provided by the Contractor at no extra cost to the Engineer.

Any materials, workmanship, or completed pipes, which are shown by such independent tests not to be in accordance with the Specification, shall be rejected, notwithstanding any previous certificate which may have been provided.

3.3.2.2.6 Rejected Goods

Any Goods delivered to the Site which have been rejected by the Engineer shall immediately remove from the Site by, the Contractor, free of cost. Replacement of rejected Goods shall be made as soon as possible but in no case exceeding forty five (45) days from the time of rejection.

Any goods which have been rejected shall be marked in a distinctive manner which shall preclude any possibility of their use for the purpose for which they were supplied. Such goods may be submitted for retest following the correction of any defects, where such correction is permitted by the Engineer.

3.3.2.2.7 Approved Manufacturer's Instructions

The Contractor shall supply manufacturer’s instructions in English for the operation and maintenance, and where necessary the assembly, of the items supplied. If the translation of the instructions, the quality of accompanying illustrations, or any other element of the instructions are unclear or ambiguous they shall be revised and resubmitted, until approved by the Engineer, all revisions will be at the Contractor’s expense.

3.3.2.2.8 Identification and Marking

3.3.2.2.8.1 Permanent Marking of Items

All supplied items shall have permanent distinguishing marks as per this Specifications or a standard approved by the Engineer. All marks shall be visible and legible and not obscured by any protective coating.

3.3.2.2.9 Packing and Protection

Before any item is dispatched from a manufacturer’s factory it shall be adequately protected and packed so as to arrive at the Site intact and undamaged. The method of protection and packing must be suitable to withstand the conditions which may be experienced in shipment and delivery to the Site. It should also be suitable to withstand long periods of storage out of doors. As a minimum requirement: unpainted surfaces, including bolts and nuts, machined surfaces, tapped holes and studs, and all other exposed ferrous surfaces, shall be protected with a heavy coat of suitable grease or other easily removed corrosion-protective material, rubber gaskets and glands, and other components which are subject to deterioration by ultraviolet light shall be packed so as to exclude sunlight.

All flanges and mating surfaces shall be protected by means of a wooden template or similar. This template shall not be secured by the bolts, screws etc, which form part of the final installation.

Unless otherwise specified all pipes and fittings shall receive their complete protective coatings before dispatch from the manufacturer’s works and shall be additionally protected by approved means for the period of transit, storage and erection, against corrosion and accidental damage.

For the protection of pipe linings and in particular for protecting cement mortar linings from drying out, protective metal or timber discs shall be attached to all flanges of pipes and fittings by means of bolts specifically provided for the purposes and which shall be discarded when the item is incorporated in the Works. The ends of non flanged pipes and fittings shall be wrapped with two layers of opaque 0.3 mm thick plastic sheeting secured with plastic bands, the sheeting and the bands shall not deteriorate during long (4 years) exposure to sunlight. The sleeves and flanges of flexible joints shall be wired together in suitable bundles.

3.3.2.2.9.1 Packing of Bolts, Joint Rings and Gaskets

Bolts of the same length and size (and their accompanying nuts and washers) shall be packed together in boxes not exceeding 100 kg. gross weight. Joint rings and gaskets shall be packed in boxes and separate packages shall be provided for each size and description of ring or gasket.

3.3.2.2.9.2 Flanged Joint Protection

All flanged pipes and sluice valves shall be supplied with complete ‘Corrosion’ protection materials in accordance with the manufacturer's recommendation. The complete joint protection includes the materials, namely profiling mastic or primer, paste, tape and PVC or polyethylene outer wrapping. The quantity of materials required for each diameter joint

shall be calculated in accordance with the manufacturer to cover the whole joint including nuts and bolts. The Contractor shall provide the required details of quantities in the schedule of particulars.

3.3.2.2.10 Pre-Shipment Inspection

Before the goods are ready for packing and dispatch after production, the Employer or its representative shall have the right to inspect and/or to test the goods to confirm its compliance with the provisions of the approved QAP /specifications. All in-house technical, production and test data related to the goods that may be conducted on the premises by the manufacturer shall be furnished to the Employer or an inspection agent appointed by the Employer, at no charge to the Employer.

The Contractor shall cover the costs related to the services of the inspection agent, but the selection of the agent shall be the solely the responsibility of the Employer.

The Employer or an agent appointed by the Employer will visit the manufacturing premises of the goods being manufactured and satisfy himself either through the in-house test results provided by the manufacturer; or shall draw samples of the goods readied for delivery, and carry out necessary tests on the manufacturing premises to determine that the goods fully comply with the requirements of the contract. Test carried out at the manufacturing premises shall be at no charge to the Employer.

The goods will be packed and shipped only after it has been cleared for shipment by the Employer or an inspection agent appointed by the Employer. The Employer shall notify the Contactor in writing of the identity of the agent, if any, or its representative retained for such purpose.

Should the goods or any part fail to meet the requirements of the specifications, the Contractor shall replace such goods or the part within the time specified for delivery or extension granted. However, under such circumstances the Contractor shall bear the extra costs incurred in connection with additional inspection, failing which the Employer shall be entitled to recover all such costs from any payments due to the Contractor.

The Employer's right to inspect, test and, where necessary, instruct Engineer to reject the goods after delivery to the Employer's stores, shall in no way be limited or waived by reason of goods having previously been inspected, tested and passed by the Employer or its representative prior to the shipment from the country of origin.

Providing always that replacement is possible, the Contractor shall refund to the Employer all amounts paid on account or recovery may be made from the security for performance.

Nothing in this clause, in any way, releases the Contractor from any warranty or other obligations under the Contract. Employer's failure to inspect and accept or reject goods shall not relieve the Contractor from responsibility nor impose liability on Employer, for non-conforming goods.

3.3.2.3 Supply of Goods

3.3.2.3.1 General

All items supplied under this Contract must be new, of first quality, free from defects, and shall be designed to meet the requirements of the specification. They shall be service proved products of specialized manufacturers.

The Contractor shall submit indicative list that the items have performed successfully in similar conditions for at least 5 (Five) years. Alternately if the products have been designed or developed more recently, the Contractor shall prove in a way acceptable to the Engineer that the supplies are suitable in every respect for the work intended and meet the requirements for this contract. In this respect, reliability in operation and ease of maintenance will be considered the decisive criteria.

Each item should be dimensioned as indicated in the drawings or the specified standard or code, where there is a difference between the details and the Contractor's item he shall inform the Engineer of the differences.

3.3.2.3.2 Experience of Manufacturer

The Contractor must show at the time of Bidding that the Manufacture whose product he intends to supply has proven experience and capacity in the manufacture of the type of Goods to be supplied under this contract.

The Contractor must name the manufacturer(s) at the time of Bidding from whom he proposes to obtain any material under the contract. As a proof, he should also include a Letter of Consent from the manufacturer(s) stating his acceptance to sell the material to the Contractor on award of the contract. Normally, the material supplied should be the product from the quoted manufacturer(s). However, in situation beyond the control of the Contractor, the Engineer may consent to accept material from other manufacturer; provided he is satisfied, that the new experienced and capable to produce the material and that the product is either equivalent or superior to the product from the previously agreed manufacture. No orders shall be placed with the newly named manufacturer without the written consent of the Engineer.

3.3.2.3.3 Equivalency of Standards and Codes

Wherever reference is made in the Contract to specific standards and codes to be met by the items to be furnished, and work performed or tested, the provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise expressly stated in the Contract. Where such standards and codes are national, or relate to a particular country or region, other authoritative standards which ensure an equal or higher quality than the standards and codes specified will be accepted subject to the Engineer's prior review and written approval. Differences between the standards specified and the proposed alternative standards must be fully described in writing by the Contractor and submitted to the Engineer at least 28 days prior to the date when the Contractor desires the Engineer's approval. In the event the Engineer determines that such proposed deviations do not ensure equal or higher quality, the Contractor shall comply with the standards specified in the documents.

The following is a list of some internationally accepted standards and codes and some associations concerned with the standardization of products and abbreviations below will be used in the following text.

a)	ANSI ASA).	American National Standards Institute (Successor of
b)	AS	Australian Standard
c)	ASTM	American Society for Testing and Materials
d)	AWWA	American Water Works Association
e)	BS	British Standard
f)	DIN	German Industrial Standard
g)	ISO	International Organisation of Standards
h)	JIS	Japanese Industrial Standard
i)	JWWA	Japanese Water Works Association
j)	SIS	Swedish Standards
k)	IS	Indian Standards
l)	NS	Nepalese Standards

3.3.2.3.4 Application

This chapter shall apply to all ductile iron pipes, valves, fittings, appurtenances and other special unless otherwise required by the Specification.

3.3.2.3.5 Works Inspection

The Contractor shall provide a program showing the planned manufacture of items and a schedule of works test. The minimum tests shall be those necessary to show compliance with the required standards. The manufacturer shall give the Engineer 28 days notice of the start of a series of tests and an equivalent amount of notice of the end of the test series. The manufacturer shall give unimpeded access to witness the tests, to the Employer and /or his designated inspection agent.

3.3.2.3.6 Shop Testing and Inspection

The inspection and testing of pipes, valves, fittings and accessories will take place on the manufacturer's premises. The manufacturer shall provide, free of charge, the testing equipment, the needed material, checking devices and necessary trained personnel for each test. The manufacturer of concern goods shall provide for two personnel or representatives of the Employer to witness concern good testing on the concern manufacturer's premises, free of charge, for two periods of 5 days each. The Contractor shall provide, free of charge, for transportation of the Employer's personnel or representatives to and from the manufacturer's premises, accommodation for the Employer's personnel or representatives during the testing periods, and incidental expenses of the Employer's personnel and representatives during the periods of testing.

Tests shall be carried out in accordance with relevant standard as approved by the Engineer. Each successfully tested batch will be identified by a mark. Results of all such tests shall be submitted to the Engineer on a previously approved certificate or form certified by the manufacturer or by a recognized agency.

The pipes, valves, fittings and accessories which show in the opinion of the Engineer minor imperfections unavoidable occurring during manufacturing and not disadvantageous for their use, shall not be rejected and the manufacturer may under his own responsibility decide the method of removing such small visual superficial imperfections. He may also after approval of the Engineer repair certain defaults by any method other than welding.

3.3.2.3.7 Final Acceptance at site

All pipes, fittings, valves and accessories shall conform to the specification at site. Engineer shall carryout necessary inspections at site prior to final acceptance.

3.3.2.4 Ductile Iron Pipe and Fittings

3.3.2.4.1 Pipes and Fitting

3.3.2.4.1.1 General

All Ductile iron pressure pipes and fittings shall comply with ISO 2531(2009), and shall have allowable pressure as stated in tables of ISO 2531(2009) ie. Table 1 and 2 for pipes and Table 3 for fittings. All pipes up to a diameter of 300mm shall be Class C40, socketed unless otherwise specified. Pipes with diameters from 350 to 600mm shall be of Class C30. Pipes greater than 600 mm shall be Class C25.

All components with flanged joints, including pipe and pipe fittings shall be of PN 16 pressure class and shall comply with ISO 2531(2009),.

Considering the geometric design of road of the project area, pipes of smaller effective length is preferred. However, the contractor should carry out pipe layout survey and take approval of the Engineer before placement of order of the pipes and its sizes (diameter and effective length of pipes).

The manufacturer should be equipped with a specific device in order to control wall thickness of pipes.

All DI fittings have to be produced by a process of Sand-Mould cast by using a sand mould plus a resin-sand core, so as to ensure the designed shape (to ensure accurate dimensions that guarantee joint water tightness) and thickness (to ensure strength) of fittings.

3.3.2.4.1.2 Materials

The materials used in the manufacture pipes and fittings shall comply with ISO 2531(2009).

3.3.2.4.1.3 Tests

Tests on pipes and fittings shall be carried out in accordance with ISO 2531(2009). The Employer shall be permitted free access to the place to manufacture for the purpose of examining and witnessing the testing of pipes and fittings.

3.3.2.4.2 Joints

3.3.2.4.2.1 Flexible non restrained (push fit)

These shall be flexible spigot and socket joints with sockets integral with the pipes and incorporating rubber rings recommended by the manufacturer and approved by the Engineer. Elastomeric gasket components shall comply with ISO 4633.

All push on joints shall be designed to be fully flexible: consequently, the allowable angular deflection certified by the manufacturer shall not less than the allowable deflection has been described in Article 5.2.2 of ISO 2531-2009, but preferably to provide below angular deflection degree in order to achieve the best protection to the safety of the pipeline in the event of unequal ground settlement due to the earthquake and swampy area.

All joints shall be designed to provide sufficient axial movement; the manufacturer shall declare the allowable withdrwal.

3.3.2.4.2.2 Mechanical joints

These shall be flexible spigot and socket joints with the sockets integral with the pipes. The joint shall be sealed by compressions of a rubber ring in the socket by means of bolting. The joint shall be suitable for use on the spigot of normal push fit jointed pipe.

3.3.2.4.2.3 Restrained joints

These shall be push fit type joints and shall incorporate some means of preventing the spigot being withdrawn from the socket once the joint is made. The joint shall be able to withstand the forces imposed when testing the pipeline using an end cap fixed with the restrained joint.

The restrained joints and anchoring system solution of DI pipes and fittings shall be featured with separate water tightness and anchorage system functions.

The manufacturer of DI pipes and fittings with restrained joint shall need to demonstrate:

1) Restrained joints and anchoring system shall be available for all range of pipes between 150mm to 500mm.
2) Present test certificate from reputable third party inspection organization, to certify that the manufacturer's design of restrained locking system fully satisfy the prescribed angular deflection by the manufacturer.
3) Evidences of deliveries of such anchoring system, within the Ductile Iron pipeline group, on identical projects (same pipe size and pressure rating) over the past 5 years.

3.3.2.4.2.4 Flanged Joints

All flanges shall comply with ISO 7005-2 or EN 1092-2. Joint sets shall be provided with all necessary nuts, bolts, washers and gaskets. The Contractor shall also supply in suitable containers sufficient graphite grease for application to the bolt threads when joints are made.

3.3.2.4.2.5 Nuts, Bolts and Washers

Nuts, bolts and washers shall be suitable for PN 16 Pressure Rating with ISO 2531(2009) or BS EN 1092-2 flanges and shall be made of steel with hot dipped cadmium coating or equivalent. Bolts shall be of sufficient length that one thread shall show through the nut when in the fully tightened condition.

3.3.2.4.2.6 Gaskets and Joint Rings

Joint rings shall be manufactured to conform to ISO 4633 and shall be of chloroprene rubber or other approved synthetic material suitable for temperatures up to 80°C.

Gaskets for flanged joints may be inside the bolt circle type and shall comply with BS EN 1514 or ISO 7483. Alternatively the gasket shall be to the full diameter of the flange, drilled to suit the appropriate bolt provisions.

Until immediately required for incorporation in a joint, each rubber ring or gasket shall be stored in the dark, free from the deleterious effects of heat or cold, and kept flat so as to prevent any part of the rubber being in tension.

Only lubricants suitable for use with potable water and recommended by the manufacturer shall be used in connection with rubber rings and these lubricants shall not contain any soluble constituent, shall be suitable for the climatic conditions at the Site and shall contain an approved bactericide.

3.3.2.4.3 Puddle and Thrust Flanges

Puddle and thrust flanges shall comply with Clause 3.3.2.4.1 but remain un-drilled.

3.3.2.4.4 Internal Linings

3.3.2.4.4.1 Pipes

The pipes shall be internally lined in the factory with a sulphate resisting or portland cement mortar. The thickness and the lining shall be in accordance with ISO 4179. Prior to application of the lining the internal surfaces shall be shot blast cleaned to acceptable standard. The lining shall be applied centrifugally. The cement composition shall conform to BS 4027 or BS EN 197-1.

Certain sections are amplified as follows:

No additives shall be used without the written approval of the Engineer, and shall be used strictly in accordance with the manufacturer’s recommendations.

The thickness of the lining at any one point shall not be less than the specified minimum thickness.

All linings shall have a smooth uniform surface finish.

3.3.2.4.4.2 Fittings

The fittings shall be internally lined in the factory with Fusion bonded epoxy 200 microns, in accordance with EN14901-2006. The epoxy coating shall be for potable water by test certificate from international health institute, shall be abrasion, resistant and shall be subject to approval of the Engineer. Prior to application of the lining the internal surfaces shall be shot blast cleaned to acceptable standard. All linings shall have a smooth uniform surface finish.

3.3.2.4.5 External Coating

3.3.2.4.5.1 General

Unless otherwise specified, ductile iron pipes and fittings shall be zinc coated with bitumen over coating, all in accordance with the following Specifications. Buried pipes and fittings shall also have a site or factory applied polythene sleeving. Pipe coatings shall be inspected on site and any damage or defective areas made good to the satisfaction of the Engineer.

3.3.2.4.5.2 Zinc Coating

Zinc coating shall comply with ISO 8197 and shall be applied as a spray coating. The mass of sprayed metal shall not be less than 130 to150 g/m2 as described in the standard.

3.3.2.4.5.3 Bitumen Coating

Bitumen coating shall be of normal thickness 0.07 mm unless otherwise specified. It shall be a cold applied compound complying with the requirements of BS 3416 Type II, suitable for tropical climates, factory applied in accordance with the manufacturer’s instructions.

Damaged areas of coating shall be repainted on site after removing any remaining loose coating and wire brushing and rusted areas of pipe.

3.3.2.4.5.4 Polyethylene Sleeving

Unless indicated otherwise, polyethylene sleeving shall be provided in addition to bitumen coating. Polyethylene sleeving shall comply with ISO 8180 and be marked in accordance with AWWA C105.

Site applied sleeving shall be stored under cover, out of direct sunlit, and its exposure to sunlight shall be kept to a minimum. Pipes having a factory applied sleeving must be stored in the same conditions.

3.3.2.5 Slip-on Type couplings

Slip-on type couplings shall include the following couplings:

- a) Straight flexible couplings;
- b) Stepped flexible couplings;
- c) Flange adapters
- d) Dismantling joints.

Slip-on type couplings shall be procured from approved Contractors and suitable for use with ductile iron pipes manufactured to ISO 2531. These shall be capable of withstanding the test pressures appropriate to the pipes for which they are supplied.

The preparation of pipe ends for slip-on type couplings shall be in accordance with the requirements of and the tolerances specified by the joint manufacturer. Couplings shall be installed fully in accordance with the manufacturer's recommendations.

Gaskets, bolts, nuts, glands, end rings, and hardware for pipe couplings of all types shall be furnished by the manufacturer of the pipe coupling and shall be designed as an integral system by the pipe coupling manufacturer. Gaskets shall be designed for the coupling and appropriately sized to provide a watertight seal at the design pressure and temperature. Gaskets, bolts, nuts, glands, end rings and hardware for pipe couplings shall be shipped with the pipe coupling and shall be clearly labeled indicating the origin of the material, place and date of manufacture. Manufacturer's printed installation instructions shall be packaged with each pipe coupling.

The Contractor shall follow the manufacturer's recommendations as to the methods and equipment to be used in assembling the joints. In particular, the Contractor shall ensure that rubber rings are correctly positioned and free of twists. The rubber rings and any recommended lubricants should be obtained only from the coupling manufacturer.

All nuts, bolts and washers used in the construction of the coupling shall be cadmium plated. Flanges which mate with pipes, fittings and valves shall be drilled to BS EN 1092-2 (ISO 2531)

3.3.2.6 Mechanical Coupling

Mechanical coupling shall be made of cast iron. The mechanical coupling shall be able to join to plain ended pipe and withstand a pressure of at least 25 bar after jointing. The mechanical coupling shall be designed as dismantling pieces suitable to slip into a broken main. The mechanical coupling should be supplied with adequate number of nut, bolts and gaskets.

3.3.2.7 Valves

Vales supplied shall be as per internationally recognized standards suitable for ISO 2531 ductile Iron Pipes. All materials of manufacture shall be suitable for use with water at temperatures up to 45 deg. C.

Valves shall be suitable for frequent operation as well as operation after long periods of idleness in either open or closed position. The valve steam, thrust washers, screws, nuts and all other components exposed to drinking water shall be of corrosion resistant grade of stainless steel.

Sluice valves and butterfly valves shall be suitable for flow in either direction.

The gate, sluice/butterfly vales shall have full clear bore to nominal diameter to achieve optimum flow. The operating torque shall minimum according to relevant standards of valves.

For sluice/gate vales back seating arrangement shall be provided.

Unless otherwise specified, all standard valves shall be flanged type where flanges shall be of PN 16 and complying with ISO 7005-2, EN 1092-2.

Pressure testing shall be according to ISO 5208. Test certificates shall be supplied with each valve.

The Engineer shall have the right to reject any casting, forging, bearing etc and the Supplier shall replace any such defective parts at his own expense.

The following records and drawings of all types of valves shall be made available by the Contractor for inspection.

1) Drawings showing overall dimensions, valve construction and settings
2) Data related to pressure ratings, weights and materials of manufacture (each component)
3) Test certificates of works tests
4) Performance data of air valves
5) Seating design and the seating materials of butterfly valves

3.3.2.7.1 Types of Control Valves

3.3.2.7.1.1 Butterfly Valves

All butterfly valves shall be double flanged eccentric butterfly valve designed according latest version of ISO 10631 or EN 593 or EN 1074-1 and 2 and should have integral standing feet. All butterfly valves shall be through plant test according to ISO 5208 checked All butterfly valves shall be operated by manual. The manual actuators can be replaced by motorized actuator. All valves shall have nominal pressure rating PN16 unless indicated otherwise in the Drawings or Bill of Quantities.

Valves shall be bubble-tight at rated pressures in either direction, and shall be satisfactory for applications involving throttling service and for applications requiring valve actuation after long periods of inactivity. Valve discs shall rotate 90° from the full open position to the tight shut position. Regardless of valve size, angular misposition of disc can be up to 1° off center without leakage.

Flange drilling of each butterfly valve shall be according to ISO 7005-2 or EN 1092-2 and face to face dimension shall be according to ISO 5752 series 14. Materials of component of all butterfly valves shall be as follows:

a) Body: Ductile iron
b) Disc: SG 400-15 ductile iron to BS 2789
c) Shaft: stainless steel 304 in self lubricants bushes
d) Internal bolts, nuts and set screws: stainless steel
e) Body and disc painted with epoxy 250 micron thick
f) Marking: each butterfly valves shall have following marking

On the Body like EN19

Nominal diameter in mm (DN)
Nominal pressure in bar (PN)
Type of ductile iron;
Manufacturer's logo;
Model code;
Fusion date.

On the label like EN19:

Nominal diameter in mm (DN);
Nominal pressure in bar (PN);
Maximum operating pressure (PFA);
Closing direction;
Model code;
Manufacturing order, Order confirmation;
Manufacturer's logo.

On the disc:

Nominal diameter in mm (DN);
Nominal pressure in bar (PN);
Type of ductile iron;
Manufacturer's logo;
Model code.

The Contractor shall provide a test certificate confirming that the valves have been tested in accordance with BS 5150 and stating the actual pressures and medium used in the test. In addition the Contractor shall ensure that the Employer has access to the manufacturer's works at all reasonable times for the purposes of inspecting the assembled valves and witnessing testing.

3.3.2.7.1.2 Gate Valves

All Gate valves shall be double flanged valve designed according latest version of ISO 7259. All Gate valves shall be operated by manual and motorized actuator valves. All valves shall have nominal pressure rating PN16 unless indicated otherwise in the Drawings or Bill of Quantities

Gate valves shall comply with plant test acording to ISO 5208. All valves shall be suitable for use with potable water.

Specific Clauses are amplified as follows:

a) Types of valves: Solid with non-rising stem.
b) Face to face dimension: Shall be as per ISO 5752 series 14, BS EN 558 Series 3
c) Flanged and drilled to BS EN 1092-2, ISO 7502-2 PN-16
d) Nominal Pressure: PN 16 unless otherwise indicated in the Price Schedule.
e) The valve Body and other uncoated ferrous part shall be painted with epoxy paint 250 micron thick.
f) Marking

On body:

Nominal diameter in mm (DN),
Nominal pressure in bar (PN).

On identification label:

Reference of valve
Closing direction (FSH / FAH)-nominal diameter (DN)-flange drilling
Year and month of manufacture-number,
Number of the norm

The Contractor shall provide a test certificate confirming that the valves have been tested in accordance with ISO 5208, BS 5150 and stating the actual pressures and medium used in the test. In addition the Contractor shall ensure that the Employer has access to the manufacturer's works at all reasonable times for the purposes of inspecting the assembled valves and witnessing testing.

3.3.2.7.1.3 Globe Valve

Globe Valve are used for throttling purpose. All Globe valves shall be double flanged valve of minimum 16 PN rating. The valves shall be designed, manufactured and tested in accordance with BS 1873, BS EN 558-1 or ISO 12159 Standard. The valves shall be certified to be Lead-Free in accordance with NSF/ANSI 61, Annex G.

Manufacturer shall have a quality management system that is certified to ISO 9001 by an accredited, certifying body.

The body ends are in line with each other and the disc is lifted from or lowered on to the body seat by a stem whose axis is at right angles to that of the body ends. In globe valves, the pressure acts on the underside of the valve disc and there is a change of direction of flow inside the valve body.

Face to Face Dimension shall be according to EN 1092-1 and all Globe valves shall be tested as per ISO 5208:2008(E)

3.3.2.7.1.4 Ball Valves

All Ball valves shall be double flanged valve. The valves shall be designed, manufactured and tested in accordance with American Water Works Association Standard ANSI/AWWA C507. The valves shall be certified to be Lead-Free in accordance with NSF/ANSI 61, Annex G.

Manufacturer shall have a quality management system that is certified to ISO 9001 by an accredited, certifying body.

The valve shall be constructed with a two-piece body rated for 160 psi and with end flanges in full conformance with ANSI B16.1 Class 125 or Class 250. The main body section and end piece shall contain integrally cast support feet and lifting lugs.

The valve port shall be a 100% clear bore equal to the nominal valve size with no seat hardware in the flow stream when fully open.

Double (or single) resilient seats shall provide drop-tight service and shall be located on the ball and mechanically retained with a stainless steel retaining ring and stainless steel nylok cap screws, which shall pass through both the resilient seat and the retaining ring. The retaining ring shall be continuous or investment cast with overlapping sections, serrated grooves and shoulders. The resilient seat shall be field adjustable and replaceable without removing the valve from the pipeline and mate to a continuous 316 stainless steel body seat ring.

Valve shafts shall be inserted into blind hubs in the ball and locked to the ball with taper pins retained with stainless steel jam bolts. The shaft shall be sealed with resilient grit seals in the body bores.

Teflon-lined, fiberglass-backed sleeve bearings shall be located in the body hubs.

An adjustable thrust bearing shall be provided to center the ball in the body.

Shaft seals shall be of the V-type and shall be replaceable without removal of the valve from the line or the shaft from the valve.

Valve interiors and exteriors shall be coated with an NSF/ANSI 61 certified fusion bonded epoxy in accordance with AWWA C550.

Manual actuators shall be of the traveling nut design with characterized closure per AWWA C507 and equipped with externally adjustable closed position stops capable of withstanding 450 ft-lbs. Actuators shall be lubricated with EP-2 grease and fully enclosed in an iron housing sealed against the entry of water.

Cylinder actuators shall be traveling nut design with characterized closure sized to position the valve with an air, water or oil supply pressure of 80-150 psi and built in accordance with AWWA C541. The rotating mechanism will consist of a lever and traveling nut directly connected to the cylinder rod. The cylinder rod, heads and barrel shall be constructed of stainless steel or non-metallic material for water service. Rod and piston seals shall be of the self-adjustable, wear-compensating type. The piston shall be one-piece with a wear strip.

Motor actuators shall be furnished in accordance with AWWA C542 for Power Actuators and factory tested on the production ball valve. The motor unit shall be mounted to a self-locking traveling nut actuator with characterized closure and externally adjustable closed stop. The motor actuator assembly shall be designed for open/close service with a minimum operating time of 60 sec.

The Contractor shall provide a test certificate confirming that the valves have been tested in accordance with American Water Works Association Standard ANSI/AWWA C507. In addition the Contractor shall ensure that the Employer has access to the manufacturer's works at all reasonable times for the purposes of inspecting the assembled valves and witnessing testing.

3.3.2.7.2 Automatic Air Relief Valves

3.3.2.7.2.1 Design of Air Valves

Automatic air relief valves shall be designed to meet the following conditions:

a) Discharge air during charging of the pipeline
b) Admit air during emptying of the pipeline, or when the pipeline pressure falls below atmospheric pressure during a surge event
c) Discharge air accumulated at local peaks along the pipeline under normal operating condition.

Conditions (a) and (b) shall be met by the employment of a large orifice capable of handling large volumes of air at a high flow rate, and condition (c) by a small orifice capable of discharging small quantities of air as they accumulate.

Valves with air intakes or exhaust facilities shall have approved screening arrangements to prevent the ingress of air borne sand.

3.3.2.7.2.2 Types of Air Valves

a) Double Acting Air Valves

These shall combine both large and small orifices within one valve. The large orifice shall be sealed by a rigid float and the chamber housing shall be designed to avoid premature closing of the valve by the air whilst being discharged.

The small orifice shall be sealed by a float at all pressures above atmospheric except when air accumulates in the valve chamber.

b) Single Air Valves

These include a small orifice only operating in a manner identical with the small orifice in a double acting valve.

3.3.2.7.2.3 General Specification

The nominal pressure range shall be PN 16 unless indicated otherwise in the price schedule. All air valves shall be made as per EN 1074-1 to 1074-4. In case flanged air valves the flange shall be as per EN 1092 -2 or ISO 7005-2.

Body ends shall be flanged with raised faces and drilled according to latest version of EN 1092-2 (ISO 7005-2).

The materials for the valves shall be as follows:

Body cover and cowl	-	Ductile Iron SG 400-15 to latest version of BS 2789
Small orifice	-	Ductile iron with gunmetal seat
Small orifice float		Rubber covered or other approved

Large orifice	-	Ductile iron with rubber seat
Large float	-	Vulcanite covered or other approved

Body and other uncoated ferrous parts painted with epoxy 250 micron thick

3.3.2.7.2.4 Tests

Test certificates shall be provided with each valve showing.

a) Hydraulic testing to at least 1.5 x working (rated) pressure or high pressure strength test
b) Low head leakage tests
c) Small orifice testing
d) Large orifice discharge test

During the tests the air flow rates shall be measured by orifice plates in accordance with latest version of BS 1042. Pressures (positive and vacuum) shall be measured by Bourdon tube gauges in accordance with latest version of BS 1780, or by means of mercury-in-glass manometers. The temperature of the flowing air shall be measured in accordance with latest version of BS 1041: Part 1 and Part 2. The barometric pressure shall also be measured.

3.3.2.7.3 Ball Float Valves

Ball float valves shall be designed for installation on the inlet pipe of a storage tank to shut the water off automatically when it reaches a predetermined level. They shall be of the single or double beat type or pilot operated with direct float and lever operation.

The valve shall be either full open or full closed and the design characteristic of the valve controls causes the main valve piston to modulate (close slowly) over the last few inches of filling.

Valves shall be designed for the working pressure specified and shall be tested for leakage at that pressure, when they should be drop tight. They shall be tested for body and valve element strength with the valve closed and a test pressure 1.5 times the working pressure applied to the inlet end.

The body end shall be flanged, faced and drilled to BS EN 1092 – 1: 2007 Valves shall not contain brasses containing more than 5% zinc. Gunmetal (to BS EN 1982:2008 Grade LG 2), aluminum bronze or nickel copper alloy may be used for internal components.

The body or stopper shall be of ductile iron. Floats shall be copper or glass fibre. The lever and links shall be of mild steel with bronze pins.

Where a stilling tank arrangement is required it shall accommodate a cheese type float mounted on a central tube connected to the valve operating lever and sliding vertically on a guide rod secured to the base of a galvanized wrought iron cylindrical tank perforated at the base.

3.3.2.7.4 Non Return Valve/Check Valve

Unless otherwise specified, check valves shall be swing type conforming to BSEN 12334:2001 with a pressure rating of PN 16 (i.e. 16 bar). Check valves shall be constructed so that disc, seat, seat rings and other internal working parts, which may become necessary for repairs, shall be readily accessible, removable and replaceable without use of special tools and removing the valve from the line. The valve body and the disc shall be of ductile iron complying with BS EN 1563 : 1997 and having smooth operating stainless steel hinge pins with gun metal bushes, EPDM / SBR encapsulated discs. They shall possess high speed closing characteristics with minimum shock on closing. All valves shall be tested to BSEN 12334:2001 and as specified in BSEN 12266-1 : 2003 and the test certificates issued by the manufacturer shall be submitted. All check valves shall be coated to as specified in clause 1.7 above. The flange drilling shall comply with BSEN 1092-1:2007, BSEN 1092-2:2007 or BSEN 1092-3:2007.

The body shall have an inspection cover on the top, through which the body can be cleaned and the disk exchanged.

- Installation position is horizontal
- Dimension: short widths
- Flanged connections according to ISO, EN, DIN

3.3.2.7.5 Pressure Reducing Valves

3.3.2.7.5.1 General

Pressure reducing valves shall be hydraulically operated pilot controlled diaphragm valve of a similar design to the flow control valve.

The valve shall limit the downstream pressure to the specified value regardless of the flow. The valve shall be controlled by a differential pilot valve sensing the downstream pressure.

The main valve shall consist of a removable Aluminum-Bronze seat and resilient rubber seal fully supported by a seal disc.

The stem will be guided at the top by a replaceable guide bearing in the valve bonnet, and at the bottom, by an Aluminum-Bronze centering device, connected to the seal disc and moving freely inside the seat.

No bottom guide bearing is permitted.

The synthetic rubber diaphragm will be fully supported, top and bottom, by rigid discs and will be connected to the stem in a way which enables fast and easy replacement on site.

No external packing gland and piston activation is permitted.

The valve will be equipped with a position indicating rod.

The pilot system shall contain a differential pilot designed to close when the controlling pressure exceeds the adjustable spring setting. The pilot control is normally held open by the force of the compression on the spring above the diaphragm and it closes when the pressure acting on the underside of the diaphragm exceeds the spring setting. The pilot control system shall contain a fixed orifice. No variable orifices shall be permitted.

The orifice plate flange assembly shall be of non ferrous material.

Small diameter non ferrous pipe work, valves, strainers shall be provided to allow operation of the system.

All ferrous items shall be protected by an epoxy coating with a minimum 300 microns thickness.

3.3.2.7.5.2 Tests

Each pressure reducing valve shall be tested at the manufacturer's works as follows:

- Body strength: closed end test, valve open, test pressure 1.5 times working pressure
- Valve element strength: open end test, valve closed, test pressure applied to inlet end of 1.5 times working pressure
- Leak tightness: open and test, valve closed, test pressure of the working pressure applied to inlet end, no visible leakage permitted.

Test certificates shall be supplied with every valve.

3.3.2.7.6 Flap Valves

Flap valves shall be circular door double hung. The valve shall be suitable for mounting on a wall or flanged pipework thimble. Valves for flange fixing shall be suitable for flanges drilled to BS EN 1092-2 (ISO 2531).

3.3.2.7.6.1 Materials:

- Frame - Ductile Iron BS 2789
- Door - Ductile Iron BS 2789
- Sealing faces - Copper Alloy
- Hinge links - Mild Steel
- Hinge brackets - Ductile Iron BS 2789
- Hinge Pins - Bronze

All ferrous metal parts shall be painted with epoxy paint 250 microns thick.

3.3.2.7.6.2 Tests

Flap valves shall be tested with a head of 5 m for free operation in opening and closing and for leak tightness. A certificate shall be provided with each valve.

3.3.2.7.7 Rubber Expansion Joints

The rubber expansion joints shall provides single and multiple arch rubber expansion joints and the flanges are carbon steel/stainless steel drilled such as standard drillings to our pipe's flange specifications. The supplied rubber joints for installation shall have minium following features:

1. Body shall be made of CR, EPDM, IIR, NBR, CSM, VITON material
2. Reinforcement shall be of Nylon Cord Fabric or equivalent material
3 Wire shall be Hard Steel Wire

In addition to above features, the Rubber Expansion Joints shall have:

1. Greater movements provide high level of installation flexibility.

2. Precision molded of synthetic rubber reinforced with nylon cord.
3. Excellent ability to absorb vibration and sound, withstands high pressures (minimum of 15 bar).

3.3.2.7.8 Extension Spindles, Tee - Keys and Caps

The depths of installation of all valves are as indicated in the BOQ descriptions (or as shown on the drawings) and a Tee - Key for the operation of valves shall be supplied in the following manner.

Four Tee - Keys for each size of valves to be supplied. The maximum length of Tee key shall be limited to 1m and Valves shall be provided with extended spindle to the Valve. The material of Tee - Keys shall be galvanized mild steel.

In case extension spindles are necessary, extension spindles shall be provided with suitable bearings, which are rigidly held on brackets or stays. Bearings and extension spindles shall be suitably protected against corrosion.

Where a valve does not require an operating or extension spindle, the valve spindle shall be protected with a properly fitting cap as per BS 5163: 2004.

3.3.2.7.9 Fire Hydrants

The fire hydrant shall be Traffic Fire Hydrant type. Traffic fire hydrant shall be dry-barrel fire hydrant complying with AWWA C502 and AWWA C550. Main valve seat opening shall be at least 115 mm. The nozzle section shall consist of two (2) x 2 ½" hose nozzles and one (1) x 2 ½" pumper nozzle, all of bronze alloy material. Thread types shall be as approved by the Engineer.

Hydrants shall have non-corrosive drain valves.

Hose and pumper caps shall be cast iron chained to the hydrant.

Hydrants shall be so designed, that in the event of accident, or breaking of the hydrant above or near grade level, the main valve will remain closed.

Operating threads shall be sealed from water at all times, when the valve is either in the open or closed position. The operating nut shall be made of bronze.

Fire hydrants shall be rated at PN 16.

Fire hydrant body shall be made of ductile iron.

Internal and external coating shall be epoxy as per AWWA standards. External color shall be fire red.

3.3.2.7.10 Pressure Gauges

Pressure gauges shall be oil-filled and of brass and black molded phenol plastic construction with acrylic plastic or toughened glass windows. Dials shall be at least 75mm diameter.

Internal gauge components shall be stainless steel or other corrosion resistant material with an accuracy of at least +1 percent of full scale. Gauges shall wherever possible operate about their mid-scale position. No aluminum shall be used in the construction of gauges. Scales shall be calibrated in meters head for water. Gauges shall be fitted with ball valve isolation valves and shall be equipped with a combined isolating valve and air release vent.

3.3.2.7.11 In-line Basket Strainer

This specification covers strainers to block or strain objects greater than 3/16" diameter, designed to prevent objects such as stones and pebbles from entering and causing physical damage to the PRV.

The strainer should be designed for minimum weight and pressure loss

The screen shall be made of perforated stainless steel and shaped to give maximum rigidity against flow steam forces

An access cover plate shall be provided.

The effective straining area shall be at least double that of the inlet.

Housing and cover shall be cast iron or ductile iron. Raised letters indicating flow direction will be clearly visible.

Casing bolts, nuts, screws and washers shall be stainless steel.

Head loss at maximum flows shall not exceed 3.0 psi.

3.3.2.7.12 Surface Boxes

Surface boxes shall be Ductile iron, grade "A" heavy duty complying to BS 5834 Part 2 : 1983 with the minimum clear opening sizes (mm), of 100mm, 135mm,225mm and 300mm depending on the location and as specified in the BOQ.

Surface boxes shall be painted before installation with two coats of bituminous paint. They shall be with captive hinge arrangement to prevent vandals and with suitable watertight arrangement to prevent ingress of surface water into the keyhole. The hinge pin shall be made from steel or ductile iron manufactured to suit the design and dimension of the unit.

The diameter of the hinge pin shall not be less than 6mm.The lids or covers of surface boxes shall have cast in-letters of words in English to indicate the function of the fittings as “FH, WO, SV, METER” and also the marking “WATER” in suitable size, cast in raised letters.

3.3.2.8 Polyethylene Pipes and Fittings

3.3.2.8.1.1 Polyethylene Pipes of PE-100 for 10 kg pressure pipe

The term "material" shall mean all materials and articles of every kind whether raw, processed or manufactured which are used in the manufacture of the Goods to be supplied under the Contract.

These specifications are for Polyethylene Pipe for Distribution Network of Dia 50 mm and above outside diameter (OD) and house service connections of Dia 20 mm OD. All these polyethylene pipes hereinafter referred as PE-100 pipes HDPE pipes used for 6, 10, 12.5 and 16 PN.

Raw Material and Pressure Rating

Raw material used to Manufacture PE-100 Polyethylene Pipe shall be Virgin Natural Resin PE100 containing those anti – oxidants, UV Stabilizers & Pigments necessary for Manufacturing of pipes. The Density of Pipes shall be confirming to ISO 4427 or NS 40-2079 Standard. The PE100 Resin shall have minimum required strength (MRS) of 10 Mpa (MRS at 50 years and 20 degree Celsius). Pressure rating for different diameters PE-100 pipes shall be according to table (below)

Effects on Water Quality

The PE-100 Pipes shall confirm to clause 3.5 of ISO 4427 or NS 40-2079 for conveyance of Water for Human Consumption. Also the pipes intended for conveyance of Potable water for Human consumption to be tested to comply with BS 6920 specifications in Internationally Reputed Laboratories and certificate of compliance to be produced for the following parameters:

Odour & Flavour of Water

Appearance of Water

Growth of Micro Organism

Extraction of substances that may be of concern to Public Health (Cyto Toxicity)

Extraction of Metals

Colour of Pipes

The Colour of PE-100 Pipes shall be BLACK with BLUE stripes confirming to Clause 3.2 of ISO 4427 or NS 40-2079 .

Dimensions

The pipe dimensions shall be as per latest revisions of Clause 4.1 of ISO 4427 or NS 40-2079. The length of straight pipes and coil shall be according to agreed length or coil-size between Contractor and the Employer. The internal diameter, wall thickness and other dimensions of pipes shall be as per relevant tables of ISO 4427 or NS 40-2079. Each pipe shall be of uniform thickness throughout its length.

The dimension tolerances shall be as per ISO 4427 clause 4.1.3 or NS 40-2079.

Performance requirements

The Pipe supplied should have passed the acceptance test as per ISO 4427 or NS 40-2079. The manufacturer should provide the test certificates for the following tests.

Melt Flow Rate

Density,

Oxidation and Induction test,

Hydrostatic Test,

Pigment dispersion Test,

Longitudinal Reversion Test.

These tests should be performed in the in-house laboratory of the pipe manufacturer. The Employer will depute Third Party Inspection Agency to the pipe manufacturing facility of the manufacturer to inspect the pipes as per QAP approved by Engineer In charge. The cost for the inspection and tests shall be borne by bidder/operator.

Marking

All pipes shall be permanently and legibly marked in such a way that the marking does not initiate cracks or other types of failure and such that normal storage, weathering, handling, installation and use does not affect the legibility of the marking.

The marking shall be such that it is legible without magnification.

The minimum required marking shall be in accordance with Table 6 of ISO 4427-2 or NS 40-2079, with the frequency of marking being not less than once in 5 meters.

3.3.2.8.1.2 Polyethylene Pipes of PE-80 100 for 6 kg pressure pipe

The term "material" shall mean all materials and articles of every kind whether raw, processed or manufactured which are used in the manufacture of the Goods to be supplied under the Contract.

These specifications are for Polyethylene Pipe for Distribution Network of Dia 50 mm to 180 mm outside diameter (OD). All these polyethylene pipes hereinafter referred as PE-80 pipes or HDPE pipes of 6 PN.

Raw Material and Pressure Rating

Raw material used to Manufacture PE-80 Polyethylene Pipe shall be Virgin Natural Resin PE80 containing those anti – oxidants, UV Stabilizers & Pigments necessary for Manufacturing of pipes. The Density of Pipes shall be confirming to ISO 4427 Standard or NS 40-2079. The PE80 Resin shall have minimum required strength (MRS) of 6 Mpa (MRS at 50 years and 20 degrees Celsius). Pressure rating for different diameters PE-80 pipes shall be according to table (below).

Effects on Water Quality

The PE-80 Pipes shall confirm to clause 3.5 of ISO 4427 or NS 40-2079 for conveyance of Water for Human Consumption. Also, the pipes intended for conveyance of Potable water for Human consumption to be tested to comply with BS 6920 specifications in Internationally Reputed Laboratories and certificate of compliance to be produced for the following parameters:

Odour & Flavour of Water

Appearance of Water

Growth of Micro Organism

Extraction of substances that may be of concern to Public Health (Cyto Toxicity)

Extraction of Metals

Colour of Pipes

The Colour of PE-80 Pipes shall be BLACK with BLUE stripes confirming to Clause 3.2 of ISO 4427 or NS 40-2079.

Dimensions

The pipe dimensions shall be as per latest revisions of Clause 4.1 of ISO 4427 or NS 40-2079. The length of straight pipes and coil shall be according to agreed length or coil-size between Contractor and the Employer. The internal diameter, wall thickness and other dimensions of pipes shall be as per relevant tables of ISO 4427 or NS 40-2079. Each pipe shall be of uniform thickness throughout its length.

The dimension tolerances shall be as per ISO 4427 clause 4.1.3 or NS 40-2079

Performance requirements

The Pipe supplied should have passed the acceptance test as per ISO 4427 or NS 40-2079. The manufacturer should provide the test certificates for the following tests.

Melt Flow Rate

Density,

Oxidation and Induction test,

Hydrostatic Test,

Pigment dispersion Test,

Longitudinal Reversion Test.

These tests should be performed in the in-house laboratory of the pipe manufacturer. The Employer will depute Third Party Inspection Agency to the pipe manufacturing facility of the manufacturer to inspect the pipes as per QAP approved by Engineer In charge. The cost for the inspection and tests shall be borne by bidder/operator.

Marking

All pipes shall be permanently and legibly marked in such a way that the marking does not initiate cracks or other types of failure and such that normal storage, weathering, handling, installation and use does not affect the legibility of the marking.

The marking shall be such that it is legible without magnification.

The minimum required marking shall be in accordance with Table 6 of ISO 4427-2 or NS 40-2079, with the frequency of marking being not less than once in 5 meters.

3.3.2.8.1.3 Compression Fittings

Compression fittings used for House service connection comply as per ISO 14236

Material of Construction

Compression fittings material shall confirm to ISO14236.Clause -5.

a. Body-Polypropylene
b. Nut / Cap –Polypropylene.
c. Clip Ring-POM (Acetylic resin)
d. Packing bush- Polypropylene
e. “O” ring – NBR
f. Threaded metal inserts –SS 304 with BSP Threads

Pressure testing

The pressure rating of compression fittings as per clause 8 of ISO 14236 which shall be PN16

Dimensions

The Dimension of compression fittings shall be as per clause 7.1 of ISO 14236

Performance requirements

The compression fittings shall be tested as per ISO 14236. Following Test methods shall be performed.

Clause 8.2.1 -Leak tightness under internal pressure.

Clause 8.2.2 -Resistance to Pull out.

Clause 8.2.3 -Leak tightness under Internal Vacuum.

Clause 8.2.4 -Long term Pressure Test for Leak tightness for assembled joint

Clause 8.3.2.1 -MRS Value as per ISO 9080

Clause 8.3.3.1 -Resistance to Internal pressure.

Effects on Quality of Water

The Compression fittings for intended for conveyance of Potable water for Human consumption to be tested to comply with BS 6920 specifications in any of their Certified Laboratories and certificate of Compliance to be produced for the following parameters:

a Odour & Flavour of Water.
b. Appearance of Water.
c. Growth of Micro Organism
d. Extraction of substances that may be of concern to Public Health (Cyto Toxicity)
e. Extraction of Metals.

For clear identification of the water services, the nuts of the fittings should be coloured blue while the body to be black. All fittings with threaded ends should be with BSP threads.

3.3.2.8.1.4 U PVC Ball Valves (Stop Cocks)

Ball Valves used for HOUSE Service Connections comply to ISO 4422, Part 4.

Material of Construction

Ball Valve material shall confirm to as per clause 4 of ISO 4422.

a. Body and Handle - UPVC
b. Seals - PTFE
c. O-rings – NBR/EPDM
d. Material of Construction for compression end will as per specifications for compression fittings.

Pressure Rating

The Pressure of the Ball Valve shall be as per ISO 4422 shall be PN 16.

Dimensions

The Dimensions of the Ball Valve shall be as per Table 3 of ISO 4422.

Performance Requirements

The Ball valves shall be tested as per ISO 4422. Following test methods will be performed.

Clause 7.1 - Resistance of Valve Bodies to internal pressure

Clause 7.2 - Crushing Test

Clause 7.3 - Endurance Test

Clause 7.4.2 - Seat and Packing Test

Clause 7.4.1 - Operating torque Test

The Ball Valves intended for conveyance of Potable water for Human consumption to be tested to comply with BS 6920 specifications in any of the laboratories like DVGW / KIWA / SPGN / WRc –NSF and certificate of compliance to be produced for the following parameters:

a. Odour & Flavour of Water.

b. Appearance of Water.

c. Growth of Micro Organism

d. Extraction of substances that may be of concern to Public Health (Cyto Toxicity)

e. Extraction of Metals.

3.3.2.8.1.5 DI CLAMP SADDLE FOR SERVICE CONNECTIONS

General Specifications

Clamp saddles for service connection from water distribution mains shall be of wrap around design, wide skirt and wide straps supports, which shall reinforce the pipe while providing excellent stability to the saddle.

Clamp Saddles for Service connections shall be of fastened strap type with threaded outlet for service connection.

The service connection threading sizes shall be conforming to IS: 554

Clamp saddles shall be suitable for DI pipes of nominal size 3" (NB 80) to 12" (NB 300) with nominal service connection size from ½ " (NB 15), ¾ " (NB 20),1" (NB 25),1 ¼" (NB 32), 1 ½" (NB 40) and 2" (NB 50).

The straps shall be elastomer coated (insulated) type for firm grip on pipe as well as to protect the coating on the pipe and to insulate the un –identical metals. The saddles shall be single strap type up to pipe size of NB 600 and service outlet of ½", ¾", and 1".

The saddles shall be double strap type for pipe sizes above NB 600 or when the service outlet is 1 ¼",1 ½" or 2".

Fasteners shall be of thread nut-bolt-washer type. Nut-bolts of size ½" (M12) shall be used for saddles of size up to 4" (NB 100) and Nut-bolts of Size 5/8" (M 16) shall be used for saddles of size 6" (NB 150) and above.

The sealing between the saddle and mains shall be obtained by using a profiled elastomer seal matching to the curvature of the pipe.

The seal shall be of elastomer type, suitable for all potable water applications.

The Material of construction of the body, straps, fasteners etc. shall be of a non-corrosive material such as engineering plastic (PE / PP) or stainless steel or a combination of both or DI with Resicoatepoxy.

The design of the saddle body should be such that, the service connection outlet metal insert shallproject out towards pipe side and align with the hole drilled on the pipe to ensure positive locking against rocking or creeping on the pipe, as might be caused by vibration, pressure or excessive external loading.

The clamp saddles shall be suitable for maximum working pressures up to 10 bars

Material and Design Specifications

Saddle Body: Non corrosive Engineering Plastic body moulded with Stainless steel threaded metal insert for tapping outlet. Also, the stirrup metal plate shall be duly embedded in the plastic body, except at the place of nut-bolt lugs. Threading size and dimensions shall conform to IS: 554. The body shall have retaining cavity housing for internal and external retention of the elastomeric seal. Sealing shall be achieved by pressure exerted by the body while fastening the saddle straps & body on the pipe.

Saddle Strap: Saddle straps shall be made of plastic with or without metal reinforcement depending on size and injection moulded to prevent galvanic corrosion over the long service life. In case of metal reinforcement, the metal should not come in direct contact with pipe.

Strap Insulation: In case of plastic strap, insulation is NOT required.

Saddle Seal: It shall be virgin rubber SBR Grade 30 / NBR (NSF 61 approved). It shall be of type pressure activated hydro-mechanical design. It shall be contoured gasket to provide a positive initial seal which increases with increase in the line pressure. Gasket shall be gridded mat, with tapered ends, with the outlet section having 'o' ring contacting the saddle body multiple o-rings contacting the pipe, preferably with a Stainless steel reinforcing ring insert moulded to prevent expansion under pressure.

Nut-Bolts –washer: Stainless Steel Type 304, NC Rolled thread, Tightening torque for ½" (M12) nut –bolt: 14-15 Kg.m and for 5/8" (M16) nut-bolt: 21-23 Kg.m

3.3.2.8.1.6 Electrofusion Fittings For Polyethylene Distribution Mains

General

All the electrofusion fittings included in this document should be designed for use in water distribution systems and be manufactured/supplied by manufacturers having ISO 9001certification for their quality systems. The products should comply with the following specific requirements.

1. The products shall comply with the requirements of BS EN 12201-3: 2003, BS EN 1555-3 or ISO 8085-3.
2. All the fittings shall be of SDR 11 rating.
3. The product group used for drinking water applications should have undergone type test by WRc-NSF, U.K according to BS 6920 in any of their Certified Laboratories and certificate of Compliance to be produced for the following parameters:
    a. Odour & Flavour of Water
    b. Appearance of Water
    c. Growth of Micro Organism
    d. Extraction of substances that may be of concern to Public Health (Cyto Toxicity)
    e. Extraction of Metals
4. All the products shall be manufactured by injection moulding using virgin compounded PE100 polymer having a melt flow rate between 0.5 – 1.1 grams/10 minutes and shall be compatible for fusing on PE 100 distribution mains manufactured according to the relevant national or international standards. The polymer used should comply with the requirements of BS 3412 and/or BS EN 12201-1.
5. All the electrofusion products should be individually packed so that they can be used instantaneously at site without additional cleaning process. The protective packing should be transparent to allow easy identification of the fittings without opening the bags.
7. The electrofusion products should be with only a single heating coil to fully electro fuse the fitting to the adjoining pipe or pipe component as applicable. The heating coils shall be terminated at terminal pins of 4.0 or 4.7 millimeter diameter, protected with termina shrouds. Each terminal shroud should be additionally protected with polyethylene shroud caps.
8. No heating element shall be exposed and all coils are to be integral part of the body of the fitting. The insertion of the heating element in the fitting should be part of the injection moulding process and coils inserted after the injection moulding process or attached to the body of the fitting as a separate embedded pad etc. are strictly not acceptable.
9. The brand name, size, raw material grade, SDR rating and batch identification are to be embedded as part of the injection moulding process. Each fitting should also be supplied with a barcode sticker for fusion parameters attached to the body for setting the fusion parameters on an automatic fusion control box. The barcode sticker should also include the fusion and cooling time applicable for the fitting for the manual setting of a manual fusion control box.
10. The fittings should be V-regulated type designed to fuse at a fusion voltage of 40 volts AC.
11. The heating elements should be designed for fusion at any ambient temperatures between -5 to +40 degree centigrade at a constant fusion time i.e. without any compensation of fusion time for different ambient temperatures.

12. A limited path style fusion indicator acting for each fusion zone as visual recognition of completed fusion cycle should be incorporated into the body of each fitting near the terminals. The fusion indicators should not allow the escape of the molten polymer through them during or after the fusion process.

13. All the sockets in the electrofusion fittings should include a method of tapping controlling the pipe penetration (pipe positioner/stopper).

Flanged PE Pipe / Stub Ends

HDPE Stub ends shall be square ended with extra spigot length for Electro fusion coupler jointing, conforming to ISO: 8085 / pr EN 1555-3 / BS EN 12201 specifications. Stub ends will be made of PE 100 material and will be welded on the pipe by Electrofusion jointing only. Stub ends should smooth outer body surface for easy movement of slip on flanges. Flange will be of slip on flange type as described below.

Slip-on Flanges

Slip-on flanges shall be metallic flanges (MS) covered by epoxy coating or plastic powder coating. Slip-on flanges shall be conforming to standard meeting relevant flanges of valves, pipes etc. Nominal pressure rating of flanges will be PN10. Thickness & Internal diameter of the flanges should be as per relevant BS (10 Table D)/ ISO/BSEN standard. Outer diameter and PCD of the flanges should be made as per the other companion flanges of other side to connect the metal pipes / valves etc.

Jointing of PE Pipes shall be made by qualified/certified welders only. Qualification and training of the welders for electrofusion is certified and carried out by the fittings supplier.

All specials/ fittings such as Valves, Flange adopters, Cast Iron (CI)/Mild Steel (MS) specials, Galvanized Iron (GI) pipes and GI specials, Brass Tap etc., will be supplied by the Contractor. Contractor shall install these specials/fittings as per the standards specifications and as per the instructions of the Engineer.

The PE pipes shall be laid in accordance with the latest IS 7634 Part- 1 and 2 and BS EN 12201-3.

After laying and jointing of the PE pipes, after partial refill and before final refill a underground Warning Tapes as per clause 3.3.4.10shall be laid above the crown of the pipe as per the standards and as per the instructions of the Engineer.

GI (light duty)/concrete (Non Pressure) casing pipe shall be provided for HDPE pipe for the particular section line plus required bearing where the alignment of pipe line crossing major roads, natural/side/cross drains, as instructed by the Engineer.

Layer of concrete of required grade shall be provided over the particular section the pipe line where contractor is not able to achieve the specified depth of excavation due to natural hard strata as instructed by engineer in charge.

Contractor has to submit detailed as built drawing of work done in latest Auto Cad version, showing the details of pipe line, specials/fittings, valves and joints in four hard copies and one soft copy.

Field Hydraulic Test

The Sectional Hydraulic Test shall be carried out after the pipeline section to be tested has been laid jointed and backfilled to a depth sufficient to prevent floatation, but leaving the joints exposed which are to be tested. The sections to be tested shall have be to the approval of the Engineer shall be according to clause 3.3.3.6.

3.3.2.8.1.7 Electrofusion Tapping Saddle for House Service Connection

All the electrofusion fittings included in this document should be designed for use in water distribution systems and be manufactured/supplied by manufacturers having ISO 9001certification for their quality systems. They should have supplied to government water boards for their water supply projects. The products should comply with the following specific requirements.

1. The products shall comply with the requirements of BS EN 12201-3: 2003, BS EN 1555-3 or ISO 8085-3.
2. All the fittings shall be of SDR 11 rating.
3. The EF Tapping Saddle used for drinking water applications should have undergone type test by WRc-NSF, U.K according to BS 6920 in any of their Certified Laboratories and certificate of Compliance to be produced for the following parameters:
    a. Odour & Flavour of Water
    b. Appearance of Water
    c. Growth of Micro Organism
    d. Extraction of substances that may be of concern to Public Health (Cyto Toxicity)
    e. Extraction of Metals

4. All the EF Tapping Saddle shall be manufactured by injection moulding using virgin compounded PE 100 polymer having a melt flow rate between 0.5 – 1.1 grams/10 minutes and shall be compatible for fusing on PE 100 distribution mains manufactured according to the relevant national or international standards. The polymer used should comply with the requirements of BS 3412 and/or BS EN 12201-1.

5. The Electro fusion Tapping Saddle intended for water distribution applications shall be coloured Black.

6 All the electro fusion Tapping Saddle should be individually packed so that they can be used instantaneously at site without additional cleaning process. The protective packing should be transparent to allow easy identification of the fittings without opening the bags.

7. The electro fusion Tapping saddle should be with only a single heating coil to fully electro fuse the fitting to the adjoining pipe or pipe component as applicable. The heating coils shall be terminated at terminal pins of 4.0 or 4.7 millimeter diameter, protected with terminal shrouds. Each terminal shroud should be additionally protected with polyethylene shroud caps.

8. No heating element shall be exposed and all coils are to be integral part of the body of the fitting. The insertion of the heating element in the fitting should be part of the injection moulding process and coils inserted after the injection moulding process or attached to the body of the fitting as a separate embedded pad etc. are strictly not acceptable.

9. The pipe fixation shall be achieved by external clamping devices and integral fixation devices are not acceptable.

10. The brand name, size, raw material grade, SDR rating and batch identification are to be embedded as part of the injection moulding process. Each fitting should also be supplied with a barcode sticker for fusion parameters attached to the body for setting the fusion parameters on an automatic fusion control box. The barcode sticker should also include the fusion and cooling time applicable for the fitting for the manual setting of a manual fusion control box.

11. The fittings should be V-regulated type designed to fuse at a fusion voltage of 40 volts AC.

12. The heating elements should be designed for fusion at any ambient temperatures between -5to + 40 degree centigrade at a constant fusion time i.e. without any compensation of fusion time for different ambient temperatures.

13. A limited path style fusion indicator acting for each fusion zone as visual recognition of completed fusion cycle should be incorporated into the body of each fitting near the terminals. The fusion indicators should not allow the escape of the molten polymer through them during or after the fusion process.

14. All the sockets in the electro fusion fittings should include a method of tapping controlling the pipe penetration (pipe positioner /stopper).

15. The Electro fusion Tapping saddle should be the top loading type which are to be clamped on the mains for fusion using the custom made top loading clamps exerting 1500N (150 kilograms approximately) top load. Saddles with wrap around clamps shall also be acceptable of PE 100material and black in colour.

16. The tapping EF Tapping Saddle should be supplied with suitable adaptors for proper positioning of the top loading clamp into the saddle.

17. The torque required to operate the cutter after fusion on the PE mains should not exceed 45N-m.

18. The common cutter provided by the manufacturer should be designed in such a way that the cut coupon is not allowed to fall into the pipeline and is retained inside the body of the cutter providing a positive sealing of the hole in the cutter head for pressure testing.

19. The EF tapping Saddle will have female threaded outlet to connect Compression Metal insert Male thread adaptor fitting or metal ferrule for further extension of connection.

20. The threaded outlet should be from sizes ½” to 2” BSP to suit the required House service connections.

21. The outlets should be reinforced with female threaded metal inserts of stainless steel -SS 304.The tapping on the PE mains shall be achieved by a custom built metal cutter supplied by the manufacturer.

3.3.2.9 Specification for High Tensile Carbon Steel Seamless Pipe

1. Composition:

ASTM A53 pipe covers Seamless and Welded, Black and Hot-Dipped Galvanized nominal (average) wall pipe for coiling, bending, flanging and other special purposes and is suitable for welding. Continuous-Welded pipe is not intended for flanging. Purpose for which pipe is intended should be stated on order.
Type S (seamless)

	Grade 1	Grade 2
Carbon max. %	0.25	0.30
Manganese %	0.95	1.2
Phosphorous, max. %	0.05	0.05
Sulfur, max. %	0.045	0.045
Copper, max.%	0.40	0.40
Nickel, max. %	0.40	0.40
Chromium, max. %	0.40	0.40
Molybdenum, max. %	0.15	0.15
Vanadium, max. %	0.08	0.08

2. Permissible Variations in Wall Thickness

The minimum wall thickness at any point shall not be more than 12.5% under the nominal wall thickness specified.

3. Tensile Strength

	Grade 1	Grade 2
Tensile Strength, min., kgf/mm²	38.5	42
Yield Strength, min., kgf/mm²	21	24.5

4. Hydrostatic inspection test

Hydrostatic inspection test pressures for plain end and threaded and coupled pipe are specified. Hydrostatic pressure shall be maintained for not less than 5 seconds for all sizes of seamless pipe.
Each length of pipe shall be subjected to hydrostatic test without leakage. Test pressure for pipe in sizes 457.2 mm and smaller shall be held for not less than 5 seconds. The pipe shall be struck while under pressure with 1-kg hammer or its equivalent near the weld at the both the ends of pipe.
The test pressure shall be calculated by the following equation:

$$P = 200\frac{St}{D}$$

Where,
P = hydrostatic test pressure in kgf/cm²
S = fibre stress in kgf/cm² (75-80% of specified minimum yield strength)
t = specified wall thickness in mm, and
D = specified outside diameter in mm

5. Length of pipe

The pipe shall be supplied in standard lengths of 5 to 7 meters each. The both ends of each pipe shall be plain.

6. Standards

All materials, workmanship and components shall, where applicable and unless otherwise stated in the Contract, comply with either:

a) Indian Standards IS 6286 (1971 reaffirmed 2003): Seamless and welded steel pipes for sub-zero temperature service [MTD 19: Steel Tubes, Pipe and fittings] published by Bureau of Indian Standards, Manak Bhawan, New Delhi, India

The acceptance of a tender based upon a Standard or Code proposed by the Supplier shall only signify the Purchaser's general approval to the use of such Standard or Codes and shall not make the Purchaser liable to accept a Standard or Code subsequently found to be inferior to that specified in the corresponding Standard or Code of Practice.

7. Test Certificate

Certificates in triplicate shall be provided by the Supplier for pipe and fittings supplied giving the process of manufacture and the results of the specified tests.
Similar certificates in triplicate shall be provided by the Supplier in respect of materials to be used in the manufacture of the pipes and fittings giving the process of manufacture, chemical analysis (where relevant) and the results of the specified tests.
The material shall be suitably marked to enable them to be identified from references on the certificates.

8. Independent Tests

The purchaser reserves the right to carry out any independent or local tests he may deem fit on the completed pipes and fittings or on any material provided under the Contract at any stage during the Contract including the guarantee period. In addition to any relevant clause in the General Conditions of Contract of Contract any materials, workmanship or completed pipes and fittings which are shown by such independent tests not to be in accordance with the Specification shall be rejected notwithstanding any previous certificate which may have been provided

9. Rejected Goods

Any materials delivered to Site, which are rejected by the Purchaser shall immediately be removed from the Site by, and at the expense of, the Supplier.
Any pipes and fittings, which have been rejected, shall be marked in a distinctive manner, which shall preclude any possibility of their use for the purpose for which they were supplied. Such pipes and fittings may be submitted for re-test following the correction of any defects, where such correction is permitted by the Purchaser.

10. Tests Bend

2" & under Std. & XHY 90° to 12 times nom. diameter. Close coiling 180° to 8 times nom. Dia.

11. Flattening

over 2" nom. XHY & lighter. CW 90° to 75% ODv

12. Wall tolerance

Min. wall shall not be more than 12.5% under nominal wall

DIMENSION AND WEIGHT

Nominal Pipe Size mm/inch	OD mm	SCHEDULE WALL THICKNESS (mm) / WEIGHT (kg/m)													
		Sch 5	Sch 10	Sch 20	Sch 30	STD	Sch 40	XS	Sch 60	Sch 80	Sch 100	Sch 120	Sch 140	Sch 160	XXS
6	10.3	-	1.24	-	-	1.73	1.73	2.41	-	2.41	-	-	-	-	-
1/8		-	0.28	-	-	0.37	0.37	0.47	-	0.47	-	-	-	-	-
8	13.7	-	1.65	-	-	2.24	2.24	3.02	-	3.02	-	-	-	-	-
1/4		-	0.49	-	-	0.63	0.63	0.80	-	0.80	-	-	-	-	-
10	17.1	-	1.65	-	-	2.31	2.31	3.20	-	3.20	-	-	-	-	-
3/8		-	0.63	-	-	0.84	0.84	1.10	-	1.10	-	-	-	-	-
15	21.3	1.65	2.11	-	-	2.77	2.77	3.73	-	3.73	-	-	-	4.78	7.47
1/2		0.80	1.00	-	-	1.27	1.27	1.62	-	1.62	-	-	-	1.95	2.55
20	26.7	1.65	2.11	-	-	2.87	2.87	3.91	-	3.91	-	-	-	5.56	7.82
3/4		1.03	1.28	-	-	1.69	1.69	2.20	-	2.20	-	-	-	2.90	3.64
25	33.4	1.65	2.77	-	-	3.38	3.38	4.55	-	4.55	-	-	-	6.35	9.09
1		1.29	2.09	-	-	2.50	2.50	3.24	-	3.24	-	-	-	4.24	5.45
32	42.2	1.65	2.77	-	-	3.56	3.56	4.85	-	4.85	-	-	-	6.35	9.70
1 1/4		1.65	2.69	-	-	3.39	3.39	4.47	-	4.47	-	-	-	5.61	7.77
40	48.3	1.65	2.77	-	-	3.68	3.68	5.08	-	5.08	-	-	-	7.14	10.15
1 1/2		1.90	3.11	-	-	4.05	4.05	5.41	-	5.41	-	-	-	7.25	9.55
50	60.3	1.65	2.77	-	-	3.91	3.91	5.54	-	5.54	-	-	-	8.74	11.07
2		2.39	3.93	-	-	5.44	5.44	7.48	-	7.48	-	-	-	11.11	13.44
65	73.0	2.11	3.05	-	-	5.16	5.16	7.01	-	7.01	-	-	-	9.53	14.02
2 1/2		3.69	5.26	-	-	8.63	8.63	11.41	-	11.41	-	-	-	14.92	20.39
80	88.9	2.11	3.05	-	-	5.49	5.49	7.62	-	7.62	-	-	-	11.13	15.24
3		4.52	6.46	-	-	11.29	11.29	15.27	-	15.27	-	-	-	21.35	27.68
90	101.6	2.11	3.05	-	-	5.74	5.74	8.08	-	8.08	-	-	-	-	-
3 1/2		5.18	7.41	-	-	13.57	13.57	18.64	-	18.64	-	-	-	-	-
100	114.3	2.11	3.05	-	-	6.02	6.02	8.56	-	8.56	-	11.13	-	13.49	17.12
4		5.84	8.37	-	-	16.08	16.08	22.32	-	22.32	-	28.32	-	33.54	41.03
125	141.3	2.77	3.40	-	-	6.55	6.55	9.53	-	9.53	-	12.70	-	15.88	19.05
5		9.46	11.56	-	-	21.77	21.77	30.97	-	30.97	-	40.28	-	49.12	57.43
150	168.30	2.77	3.40	-	-	7.11	7.11	10.97	-	10.97	-	14.27	-	18.26	21.95
6		11.31	13.83	-	-	28.26	28.26	42.56	-	42.56	-	54.21	-	67.57	79.22
200	219.10	-	-	6.35	7.04	8.18	8.18	12.70	10.31	12.70	15.09	18.26	20.62	23.01	22.23
8		-	-	33.32	36.82	42.55	42.55	64.64	53.09	64.64	75.92	90.44	100.93	111.27	107.93
250	273.00	3.40	4.19	6.35	7.80	9.27	9.27	12.70	12.70	15.09	18.26	21.44	25.40	28.58	25.40
10		22.61	27.78	41.76	51.01	60.29	60.29	81.53	81.53	95.98	114.71	133.01	155.10	172.27	155.10
300	323.80	-	-	-	8.38	9.53	10.31	12.70	14.27	17.48	21.44	25.40	28.58	33.32	25.40
12		-	-	-	65.19	73.86	79.71	97.44	108.93	132.05	159.87	186.92	208.08	238.69	186.92
350	355.60	-	-	-	9.53	9.53	11.13	12.70	15.09	19.05	23.83	27.79	31.75	35.71	-
14		-	-	-	81.33	81.33	94.55	107.40	126.72	158.11	194.98	224.66	253.58	281.72	-
400	406.40	-	-	-	9.53	9.53	12.70	12.70	16.66	21.44	-	-	-	-	-
16		-	-	-	93.27	93.27	123.31	123.31	160.12	203.54	-	-	-	-	-
450	457.00	-	-	9.53	11.13	9.53	14.27	12.70	19.05	23.83	-	-	-	-	-
18		-	-	105.17	122.38	105.17	155.81	139.16	205.75	254.57	-	-	-	-	-
500	508.00	-	-	9.53	12.70	9.53	15.09	12.70	20.62	26.19	-	-	-	-	-
20		-	-	117.15	155.13	117.15	183.43	155.13	247.84	311.19	-	-	-	-	-

13. Marking

The pipes should be marked with the following particulars:

a) Manufacturer's name or trade mark
b) Size
c) Weight per metre
d) Grade
e) Process of manufacture
f) Type of steel
g) Heat treatment
h) Test pressure

The product may also be marked with standard mark.

3.3.3 Installation of Water Pipelines

This specification covers the transportation to Site, installation and testing of water supply pipe lines, valves, fittings and other specials supplied as per Clause 3.3.2 of this specification

It also covers the construction of valve chambers, thrust blocks, manholes and other structures required for the operation of the water mains.

3.3.3.1 Interpretations

3.3.3.1.1 Supporting Specifications

The following specifications shall, inter alia, form part of and shall be read in conjunction with this specification:

a) 1.1 General
b) 2.1 Site Clearance
c) 2.2 Earthworks
d) 2.3 Cement Concrete
e) 2.4 Brickworks
f) 2.10 Roads and Parking Areas
f) 3.1 Pipe Trenches
g) 3.2 Pipe Bedding
h) Supply of Material

3.3.3.1.2 Application

This specification contains clauses that are generally applicable to the construction and installation of water supply pipelines and appurtenances, Pipes, Valves and Fittings Installation, Testing and Commissioning.

3.3.3.2 Materials

Ductile Iron, Galvanised Iron and PE pipes, specials, polyethylene sleeving and valves, shall be capable of withstanding the applicable test pressure specified in Clause 3.3.3.6 below. All pipes and fittings shall be supplied complete with couplings and jointing material.

Satisfactory temporary end covers shall be provided by the contractor for the protection of threads, flanges, and prepared ends of plain-ended pipes and fittings, and to prevent damage to internal lining during transportation and during handling on Site.

The Contractor shall supply a mastic putty, and a wrapping tape, to protect all buried nuts and bolts from corrosion

The Contractor shall supply protective wrapping tape to be used to protect the pipe and joints from corrosion in the locations indicated on the Drawings. The primer used before application shall consist of xylene and bituminous material and shall be supplied by the tape manufacturer. The tape shall be black in color and consist of a PVC backing bonded to a self adhesive bituminous rubber compound with a total thickness of 1.65mm. The PVC backing shall be extruded (non-calendered) and have an average thickness of 0.75mm. The tape shall be supplied on a high quality overwidth silicone release paper, extending some 12.5mm wider than the tape.

Pipeline materials shall be so transported, stored, and handled that pipes are not overstressed at any time and fittings are not damaged in any way. Pipes damaged or cracked in any way shall be removed from the Site and replaced at the Contractor's expense.

Materials for manhole covers and surface boxes shall be as specified in Clause 3.3.3.4.8.

3.3.3.3 Construction Equipment

Any vehicle on which pipes are transported shall have a body of such length that the pipes do not overhang. Large pipes shall be placed on cradles and the loads properly secured during transit. The pipes shall be handled in accordance with the manufacturer's recommendations.

The equipment and rigging equipment used by the Contractor for the handling and placing of pipes shall be in accordance with the manufacturer's recommendations and shall be such that no pipe is overstressed during any operation covered by the specification.

The Contractor shall provide all tools and equipment used for the cutting, jointing and laying of pipes, fittings and valves.

The Contractor may use any acceptable device, including one incorporating a laser beam, to control the alignment and laying of the pipeline subject to the approval of the Engineer.

The Contractor shall provide all equipment and tools required for installation of polyethylene sheeting, mastic putty and all types of wrapping tape.

The Contractor shall provide all equipment, materials, tools and fittings required for the cleaning and swabbing of the pipeline.

The Contractor shall provide all the equipment, materials, tools, and fittings required for the performance of the tests given in Sub-section 3.3.7 below. Test gauges shall be of approved manufacturer having dials at least 200 mm diameter, graduated such that the test pressure is at least 75% of the gauge reading. If necessary different gauges shall be supplied for different pipeline sections. Two gauges of each type shall be provided for the sole use of the Engineer and shall remain in the Engineer's possession for the duration of the Contract.

All gauges shall be dead weight tested and proved at the commencement of use and at regular intervals thereafter as required by the Engineer.

All equipment and methods shall be subject to the approval by the Engineer.

3.3.3.4 Construction and Workmanship for DI Pipes

3.3.3.4.1 Handling of Pipes and Fittings

Coated pipes shall be transported on trucks or trailers fitted with approved padded timber cradles shaped to fit the curvature of the pipes and of adequate dimensions so as to prevent any damage to the pipe coating. Successive tiers of coated pipes shall be separated by similar suitable shaped timber cradles when more than one tier of pipes is being transported. Pillows shall be provided between securing chains or lashings when loads are being transported.

Particular care shall be taken during unloading, loading, handling and transportation to avoid distortion, flattening, denting, scoring or any other damage to the pipes, fittings and any damage to the external or internal coating or lining of the pipes, fittings etc. Under no circumstances shall pipes be dropped, be allowed to strike on another, be rolled freely or dragged along the ground.

Loading, unloading and handling shall be carried out using special hooks, well padded, with a curved plate to fit the curvature of the pipes or webbing slings not less than 30 cm wide or other means approved by the Engineer. Steadying ropes shall be employed. The positions of lifting slings shall ensure that stresses and tendency towards deformation in the pipes are kept at a minimum. Pipe handling equipment shall be maintained in good repair and any equipment which in the opinion of the Engineer may cause damage to the pipes shall be discarded.

End covers and protection shall not be removed until incorporation of the pipes and fittings into the Works.

Care shall be taken during loading, transporting, and unloading to prevent damage to the pipes, fittings or coatings. When loading pipes in the stockyard the Contractor will be responsible for any damage to pipes and fittings which shall be noted and reported to the Engineer. After unloading all pipes or fittings will be examined and any defects or damage shall be noted and reported to the Engineer. Any damage shall be repaired in a manner recommended by the Manufacturer with the approval of the Engineer. Any pipe not considered by the Engineer to be of an acceptable quality after repair will not be accepted and the Contractor will not be paid for the supply of the item.

When materials are temporarily stored at the edge of the wayleave, they shall be stored clear of the ground and positioned to avoid damage by passing traffic in a manner approved by the Engineer.

3.3.3.4.2 Laying

To ensure that his supervisors and operators are familiar with the manufacturer's instructions/pipeline construction manuals for the laying and jointing of pipes and that these instructions are strictly adhered to, the Contractor shall employ the manufacturer to demonstrate laying and jointing. The demonstration shall also include the cutting of pipes and the repair of damaged pipes.

Pipe laying shall not commence until the bottom of the trench and the pipe bed have been approved by the Engineer.

The trench bottom shall be prepared as specified in Clause 3.1.5.8. Trenches shall be kept dry to allow proper and safe bedding, laying, jointing of pipes and construction of the selected fill blanket over the pipes.

The DI pipeline shall be sheathed in polythene sleeve for protection, installed in accordance with AWWA C105. The use of the type of protection shall be based on ground conditions in accordance with the following table or as directed. The Contractor shall measure soil resistivity and pH at 100 m intervals.

The protected pipeline shall be laid and bedded to even grades and to levels and alignments shown on the drawings or as directed. It shall be laid centrally in the trench and with the manufacturer's class and quality identification marks visible from the top of the trench, if possible. Control of laying and bedding shall be by means of boning rods and sight rails or an acceptable laser beam device. Sight rails shall be painted black and white and shall be fixed securely and accurately.

Pipes shall be brought to the correct alignment and inclination, concentric with the pipes already laid. Adjustments to line and grade should be made by scraping away or adding adequately compacted foundation material under the pipe and not using wedges and blocks or beating on the pipe.

Pipes shall be handled in manner which eliminates any possibility of high impact or point loading, taking care to protect the joint elements.

Every reasonable precaution shall be taken to prevent the entry of foreign matter and water into the pipeline. At the close of each day's work or at any time when work is suspended for a significant period, the last laid pipe shall be plugged, capped, or otherwise tightly closed until laying is recommenced.

Where so required, the cover or the alignment of a pipeline may change gradually by deflection at pipe joints, but this deflection shall not be greater than half the deflection permitted by the manufacturer of the pipe.

The minimum clearance between the outside of a pipeline being laid and the outside of any other pipe that it crosses shall be 150 mm. Where this requirement conflicts with the requirements for cover over the pipeline the Contractor shall ask the Engineer for written instructions and shall carry out the work in accordance with those instructions.

3.3.3.4.3 Jointing

All pipelines shall be jointed in accordance with the manufacturer's instructions and to the approval of the Engineer.

Until required for incorporation in a joint, each rubber ring or gasket shall be stored in the dark, free from the deleterious effects of heat or cold, and kept flat so as to prevent any part of the rubber being in tension.

Spigots and sockets of pipes being jointed shall be thoroughly cleaned by brushing and wiping immediately before being jointed. All rubber rings and seals shall be carefully inspected after being placed in position and before the joint is closed, to ensure that they have not suffered any cuts, tears, or other damage, and are not in any way defective.

All pipes with flexible joints shall be accurately marked prior to laying to ensure that the correct gap is left in the joint.

For push-fit and bolted gland joints only lubricants recommended by the manufacturer shall be used in connection with rubber rings and these lubricants shall not contain any constituent soluble in water conveyed in the pipe. They shall be suitable for the climatic conditions at the Site and shall contain an approved bactericide.

For bolted gland joints the joints ring shall be pushed into place by the gland ring using only hand pressure, fixing nuts and bolts should then be fitted and first tightened to finger pressure. Thereafter tightening shall be in the sequence proposed by the manufacturer and to the torque recommended.

In the jointing of pipes with flanges, special care shall be taken to align, grade, and level the pipes, specials, and valves to avoid straining of the flanges. All bitumen and paint shall be removed from the mating face of each flange immediately before jointing. Bolts shall be tightened up evenly in opposite pairs to ensure uniform bearing, the final tightening shall be to the torque specified by the manufacturer.

For flanged joints the gasket shall be fitted smoothly to the flange and the joint made by tightening the nuts to finger pressure first. Thereafter the final tightening of the nuts shall be made by gradually and evenly tightening bolts in diametrically opposite positions using only standard spanners of a type approved by the Engineer.

Graphite grease shall be applied to the threads of bolts before joints are made. All joints containing nuts and bolts which are buried shall be protected with anticorrosive mastic and wrapping tape, applied in accordance with the manufacturer’s recommendations.

Care shall be taken to avoid damage to the internal surface of the pipes during assembly of the pipeline.

Once joints are made they shall be protected to a level appropriate for the pipe by: polyethylene sleeving, muffs, or with molding putty and tape wrapping.

3.3.3.4.4 Setting of Valves, Specials, and Fittings

Unless otherwise shown on the drawings, or directed by the Engineer, gate valves shall be set upright and butterfly valves shall be set with the main shafts horizontal. All valves, specials, and fittings shall be located in the exact positions shown on the drawings or otherwise directed. All bolts and flanges which are to be buried shall be covered with a corrosion inhibiting mastic putty or molding compound to produce smooth contours, the prepared fitting shall then be wrapped in protective tape.

3.3.3.4.5 Cutting of Pipes

Pipes shall be cut by a method which provides a clean square cut of the pipe and of the lining, without damage to pipe or lining. All cut or trimmed ends and the parts of any pipe on which the coating may have suffered damage shall be re-coated as specified before the pipes are laid.

The external area at cut spigot ends of ductile iron pipes shall be ground smooth for a distance of at least 125 mm, and then chamfered or otherwise made suitable for jointing as recommended by the pipe manufacturer.

3.3.3.4.6 Anchor/Thrust Blocks and Pedestals

At tees, bends, terminal valves, end caps, and where otherwise directed, anchor/thrust blocks shall be constructed to dimensions ordered or shown on the drawings. Unless otherwise indicated on the drawings, anchor/thrust blocks and pedestals shall be constructed of Grade C20 or M20 concrete. The concrete shall be well punned around the pipe, if in trenches, against the undisturbed faces and bottom of the trench. Backfilling behind or under thrust faces will not be permitted. Excess excavation shall be replaced with the prescribed mix concrete given above at the Contractor's expense.

Care shall be taken to leave all joints accessible. No anchor/thrust block and pedestals shall be concreted before the approval of the Engineer has been obtained.

3.3.3.4.7 Valve Chambers

All washout valves, pressure reducing valves, and air valves in pipelines shall be housed in a chamber as shown on the drawings or directed by the Engineer.

3.3.3.4.8 Covers for Chambers

All covers and frames shall be manufactured, from cast grey or ductile iron, and be coated to the approval of the Engineer.

For non-vehicular area like septic tank, soak pit and at other structures shown in drawing, Heavy Duty (HD-20) Manhole Cover with square frame as per Table 1 of IS 1726 shall be used. And for chambers in traffic area and other structure shown in drawing Extra Heavy Duty (EHD-35) Manhole with Square frame confirming to IS 1726 (Table 1) shall be used.

All covers shall be fitted to the frames and tested at the manufacturer's works and covers and frames shall be similarly numbered in a legible and permanent manner in a position which will not be visible when fitted in place, and shall be of such construction as to minimize the ingress of sand.

The Contractor shall ensure that the covers are fitted to the appropriately numbered frames after the frames have been fitted.

The name of the Employer, year of manufacture, and any additional markings shown on the drawings shall be embossed in all covers.

3.3.3.4.9 Interface Points

i. General

Where the interface is a pipe flange, the Contractor may be instructed by the Engineer either to install a blank flange, backfill and mark the interface, or to expose and connect to a flange installed by another contractor and backfill on completion.

ii. Installation of Flanged Connection Point

The connection point shall be provided at the location specified. The flange shall be installed so that it is vertically plumb and its face is perpendicular to the axis of the pipeline. The flange shall be covered by a PN 16 blank flange, the flange shall be installed in the specified manner. The flange shall be backfilled and the location marked with a marker post.

iii. Connection to Flanged Connection Point

The connection point shall be at the location specified and indicated on Site by a temporary marker post. The Contractor shall excavate to expose the flange, remove and dispose of the blank flange and water contained in the pipe and make the flange joint in accordance with the Specification, including the provision of all jointing materials.

3.3.3.4.10 Internal Pipe Cleaning

Pipelines of 750 mm diameter and larger shall be manually cleaned internally of all debris, stones and sand prior to testing.

All pipelines less than DN 750 shall be cleaned by the passing through of a foam swab before the hydraulic test on completion. Swabbing shall be carried out successively between adjacent temporary swabbing points installed by the contractor.

The foam swab shall comply with the following:

Size:

Main up to DN 300: swab diameter = pipe diameter + 25%

Main over to DN 300: swab diameter = pipe diameter + 75 mm

Quality:

Hard

Where restrictions in the main do not reduce the diameter of the pipeline to less than two thirds of the swab diameter.

Soft

Where restrictions in the main are in excess of the above but do not reduce the diameter of the pipeline to less than one half of the swab diameter.

3.3.3.4.11 Disinfection of Potable Water Pipelines

The internal surfaces of all pipelines and pipework including all equipment incorporated in a pipeline or pipework through which water will pass shall be disinfected after they have been cleaned to the satisfaction of the Engineer.

Disinfection shall be affected by filling the pipeline with water heavily dosed with chlorine, and shall be carried out when filling the pipeline with water for carrying out the hydraulic test on completion. Alternative methods may be adopted with the approval of the Engineer.

The level of the chlorine dosing shall be such as to make available 50 mg/l of free chlorine throughout the pipeline.

The water, heavily dosed with chlorine, shall stand in the pipeline for a period of 24 hours or for such longer period as the Engineer shall require and all valves in the system shall be operated at least once during this period.

At the termination of the required period, chlorine residual tests shall be taken at the end of the pipeline farthest from the point of injection and the test shall be repeated, if necessary, until the residual is not less than 10 mg/l.

The Contractor shall obtain the Engineer's approval to the method to be adopted for disposing of the chlorinated water and the time when such disposal shall take place on completion of disinfection. The Contractor shall neutralize the chlorine by the use of sodium thiosulphate prior to disposal.

3.3.3.5 Tolerances

3.3.3.5.1 General

No deviation will be permitted from the minimum cover specified or as shown on the drawings.

The criteria for the level and gradient to which pressure pipelines shall be laid are as follows:

the cover above the crown of the pipe to ground level shall be as shown on the Drawings. The upward gradient shall be steeper than 1 in 500 with flow, or steeper than 1 in 250 against the flow except where expressly shown in the Drawings.

3.3.3.5.2 Control Points

For the purpose of this specification valves set on the centre line of the pipeline, designated changes in gradient and designated changes in horizontal alignment, shall be regarded as control points and shall be located with a permissible deviation of + 100 mm on the centre line. The same deviation will be permissible laterally except where the Contractor is required to lay the pipeline to a curve or at a designated distance from a boundary, kerb line, or fence line, in which case the permissible deviation shall be + 30 mm.

Unless otherwise directed and subject to a permissible deviation (measured along the centre line) of + 5 m, scour valves shall be located at the lowest points in pipelines and air valves at the highest points.

3.3.3.5.3 Alignment (plan and level)

Unless otherwise directed, the permissible deviation in alignment between control points from a straight line joining the control points, when measured on the top centre of the pipeline, shall be + 100 mm or + 20% of the nominal diameter, whichever is the larger, and the permissible deviation per pipe length shall be + 30 mm. The permissible deviation from the designated level at any point on the invert of the pipeline shall be + 50 mm or + 10% of the nominal diameter of the pipe, whichever is the larger.

Each pipe shall be laid to the required gradient such that the end of the pipe is + 5mm of the required level relative to the other and of the pipe.

3.3.3.5.4 Valve chambers, Manholes, etc.

Valve chambers, manholes, and the like shall be constructed centrally on the control points and, with the exception of tolerances that affect access to bolts, nuts, etc., with a permissible deviation of + 50 mm on all clearance dimensions. The clearance dimension between the outside of each nut and bolt-head and the inside face of the wall of a structure or any other fitting shall generally be not less than 150 mm.

3.3.3.5.5 Pipe Protective Coatings, etc.

No air must be trapped underneath the wrapping tape. Unsatisfactory pipes shall be cleaned, prepared and rewrapped.

All damage to protective coatings must be repaired. In the following manner;

3.3.3.5.5.1 Bitumen Coating

Damage to bitumen coating will be repaired by preparing and repainting the damaged area in accordance with the pipe manufacturers' instructions.

3.3.3.5.5.2 Polyethylene Sleeving

Minor damage, small holes etc, to polyethylene sleeving may be repaired by sticking adhesive tape over the damaged point. Larger damage shall be repaired by replacing the sleeve or by sticking a large patch of the sleeving material over the damaged area.

3.3.3.5.5.3 Tape Wrapping

Minor damage, small holes etc, to wrapping may be repaired by sticking adhesive tape over the damage after cleaning and preparing the damaged point. Larger damage shall be repaired by cleaning and rewrapping the damaged area.

3.3.3.6 Pressure and Leakage Test

All newly installed pipelines and old pipes for connection to the new system must undergo sectional pressure and leakage testing prior to final acceptance. This memorandum provides recommended standards for pressure and leakage testing ductile iron and HDPE water lines. These recommendations closely follow relevant AWWA Standards and industry specifications. The applicable AWWA Standards are C600 for ductile iron mains and M55 for HDPE.

Simultaneous or separate pressure and leakage tests should be performed. The test duration and pressures for each option are specified in table below. If separate tests are made, the pressure test should be conducted prior to the leakage test.

Pressure and Leakage Test Methods

Procedure	Test Pressure	Duration of Test
Simultaneous Pressure & Leakage Test	150% of working pressure* at the point of test, but not less than 125% of normal working pressure at the highest elevation	2 Hours
Separate Pressure test	150% of working pressure* at the point of test not less than 125% of normal working pressure at highest elevation	1 Hour
Separate Leakage Test	150% of working pressure* of segment tested	2 Hours

Note: working pressure is defined as the maximum anticipated sustained operating pressure. However, in no case shall the test pressure exceed the pressure rating for the pipe, valves, appurtenances, or thrust-restraints.

The purpose of the pressure test is to locate defects in materials or workmanship. Before testing, the pipeline must be backfilled and braced sufficiently to prevent movement under pressure.

If concrete thrust blocks are used, sufficient time must be allowed before testing to ensure that the concrete has cured sufficiently. The test ends also should be restrained to withstand thrusts potentially developed under the test pressures.

A pressure test should be conducted at 150% of the working pressure in the line. The working pressure is defined as the maximum anticipated sustained operating pressure in the line being tested. Care must be taken not to exceed the pressure rating of pipes, valves, fittings, thrust restraints, or other appurtenances. Pressures in the main may exceed the specified test pressure if the water pressure is read from a gauge located at a high point in the main.

Potable water is introduced into the main through a temporary connection line. While filling the new main, air must be expelled from the pipeline by venting through service connections, hydrants, or air-release valves. It is important to completely expel air from each section of the main to be tested. Compressed entrapped air may amplify surges within the main or cause erroneous pressure test result.

After filling the main with water and expelling air, a pump is utilized to increase the water pressure within the line up to the required test pressure and to maintain that pressure for the required duration (see table above). An accurate method for measuring the amount of water pressure within the line must be provided. A key criterion for the pressure test is that the measured water pressure within the main (after reaching the required test pressure) should not vary by more than 5 psi during the duration of the test. While the line is under pressure, the system and all exposed pipe, fittings, valves, hydrants, or joints should be repaired or replaced and the pressure test repeated until satisfactory results are obtained.

The purpose of the leakage test is to establish that the section of main being tested, including all joints, fittings and other appurtenances, will not leak or that leakage is within acceptable limits. if the leakage test is to be performed simultaneously with the pressure test, the system should be allowed to stabilize at the test pressure before conducting the leakage test.

Equipment necessary for conducting the leakage test includes a pump equipped with a make-up reservoir and pressure gauge for measuring water pressure in the main. In addition, there must be an accurate method for measuring the quantity of water pumped into the main being tested. Methods used to measure water volume include a calibrated make-up reservoir, a calibrated positive-displacement pump, or a water meter.

The specified test pressure for the leakage test is the same as for the pressure test (see Table) and the test should be conducted for at least 2 hours in duration. Leakage is defined as the quantity of water that must be supplied into the main in order to maintain the water pressure within 5 psi of the specified test pressure after the pipe has been filled with water and air expelled. No pipe installation will be acceptable if the leakage is greater than that determined by the following formulas:

$$L = (SD\sqrt{P})/71300$$

Where:

L = allowable leakage, in liters per hour

S = length of pipe tested, in meters

D = nominal diameter of the pipe, in millimeters

P = average test pressure during the leakage test, in kg per square centimeter

The above equation is based on a leakage rate of 11.65 gallon per day, per mile, per inch nominal diameter at a pressure of 150 psi.

Leakage less than the quantity specified by the above equation may be considered "allowable leakage" resulting from such factors as trapped air, take-up of restraints, and temperature variations during testing. However, observed leaks should be repaired regardless of leakage measurements through metering equipment.

A swift loss of water pressure in the main could be the result of a break in the line, major valve opening, loose mechanical joint bolts, missing or dislodged gasket, or inadequate thrust block. a slow loss of pressure in excess of allowable limits could be the result of minor problems such as a leaking valve or a corporation stop not completely shut off. In addition, air entrapped in the line can result in an apparent leakage in excess of the allowable limit.

Recommendations for avoiding minor leaks include the following:

- Vent all high points in the line by use of air release valves or corporation stops.
- Check all mechanical joint bolted connections.
- Cure thrust blocks before testing.
- Insure that exposed gasket grooves are properly cleaned before inserting gaskets.
- When inserting pipe into a mechanical joint or gasket joint, insure that the spigot end is squarely cut and beveled properly for the hub.

One approach for determining if the apparent leakage is the result of air trapped in a line is to immediately repeat the leakage test (i.e., continue the test for another two hours) and determine the amount of make-up water required to fill the line a second time. If this amount is significantly less the first filling, the difference in apparent leakage is probably the result of air being present in the line. If no significant difference in make-up water is recorded, a leak is probable.

3.3.3.7 Sectional Allowable Lengths of Installed Pipe for pressure and leakage test

Maximum sectional completion of the laid pipe for the test should not be more than the length mentioned below.

S. No.	Pipe ND (mm)	Maximum allowable stretch (m)
1	350 mm	1500 m
5	150 to 300	2500 m
6	Up to 150	3500 m

3.3.3.8 Field Testing of Valves

When the valves and appurtenances have been completely installed and as soon as operation conditions permit, they shall be given a field test by the Engineer to demonstrate that they have been suitably installed, that they meet all requirements, are in good operating condition and are, in every way, adequate for the service intended.

3.3.4 Supply and Installation of Galvanized steel pipes and fittings

3.3.4.1 General

Galvanized Iron (GI) pipes shall be used for the new pipe network, reinstatement and relocating of existing water distribution system.

3.3.4.2 Material and Standard

The pipes shall be Galvanized mild steel hot finished seamless (HFS) or welded ERW, HRIW or HFW screwed and socketed conforming to IS:1239 (Part-I) 2004 or NS 199-2046 for grade specified in BOQ. If grade of GI pipe it not mentioned in BOQ, it will be undersood that all GI pips shall be of heavy grade. The zinc coating shall be uniform adherent, reasonably smooth and free from imperfections for respective grade as per IS 1239-2004 or NS 199-2046.

All screwed pipes and sockets shall have pipe threads conforming to the requirements of IS:554. Screwed tubes shall have taper threads while the sockets shall have parallel threads.

Where the pipes have to be cut or threaded, the ends shall be carefully filed out so that no obstruction to bore is offered. The ends of the pipe shall then be carefully threaded conforming to the requirements of IS:554 with pipe dies and tapes in such a manner that it will not result in slackness of joints when two pieces of pipes are screwed together. The taps and dies shall be used only for straightening screw threads which have become bent or damaged and shall not be used for turning of the threads as to make them slack, as the later procedure may not result in a water tight joint. The screw threads of the pipes and fittings shall be protected from damage until they are fitted.

3.3.4.3 Dimensions

The dimensions and weights of medium grade GI pipes and sockets and tolerances shall be as prescribed in the relevant standard.

3.3.4.4 Tolerance

3.3.4.4.1 Tolerance in Thickness

Tolerance shall be as per relevant code and grade of GI pipes.

3.3.4.4.2 Tolerance in Weight

Tolerance shall be as per relevant code and grade of GI pipes.

3.3.4.5 Specials and fittings

The fittings for GI pipes shall be of mild steel tubular or wrought steel fittings conforming to IS:1239 (Part-II). The fittings shall be designated by the respective nominal bores of the pipes for which they are intended.

3.3.4.6 Jointing

The pipes shall be cleaned and cleared of all foreign matter before being laid. While jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with white lead and a few turns of spun yarn wrapped round the screwed end of the pipe. The end shall then be screwed in the socket, tee etc., with the pipe wrench. Care shall be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burr from the joint shall be removed after screwing. After laying, the open ends of the pipe shall be temporarily plugged to prevent access of water, soil or any other foreign matter.

3.3.4.7 Laying of GI pipes and fittings

3.3.4.7.1 External work

GI pipes if used for external work, shall be laid according to Clause 3.3.3. in case of pipe in trench, the maximum widths of trench shall be according to drawing.

At joints the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with the Specifications on laying of pipes given in this chapter.

3.3.4.7.2 Polythene Steeling and Paintings

The pipes shall be painted with two coats of anticorrosive bitumastic paint of approved quality.

Polyethylene sleeving shall be provided in addition two coat of paintings. Polyethylene sleeving shall comply with ISO 8180 and be marked in accordance with AWWA C105.

Site applied sleeving shall be stored under cover, out of direct sunlit, and its exposure to sunlight shall be kept to a minimum. Pipes having a factory applied sleeving must be stored in the same conditions.

3.3.4.7.3 Testing

The pipes and fittings after they are being laid and jointed shall be tested to a hydraulic test pressure of 60 kg/cm2 (600 m). The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shocks or water hammer, which may develop otherwise. The draw off taps and stop cocks shall then be closed and specified hydraulic pressure shall be applied gradually. A calibrated and accurate pressure gauge shall be used for testing the pressure. The test pump having been stopped; the test pressure should be maintained for at least half an hour. The pipes and fittings shall be tested in sections as the work of laying proceeds, having the joints exposed for inspection during the testing. Pipes or fittings which are found defective shall be replaced and joints found leaking shall be redone, without any extra payment.

The water for testing shall be provided by the Contractor. The quality of water should be approved by the Engineer.

3.3.4.8 Other Specials and Fittings Required for GI Pipelines reinstatement

3.3.4.8.1 Stop Valves

Stop valves shall be gunmetal wedge gate valves, rising stem, hand-wheel operated with screwed female ends; conforming to IS: 778 - 1984 Class 1 or equivalent.

3.3.4.8.2 GI Flange

Flanges shall be female threaded to join GI pipe and valves etc and shall be drilled in accordance with BS: 4504 PN 16 or equivalent. The supply shall be complete with nuts, bolts and washers, all adequately tightened.

3.3.5 Measurement and Payment

Unless and otherwise mentioned in BOQ:

All pipe works of HTS, DI, GI or PE shall be measured according to the work actually carried out and no allowance will be made for any waste in cutting to the exact length required.

The rate for supply including transportation, laying and jointing of DI and other pipes and fittings shall be deemed to include the cost of supply, laying, jointing and other temporary provision for pipe works not mentioned in BOQ.

Pipes shall be described by their internal diameter. The pipe work shall be measured in running meters. The measurement shall be taken along the centre line of pipe excluding fittings which shall be measured separately. The lengths of pipes shall not include the portion of spigots within the sockets of fittings and pipes.

If any damage is caused to the pipeline during the execution of work or while cleaning/testing the pipeline as specified, Contractor shall he held responsible for the same and shall replace the damaged pipeline and retest the same at his own cost of the full satisfaction of Engineer.

Fittings and specials shall be described by their internal diameter. The supply including transportation and installation of fittings and specials associated with pipeline work shall be measured in numbers or set.

The cost for field testing as per BOQ shall be paid only for single time successful testing. Cost of the field testing shall be measured in meter length of corresponding pipe size inclusive of supply, assembling and de-assembling (after the successful testing) of suitable Pressure Pump (with engine or motor), Pressure Gauge, Pressure Recorder, Suction Hose, Connection Hose, Overflow Hose, Potable Water, Water Tank With Water Meter, Connection Pieces (including valves or cocks), all DI fittings (Blind Flanges, Flanged Spigots, Flanged Sockets, Gaskets for Blind Flange, Concrete blocks, sand bags and all other accessories required for the field pressure testing.

Suitable GI ducting for road and / or drain crossing (for laying of Communication Pipe and other pipes as instructed by the Engineer) shall be responsibility of the Contractor. The items required (GI pipe and other accessories) for the ducting shall be arranged by the contractor at his own cost.

Other cost not mentioned in BOQ for pipeline works as an item shall be arranged by Contractor at his own cost.

4 WATER METERS

4.1 Household Revenue Meters

4.1.1 General

All water meters shall be dry dial multijet water meter iron body with the essential features of household water meters described in the following sections are sought for supply and installation.

4.1.2 Materials

Only the best quality and type of materials shall be used, which shall be suitable for the purpose intended. Unless otherwise specified, materials shall be selected by the supplier. The materials shall be appropriate both mechanically and chemically to the operating conditions. In connecting units they shall be mechanically chemically and electrochemically compatible with one another and with the environment.

Materials shall be selected to the adequate resistance against abrasion and corrosion. Where necessary, protective coating and lining shall be applied.

All materials in contact with the potable water shall be non-toxic and shall not affect the quality of the potable water at any given time.

4.1.3 Design and Construction

Design and construction shall be conforming to ISO 4064 requirements and according to ISO and Nepalese standards NS 428:2075 or equivalent for cold water meters. The meters shall be Metrological Class B for cold water up to 40°C (working range 5°C to 40°C) and pressure-rating of minimum PN 10. Pressure loss shall be on a minimum.

All water meters shall be provided with an efficacious replaceable strainer in the inlet fitting. The strainer screen shall be rigid, fit snugly, be easy removable and have an effective straining area at least double that of the inlet.

Meters shall be dry dial and have modular design, consisting of an outlet case and separate measuring chamber. For calibration, replacement or maintenance the dry section shall be easy to repair and maintain. There should be a provision for change of the counting devises without dismantling the meter from its position.

The dry compartment register (Dry Dial) shall be possible to turn on 360° and the glass shall be scratchproof and transparent. Registration shall be direct reading digital counter, with a singly to show the smallest measurement.

Registration shall be in cubic meters. For ease and accuracy of calibration and adjustment, dials shall register or as to permit accurate readings of 0.05% of the nominal discharge.

All meters shall be provided with wire and lead seals, both to the register and to the plug covering the adjustment screws.

The calibration screw shall be suitable to a wire and lead seal, also to the register and to the plug covering the adjustment screws.

A strainer shall be fitted to the inlet of each water meter. The strainer screen shall be rigid, fit snugly, be easily removable and have an effective straining area at least double that of the inlet.

All parts shall have smooth surface, special the parts in contact with water to prevent encrustation.

The water meter shall be suitable for out- and indoor connection for tough conditions.

Each delivered part shall be new and not used before and supplied according to technical specifications descript.

The water meter shall be designed for a lifetime of 10 years of normal operating conditions.

Weight of each meters shall be minimum of 1.3 kg with connections and 1.1 kg without connection.

4.1.4 Markings

The following markings shall be provided on the meters:

- One arrow caste on the body indicating the flow direction,
- Nominal size of the water meter to be caste on the body,
- Identification of the model, class, ISO standard or approval by international body, serial number and year of manufacturing engraved on the body or indelibly marked on the dial, and
- Manufacturers name and serial number engraved on the lid or otherwise suitably marked.

4.1.5 Meter Performance

Required Performance and accuracy shall be as indicated below. The range of measured flow rates is sub divided into 3 reaches. The limits being defined by the following flow rates:

Identification	Description Value	Remarks
Qs	Starting Flow rate	
Qm	Minimum flow rate for reliable registration	Error permission +/- 5%
Q1	Limiting flow rate for increased accuracy of registration	Error permission +/- 2%
Qn	Nominal flow rate for continuous or limiting function.	Error permission +/- 2%
Qmax	Maximum flow rate at which the meter shall function for a limited time without exceeding a metering error	Error permission +/- 2% Qmax should be 2 x Qn
H wz in bar	Pressure loss in Qm and Qmax	With installed strainer
P	Maximal permissible pressure	Min. requirement 10 bar (+ 50% for 30 minutes)

4.1.6 Factory Warranty

Warranty starts from the day of delivery and written acceptance by the client and shall be minimum 2 years after installation. This includes:

- Meter performance,
- Materials, and
- Function.

4.1.7 Essential Features

All water meter shall be of ND 15 volumetric water meters, with multijet type. The two ends shall be threaded connection and the inlet and outlet shall have a common axis. They shall have water tight dismantling coupling on each side to allow easy removal of the instrument from the pipe works.

A plug-in non-return valve shall be fitted on the outlet site of the water meters with to prevent backflow of the water.

Installation of the water meter can be done in horizontal and vertical position without hampering meters' performance.

The water meter shall be suitable for out- and indoor connection for tough conditions and shall afford reasonable safeguards against destruction. Special regards shall be given to the strength of the glass and the cover-lid.

The dial shall be easy-read in cubic meters with a digit roller but also pointers for control and calibration. The body as well as all parts in water contact shall be in corrosion free materials and approved for drinking water and to be a short construction the connection shall be in thread connection according to ISO. Adequate connecting nipples for the inlet as well as for the outlet together with all necessary seals shall be provided.

The meter body shall be manufactured from bronze metal (containing a minimum of 50 to 60% of copper).

The meters shall have the following minimum performance characteristics:

ND, mm	15
Flow rate Qn m^3/h	1.00
Maximum flow rate Qmax m^3/h	2.00
Minimum flow rate Qmin m^3/h	0.020

Otherwise water meters shall comply with Class C EEC standard.

4.1.8 Testing

It is required that the quality and the compliance with these specifications shall be demonstrated for all materials and equipment by appropriate tests performed during the various phases of the work of production.

The minimum test pressure shall be the specified nominal pressure plus 50%. This pressure shall be applied increasing from 0 to maximum event over 15 minutes.

The test pressure shall be held without pressure drop for at least half an hour without any sign of leakage.

The measuring devices used in shop testing shall afford the following accuracy:

- Capacity : plus minus 0.1%
- Differential head : plus minus 1%
- Time measurement : plus minus 0.03%

Shop testing shall be run with water of not more than 40 degree C and not less that 10 degree C temperature. Shop testing shall sufficiently cover the entire range of the capacity to demonstrate that the characteristics are stable.

Each point shall have at least 3 (three) readings and the arithmetic means shall be considered the proven value.

None of the individual readings shall differ from the specified limits more that in admissible by accuracy of measurement as defined above.

The arithmetic mean of all readings for one performance point shall be within the specified limits.

4.2 Bulk Water Meters

4.2.1 General Applications

Water meters supplied and installation under this Contract must be of first quality and shall be designed to withstand the stated pressures and temperatures.

All water meters shall belong to a class which can withstand the stated maximum pressure, they will attain in service including any surge pressure.

Flanged joints of all water meters shall be provided with required numbers of bolts, nuts, washers and gaskets, which conform to DIN 2690, inside with steel ring, and the faces of all flanges shall be machined to give a true angle of 90° to the centre line of the pipe or fitting.

Before being dispatched from the place of manufacture the ends of the water meters, shall be suitably capped and covered to prevent any accumulation of dirt or damage.

Where the coating of water meters is damaged during delivery, the surface shall be cleaned and dried and the Contractor shall paint the damaged area with a minimum of three coats of paint and to the full thickness and specification as the original coating.

4.2.2 Reference to standards

In general, the relevant DIN, ISO or EN standards shall be applied. Reference to any other national standard or publication in these Specifications is intended to indicate general configuration, type and quality only.

The following general standards shall apply in addition to those specially indicated in the “Bill of Quantities“ and other chapters of the Technical Specifications.

- ISO 4064-1: Measurement of water flow in closed conduits – Meters for cold potable water-Specifications
- ISO 4064-2: Measurement of water flow in closed conduits – Meters for cold potable water – Installation requirements
- ISO 4064-3: Measurement of water flow in closed conduits – Meters for cold potable water – Test methods and equipment
- DIN 3547 for testing and approving of appurtenances in water supply, and
- DIN/ISO 9001 as quality assurance

Goods meeting other internationally accepted standards may be furnished, provided that overall quality will be at least equal to that required by the standards specified.

4.2.3 Shop testing and inspection

If required by the Engineer, the inspection of water meters will take place on the manufacturer's premises according to ISO 4064/3. The Contractor shall provide the testing equipment, the needed material, the checking devices and necessary trained personnel.

Inspection of external appearance, shape, dimensions and weight shall be carried out for each water meter, appurtenances and accessories. This includes inspection of external appearance, shape and dimensions for each type of water meter according to ISO 4064. All water meters, appurtenances and accessories shall be sound and free from surface defects.

Accuracy tests shall be performed on test water meters selected at random out of batches, grouped in different types of water meters, as follows:

- 5% of the total quantity or at least one water meter per diameter and type

Each successfully tested batch will be identified by a mark. Results of all such tests shall be submitted to the Engineer on a previously approved certificate or form certified by the manufacturer or by a recognized agency.

Pieces of which the deviations from standard dimensions or accuracy exceed the tolerances shall be rejected.

4.2.4 Submittals

The Contractor shall furnish to the Engineer the following:

- A sworn statement that the inspection and all of the specified tests have been made and the results thereof comply with the applicable standard.
- Results of tested water meters.

4.2.5 Handling and storing

Care shall be taken during loading, transporting, and unloading to prevent damage to the materials or coatings. Water meters that were examined and found to be defective shall not be accepted. Any damage to the water meter shall be repaired as directed by the Engineer.

Special handling of water meters shall be in accordance with the manufacturer's instructions.

Particular care shall be taken during loading, unloading, handling and transportation to avoid distortion, flattening, denting, scoring or any other damages to the water meters.

Any goods which, in the opinion of the Purchasers' representative are delivered damaged or are damaged by the Contractor in the process of stockpiling at the delivery site shall be promptly removed from the site. The Contractor shall receive no compensation for the damaged material or its removal until it is either repaired to the satisfaction of the Engineer or completely replaced.

4.2.6 General Design and Construction

Meters shall be designed for use in climate ranging from -5°C to 45°C.

Meters shall have a modular design, consisting of an outlet case and separate measuring chamber. The measuring chamber shall be removable and rapidly exchangeable without removing the body.

Registration shall be by direct straight reading in cubic meters with single pointers to show the smallest measurements. The pointers shall move in clockwise direction.

For ease and accuracy of calibration and adjustment, dials shall register so as permit accurate readings of ±0.5% of the nominal discharge.

Dials cover for dry type water meters shall provide an air-tight seal.

All revenue water meters shall be provided with a lid, which shall be recessed and shall overlap the registration box to protect the lens.

All meters shall be provided with wire and lead seals, both to the register and to the plug covering the adjustment screws.

All parts in contact with the water shall have smooth surfaces, protected where necessary to prevent incrustation.

Water meters shall be designed for a lifetime of 10 years under normal operating conditions.

4.2.7 Requirements

The water meters shall be of the Woltman type and shall comply with ISO 4064 or BS 5728 Class B. They shall be of horizontal type with completely water proof encased gear train, magnetic transmission and registration, shielded against tampering or any external magnetic field.

The water meters' bodies may be protective coated ductile or cast iron, but all internal mechanisms must be composed of corrosion free materials; viz. usually stainless steel or composite plastics. Meter bodies should preferably be epoxy powder coated for protection in all environments. All materials for internal parts like thrust pads and stud spindles should be of high quality like tungsten carbide for maximum life against wear.

An inline strainer is also recommended to protect the rotor and reduce the effect of turbulence.

Water meter body connections must be flanged with flanges to ISO 7005 Part 2 PN 10 (identical to BS 4504 PN 10).

The ends of water meters to accommodate flange adapters and couplings shall be faced and sized to the tolerances recommended by the manufacturer of the coupling. The faces of flanges shall be machined to give a true angle of 90° to the centre line of the meter. The flanged inlet and outlet shall have a common axis

The required meters shall meet following requirements:

- Meters shall be equipped with counter-mechanism flood and moister proof (IP 68), glass-copper-capsuled, counter-device turnable for 360°.
- Range of temperature: up to 45 °C, overload for a short time up to 50 °C.
- Working pressure: up to 16 bar
- All meters shall be equipped so that an additional installation of pulsing equipments as integrated part of the water meter is possible.
- The transmitting head shall allow the connection of any optical electronic pulse unit without breaking the meteorological seal.
- Protection covers shall made of special plastic, covers must be suitable for use of future impulse connection without later removal or replacement
- All water meters must be supplied with corroded prove bolts, nuts and washers according to DIN 50976 and one set of flanged gaskets of NBR, steel reinforced and approved for drinking water.

4.2.8 Technical requirements

Each meter shall have following minimum technical requirements:

- horizontal counter-mechanism
- glass-copper-capsule
- counter-device horizontal turn able 360° for better read ability
- housing shielded against tampering or any external magnetic field and magnetic transmission and registration
- transmitting head shall allow the connection of optical electronic pulse unit without breaking the meteorological seal. Contractor shall submit brochures/specifications of such electronic add-ons.
- measuring unit shall be exchangeable for exchange without removing the body of the meter from the line
- Regulation device must be placed under the counter-mechanism optimal corrosion-proof (secured by powder-coat)
- Means of adjustment by a by-pass chamber and screw which adjusts the cross-section of the chamber. The adjustment screw shall be operable from outside the meter, and shall be protected by a screw in sealed plug.
- Wire and lead seals, both to the register and to the plug covering the adjustment screws.
- Surfaces in contact with water shall have smooth surfaces, protected where necessary to prevent incrustation.

4.2.9 Markings

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

- At least one arrow cast onto the body indicating direction of flow
- Nominal size
- Nominal flow rate (Qn) preferably on counter housing
- Model identification
- Year of manufacture
- Serial number

- Manufacturer's name

In case not indicated differently the information shall be cast onto the body or engraved on the lid or painted onto the counter housing or otherwise suitably marked.

4.2.10 Characteristic flows

General performance and accuracy shall be as indicated below. The range of measured flow rates is subdivided into three reaches, the limits being defined by the following flow rates:

Qs = Starting flow rate. Below this flow rate the register will not show any reactions.

Qmin = minimum flow rate for reliable registration ± 5%

Q1 = limiting flow rate for increased accuracy of registration

Qn = nominal flow rate for continuous or intermittent function of the water meter ± 2%

Qmax = maximum flow rate at which the meter may function for limited time without damage

Minimum Performance Specifications (Revenue Flow Meters)

Meter Size (mm)	**Unit**	**50**	80	**100**	**125**	**150**	**200**	**250**	**300**
Minimum Flow Qmin +/- 5%	m3/h	≤.0.50	≤1.20	≤.1.80	≤.3.00	≤.4.50	≤.7.50	≤.12.0	≤.18.0
Nominal Flow Qn +/- 2%	m3/h	15	40	60	100	150	250	400	600
Maximum Flow Qmax +/- 5%	m3/h	30	80	120	200	300	500	800	1200
Weight	Kg	≥10	≥13	≥17	≥20	≥29	≥42	≥50	≥50

4.2.11 Accuracies

Accuracy shall be as indicated below

- From Qmin to Qt: the error shall not exceed ± 2%
- From Qt to Qmax: the error shall not exceed ± 1%
- At Qn : the error shall not exceed ± 2%

The Supplier shall include with his Tender the information in a format set out in the Technical Data Sheets regarding the above performance.

4.2.12 Packing

Each meter shall be mounted on a pallet secured against movement, with protection against damages; especially the housing of the counter shall be covered. In case there is sufficient space, more than one piece can be mounted.

4.2.13 Factory Warranty

Factory warranty shall be 128 months after successful test, however minimum 24 months after the installation.

5 ELECTRICAL INSTALLATIONS

5.1 Scope

This specification covers the general standards to be achieved when installing lighting and small power systems. i.e. guardhouse, operators quarters and site lighting. Details of the electrical works, including relocation of existing NEA lines etc. described in Appendix A; all materials and workmanship on the NEA power system shall be as per NEA practice.

5.2 Interpretations

5.2.1 Supporting Specifications

The following specifications shall, inter alia, form part of and shall be read in conjunction with this specification:

a) 1 Item of General Application
b) 2.2 Earthworks

5.2.2 Application

This specification contains clauses that are generally applicable to electrical installations and associated work.

5.2.3 Abbreviations

Wherever the following abbreviations are used they shall have the meanings below:

Institutional:

AIEE-American Institute of Electrical Engineers

BSI-British Standards Institution

DIN-Deutsches Industrie Normen

IE-Indian Electricity Rules

IEC-International Electrotechnical Commission

ISO-International Organisation for Standardisation

ISI-Indian Standards Institute

NEA-Nepal Electricity Authority

NEC-US National Electrical Code

NEMA-National Electrical Manufacturers' Association

Technical:

R-red phase

Y-yellow phase

B-blue phase

ac-alternating current

dc-direct current

A-amp

mA-milliamp

V-volt

HRC-High Rupturing Capacity

kW-kilowatt

kVA-kilovolt amp

kWh-kilowatt hour

MVA-megavolt amp

Hz-hertz (cycles per second)

SP-single pole

SPN-single pole and neutral

DP-double pole

TP-triple pole

TPN-triple pole and neutral

SPSwN-single pole and switched neutral

TPSwN-triple pole and switched neutral

MCB-miniature circuit breaker

MCCB-moulded case circuit breaker

RCD-residual current device

GES-General Electric Standard

5.3 Materials

5.3.1 Low Voltage Distribution Boards

Low voltage distribution boards shall be of fabricated sheet metal construction, arranged for conduit and/or cable entry as required, fully rust-proofed, painted to an approved finish and protected against ingress of solid foreign bodies and liquid according to IEC Recommendation 144 Degree IP 32. All boards shall be rated as required and shall conform in all respects with IS 13947. Exterior boards shall be protected to IP 65.

Low voltage distribution boards shall have banks of fuses or miniature circuit breakers which are easily removable and readily accessible for easy wiring. All boards shall have 25% spare ways fitted within the case. Incoming supplies to the distribution board shall enter by means of a lockable isolator, switch fuse, residual current device or moulded case circuit breaker.

Boards which have feeders looped in or out at the busbars shall have double terminal blocks on each busbar.

All boards shall have insulating barriers installed between phases and between each phase and earth.

When required suitable holes/knockouts shall be provided to the top or bottom of the board to accommodate all incoming and outgoing cables through rubber washer glands.

Distribution boards shall be fitted with a permanent label giving details of fuses or miniature circuit breakers when their replacement by equipment of other makes or types would adversely affect the protection or discrimination provided.

5.3.2 Fuses

Fuses shall be Category AC 80, 660 volt to IS 13703. Fuse carriers and bases shall comply with IS 13703: Part 2.

5.3.3 Miniature and Moulded Case Circuit Breakers

Miniature and moulded case circuit breakers shall comply with IS 13032 and IS 13947 respectively. All breakers shall be selected in accordance with the Indian Standards with due regard to operating characteristics, current rating, calibration and discrimination. Adequate back-up protection by HRC fuses shall be provided.

Miniature circuit breakers shall be unconditionally rated at a category of duty M6 or higher. The effect of ambient temperatures, operating duty, and application shall be fully considered in applying de-rating factors for application at site.

Miniature and moulded case circuit breakers shall have means for preventing any one pole of a multi pole circuit breaker being operated or tripping independently of the other poles.

Miniature and moulded case circuit breakers shall have locking facilities and be supplied with all keys, or shall be enclosed in cases with locking facilities which shall be provided with keys.

Miniature and moulded case circuit breakers shall be of the same type throughout the Contract.

5.3.4 Residual Current Circuit Breakers

Residual current operated devices are to be either 3 phase and neutral or 1 phase and neutral. Both types will be of the circuit current rating and rated tripping current as stated elsewhere in this Specification or on the drawings. Either type must isolate all poles and neutral and be complete with a test button marked 'PUSH TO TEST'. The unit must be of robust construction and be mounted in an enclosure of pressed steel.

Where residual current circuit breakers are used they shall be of the ac/dc current operated type complying with IS 12640 when incorporated in fixed socket outlets, except that they shall be suitable for the service conditions as defined at site.

5.3.5 Cables

All cables shall be manufactured to Nepalese Standards

(i) Low voltage (600/1000 V grade)

- PVC/SWA/PVC and XLPE/SWA/PVC multicore cable. Installed direct in the ground, in ducts, on tray or clipped direct. Aluminum wire armouring shall be used for single core cables.

(ii) Low voltage (600/1000 V grade)

- PVC/PVC multicore cable to BS 6346. Installed in floor ducts, trunking or conduits.
- PVC single core non-sheathed (450/750 V grade). Installed in conduit or trunking.
- PVC single core non-sheathed (600/1 000 V). Installed as internal wiring within switchgear and control assemblies.

(iii) Instrumentation

- PE/PSCR/OSCR/PE/SWA/PVC Plain annealed multistranded copper conductors, solid polyethylene insulation with aluminium-mylar pair screening including drain wire, with collective aluminium mylar screen including drain wire, solid polyethylene bedded steel wire armour with an outer sheath of flame retardant PVC. PVC sheath to be blue colour for intrinsically safe circuits, black for ac and dc non-intrinsically safe circuits, 300/500 V grade.

(iv) Control Digital

- PE/OSCR/PE/SWA/PVC Plain annealed multistranded copper conductors, solid polyethylene insulation collective aluminium mylar screen including drain wire, solid polyethylene bedded steel wire armour with an outer sheath of flame retardant PVC. PVC sheath to be blue colour for intrinsically safe circuits, black for ac and dc non-intrinsically safe circuits, 300/500 V grade.

5.3.6 Site Lighting

Poles shall have:-

(i) A weatherproof access door to the base compartment, fitted with tamper proof lock, to provide easy access to the equipment. The doors shall be inter-changeable between poles without adaption, and keys shall be supplied. Doors shall be provided with an earthing terminal for connection of an earth continuity conductor to the earth terminal block installed in the base compartment.

(ii) A non-rusting earthing terminal bar near to the point of electrical supply and clearly marked 'earth'. This terminal shall be capable of accommodating an earth continuity conductor not less than 6 mm2 nominal cross sectional area.

(iii) Cable slot entries of not less than 150 mm long by 50 mm wide. The top of the slots shall be no more than 350 mm below ground level.

(iv) A treated base board, within the compartment, of suitable size to accommodate all necessary control gear, cable terminations and looping type fuse service cut out. The base board shall be securely fixed within the pole.

Cut-outs housed in the base compartments of lighting poles shall be designed primarily for use in street lighting poles and shall be suitable for termination or looping-in of the cables used. They shall consist of a substantial moulded plastic drip-proof enclosure with separate terminals for live, neutral and earth conductors, and incorporate a fuse carrier suitable for a fuse to IS 13703. Terminals shall be large enough to take the service cables used.

Three way type earth terminal block capable of accepting a cable size up to 6 mm2. shall be fixed to the base board adjacent to the cut-out. The terminal block may be incorporated within the cut-out.

Ballast units shall comply with IS 1534 and shall be drip-proof, totally enclosed, polyester filled, symmetrically wound type, silent in operation, and suitable for use on a 240 volt 50 Hz supply. Tappings shall be brought to suitable marked terminals to which lamp and supply connections can be made. Terminals shall be shrouded non-track type, and separate earth terminals shall be provided.

Capacitors shall comply with IS 1569 and shall be of the unfused type, totally enclosed and proofed against condensation and climatic conditions, complete with discharge resistor, with sealed-in PVC insulated cable tails. Capacitors shall be suitable for working with the lamps and associated equipment specified and shall correct the power factor to not less than 0.85 lagging. The capacitors shall be marked with the manufacturer's name, capacitance and working voltage. Ballasts and capacitors shall carry the ISI mark.

Wiring between the terminal block in the lantern and the components in the base of the pole shall be PVC insulated, PVC sheathed cable of 1000 V grade having a copper conductor of not less than 2.5 mm2 cross sectional area to IS 694. All cables shall be correctly colour coded. Unsupported lengths of wiring shall be kept to a minimum and taped such that they do not come into contact with components.

All metalwork other than current carrying parts shall be earthed.

Road lighting luminaries shall be die cast from aluminum alloy suitable for side entry spigot mounting. The luminaries shall be complete with polished aluminum reflector for use with the lamps and remotely mounted control gear. The impact resisting bowl shall be sealed to provide a totally weatherproof unit and hinged to facilitate revamping.

Discharge lamps shall carry a 6000 hour guarantee, and shall be controlled by ballasts and capacitors, as recommended by the lamp manufacturer. High pressure sodium discharge lamps shall be provided with an external ignitor unit.

5.3.7 Lighting Luminaries

All 'discharge' luminaries shall be provided with a capacitor for the purpose of power factor correction to a value in excess of 0.85 lagging.

Breakjoint rings or 'biscuit' rings of approved colour shall be provided by the Contractor for all suspended luminaries and fluorescent batten luminaries where the batten is of insufficient width to completely cover the conduit box and its associated clearance hole in the finished ceiling.

Heat resisting cables shall be installed as the final connection to all tungsten luminaries.

All flexible cords to be used in conjunction with lighting luminaries shall be white 3 core circular 300/500 volt grade PVC insulated and sheathed manufactured to IS 694. Conductors smaller than 0.75 mm2 cross sectional area shall not be used unless previously approved by the Engineer.

Fluorescent and incandescent luminaries shall be of the following types:

- A. Tubular fluorescent luminaries:
    - Reflection
    - Diffuser
- B. Incandescent type:
    - Reflection/Shade
    - Diffuser
    - Water proof
    - Bulk head

5.3.8 Lamps

Tungsten lamps shall be coiled coil pattern to IS 418 and IS 6702. Fluorescent lamps shall be manufactured to IS 2418. High pressure mercury lamps shall be manufactured to IS 9900. High pressure sodium lamps shall be manufactured to IS 9974.

Incandescent lamps shall have IEC type B22d caps. Tubular fluorescent lamps shall have bi-pin caps. Discharge lamps shall have type ES 40 caps (GES).

5.3.9 Lighting Switches

Lighting switches for domestic and office purposes shall comply with IS 3854. They shall be of approved manufacture with shuttered outlets.

5.3.10 Small Power Outlets

For domestic and office applications, 13 amp socket outlets which comply with IS 1293 shall be used. These shall be switched unless otherwise indicated and supplied with a plug fitted with a fuse rated according to IS 13703. The fuse shall suit the apparatus served.

Where cooker control units are installed, double pole switches of suitable rating shall be installed without a socket outlet.

Fused spur units shall be of approved manufacture, of the same type and finish as socket outlets installed. Fuses to IS 13703 shall be sized to suit the connected load.

5.3.11 Ceiling Fans

Propeller fans of the non-ducted ceiling mounting type together with their associated control units shall comply with IS 374 and IS 3588.

5.3.12 Conduits

Rigid conduit shall be super high impact heavy gauge PVC conduit (HIP) and PVC accessories complying in all respects with IS 9537 and IS 3419. Each length of conduit shall bear the manufacturer’s name or trademark and be smooth inside and out and free from imperfections.

20 mm diameter conduit shall have minimum 1.8 mm wall thickness; 25 mm diameter conduit shall have a minimum 1.9 mm wall thickness.

Flexible conduit shall be of the waterproof galvanized type or PVC wire-wound type with cadmium plated mild steel couplings.

5.3.13 Earth Electrodes

Earth electrodes shall be 38 mm diameter galvanized iron rods made up in sections to the required length. Couplings joining rods shall be silicone bronze aluminum counter bored and of sufficient length to cover the rod thread.

Earth plates shall be of a minimum size of 600 x 600 x 6 mm copper or galvanised iron.

5.4 Plant And Equipment

Plant, equipment, and tools for the execution of electrical installations shall be sufficient in number and capacity, in good working order, and in accordance with the requirements of the applicable safety regulations.

5.5 Construction and Workmanship

5.5.1 Regulations and Standards

The electrical installation shall comply with all relevant IS regulations, statutory instruments and regulations current at date of Bid (unless otherwise indicated.

The Contractor shall be responsible for complying with all local byelaws, supply authority and local authority requirements. It shall be the Contractor's responsibility to determine the existence of these requirements and to comply with them.

5.5.2 Cable Installation

Cables to lighting and small power circuits shall be of one of the following sizes unless indicated otherwise:

i) 1.5 mm2 single core PVC for circuits loaded less than 1 kW.
ii) 2.5 mm2 single core PVC for circuits loaded up to 3 kW.
(iii) 4 mm2/6 mm2 2 core PVC for circuits loaded above 3 kW
iv) 1.0 mm2 light duty multicore PVC for control circuits.

Cables shall be segregated into the following categories:

i) power (less than 1 000 V phase to phase)
ii) instrumentation/telemetry
iii) control
iv) Telecommunications.

Cables shall be laid in a manner such that any electrical interference between cables shall not have a detrimental effect on the life and operation of equipment installed within the installation. As a general rule the following minimum clearances shall be adhered to wherever practical.

	HV power (mm)	MV/LV power (mm)	Instrumentation Telemetry Control (mm)	Telecommunications (mm)
HV power	-	-	-	-
MV/LV power	300	-	-	-
Instrumentation/ telemetry/control	300	150	-	-
Telecommunications local area network	300	150	150	-

LV power cables may be bundled together where allowance is made for any derating factors.

Digital and analogue signals shall be segregated within junction boxes.

Cables shall be drawn into conduits simultaneously without twists. Cables bunched into circular groups shall have the appropriate de-rating factor applied in accordance with Appendix 9 of the IEE Regulations.

Cables shall be installed on the 'loop-in' principle, no joints or junction boxes being permitted. Single core cables in conduit shall have the line conductors looped at switches and the neutral conductors looped at lighting points. Multicore cables, shall have the line and neutral conductors looped at the lighting point.

Wiring shall not be looped at terminal blocks internal to lighting luminaries. For fluorescent or similar luminaries having internal terminal blocks, the fixed wiring shall terminate at the conduit box with tails taken into the fitting. The arrangement shall be such that the fittings and tails may be removed without causing the other lighting luminaries on the circuit to be disconnected.

Wiring to 13 A socket outlet circuits shall be ring wired throughout. Spur circuits shall be used only where specified.

(i) General

Cables shall be installed in such a way that the minimum bending radii are not reduced when installed or during installation. Cables shall not be installed in ambient temperatures below that recommended by the cable manufacturer.

Cables grouped together shall have insulation capable of withstanding the highest voltage present in the group.

(ii) Direct in Ground

Buried cable up to 600/1000 V shall have a minimum cover of 500 mm measured to the top of the highest cable. On crossing roadways the cable shall be run through a PVC-U duct of minimum diameter 100 mm with a minimum of 1000 mm cover and encased on all sides by 150 mm of concrete.

The bottom of the cable trench shall be freed of sharp stones and such like and 75 mm of sieved sand laid below the cable. After cable laying 75 mm of sieved sand shall be laid above the cable.

Interlocking cable protective covers, minimum 1 m long x 150 mm wide, marked `Danger -Electric Cable' in English, and Nepali shall be laid on top of the sieved sand. Covers shall extend the whole length of the cable trench and shall overlap cables by a minimum of 50 mm.

Warning tape shall be laid a minimum of 200 mm above the protective covers.

Cables are to be installed without tees or through joints unless otherwise approved by the Engineer. Single core cables are to be run in trefoil formation.

(iii) In Underground Ducts

Underground ducts shall be constructed of impact resistant PVC-U, glazed earthenware or concrete and laid at a minimum depth of 500 mm. Ducts shall be surrounded by at least 75 mm of sieved sand except at road crossings where they shall be 1 m deep and encased on all sides by concrete.

The Contractor shall ensure that sufficient draw-in points have been provided and that adequate room has been allowed for installation of cables. Drawstrings shall be provided in all ducts to enable additional cables to be installed when required.

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 other method approved by the Engineer. The stopper shall have a fire resistance of at least 30 minutes. Single core cables in trefoil formation shall pass through the same duct and shall not be separated.

(iv) Conduit

Particular care shall be taken with the storage of conduit. A rack shall be provided for this purpose to ensure that the finish is not defaced. Conduit which is allowed to spread across the floor when stored so that the surface finish becomes damaged by being walked over or similar shall be rejected and removed from site.

All conduits shall be of sufficient size to permit the easy withdrawal and replacement of cables at a later date, no conduit smaller than 20 mm shall be used.

A space factor of 40% shall not be exceeded. The tubing shall be perfectly smooth inside and out and free from flaws and imperfections of any kind. Both ends of every length of tubing shall be properly reamed with all sharp edges removed before erection.

All bends shall be formed using bending springs in complete accordance with the manufacturer's instructions, and without alteration to the conduit section. Bends may be formed cold but in severe weather it may be necessary to warm the conduit slightly at the point where the bend is to be made. The inside radius of any bend shall not be less than 8 times of outside diameter of the conduit.

All conduit boxes on to which lighting fittings are to be affixed shall be capable of withstanding a dead weight of 10 kg and shall be fixed using two screws and washers. No weight shall be taken by any suspended ceiling.

For conduit boxes, couplers and all items of equipment that require adhesives, the manufacturer’s recommended adhesive shall be used. Connection to square or rectangular boxes shall be made using female threaded sockets and male screwed bushes. On no account shall the conduit protrude into such items as switch boxes or socket boxes. Inspection bends, elbows, couplings and tees shall not be used.

Circular PVC boxes, having spout entries, shall be used at the termination of all lighting points and as draw-in boxes on long runs. For 20 mm conduits round boxes shall be used as draw-in points, but for 25 mm and larger conduits, rectangular boxes shall be used. In each case heavy quality lids shall be used and secured by brass screws.

Sufficient draw-in boxes shall be installed to permit the re-wiring of the installation and they shall be positioned to ensure that all boxes are in accessible positions. The Contractor shall check all proposed positions with the Engineer before installation. In the case of flush draw-in boxes the Contractor shall fit a joint ring or spacer ring to finished plaster level.

Generally not more than two bends or offsets or one coupling will be permitted without a suitable inspection accessory. Fish wires shall not be left in conduits after erection. The whole of the installation shall be arranged for a loop-in type of system with joints being carried out at switches, isolators, etc. Intermediate joints in the cable will only be allowed by arrangement with the Engineer. Where terminal blocks are necessary, they shall be of the porcelain type with brass pinching screws.

For entry into trunking and any item requiring holes to be cut, the method shall be by bell mouth bushes and sleeves. For entry into sheet metal boxes and any item complete with pre-cut holes, the method shall be by threaded female sockets and male screwed bushes.

Ends of conduits which are liable to be left open for any length of time during building operations shall be plugged to prevent the ingress of dirt, cement, etc. and covers, either temporary or permanent, shall be fitted on all boxes.

The conduits shall be completely assembled, fixed and swabbed out before wiring is commenced.

Generally, conduits shall not cross expansion joints of buildings, but where they cannot be installed in any other manner then a flexible conduit shall be used across the expansion joint. A total 150 mm movement shall be allowed.

The Contractor shall provide a typical installation method drawing for all conduit installations, when requested by the Engineer.

Where conduits are taken through walls and/or floors, the holes shall be made good with incombustible material.

All conduits to the telephone, TV and radio systems shall be installed with draw wires.

All conduits to lighting and small power systems shall be installed with a circuit protective conductor.

(a) Surface Installation

All surface work, work in ducts or ceiling voids, etc., shall be secured by means of heavy quality spacer bar saddles secured by screws driven into rawlplugs, or equivalent fiber, PVC, metal or compound types. The spacing of fixings shall not exceed 1.25 m for 20 mm, 25 mm and 32 mm conduit or less in hot temperatures. It should be noted that saddles are designed to be a sliding fit for PVC conduits and it is important to ensure that all fixings are sliding due to the requirement for expansion.

Due to the materials used in PVC conduits a rise in temperature of 25^0 C would cause an increase of approximately 6 mm in a 4 m length of conduit. Where long straight runs in excess of 4 m occur in conditions of varying temperature, expansion couplers must be used in accordance with the manufacturer's installation instructions. A draw wire must be installed in runs where expansion couplings are used.

An efficient means shall be adopted to provide for the drainage of condensation and the runs shall be properly ventilated. 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 would occur, use may be made of galvanized cable trunking.

(b) Concealed Installation

If the floor of any building is of solid concrete construction, conduits shall not be run in the screed rising to the outlets, etc., unless specifically instructed elsewhere in this Specification.

Where, due to the type of construction, it is necessary to cast conduits into concrete to serve lighting points, backed outlet boxes shall be used, using female threaded sockets and male screwed bushes, with the conduit installed in such a manner as to be self draining in accordance with the IEE Regulations.

Concealed conduits shall be securely fixed to prevent movement before laying of screeds, floating of plaster, casting of columns or other building operations necessary after the conduit installation. Crampets or similar fixings shall be used for attaching the conduit to blockwork, etc. Building nails will not be accepted.

At least 15 mm cover shall be allowed for finishes over the conduit. Where this cover cannot be maintained then expanded metal shall be fitted with the conduit. Conduit cast into reinforced concrete floors shall be fixed to the steel reinforcing with binding wire and the conduit boxes filled with expanded polystyrene or enclosed in a plastic bag to prevent the ingress of concrete when poured. Where possible, the conduit boxes shall be fixed to shuttering to give a flush finish.

Conduit installed in voids, false ceilings, and other concealed routes shall be installed as specified for the surface conduits. Wiring shall be carried out after the false ceiling or permanent ducts have been completed. Conduit installed in floors shall be sealed against ingress of moisture.

The conduit installation shall be inspected by the Engineer before the building operation conceals the work.

(c) Flexible Conduit

Flexible conduit shall be of the waterproof galvanized type or PVC wire-wound type with cadmium plated mild steel couplings. Lengths of flexible conduits shall be sufficient to permit withdrawal, adjustment or movement of the equipment to which it is attached and shall have a minimum length of 300 mm. Flexible conduit 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 through type box and 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 by properly designed earthing screws. The use of lid facing screws, etc., will not be permitted. Adapters shall incorporate a grub screw or a gland to prevent the flexible conduit becoming loose.

(d) Clipped Direct

All cable hangers, clips, cleats and saddles shall be of an approved type and appropriate to the type and size of cable installed.

Their spacing shall be such as to ensure a neat appearance and prevent sagging of the cables at all times during their installed life.

(e) In Internal Floor Trenches

In shallow trenches used for electrical services only, cables may be laid in a neat and orderly manner on the floor of the trench. One layer only shall be allowed. Additional cables shall be installed on the walls of the trench in an approved manner.

Where the trench is shared by other services, cables shall be installed on the walls of the trench in an approved manner.

5.5.3 Distribution Boards

Where boards are fixed on steelwork or concrete columns, reinforced concrete or brick walls, they shall be mounted on the surface with conduits and/or trunking rising vertically from them.

Where boards are fixed on plaster finished walls, they shall be surface mounted on the finished face of the plaster with an adaptable galvanized metal box (minimum size 150 x 150 x 75 mm), recessed into the wall at the back of each board.

The adaptable box and fuse board shall be electrically and mechanically linked together, but independently fixed on the wall by bolts and expansion shields.

5.5.4 Small Power Outlets

Low voltage socket outlets for small power applications shall be fixed at a height of 300 mm from the finished floor level to the horizontal centre line of the switch.

Where recessed spur units control appliances such as incinerators, fans, water heaters, etc. a conduit shall be taken from the spur outlet box to an outlet box located immediately adjacent to the appliance in order to conceal the final connection to the appliances.

Wiring of spur units shall be carried out on 'ring' or 'radial' circuits as specified and shall conform to IEE Regulations.

5.5.5 Lighting Switches

Lighting switches of a single pole type shall be connected to the phase conductor. Switches shall be fixed at a height of 1410 mm from the finished floor level to the horizontal centre line of the switch. Where grouped switches are used, they shall be mounted in multi-gang boxes with plates.

All lighting switches shall be suitable for the power supply to which they are connected.

Lighting switches shall be mounted in separate boxes for separate circuits derived from different distribution boards.

Where multi-gang switches are supplied from opposite phases, phase barriers and warning labels shall be provided. Single gang switches connected to opposite phase polarity shall, in no case, be positioned less than 2 m apart.

5.5.6 Lighting Luminaries

The Contractor shall check final positions of all lighting points with the Engineer and obtain his approval before installation commences.

All lighting luminaries shall be mounted and located in such positions as to be readily accessible for maintenance purposes from ladders or steps.

Fixing and suspension plates shall be suitable for direct connection to conduit boxes or as otherwise specified. Luminaries having conduit suspensions shall be provided with earthed pattern ball and socket back plates. The rigid type of backplate will not be accepted. Tubular fluorescent luminaries shall have at least two separate fixings at the manufacturers recommended spacings.

5.5.7 Earthing and Bonding

The earthing system shall comply with Clause 67 of the Indian Electricity Rules.

All low voltage systems shall be properly and efficiently earthed in accordance with BS/IS 3043.

The Contractor shall ensure that complete earth continuity exists throughout the system and that the resistance of the earth parts complies with the IEE Regulations.

Each control room building shall have a main earth bar consisting of a hard drawn high conductivity copper bar of at least 150 x 25 x 6 mm, mounted on stand-off insulators. Connections to this bar shall be by brass bolts, flat washers, nuts and locknuts.

The system neutral, where applicable, earth bars of all switchboards and all earthing terminals of all transformers shall be securely bonded to the main earth bar. For bonding purposes, a galvanised iron earthing strip may be used, at least 25 x 6 mm in cross section.

Metal sheaths and armouring of all incoming, outgoing and interconnecting sub-station cables shall be securely bonded to the main earth bar. The sizes of bonding conductors shall be in accordance with IS 3043. Bonding conductors may be connected to the earth bar of the switchboard or other apparatus served.

All cables and conduits used throughout the installation shall be securely bonded to the associated equipment, and earthing straps shall be fitted. To facilitate such bonding, all cable glands shall be supplied with substantial armour clamps, having additional earthing lugs. Compression glands shall be fitted with earth tags and brass set screws.

Earthing terminals of every distribution board, isolator or switchgear item or other apparatus shall be securely bonded through 14 SWG copper conductor or 25 x 6 mm galvanised iron strip or by connecting the bonding conductors to the earth bar of the apparatus.

All electric motors and other items of electrical equipment within the Contract shall be bonded to earth by flexible copper cables, braids, or conductors of not less than 6mm2 equivalent size connected to the armouring of armoured cables unless stated otherwise.

All bonding of motors shall be to the stator frame of the motor. Bonding to end-shields, terminal boxes etc. is not acceptable.

Incoming gas, water, piped services and ducting shall be bonded in accordance with the requirements of IEE Regulation 413-2. The minimum size of the bonding conductor shall be 6mm2. Copper strip of green and yellow PVC insulated single core copper cables shall be used.

Earth clamps shall comply with IS 3043. In dry areas tinned brass clamps shall be installed. In areas where dampness is to be expected phosphor bronze clamps shall be used.

Where electrical components are mounted on custom built frames, each of the above earth bonds shall include the metalwork of the support structure.

Conduit or trunking shall not be used as the sole circuit protective conductor.

5.5.8 Earth Electrodes

Where connections to the mass of earth are specified for lightning protection or system earthing, the Contractor shall supply, install and test the connection in accordance with the following Clauses.

The Contractor shall, at the commencement of the Contract, carry out soil resistivity tests over the area of the Site indicated on the Drawings. A minimum of two tests of different spacings shall be carried out at each test location.

The results of these tests shall be used to determine the type and number of rods, plates or strips required.

The top end of rods shall be terminated at least 300 mm below finished ground level. Where rods are installed in areas accessible to persons or animals this depth shall be increased.

The position of earth rods shall be indicated by pre-cast concrete inspection pits.

Where multiple earth rods are installed, interconnections shall be made using bare galvanized iron strips. The strip shall be buried at a minimum of 600 mm below finished ground level.

The earth electrodes shall be connected to the main earth bar through test links. The earth electrode installation shall be tested in the presence of the Engineer when disconnected from the main system, using the method shown in Appendix 15 of the IEE Regulations.

Where the earth connection forms a link between a high voltage system and a low voltage system the earth connection resistance to earth when disconnected from the earth bar shall not exceed one ohm.

Where earth plates are required to carry a heavy system fault current these shall be buried at a depth of at least 2 m. Connection of copper tapes to earth plates shall be brazed and protected against corrosion.

Marker posts and plates shall be provided to mark the position of all electrodes and buried conductors.

5.5.9 Site Lighting

The installation shall be in accordance with layouts with exact positions of control equipment, poles and lighting points determined on site to the approval of the Engineer, prior to starting erection.

The equipment shall be supplied in new and unused condition, having been tested in the course of manufacture and stored in weatherproof accommodation on site.

The Contractor shall carry out all unloading, slinging, stacking, erection and fixing of poles and brackets in accordance with the manufacturer's instructions.

Excavation for poles shall not be by mechanical means unless agreed by the Engineer. The bottom portion of pole shall be fixed in a solid precast concrete block not less than 450 mm square for the full depth of the block. Final adjustment shall be carried out using aluminum or hardwood wedges and the remaining annulus packed with sand. A cable duct shall pass through the concrete block into the column cable entry. Precast blocks shall be supplied and installed by the Contractor. The cable entry slot shall be temporarily plugged to ensure that it is maintained free from material during the backfilling process. The block shall be bedded on a 100 mm thick concrete base.

Poles shall be erected in a truly vertical position. The Contractor shall be responsible, until the expiry of the Defect Liability Period for correcting the alignment of any column which he has erected which has departed from the vertical position, excepting where it is established that such departure is due to an event outside the control of the Contractor.

Poles shall have their lanterns fixed and aligned in accordance with the manufacturer's instructions to prevent rotation in service. All joints shall be resistant to the ingress of moisture into the column and lantern.

5.6 Test and Acceptance

Tests shall be carried out on site and witnessed by the Engineer or his representatives as follows for LV cables:-

(i) Insulation resistance at 500 V dc shall not be less than 0.5 mega ohm.

(ii) Earth continuity and earth resistance.

(iii) Phasing and polarity (every fuse and single pole control and protective device shall be connected in phase conductors only).

5.7 Measurement and Payment

Work shall be measured according to types as an all inclusive rate or as specified on the BOQ.

6 PLUMBING

6.1 Scope

These Specifications cover the general requirements for plumbing services including fixing of pipes, fittings and sanitary appliances in buildings and general requirements external (outside buildings) water supply and sewerage works.

For the purpose of water supply arrangements inside buildings, the work can be considered as to start from ferrules and service pipes.

All the items under this group shall conform to the detailed Specifications given for each of the items, in addition to the bye-laws of the local bodies within whose jurisdiction the items are executed. Where the bye-laws of the local bodies differ from the detailed specification for an item, the bye-laws shall override these Specifications.

6.2 Interpretations

6.2.1 Supporting Specifications

The following specifications shall, inter alia, form part of and shall be read in conjunction with this specification:

a) 1 Item of General Application
b) 2.1 Site Clearance
c) 2.2 Earthworks
d) 2.3 Concrete Works
e) 2.4 Brickworks
f) 2.4 Cement Plaster Works

6.2.2 Application

This specification contains clauses that are generally applicable to plumbing and associated work.

6.2.3 Applicable codes

All materials used in the construction of any of the works or any of the appliances shall conform to the relevant Indian Standards where applicable. Where no such standards exit, the materials shall be of the quality and workmanship acceptable to Authority, and shall be open to inspection at the manufacturer's works before dispatch.

The following Indian Standard codes, unless otherwise specified herein, shall be applicable. In all cases, the latest revision of the codes shall be referred to:

IS:458	Concrete pipes (with and without reinforcement)
IS:651	Salt Glazed stoneware pipes and fittings
IS:771 (Part I to IV)	Glazed fireclay Sanitary appliances
IS:772	CI Sanitary Appliances
IS:774	Flushing Cisterns For W/C And Urinals
IS:775	CI Brackets And Supports For Wash Basins And Sinks
IS:778	Gunmetal Gate, Globe and Check valves for general purposes
IS:779	Water Meters (Domestic Type)
IS:781	Sand-cast brass screw down bib and stop taps for water services
IS:782	Caulking lead
IS:783	Code of practice for laying of concrete pipes
IS:784	Prestressed concrete pipes
IS:804	Rectangular prestressed steel tanks
IS:1200 (Part XVI)	Method of measurement for Building and Civil Engineering works - Laying of water, sewer lines including appurtenant items
IS:1239	Mild steel tubes, tubular and other wrought steel fittings
IS:1536	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage
IS:1538 (Part I to XIII)	Cast Iron fittings for pressure pipes for water, gas and sewage
IS:1545	Solid drawn copper alloy tubes
IS:1700	Drinking fountains
IS:1703	Ball valves (horizontal plunzer type) including floats for water supply purposes
IS:1711	Method for simple torsion testing of steel wire
IS:1729	Nahani Trap

IS:1742	Code of practice for building drainage
IS:1795	Pillar Taps
IS:1916	Steel cylinder reinforced concrete pipes
IS:2064	Code of practice for selection, installation and maintenance of sanitary appliances
IS:2065	Code of Practice for Water Supply in buildings
IS:2104	Water meter boxes (domestic type)
IS:2326	Automatic Flushing Cisterns For Urinals
IS:2379	Color code for identification of pipe lines
IS:2401	Code of practice for selection, installation and maintenance of domestic water meters
IS:2470	Code of practice for design and construction of septic tanks
IS:2548	Plastic water closet seats and covers
IS:2556 (Part I to XV)	Vitreous sanitary appliances
IS:2692	Ferrules for water services
IS:3076	LDPE pipes for Potable Water Supplies
IS:3114	Code of practice for laying of cast iron pipes
IS:3438	Silvered glass mirror for general purpose
IS:3589	Electrically welded steel pipes for water, gas and sewage (200 to 2000 mm nominal diameter)
IS:3950	Surface boxes for sluice valves
IS:4111	Code of practice for ancillary structures in sewerage system
IS:4127	Code of practice for laying of Glazed stoneware pipes
IS:4827	Tower Rail
IS:5329	Code of practice for sanitary pipe work above ground for buildings
IS:5455	Cast Iron steps for manholes
IS:5822	Code of practice for laying of welded steel pipes for water supply
IS:6295	Code of practice for water supply and drainage in high altitudes and or sub-zero temperature regions
IS:7231	Plastic Flushing Cisterns For W/C And Urinals
IS:10067	Material constants in building works

Other IS codes not specifically mentioned herein but pertaining to the work of internal water supply form part of these Specifications.

6.3 General Requirements

The following general requirements are applicable, though these are not explicitly specified / stated in the Drawings or designs given by the Engineer.

All work shall be done with skilled workmen experienced in the trade. All water supply installation work shall be carried through licensed plumbers.

All work shall be adequately protected, to the satisfaction of the Engineer, so that the whole work is free from damage throughout the period of construction upto the time of handing over.

No work shall be covered without the approval of the Engineer.

The Contractor shall be responsible for coordinating this work with works of other trades sufficiently ahead of time to avoid unnecessary hold-ups. Hangers, sleeves, recesses etc., shall be left in time as the work proceeds.

The Contractor shall submit as directed by the Engineer, samples, shop Drawings, manufacturer's Drawings, equipment characteristics and capacity data etc., of all equipment, accessories, devices etc., that he proposes to use in the installation, to the Engineer for approval.

Any damage caused to the building or to electric, sanitary, water supply or other installations etc., therein either due to negligence on the part of the Contractor, or due to actual requirements of the work, shall be made good and the building or the installations shall be restored to its original condition by the Contractor.

It is most important to ensure that the wholesome water supply provided for drinking and culinary purposes, is in no way liable to contamination from any less satisfactory water. There shall, therefore, be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting for conveying or containing

impure water or water liable to contamination or of uncertain quality of water which has been used for any purpose. The provision of reflux or non-return valves or closed and sealed valves shall not be construed a permissible substitute for complete absence of cross-connection.

No piping shall be laid or fixed so as to pass into, through or adjoining any sewer, scour outlet or drain or any manhole connected therewith nor through any ashpit or manure-pit or any material of such nature that would be likely to cause undue deterioration of the pipe, except as permitted in the next Clause.

Where the laying of any pipe through fouled or corrosive soil or pervious material is unavoidable, the piping shall be properly protected from contact with such soil or material by being carried through an exterior cast iron tube or by some other suitable means approved by the Engineer. Any piping or fitting laid or fixed, which does not comply with the above requirements, shall be removed and relaid in conformity with the above requirements and to the satisfaction of the Engineer.

Where lines are to be laid in close proximity to electric cables or in corrosive soils, adequate precautions should be taken to avoid electrical accidents and corrosion.

To reduce the frictional losses, piping shall be as smooth as possible inside. Methods of jointing shall be such as to avoid internal roughness and projection at the joints, whether of the jointing material or otherwise.

Change in diameter and in direction shall preferably be gradual rather than abrupt to avoid undue loss of head. No bend or curve in piping shall be made which is likely to materially diminish or alter the cross-section.

All pipe work shall be so laid or fixed, and maintained as to be and to remain completely watertight, thereby avoiding waste of water, damage to property and the risk of contamination of the water conveyed.

Underground piping shall be laid at such a depth that it is unlikely to be damaged by frost or traffic loads and vibrations. It shall not be laid in ground liable to subsidence, but where such ground cannot be avoided, special precautions shall be taken to avoid damage to the piping. Where piping has to be laid across recently disturbed ground, the ground shall be thoroughly consolidated so as to provide a continuous and even support.

The bottom of water service pipe, at all points, shall be at least 30 cm above the top of the sewer line at its highest point.

Water for drinking or for culinary purposes as far as possible shall be on branch pipes connected directly to the service.

In flats and tenements supplied by a common service pipe a stop tap shall be fixed to control the branch each separately occupied part. In large buildings a sufficient number of stop valves shall be fixed on branch pipes, and to control groups or ball valves and draw off taps, so as to minimize interruption of the supply during repairs, all such stop valves shall be fixed in accessible positions and properly protected from being tampered with, they may be of the gate type to minimize loss of head of friction.

Where the service pipe is of diameter less than 50 mm the stop valves shall be of the screw down type and shall have loose washer plates to act as non-return valves. Other stop valves in the service line may be of the gate type.

Service pipes shall be so constructed as to avoid air-locks, so that all piping and fittings above ground can be completely emptied of water to facilitate repairs. There shall be draining taps or draw-off taps (not underground) at the lowest points, from which the piping shall rise continuously to draw-off taps, ball valves, cisterns, or vents (where provided at the high points).

Piping shall be confined, as far as possible, to rooms where appliances are fixed, it shall have easy bends, and where quietness is particularly desired, holder bats or clamps shall be insulated from the piping by suitable pads.

The rising pipe to the storage cistern, if any, of any feed cistern shall be taken as directly as possible to the cistern and shall be fixed away from windows or ventilators.

Piping shall not be buried in walls or solid floors. Where unavoidable, piping may be buried for short distance provided that adequate protection is given against damage and that no joints are buried. If piping is laid in ducts or chases, these shall be roomy enough to facilitate repairs and shall be so constructed as to prevent the entry of vermin. To facilitate removal of pipe casing, floor boards covering piping shall be fixed with screws or bolts.

When it is necessary for a pipe to pass through a wall or floor, sleeves shall be fixed therein for reception of the pipe and to allow freedom for expansion and contraction and other movement. Piping laid in wooden floors shall, where possible, be parallel with the joist.

Where storage tanks are provided to meet over all requirements of water, connection of service pipe with any distributing pipe shall not be permitted except one direct connection for culinary or drinking requirements.

No service pipe shall be connected to any water closet or urinal. All such supplies shall be from flushing cisterns which shall be supplied form storage tank.

No service or supply pipe shall be connected directly to any hot water system or to any apparatus used for heating other than through a feed cistern thereof.

The service pipe shall pass into or beneath the building at a depth below the external ground level of not less than 0.75 m (provided the foundation is deeper than 0.75 m) and at its point of entry through the structure, it should be accommodated in a sleeve which should have previously been solidly built in. The space between the pipe and the sleeve shall be filled with bituminous or other suitable material for a minimum length of 15 cm at both ends.

6.4 Pipes and fittings

In order to supply water inside and premises of the building, piping arrangements of Galvanized Iron (GI) pipes, medium class, conforming to IS: 1239 or NS 199-2046, shall be used. For sewerage works uPVC or Reinforced Cement Concrete (RCC) pipes shall be used as specified. Specifications for laying of these pipes are given in Clauses 3 .

6.5 Material, fittings, appliances and structures for water supply

6.5.1 General

All pipes, fittings and appliances shall be free from cracks and other flaws before fixing and shall be undamaged in all respects during and after fixing. Any damages shall have to be rectified satisfactorily.

All the pipes, fittings and appliances shall be thoroughly cleaned before fixing and particular care shall be taken to see that no extraneous material gets into them during fixing. All items required for ensuring leak proof jointing and efficient functioning of the pipes and appliances shall be carried out without extra claim. The pipes shall be carefully cleared of all foreign matter before being laid. They shall be thoroughly brushed out internally with a well-fitting hard brush, and after laying the open end shall be temporarily plugged to prevent ingress of water, soil etc., precaution shall be taken to prevent floatation of the plugged pipes.

All cutting and waste of pipes involved in fitting them shall be included in the rate.

All diameters of pipes shall be the diameters of the inside bore. All the pipes, appliances, fixtures and all other materials to be used shall be new and of good quality. Pipes and fittings

6.5.2 Fixtures and Appliances

6.5.2.1 Brass or Gunmetal water fittings

All brass or gunmetal fittings shall be of heavy quality and of approved manufacture and pattern. The fittings shall conform to IS: 778 and IS: 781. A sample of fittings shall be got approved by the Engineer and all fittings shall be provided according to the approved samples.

The standard size of bronze or gun metal fittings shall be designated by the nominal bore of the pipe outlet to which the fittings are attached. A sample of each kind of fittings shall be got approved from the Engineer and all supplies made according to the approved samples.

All cast fittings shall be sound and free from laps, blow holes and pittings. Both internal and external surfaces shall be clean, smooth and free from sand etc. Burning, plugging stopping or patching of the casting shall not be permissible. The bodies, bonnet, spindles and other parts shall be truly machined so that when assembled the parts shall be axial, parallel and cylindrical with surfaces smoothly finished. The area of the water way of the fittings shall not be less than the area of the nominal bore. Chromium plating wherever specified shall be of 0.3 micron thick, conforming to IS:4827. The chromium shall never be deposited on brass unless a heavy coating of nickel is interposed. In the case of iron fittings, a thick coat of copper shall first be applied, then one coat of nickel and finally the coat of chromium shall be applied. In finish and appearance the plated article, when inspected, shall be free from plating defects such as blisters, pits, roughness and unplated areas and shall not be stained or discoloured. Before fitting is plated the washer plate shall be removed from the fittings, the gland packing shall be protected from the plating solution.

6.5.2.2 Bib cock (tap)s and stop cock (tap)

Bib cock and stop cock shall be of specified size and shall be of screw down type and shall conform to IS 781. The handle shall be either crutch or butterfly type, securely fixed to the spindle. Valve shall be of the loose leather seated pattern. The cocks (taps) shall open in anti-clockwise direction.

The bib cock and stop cock shall be polished bright. The minimum finished weights of bib tap and stop tap shall be as specified in the following table:

Size (mm)	Minimum finished weight	
	Bib tap (kg)	Stop tap (kg)
8	0.25	0.25
10	0.30	0.35

15	0.40	0.40
20	0.75	0.75

6.5.2.3 Screw Down Wheeled Stop Tap

The item shall conform to the Specifications covered in Clause 6.5.2.2 in all respects except that it shall have an operating wheel. The material of the wheeled stop valve shall be gun metal or brass as specified in the item.

6.5.2.4 Self closing taps and other special fittings

Self closing taps and other special fittings of approved makes are to be used on direct pipes and distributing pipes from tanks. Self-closing taps shall be of non-concussion type and shall comply with IS: 1711.

6.5.2.5 Valves for Plumbing

6.5.2.5.1 Wheel Valves (Globe valves)

The wheel valves shall be of size as specified and conforming to IS: 778 (Globe Valves).

6.5.2.5.2 Gate Valves

The gate valve shall be of size as specified and conforming to IS: 778.

6.5.2.5.3 Non-Return valve (Brass)

The valves shall be of quality approved by the Engineer and shall generally conform to IS: 778. Weights of these valves shall be as prescribed in the following table with a tolerance of 5 percent.

Diameter (mm)	Weight (kg)	
	Horizontal type	Vertical type
15	0.30	0.25
20	0.55	0.25
25	0.90	0.75

6.5.2.5.4 Non-Return valve (Gunmetal)

The valves shall be of quality approved by the Engineer and shall generally conform to IS: 778.

6.5.2.5.5 Float / Ball valves

The float valves or ball valves shall be of specified size as per Specification conforming to IS: 1703. The valve shall be of Brass or Gunmetal of specified size conforming to IS: 1703. The valve shall be of following two classes:

- High Pressure (HP) for use on mains having pressure of 1.75 kg/cm^2 and above. These shall remain closed at a test pressure of 10.5 kg/cm2.
- Low Pressure (LP) for use on mains having a pressure up to 1.75 kg/cm^2. These shall remain closed at a test pressure of 3.5 kg/cm2.

The ball valves shall be of the nominal sizes 15 mm, 20 mm and 25 mm. The nominal size shall correspond with the nominal bore of the inlet shanks. Polyethylene floats shall conform to IS 9762. These valves shall be of the following dimensions and weights:

Sr. No.	Item	Nominal Size of valve (mm)		
		15	20	25
1.	Diameter of Spherical float (mm)			
	High pressure	127	152	203
	Low pressure	114	127	178
2.	Minimum weight of ball valve including back nut, body and piston	283	446	823

6.5.2.5.6 Landing Valves

Landing valves shall be of the specified size and class and shall in all respects conform to the requirements of IS: 5290, type B.

6.5.2.5.7 Full Way Valve (Brass)

The valve shall be of brass fitted with a cast iron wheel and shall be of gate valve type conforming to IS:780, opening full way and of the size as specified. The valve shall be of best quality as approved by the Engineer.

6.5.3 Water Storage tanks on terraces

These tanks shall of HDPE circular in shape of required capacity and shall be as per approved by the Engineer and as per drawing Drawings.

For inlet, outlet and other connections fully threaded GI connections with hexagonal check nuts and washers on either side of the tank wall shall be provided. Holes for threaded connections shall be drilled and not punched. Pipes entering / leaving the tank shall be provided with unions and suitably supported on a firm basis to avoid damage to the tank walls. No separate payment shall be done for fixing of inlet, outlet, washout arrangement and associate work.

6.5.4 Underground Water Storage Tanks

Underground Storage tanks shall be of RCC, as per the Specifications given for RCC storage tanks The following requirements shall also be complied with:

- The tank shall project at least 30 cm above the highest flood level. Where this is not possible the manhole cover shall be raised 30 cm above the highest flood level of the locality or ground level whichever is higher.
- The construction of the tank shall be such as to provide for the draining of the tank when necessary and water shall not be allowed to collect round about the tank.
- The tank shall be perfectly watertight.
- The inner surface of the tank shall be rendered smooth as far as possible.
- The top of the tank shall be so leveled as to prevent accumulation of water thereon.
- The tank shall have complete cement concrete cover leaving a manhole opening provided with a properly fitting mosquito-proof hinged cast iron cover fitted with a leak proof cast iron frame. Where tank is of a large size, adequate number of manholes shall be provided.
- No gap shall be allowed to remain round the suction pipe and arrangement shall be provided for proper discharge of spill water from the electric pump by connecting the pump cabin to the water drain, or by providing a small hole which will enable the water to flow out

The overflow pipes or vent shafts, if provided, shall have a wire gauge cover of 1.5 mm mesh properly screwed tightly to the opening.

6.5.5 Fittings and accessories for RCC Water Reservoirs

Where necessary, the pipes etc., shall be embedded during the casting of concrete. Where not so necessary in the opinion of the Engineer, holes may be left while casting of the concrete and the accessories fixed later. All these holes shall be made good and waterproofed after fixing of the accessories. The frame of the manhole shall be embedded into the concrete while casting.

The following fittings and accessories are included under this item as given elsewhere:

- Ball cock of the diameter of the supply pipe.
- Galvanized iron overflow pipe with mosquito proof coupling.
- Required number of 45 cm diameter manholes with cover and frame,
- Connecting galvanised iron pipes,
- 45 cm wide mild steel ladder of 40 mm x 6 mm mild steel flat stringers and stops of 20 mm diameter mild steel bars,

The intake and outtake pipes shall be as provided separately and shall not be included in this item.

6.6 Sanitary fittings and appliances

6.6.1 General

All porcelain sanitary ware shall be of approved make. All fittings shall be of first quality, free from warps, cracks and glazing defects. All sanitary ware, fittings and fixtures shall be as shown in Drawings and as described in detail in Bill of Quantities.

6.6.2 Protection

Fixtures shall be protected throughout the progress of the work from damage. Special care shall be taken to prevent damage and scratching of chromium plated fittings. Tool marks on chromium fixtures etc., shall not be accepted.

All fixtures shall be fixed with chromium plated brass screws with washers wherever necessary. Protective paper on fixtures shall be removed with hot water only at the final completion of work.

6.6.3 Workmanship

All sanitary ware shall be fixed in a neat workmanlike manner, true to level and plumb. Manufacturer's instructions shall be followed closely regarding installation and commissioning.

6.6.4 Testing

When the installation has been completed to the satisfaction of the Engineer, it shall be tested in the following manner:

- The entire system shall be slowly filled with water, allowing any trapped air to escape.
- When all outlets are closed the system shall be checked for water tightness.
- Each outlet shall then be checked for rate of flow and correct operations.

6.6.5 Bath, Lavatory and Mixing Taps

Bath, lavatory and mixing taps shall generally comply with the requirements specified for bib taps in Clause 6.5.2.2. Combination taps, mixing valves or blenders shall conform to IS : 1701. For mixing hot and cold water and discharging the mixture through a single outlet shall be fed with both hot water and cold water under pressure only from cisterns at the same level or from the same cistern.

6.6.6 Wash basins

The item pertains to the provision and fixing of wash basin of the specified size including all necessary fixtures and pipe connections upto the outside face of the wall.

The basin shall be fixed and supported on a pair of rolled steel or cast iron cantilever brackets embedded in wall or fixed to wall with wooden cleats and screws. The height of the top of the basin from the floor shall be 75 cm unless other heights are ordered by the Engineer. All the pipe connections shall be made as shown on the plan or as found necessary and ordered by the Engineer for the item. Chromium plated brass screw down stop tap shall be fixed on the supply pipe. The pipe connections shall conform to IS: 1742. The waste pipe shall be provided with a C.P. Brass bottle trap. All the exposed pipes and brackets shall be painted with one coat of red lead and two coats of good oil paint of approved shade.

Wash basins shall be of white vitreous china conforming to IS: 2556 (Part -I) and IS: 2556 (Part IV). Wash basins either of flat back or angle back as specified shall be of one piece construction, including a combined over-flow. All internal angles shall be designed so as to facilitate cleaning. Each basin shall have a rim on all sides, except sides in contact with the walls and shall have a skirting at the back. Basins shall be provided with single or double tap holes as specified. The tap holes shall be 28 mm square or 30 mm round or 25 mm round for pop up hole. A suitable tap hole button shall be supplied if one tap hole is not required in installation. Each basin shall have circular waste hole to which the interior of basin shall drain. The waste hole shall be either rebated or bevelled internally with 65 mm diameter at top. Each basin shall be provided with non-ferrous 32 mm waste fitting. Stud slots to receive the brackets on the underside of the wash basin shall be suitable for a bracket with stud not exceeding 13 mm diameter, 5 mm high and 305 mm from the back of basin to the centre of the stud. The stud slots shall be of depth sufficient to take 5 mm stud. Every basin shall have an integral soap holder recess or recesses, which shall fully drain into the bowl. A slot type of overflow having an area of not less than 5 cm^2 shall be provided and shall be so designed as to facilitate cleaning of the overflow.

Wash basins shall be enumerated. Rate shall include the cost of all the materials and labour involved in all the operations described above.

6.6.7 Mirror

The mirror shall be of superior sheet glass with edges rounded off or bevelled, as specified. It shall be uniformly silver plated at the back and shall be free from silvering defects and with marine plywood back. Mirror shall conform to the Specifications of IS:3438.

Mirror shall be fixed in position by means of 4 Chromium Plated (C.P) brass screws and C.P brass washers, over rubber washers and wooden plugs firmly embedded in walls. C.P brass clamps with C.P brass screws may be an alternative method of fixing, where so directed. Unless specified otherwise the longer side shall be fixed horizontally.

The item, if measured separately, will be by number. It may be included in other items it so specified in BOQ.

6.6.8 Sink

Kitchen sink shall be provided at the location shown in the Drawing and as per the size mentioned.

Kitchen sink shall be of white glazed fire clay conforming to IS 771 (part II) and shall have combined overflow of weir type and their inverts shall be 30 mm below the top edge. Each sink shall be provided with a non-ferrous 50 mm diameter waste fitting. The waste fitting shall be of brass with chromium plated (CP).

The sink shall be provided with 40 mm CP brass union. CI brackets for supporting sink shall conform to IS:775. Installation of sink shall consist of assembly of sink C.I brackets, union and GI waste pipe. The sink shall be supported on CI cantilever brackets, embedded in cement concrete (1:2:4) block of size 100 X 75 X 150 mm. Brackets shall be fixed in position before the dado work is done. The CP brass union shall be connected to 40 mm nominal bore GI waste pipe which shall discharge into a floor trap. The height of front edge of sink from the floor level shall be 80 cm. This item shall be measured by number including all items stated above and shall include cost of all fixing material.

Sinks shall be enumerated. Rate shall include the cost of all the materials (bottle trap, waste pipe, washers, CI brackets, unions, other fittings and etc) and labour involved in all the operations described above.

6.6.9 Floor Trap

Floor Traps shall be of CI and self cleaning and deep water seal type with a 50 mm water seal. It shall have a 100 mm diameter grating. These shall be fixed in cement concrete blocks 1:2:4, to the required level and position. The gratings shall be got approved before use in work.

6.6.10 Water closet

6.6.10.1 Orissa Pattern Water Closet

Squatting pans shall be of white vitreous china conforming to IS: 2556 (Part-I) for general requirements and IS: 2556 (Part-III) for Orissa pattern water closet

This item pertains to provision and fixing of Orissa type white glazed earthenware Water Closet pan of specified dimensions with cast iron high level flushing cistern of 12.5 litres capacity, and other accessories and necessary pipe connections upto the soil and vent pipes fixed on the outside of walls.

Each pan shall have an integral flushing rim of suitable type. It shall also have art inlet or supply horn for connecting the flush pipes. The flushing rim and inlet shall be of the self draining type. It shall have weep hole at the flushing inlet to the pan. The flushing inlet shall be in the front unless otherwise specified or ordered by the Engineer The inside of the bottom of the pan shall have sufficient slope from the front towards the outlet and the surface shall be uniform and smooth to enable easy and quick disposal while flushing. The exterior surface of the outlet below the flange shall be an unglazed surface which shall have grooves at right angles to the axis of the outlet. In all cases a pan shall be provided with a (100 mm) S.C.I. trap with ‘P’ or ‘S’ type with approximately 50 mm water seal and 50 mm diameter vent horn, where required by the Engineer.

The pan shall be placed into position with the trap joined in cement mortar 1:1 and the connecting pipes duly connected including the lead pipe from the flushing cistern. The jointing of various pipes shall conform to IS: 1742.

The jointing of cast iron pipes shall be with 1:1 cement mortar with hemp yarn caulking.

The pan shall be sunk into the floor and embedded in a cushion of average 15 cm thick cement concrete 1:5:10 (1 cement : 5 fine and : 10 graded brick ballast 40 mm nominal size). The concrete shall be left 115 mm below the top level of the pan so and to allow flooring and its bed concrete. The joint between the pan and the trap shall be made leak proof with cement mortar 1:1 (1 cement : 1 fine sand). The pan shall be fixed slightly at a lower level than the level of the general flooring, which should slope on all sides towards the pan. If the pan is damaged in handling or fixing, it shall be replaced by the Contractor at his own expenses.

The flushing cistern shall be fixed on two iron or mild steel cantilever brackets fixed in the wall at the height indicated on the Drawing or as ordered by the Engineer. The inlet end shall be connected to the distribution pipe through a stop tap, pipe and bends. The lead flushing pipe shall be connected to the outlet nipple and tail pipe with a coupling brass nut. The 20 mm diameter overflow pipe shall be slightly bent downwards and shall be fixed with a mosquito proof coupling.

The C.P. flushing pipe shall be bent leaving a straight length of about 30 cm at the top and the lower portion after the bend shall be housed into the recess cut in the wall and shall be concealed with plaster.

The whole installation shall be tested for leak proof joints and satisfactory functioning.

The cistern, brackets and all the exposed pipes shall be painted with a base coat of red lead oil paint and the two coats of approved shade of good oil paint.

6.6.10.2 European type white glazed earthenware water-closet

The item pertains to the provision and fixing of European type white glazed earthenware water-closet pan, with 12.5 liters white steel enameled low level flushing cistern and other flushing accessories and necessary pipe connections up to the soil and vent pipes fixed on the outside of the wall. The pan shall be fixed into position in 1:1 cement mortar with the connecting pipes duly connected including the flushing cistern, piping etc., and the test shall be done as in previous Clause. The seat and lid shall be fixed to the pan with chromium plated brass hinges.

6.6.10.3 Measurement

Water closets shall be enumerated. Rate shall include the cost of all the materials and labour involved in all the operations described above.

6.6.11 Urinals

6.6.11.1 Half stall Urinals

The item pertains to the provision and fixing of a half stall type urinal with 10 litre auto flushing cistern (or any other type as defined in the BOQ) including all fittings and soil pipe connections upto the outside face of the wall. The installation of the urinal shall conform to paragraph 6.6 of IS 2064.

The urinal shall be securely fixed to the wall with the top of the bowl at 65 cm., from the floor or such distance as may be directed by the Engineer. All the pipe connections shall be made as shown on the Drawings or as necessary for the item.

The jointing shall confirm to paragraph 5 of IS: 1742. A 32 mm diameter GI pipe shall be provided with C.P. bottle trap.

The flushing cistern, its fixing and the pipe connections shall conform to the details given in Clause 6.6.10 above. All the exposed lead and ferrous pipes and the bracket for the flushing cistern shall be painted with one coat of red lead and two coats of good anti-corrosive oil paint of approved shade.

Half stall urinals shall be of white vitreous china conforming to IS 2556 (Part VI Sec 2). They shall be of one piece construction with or without an integral flushing box rim provided with slots or alternative fixing arrangement at the flat back end. They shall be provided with ridges where integral flushing is not provided in the sides of the interior of the bowl, to divert the water towards the front line of the urinal where integral flushing box rim is specified, water spreaders provided shall conform to IS:2556 Part VI: Sec 6. These shall be vitreous china of one piece construction with one integral flush inlet.

6.6.11.2 Squatting Plate Urinal

The Squatting Plate Urinal shall be of vitreous china conforming to IS 2556 (Part I) and IS 2556 (Part VI / Sec 3) with internal flushing rim with front or side inlet. Squatting plate shall be of one piece construction. Each urinal shall have integral longitudinal flushing pipe of suitable type which may be connected to flush pipe. There shall be 100 mm diameter white glazed vitreous china channel with stop and outlet piece in front.

6.6.11.3 Measurement

Urinals shall be enumerated. Rate shall include the cost of all the materials and labour involved in all the operations described above.

6.6.12 Toilet Requisites

6.6.12.1 Towel Rail

It shall be of anodised aluminum with two aluminum anodised brackets. The size of the rail shall be 75 cm x 20 mm diameter or 60 cm x 20 mm diameter, 1.25 mm thick as specified. The bracket shall be fixed by means of CP 1 brass screws to wooden cleats firmly embedded in wall.

6.6.12.2 Toilet paper holder

The toilet paper holder shall be of CP brass or vitreous china as specified and of size and design as approved by the Engineer-in charge. It shall be fixed in position by means of CP brass screws and plugs embedded in the wall.

6.6.12.3 Shower

These shall be of CP finish swivel type as specified.

6.6.12.4 Towel pipe and towel cloth stand etc.

These shall be of CP / anodized aluminum as specified. These shall be fixed by means of CP brass screws to wooden cleats firmly embedded in the wall.

6.6.12.5 Measurement

All the items mentioned above under Clause ‘Toilet Requisites’ shall be measured per number and the quoted rates shall be on this basis which shall include the cost of respective materials, necessary fixtures, fixing in position.

6.6.13 Water Heaters

These shall be of best approved make, type and capacity as per BOQ. They shall be mounted on the wall / lift with necessary bolts of approved type. They shall have a 8 mm PVC inlet pipe, 12 mm lead pipe outlet and 15 mm non-return valve.

These shall be measured per number basis and the quoted rates shall include:

- Cost of water heater with all the built-in electrical accessories like pilot lamp, thermostat, standard length of cable and three pin plug,
- PVC inlet lead outlet pipe and non-return valve,
- Fixing accessories like bolts, nuts etc.

6.6.14 Soil, Water and Vent Pipes

Unless otherwise mentioned in BOQ, soil, water and vent pipes shall be of Cast Iron conforming to IS: 1729 or IS:3989. Pipes and fittings with irregular bore, blow holes and other manufacturing defects shall not be allowed to be used for work. All the fittings shall be of the degree specified or as required at site.

6.6.14.1 Cast Iron Rain Water Pipes

Cast Iron pipes shall be treated with Dr. Angus Smith's solution before use. Cast Iron grating shall be of a slightly bigger diameter than that of the pipe.

In the case of terraced roof, the cast iron grating shall be fixed at the inlet end of the pipes properly secured in the parapet wall to receive the rain water. The cast iron grating shall be recessed at a slightly lower level than the adjacent terrace floor.

The joints shall be sealed with a few turns of spun yarn soaked in bitumen or tar. It shall be pressed home with a caulking tool for 1/3rd the depth of the joint. More skein yarn shall be wrapped if necessary and well rammed home. The joint shall then be filled with cement mortar 1:3. At the ground level, they shall be supported on a 1:2:4 cement concrete block of 30 cm x 30 cm and of sufficient height.

All the necessary fittings shall be included in the pipeline at proper places. The inlet end shall be carefully fixed to admit water from the roof. The outlet shall be with a shoe.

The pipe shall be painted with one coat of red lead oil paint and two coats of good anticorrosive oil paint of approved shade.

Pipes, fittings and joints shall be tested for leakage, any defects noticed shall be rectified without any extra cost to the corporation.

6.6.14.2 Cast Iron Soil Vent Pipes

Cast iron pipes of specified diameter shall have sockets for underground and sockets with lugs for fixing on walls. They shall be treated with Dr. Angus Smith's solution. All the pipes, fittings, etc., should be free from cracks and flaws. The interior of the pipes and fittings shall be clean and smooth. All the fittings shall be of the same quality as that of the pipes. The fittings shall have cleaning eyes with plugs where necessary.

The socket end shall be the inlet end for the soil or waste pipes. In vent pipes the socket shall face up. The joints shall be filled with lead. The joining shall conform to IS: 1742. Where the cast iron pipes are fixed on the wall they shall be supported on a 1:2:4 cement block of 30x30 cm and of sufficient height in the ground. The pipes shall be fixed on the wall with nails driven through the lugs to the holder battens. Necessary fittings shall be included in the pipes. The exposed pipes shall be painted with a base coat of red lead and two coats of good anti corrosive oil paint of approved shade. For pipes fixed on the walls, smoke test shall be carried out.

6.6.15 Gully traps

Gully traps shall be of salt glazed stoneware conforming to IS 651. Each gully trap shall have one CI grating of square size corresponding to the dimensions of inlet of gully trap. It will also have a water tight CI cover with frame inside dimensions 300x300 mm the cover weighing not less than 4.50 kg and the frame not less than 2.70 kg. The grating cover and the frame shall be of sound and good casting and shall have truly square machined seating faces. These shall be housed in masonry chambers of 300 mm x 300 mm internal size.

The masonry chambers shall be constructed in first class bricks in cement mortar 1:5 with a 10 cm brick work round the gully trap from the top of the bed concrete upto ground level. The space between the chamber walls and the gully trap shall be filled with cement concrete 1:5:10. It shall be plastered with cement mortar 1:3 finished with a floating coat of neat cement.

CI cover with frame shall be fixed on the top of brick masonry with cement concrete 1:2:4 and rendered smooth. Cement concrete in bed shall be 10 cm thick and in 1:5:10 mix (40 mm nominal size stone aggregate), projecting 7.5 cm outside the chamber walls.

6.6.16 Cast iron Nahani trap

Nahani trap shall be P or S type with minimum 50 mm seal. However if the plumbing is in two pipe system and with a gully trap at the ground level the minimum water seal shall be 35 mm. The traps shall be of self cleansing design and shall have exit of same size as that of waste pipe. These shall conform to IS 1729.

7 FILTRATION MEDIA

7.1 Scope

This specification covers the requirements for filter sand and for gravel used in filtration of water.

7.2 Terminology

For the purpose of this standard, the following definitions shall apply.

Effective Size (E. S.) - Particle diameter corresponding to 10 percent finer on the grain size curve [determined according to IS: 2720 (Part IV)-1975].

Uniformity Coefficient - The ratio D60/D10 where D60 is the particle diameter corresponding to 60 percent finer on the grain size curve, and D10 is the particle diameter corresponding to 10 percent finer on the grain size curve.

7.3 Filter Sand

7.3.1 Quality Requirements

Filter sand shall consist of hard, durable grains of silica and shall have a specific gravity of not less than 2.5. All grains of sand shall preferably be water worn.

The minimum silica content in sand as determined by method given in 7 of IS: 2000-1962 shall be 90 percent.

Any sample of filter sand shall not contain more than 5 percent by volume of impurities, such as clay, loam, silt, etc, in one hour settlement after shaking in water in accordance with procedure described in Appendix A of the IS 8419 (Part 1) 1977.

Sand for Slow Sand Filter

It should be hard, rounded grains and free from clay, fine particles, soft grains and dirt. Any sample of filter sand shall not contain more than 5 percent by volume of impurities, such as clay, loam, silt, etc, in one hour settlement after shaking a 1000 ml calibrated measuring cylinder half filled with filter sand to be tested and add filled with water until up to three-fourths of the cylinder.Ignition loss should not exceed 0.7% by weight.The specific gravity should be in the range of 2.55 to 2.65.Its silica content should be 90% or higher.Acid loss in hydrochloric acid should not exceed 5% by weight in 24 hours.Wearing loss should not exceed 3%.Effective size (d10) shall be between 0.15-0.35 mm.The uniformity coefficient (d60/d10) should be preferably between 2 to 3.5 and shall not exceed 5.

The sand shall not contain more than 5 percent of acid soluble matter as determined by solubility test described in Appendix B of IS 8419 (Part 1) 1977.

The loss on ignition, which is a measure of the organic matter present in sand, and determined by the procedure given in Appendix C of IS 8419 (Part 1) 1977 and shall not be more than 0.7 percent.

7.3.2 Grain Shape, Shape Variation and Sampling

The Grain Shape, Shape Variation and sampling of the sand shall be according to IS 8419 (Part 1) 1977.

7.4 Filter Gravel

7.4.1 Quality Requirements

Filter gravel shall consist of hard, preferably rounded stones with an average specific gravity of not less than 2.5 and shall be free from clay, sand, loam and organic impurities of any kind.

The gravel shall contain not more than 2 percent by mass of thin, flat or elongated pieces (in which the largest dimension exceeds three times the smallest dimension) determined by hand picking.

Gravel should be free from excessive amount of limestone or shells and acid solubility determined in accordance with procedure given in Appendix B of the of IS 8419 (Part 1) 1977 and should not exceed the following limits:

a) For gravel sizes 10 mm or larger 10 percent solubility

b) For sizes smaller than 10 mm 5 percent solubility

7.4.2 Sampling

Sampling and criteria for conformity for gravel shall be in accordance with 4.2.1 to 4.2.4 of the of IS 8419 (Part 1) 1977.

8 SLOW SAND FILTERS AND ACCESSORIES

8.1 Slow Sand Filer

Filter Beds of RCC open to sky shall be provided for a maximum capacity of 6.1MLD. All filters shall be identical in internal dimensions.

Filtration shall be by gravity, through a bed of filter sand supported by layers of suitably graded filter gravel on. The filter sand shall consist of hard durable grains of silica and shall have a specific gravity of not less than 2.6. All grains of sand shall preferably be water worn. The filter gravel shall consist of hard, preferably rounded stones with an average specific gravity not less than 2.6, shall be free from clay, sand, loam and organic impurities of any kind and shall be such as to ensure adequate and uniform distribution of wash water and air after leaving the orifices with the minimum risk of mixing sand with the gravel of the supporting media.

The filter media (sand and gravel) shall conform to IS: 8419 (part I) amended up to date filter sand when immersed in 40% hydrochloric acid for 24 hours, the soluble matter shall not be more than 5% by weight. Any sample of filter sand shall not contain more than 5 percent by volume of impurities, such as clay, loam, silt, etc, in one hour settlement after shaking in water in accordance with procedure described. [Fill a 1000 ml calibrated measuring cylinder with filter sand to be tested to half its volume and add water until the cylinder is three-fourths full. Shake up the mixture vigorously and allow it to settle for one hour.] It shall not contain more than 1.5% of calcium and magnesium calculated as CaCO3. Ignition loss should not exceed 0.7% of the weight. The solubility of supporting gravels in 40 % hydrochloric acid after 24 hours shall not exceed 10% for 10 mm or larger size gravel and 5 % for smaller than 10 mm size.

All filter media shall be supplied in polythene bags. Suitable care should be taken to protect the media from spillage or contamination. Storage on site shall only be in an approved area, well drained and free of mud and silt. The filter media shall be carefully placed in the filter beds and shall not be dropped or dumped or machine handled so as to be detrimental to the floor media, nozzles or sealant. Etc.

It shall be deemed that the Contractor has investigated all potential sources and verified that sufficient quantities of satisfactory filter sand can be obtained, packed and stored on site.

The under drain system shall be a pipe grid type consisting a central pipe/channel with lateral system of PE -100 or PVC Class 15 pipes having perforations or nozzles. The holes drilled in the pipes shall be according to drawing and properly bushed. Alternatively, “Tee pee type” i.e. reinforced concrete slabs with plastic or glass tube orifice may be provided. This “Tee pee type” of under drainage will be preferred subject to satisfying other design considerations. Both types of under drainage system shall confirm to IS: 8419 (Part 2). The under drain system shall be designed to provide uniform draw-off of filtered water and uniform distribution of wash water and air over the whole area of the filter. Particular provisions have to be made for the handling of the high air velocities at the inlet zone of the manifold.

Before filling the supporting layers and the sand of the filter beds the whole under drain system shall be thoroughly cleaned and tested for equal distribution of water. The Contractor shall take all necessary measures to ensure that false floor if used containing nozzles and the water conveying system of pipes of channels connected to the floor are free from any debris, concrete, sand or other material which could otherwise block or partially block nozzles or any openings orifices.

Such requirements shall also apply in the case of piped laterals with nozzles or orifices. It shall be the responsibility of the Contractor to remove any such debris before the commissions laying filter floors or laterals and shall continue to remain his responsibility for excluding unwanted materials, which could block the filters until the end of the defect liability period.

Each filter shall have a central and lateral wash water trough made, which shall be connected with adequate slope to the wash water outlet to prevent deposits of silt. They shall allow an equal withdrawal of the wash water during backwashing the filter.

The inner dimension of trough shall be as per drawing. However, thin Concrete channel of ≥M-20 grade or Steel or MS section with galvanizing can be provided with appropriate support. The section material and support shall be as per the Engineer decision.

Parameters:

Filters	
Filtration rate	6 cum/sq m./hour
Free board	0.5
Airflow for air scouring.	800 to 1000 LPM/sq.m.
Backwash water flow for backwashing.	600 lpm/sq m.
Filter media:	
Depth of sand bed > 600mm	600 mm
Effective size of sand particles	0.45 – 0.7 mm
Uniformity coefficient of sand	1.3 – 1.7
Minimum Silica Content.	90%
Depth of Gravel bed	Multi layers (Refer Drawing)
Maximum Permissible velocities (m/s)	
Filter Inlet.	0.6
Filter Outlet.	1.25
Backwash Inlet.	3.5
Backwash Out let.	3.0
Air for scouring	25

8.2 Air Blower and Motor

Supply, Installation, commissioning and testing of Twin lobe air blower shall consisting of CI body and drive motor mounted on common platform to make a complete running operational assembly for delivering compressed air to the rapid sand Filter backwashing system with the following specifications: -

8.2.1 Air Blower

Flow Rate: 800 to 1000 LPM/sq.m

Pressure outlet: 0.5 kg/ sq. cm

MOC: lobes CI grade 25.

Main casing side plate CI grade 25

Shaft: Alloy steel EN 24

Gear 20Mn Cr 5, bearing set of 4 + 4

Belt: V type belt with 3 grooved pulley of equivalent size

Base Frame: MS channels shall be as per recommendation of supplier and support for air blower and Motor assembly to give minimal vibration.

Silencer: MS sheet tubular silencer to minimize sound below 70 dB

NRV: Cast Iron NRV of dia ≥110mm duly mounted on supply line to the ETP tank complete with flanges nuts bolts and gaskets 3mm thick neoprene material.

8.2.2 Motor

Capacity for above Air blower, 4 pole, 3 phase, 415 volts, F class insulation, TEFC motor with CI casing, rain proof body and connecting plate duly tested as per standard norms applicable.

Supply, Installation, commissioning and testing of vibration pads (Cast Iron with rubber sheet packing & spring based) to be mounted at the base of the base frame of complete air blower and motor assembly as mentioned in Sr. No. 1 and 2 above.

Installation of air blower assembly to be done as per the site condition which shall include:

Modification of existing pipe line dia 300mm by cutting, welding, painting, supply and installation of NRV, flange dismantling and fixing to match with the air blower assembly height and in between distance etc. All masonry work like cutting of walls, plastering, colour washing as per site condition are in the scope of the work.

Supply, Installation, commissioning and testing of PVC insulated flexible cabling duly covered with PVC baten/ flexible pipe and clamped to wall, for connection with motor and main panel as per site conditions complete with valve mounted PVC batten of size 50 x 20 mm duly fixed with SS pins.

9 PUMPS AND RELATED ACCESSORIES

The submersible pump is used for pumping of clean, cold water, non-corrosive and non-abrasive to the pumpset material in the drinking water purpose.

Pumps supplied and installed shall be capable of satisfying the performance requirements in the relevant technical specification. However, the offered submersible pump must be operated at optimum efficiency and well perform in its duty load point. Low maintenance costs, reliability and trouble-free operation will be the prime consideration when selecting pumps.

Pumps shall be quiet in operation and free from vibration. Pump speed shall not exceed 1450/2900 RPM. The pump should have the maximum efficiency at the specified duty point. Approximate power inputs[1] are given in Schedule of Requirements; however, the minimum efficiency of the pump shall not less than 70%, and should meet the stipulated design discharge and head.

Pumps shall be designed to handle the described liquids and shall run unattended for long periods (15 – 22 hr/day). A corrosion resistant metal nameplate shall be permanently attached to the pump. Pumps shall have stable characteristic curve, the characteristic of continuously rising head with decreasing capacity from rated capacity to shut-off, unless otherwise specified. Pumps shall have in-built dry-running protection and shall be started by motor control switch panels or electric starters as specified in section 9.14. Pump characteristic curves showing head/discharge, efficiency and power absorbed shall be submitted with the contractor's Tender.

9.1 Pumps

The pump set in general shall confirm to IS: 8034 or equivalent British and other International Standard. In case of the proposal for Indian Production the pump set shall bear ISI mark. The manufacturer shall be certified as per ISO 9001.

9.2 Components of Submersible Pumps

Submersible pump set shall be a compact unit made up of a submersible pump and a submersible motor with shafts connected by a sleeve and operates beneath the surface of water. This low maintenance pump set is suspended vertically/ horizontally as per pumpset design configuration from raising main when installed.

9.3 Submersible Pumps

The submersible pumps shall be multistage centrifugal pumps with radial or mixed flow impellers. The casing of the radial flow impeller pumps shall be clamped together by flat steel hook bolts, whereas that of mixed flow impeller pumps by studs. Between the pump and the motor is the suction casing, a non-return valve shall be fitted to the pump discharge.

9.4 Submersible Motors

Submersible motors shall be water filled, water lubricated squirrel cage type. The axial thrust generated by the pump is absorbed by a trust bearing fitted at the bottom of the motor. The diaphragm below the thrust bearing compensates the overpressure which arises as a result of the thermal expansion of the water filled, when the temperature of the winding rises. Refer detail in section 9.11.

9.5 Bearings

The pump shall be provided with radial bearings. The motor has radial as well as axial thrust bearings. All the bearings shall be water lubricated and protected to a large degree against the ingress of sand by suitable structural elements.

9.6 Pump Set/Assembly Components

Submersible pump set shall have the following minimum components with the following specifications: -

a) Pump Head Assembly
b) Riser pipe
c) Pump Bowl Assembly
d) Suction case with Strainer
e) Submersible motor
f) Electric cable (submersible and
g) Motor Control panel

9.7 Pump Head Assembly

Pump head assembly shall comprise of a minimum of the following:

a) Surface Discharge Plate (refer Section 14.1)

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[1] Approximate power required for a submersible pump-set is calculated by using minimum overall efficiency as 60% and 1.15 as safety factor (excess factor). However, offered pump-set should be as energy efficient and effective as possible and should meet the stipulated design discharge and head.

b) Gate Valve (refer Section 3.3.2.7.1.2)
c) Air Valve (refer Section 3.3.2.7.2)
d) Non Return Valve (refer Section 3.3.2.7.4)
e) Mechanical Coupling (refer Section 3.3.2.6)
f) Water Meter (refer Section 4)
g) Other accessories like pressure gauges, bends, tail pieces etc. (refer section 3.3.2)

9.8 Riser Pipe and Fittings

Riser or column pipe shall be made of minimum medium class galvanized mild steel pipe and shall confirm to IS 1239 (Part-1) 2004, BS: 1387 or equivalent standards. It may be ERW or seamless. Each riser pipe shall be 3 m in length except the top and lowest pipe, which shall be 1 m long or as defined by the Engineer considering the site conditions. The pipes shall be flanged ended with welded flange in each end. Flanges which meet with pipes shall be drilled as per BS EN 1092-2 (ISO 2531). The flange should have two cuttings of the size of the cable with sufficient depth and shall be galvanized. The maximum size of the flange should be at least 2 cm less than the inner diameter of the tube-well. Nipple of various lengths as required by the Employer shall be manufactured of Medium/Heavy duty galvanized mild steel pipes conforming to IS: 1239 (Part I) - 1990 or equivalent and threads to conform with IS: 554 - 1975 or equivalent. Bolts and nuts shall be hexagonal, galvanized and shall be in accordance with BS 4190 or equivalent. Washer shall be of proper quality and strength. Each set of flange jointing materials shall be supplied complete with nuts, bolts, washers and joint rings with an additional 10% as spares.

9.9 Pump Bowl Assembly

The pump bowl Assembly shall made of close-grained cast iron, free from blowholes, sand holes or other detrimental defects. The bowl unit shall be capable of withstanding a hydraulic pressure equal to twice the pressure at the rated capacity or, 1.5 times the shot off head, whichever is greater. The pump shall be equipped with replaceable bearing, whichever provided. The pump shaft shall be made of stainless steel. Impeller may be of enclose or semi open type and shall be properly balanced. Impeller shall be made of bronze or Noryl i.e. modified Ppo as per IS: 8034-1984 or equivalent British Standard. Each impeller shall be securely fastened to the shaft. The delivery outlet of the bowl assembly shall comprise of a spring loaded Non-Return Valve.

The pump must be manufactured with non-corrosive materials, Ceramic or equivalent non corrodible materials must be used for bearing. For submersible Pump, Pump body and rotors and impellers must be made of stainless steel with a minimum grade of AISI 304 or higher. In the pump set/assembly, materials having higher grade or better performance may also be considered provided that there is a sufficient reason and documentary proof of the materials in the present operating conditions.

The bowl assembly shall bear a nameplate giving the following information:

a) Manufacturer's name or trade-mark (if any)
b) Model
c) Serial No.
d) No of stages
e) Head, at specified duty point
f) Discharge, as specified duty point

9.10 Suction Case with Strainer

The opening of the suction case for the entrance of the liquid shall be of proper size and shape to avoid eddy currents. The suction case shall be fitted with a strainer made of corrosion resistant material. Suitable sand guard shall be provided just above the suction case bearing to prevent the entry of foreign matter into the suction case.

9.11 Submersible Motor

Submersible Motor shall confirm IS 9283-1979 or equivalent British or International Standard and squirrel case induction type suitable for operation on 415± 10% Volt A.C. with 50 HZ frequency. The motor should be water filled and water lubricated. The thrust bearing design is to be Mitchell type with self-adjusting thrust pads resting on individual steel balls to absorb axial thrust under adverse conditions. The thrust bearing shall be of adequate size to withstand the weight of all rotating parts as well as the imposed hydraulic thrust. It shall have sufficient capacity to permit the pump to operate for short periods with discharge valve closed. The starter should be fully rewindable with special PVC insulated winding wire with overhang design to facilitate easy maintenance and repair; the starter stampings are to be suitably locked both in horizontal and circumferential directions to insure positive locking. The motor shall be protected by means of cable glands; rubber seals etc. from ingress of borehole water, sand and other foreign matters. The thrust bearing housing shall be provided with a drain plug to empty the pure water filled into the thrust bearing housing/motor. The rotor shaft shall be provided with a breathing attachment like bellows, diaphragm, etc to compensate the volumetric variations due to the change in temperature. The motor (casing, shaft, bolts/nuts etc.) shall

be made of corrosion resisting materials or suitably treated materials to resist corrosion under normal conditions. The motor should have at least 10% margin at duty point as well as should not get overloaded in the entire range of operation. The motor shall have following information:

Name of manufacturer
Motor rating (KW or HP)
Nominal speed
Rated current (A)
Rate Voltage (V)
Frequency (Hz)
Connection system
Starting system
Type of duty (continuous)
Materials of casing, shaft, bolts/nuts

There shall be an indication to identify the motor with its pump. A suitable Coupling arrangement shall be provided to couple the pump-set directly, which shall be capable of transmitting the total torque of the unit regardless of direction of the rotation.

9.12 Submersible Cable (Cable for Submersible pumps)

The electric cables must be well connected and sealed into the motor and delivered with a length of minimum 3 meters. Submersible cable shall confirm to 4.4 of IS 9283-1979 or equivalent British or International Standard. Submersible cable shall be sized not less than 4mm^2 up to 20 HP and 6-10 mm^2 for 30-40 HP motor, unless otherwise specified in Schedule of Requirements. The offered cable must meet the important parameter like starting current and continuous full load current. It shall be sized to limit the voltage drop to 5% at the motor's terminals. They shall be made of copper conductors. The conductor insulation shall be water and oil resistant, suitable for continuous immersion. The submersible cable will be joined by a watertight joint in the submersible motor cable. The connection shall be a permanent type and non-possibility for separation after installation. The Contractor shall for each of the submersible pump, supply adequate faster. The fastener shall be reusable and robust.

9.13 Armoured Power Cable

Suitable sizes of LT power cables for connecting the autotransformer starter to motor shall be supplied and delivered. The power cables shall 3.5-core Copper/Aluminium armoured power cables of 1.1 KV grade and suitable for 415 V, 3-phase, 50Hz, LT electric system. The sizes of the power cables are given in Schedule of Requirements. The offered cable must meet the important parameter like starting current and continuous full load current. The electric power cable shall be manufactured and tested in full compliance with latest version of NS, BS, IS, ISO or equivalent international standard.

Control wiring shall be done by 1.1 KV grade PVC wires with minimum 2.5 mm^2 copper conductor. Suitable size of control cables for connecting the starter to motor shall be also be supplied.

9.14 Motor Control Panel

The Motor Control Panel Board may be either self supported or wall mounted type made of mild steel sheet of thickness at least 1.6 mm and suitable shape and size. The board shall be painted with one coat of priming and two coats of anti corrosion paint. The switch panel might be installed outside at the well or under a shelter on an ambient temperature of 0 ^{o}C and 50 ^{o}C and in a sealable weatherproof cover.

The motor control panel must be safe to operate the pump motor. Provisions for the protection of motor against over loading, dry running, single phasing and opposite phasing should be provided.

In general, use DOL starter for maximum up to 7.5 HP, STAR/ DELTA: for above 7.5 HP to 40 HP and Autotransformer/Soft Starter: above 40 HP motor unless otherwise specified in the technical specification, suitable for the submersible pumps, 415 Volts and 50 Hz, 3 phases. Specifications must be according to IP54 or equivalent standards.

The motor control panel must be compatible with the pump-motor set, to be manufactured by same manufacturer or certified by pump-motor manufacturer or their authorized supplier adds an extra layer of assurance that the system will function correctly and meet the necessary standards.

The motor controller shall be equipped with all the required components and features for its proper functioning and safety requirements that included, but not limited to the following: -

a. Molded case Circuit Breaker (MCCB) of suitable capacity - AT /AF = 1.5 x line current / 3 x line current
b. Fully automatic air break type Starter with magnetic contactors of capacity: 3 X line current for DOL and line current rating for Star-Delta, Bi-metallic overload relay (phase current ± 20%) and electronic timer.
c. Low Water Level Guard/ Float- less Switch

d. Single Phase Preventer and Phase Sequence Relay.

e. Voltmeter with Selector Switch between all phases.

f. C/T Ammeter with Selector Switch.

g. Push Button Switches for 'START' and 'STOP' the motor.

h. Indicating Lamps for various actions.

i. Cable connector (2 x full current capacity)

j. Proper earthing should be provided to all electrical devices like, motor control panel, distribution box (DB), pump prime mover etc.

The details of technical specification may vary depending on types of motor control panel selected. The detailed information for the selected types of motor control panels should include specific to each type control panel.

Major items in one Auto-Transformer Starter (ATS) shall consist, but may not be limited, of the following unless otherwise specified in the technical specifications:

S. No	Descriptions	Quantity
1	Auto transformer tap setting 65%, 80% and 100% air cooled	One set
2	Heater 100w, 230 V A.C.	One set
3	Thermostat 0 to 110 degree centigrade	One set
4	Hour meter	One set
5	Ammeter with Selector Switch (200/5 operated)	One set
6	200/5 Current Transformers	Three sets
7	Time delay relay	One set
8	Contactor (about 2.5 times the fall load current) & Ampere TP, (coil voltage 230V, 50 Hz)	Three sets
9	Overload Relay (of suitable range) or as required Ampere rating	One set
10	Control Terminals	One set
11	Auxiliary Contact Blocks (mechanical latching type)	One set
12	Insulation/Moister/Thermister relay	One set
13	Voltage monitoring relay having phase failure and under voltage release	One set
14	ON/Trip indication	Two set
15	Push buttons (on/off)	One set
16	Control fuses	One set
17	Push button for mute of alarm hooter	One set
18	Control relay for alarm hooter with control fuses	One set
19	Indicating lamps with control fuses	One set
20	Earth fault relays	One set
21	Probe for water level	One set
22	Phase indicating lamps with fuse	One set
23	Water lever controller	One set

The indication Lamps are as following:

- ON green
- OFF red
- Fault red
- Alarms yellow

Each indicating lamp shall be of illuminated push-button type; centralized lamp test is not accepted. All the instruments, devises and parts of the panel shall be facing the front of the panels. Writing on the panel must be in English language.

The motor must be protected by a thermal overload relay of suitable adjustable range and shall be installed between the running conductor and motor. The overload range shall be approximately from 80% to 120% of the nominal current rating of the motor. The starter shall be rated to stand a minimum of four starts per hour at an ambient temperature.

Motor thermal protection relay to protect motor from overheating. The sensor provided in the motor starter winding resistor sensor as following:

- Digital indication
- Adjustable from 0 to 100 trip
- Change over contacts
- Resistor sensor
- Supply voltage of 220 Volts

Separate current transformer to be provided for protection and instrumental duties. Fuses and links shall be grouped where appropriated according to the functions and must be clearly marked both on panels and the associated wiring diagrams. All cable and piping shall be made through glands in a plate covering the base of the switchboard.

The Auto Transformer Starter (ATS) shall have the following features:

- Air cooled design
- The core and coil shall be impregnated under vacuum in high temperature grade
- Designed and tested to meet the requirement of IEC 292-4.
- Tap setting at 65%, 80% and 100%
- Insulation class F

The Auto Starter must be fully assembled by the manufacturer and where modifications such as additions of extra protection devises or indications are required; these modifications shall be performed in a similar manner by the manufactures. In this case full details of modifications and circuits diagrams shall be provided. The manufacturer should conduct the required tests on each starter as per IEC 439-1 1990.

9.15 Documentation

The following information/documents to be furnished by the Contractor for the offered model pump-motor set with their technical offer:

- Certification for relevant Standards
- Performance Curves
- Discharge vs. overall efficiency
- Head V/s Discharge Curve
- BHP (power input) V/s Discharge Curve
- Efficiency V/s Discharge Curve
- NPSH V/s Discharge Curve

Besides, following additional information the Contractor shall also be furnished from the Supplier:

- No of stages
- Discharge in l/s or l/m or m^3/hr
- Total pumping or duty head in meter
- Shut-off head
- Pump-input at duty point in KW or HP
- Efficiency of the pump at rated Duty Point
- Details of motor
    - Rating in KW or HP
    - Type
    - Details of power supply
    - Rated speed

On delivery of the pump-motor set, Contractor shall furnish following documents:

- Test certificate from the manufacturer
- Guarantee of workmanship and materials

Documentation for the cables and Auto Transformer Starter (ATS)/ motor control panel shall be furnished as per the technical specifications, along with wiring diagram of the electric panel board.

9.16 Guarantee of Performance

The pump-set shall be guaranteed for their performance of the pumping rate, head, overall efficiency and overall power input. The pump-set shall be guaranteed by the manufacturer against the defects in material and workmanship under the normal use and service for at least 12 months from the date of delivery to the purchaser or as specified in the Conditions of Contract.

9.17 Operation Maintenance Manual and Spare Part List

The Contractor must provide with each submersible pump-motor set and electric control panel board in English language:

- Installation manual
- Operating and maintenance instruction manual
- Works manual for repair and maintenance works
- Spare parts list/ manual

Contractor shall submit with their tender sufficient information to show the Contracting Authority that the proposed pumps will comply with the performance requirements.

10 TRANSFORMERS, ELECTRICAL FEEDER LINES AND INSTALLATIONS

The Scope of works includes specifications of all requirements for electricity feeder line including transformers, poles, conductors, insulators, fittings and control equipment. The specifications and associated drawings mentioned in this contract shall be according to the latest specification and construction drawing standards adopted by Nepal Electricity Authority (NEA).

10.1 Transformer

10.1.1 Distribution Transformer

10.1.1.1 Scope

These specifications cover the requirements of oil-immersed, natural-cooled single and three- phase distribution transformers suitable for outdoors installation on 11kV, 50 Hz distribution systems.

10.1.1.2 Service Condition

The transformers shall be designed and constructed for outdoor installation and operation under the following conditions:

Ambient temperature: -5 deg. C to 50 deg. C

Relative humidity: up to 99%

Altitude: up to 3000m above the mean sea level

10.1.1.3 Standards and Quality Certification

10.1.1.3.1 The equipment specified in this Section of the Contract shall conform to the latest edition of the appropriate IEC specifications and/or other recognized international standards. In particular:

IEC 60076 Power transformers

IEC 60137 Insulating Bushings for alternating voltages above 1 kV

IEC 60156 Insulating liquids-Determination of the breakdown voltage at power frequency- test method

IEC 60296 Specification for unused mineral insulating oils for transformers and switchgear

IEC 60551 Determination of transformer and reactor sound levels

IEC 60616 Terminal and tapping materials for power transformer

IEC 60722 Guide to lightning and switching impulse testing of power transformers and reactors

IEC 60733 Determination of water in insulating oils.

10.1.1.3.2 The manufacturer of the offered transformers must have been accredited with the latest edition of ISO 9001 (including design in the scope of registration) quality certification.

Item	Description	Units	11/0.4KV, Rated KVA as per rated
1.	Applicable Standards		
2.	Rated Power Output	KVA	As per BOQ
3	Number of Phases		3
4	Rated Frequency	Hz	50
5	Rated Primary Voltage	V,	11000
6	Rated Secondary Voltage	V	400
7	Vector Group		Dyn 11
8	Type		
	-Duty		Outdoor
	-Cooling		ONAN
9	Off-Load Tapping, Primary	%	+5,0,-3 X 5%
10	Temperature Rise in	0C	
	-Winding		55
	-Top Oil		50
11	Applied Test Voltage 1min, 50Hz	KV	
	-Primary winding		28
	-Secondary Winding		3
12	Impulse Test Voltage	KV	
	Full wave, primary winding		75
13	No Load Losses	Watts	As per NEA Standard
14	Load Losses	Watts	As per NEA Standard
15	Impedance Voltage	%	4
16	Material of Windings		

	-High Voltages		Copper
	-Low Voltages		Copper
17	Approximate Dimensions		
	-Length		
	-Height		
	-Width		
18	Total Weight		As per NEA Standard
19	Oil Quantity		As per NEA Standard

10.2 Diesel Generator

Genset Specification	
Genset rating	Prime
Genset output (KVA/KW)	As per BOQ
Aspiration/Cooling	TCAC
No. of cylinders/arrangement	4/ Inline
Displacement	4.87
Bore x stroke (mm)	108 x 133
Compression ratio	17.2
Rated RPM	1500
Overspeed trip (RPM)	1650
Governor type/DG Performance Class	Mech/G2
Frequency regulation	Isochronous
Air cleaner type/qty	Dry/01

Alternator Specification	
Voltage (3P)	415
Frequency (Hz)	50
Current (Amps)	As per rating of DG
Type	4P, rotating field
Voltage regulator	Solid State
Voltage regulation (%)	+ or – 1%
Insulation Class	H
Temperature rise (Deg C)	125
Bearing (qty/type)	1, sealed
Coupling	Flex disc
One step load acceptance	100% of rating
Unbalanced load acceptance	25% of rated amps

Cooling System	
Max ambient capacity (Deg C)	50
Coolant capacity (Eng+Rad) (L)	25

Exhaust System	
Max allowable backpressure (kPa)	5.5
Exhaust temperature (Deg C)	500
Silencer type	Residential

Engine Electrical System	
Charging Alternator VDC/Amps	12V /35A
Starter motor rated voltage (DC)	12
Battery Voltage (DC) / Capacity (AH)	12V/88AH

Standard Scope of Supply
Engine: Direct injection, water cooled, four-cylinder, 4 stroke, rated at 1500RPM, confirming to ISO 3046/BS 5514 with the following: -Radiator cooling -Mechanical Governor -Exhaust manifold with SS exhaust flexible - Flywheel and flywheel housing - Fuel and lube oil filters -Dry type air cleaner -Starter motor, battery charger
Alternator: Meccalte/Leroy somer/Stamford/CG
Acoustic Enclosure: Power coated weather proof canopy. Engine and alternator mounted on AV mounts, with silencer and SS exhaust bellow optimized to meet stringent MOEF/CPCB norms for sound and emission -Base rail with draw out type fuel tank, drain plug, inlet and outlet connections, air vent, level gauge
Control Panel: Fabricated from CRCA Sheet and powder coated with RAL 9003 with the following: -MCCB of suitable rating with short circuit protection

-Controller with multi feature display - Load on and set running indication lamps -Copper conductor cables between alternator and control panel
Literature: -Operation and spare parts manual in CD format -Installation and general maintenance guidelines -Foundation drawings - Alternator and control panel wiring drawings -Test Certificate

10.3 Voltage Stabilizer

Capacity	As per BOQ
Input Voltage	300 to 470 V.AC
Output Voltage (Normal)	400V Ac ± 1% (Adjustable
Supply	3-Phase- 4 Wire System
Supply Frequency	47 to 53 Hz
Load and Line Regulation	1%
Ambient Temperature	0 to 45° C
Effect of Load Power Factor	None
Correction Speed	30-45 V/Sec
Efficiency	Better than 90%
Duty Cycle	100% continuous
Cooling	Air/Oil as per site condition
Panel Control: -Input/ output select switch, Auto/Manual select switch - Buck / Boost Switch to adjust the output Voltage in manual mode. - Volts adjust program to set required output voltage in auto mode	
Panel Indication: Output -on/input- Low/Input-High and Digital Display	

10.4 11 KV AAAC XLPE Insulated Covered Conductor

10.4.1 Scope

This specification covers details of All Aluminum Alloy Stranded XLPE Insulated Covered Conductors for use on 11KV transmission system. The conductor covered insulation shall mark EN 50397-1:2006 by embossing/printing on it at every meter throughout the length.

10.4.2 Service Conditions

The conductor to be supplied against these specifications shall be suitable for satisfactory continuous operation under the following tropical conditions.

a) Maximum ambient temperature (Degree C) ----------50
b) Maximum temperature of air in shade (Degree C) ----------3.5
c) Relative Humidity (%) ----------10 to 100
d) Maximum Annual Rainfall (mm) ----------1450
e) Maximum Wind Pressure (kg/sq.m) ----------150
f) Maximum altitude above mean sea level (meter) ----------1000
g) Isoceraunic Level (days/year) ----------50
h) Seimic Level (Horizontal acceleration) ----------0.3g

10.4.3 Conductor Sizes

a) 7/2.00mm (22 sq.mm)
b) 7/2.50mm (34 sq.mm)
c) 7/3.15mm (55 sq.mm)
d) 7/3.15mm (80 sq.mm)
e) 7/4.26mm (100 sq.mm)
f) 19/3.15mm (148sq.mm)
g) 19/3.94mm (232sq.mm)

10.4.4 Application Standards:

Unless otherwise stipulated in this specification, the conductor shall conform to the following Indian/International Standards.

S.No.	INDIAN/INTERNATIONAL STANDARDS	
1.	IS:398 (Part IV) / 1994	Specification for aluminium conductors for overhead transmission purpose
2.	EN 50397-1:2006	XLPE Insulation covered conductor Specification for Voltage 1KV to 33KV
3.	IS: 10418	Reels and drums for bare conductors.

10.4.5 Properties of Conductor

The properties of stranded all aluminium alloy conductors of Various sizes shall be as in Table-I.

Table-I All Aluminium Alloy Stranded Conductor

Actual Area	Stranding & Wire dia.	Approx. overall dia.	Approx. mass	Calculated resistance at 20 d.c. (max)	Approx. calculated Breaking Load	Reactance per Km	Current Rating
1	2	3	4	5	6	7	8
Sq.mm	mm	mm	Kg/km	Ohm/km	kN	Ohms	Amps
22	7/2.00	6.0	60.16	1.5410	6.45	0.3556	115
34	7/2.50	7.5	94.00	0.9900	10.11	0.3556	150
55	7/3.15	9.45	149.20	0.6210	16.03	0.3556	234
80	7/3.81	11.43	218.26	0.4250	23.41	0.3394	270
100	7/4.26	12.78	272.86	0.3390	29.26	0.3394	325

10.5 Disc Insulator Fittings

10.5.1 Scope

This specification covers the fabrication and supply of tension type disc insulator fittings.

10.5.2 Description

10.5.2.1 The disc insulator fittings shall be supplied with ball and socket couplings (socket eye, ball eye/ball clevis etc.), twisted straps, and bolted type tension clamps. Number of U-bolts in tension set shall be 3 (three).

10.5.2.2 Tension clamp shall be suitable for ACSR conductor, diameter ranging from 5 mm. to 16.5 mm.

10.5.2.3 The ultimate strength of disc insulator fittings shall be more than 45 kN.

10.5.2.4 All components of disc insulator fittings shall be such that they fulfill all requirements of this specification and compatible with disc insulator specified in SPECIFICATION: SP-11.0

10.5.2.5 All parts of different fittings, which provide for interconnection, shall be made such that sufficient clearance is provided at the connection point to ensure free movement of insulator assembly.

10.5.2.6 The twisted strap shall be suitable for 50×100×50 mm. cross arm. Size of the holes for bolt, which anchors twisted strap with cross arm shall be suitable for insulator pins specified in SPECIFICATION: SP-11.0 and width of the twisted strap shall be designed accordingly. Diameter of nuts and bolts of strap shall be equal to shank diameter of insulator pins. Nuts and bolts shall also be provided with spring washer and split pin.

10.5.2.7 Unless otherwise specified in these specifications, disc insulator fittings shall be in accordance with IS: 2486 (Part I & II) or any other equivalent national or international standards.
2.8 The manufacturer of the disc insulator fittings must have been accredited with ISO 9001:2000 with design and manufacturing quality certification.

10.5.3 Material

10.5.3.1 The tension clamp shall be made of the aluminium alloy type. Other accessories like ball eye/ball clevis, socket eye, nuts, and bolts shall be made of hot rolled steel and obtained preferably by process of forging. Twisted cross arm strap shall be made of MS sheet metal. Cotter bolts and U-bolts shall be of galvanized steel. Cotter pins shall be stainless steel. Chapter 2. Specification of Electrical Equipment and Line Materials 2-199

10.5.3.2 All forging and castings shall be of good finish and free from flaws and other defects. The edges on the outside of fittings, such as at the eye, socket and holes, shall be rounded.

10.5.4 Galvanizing

10.5.4.1 All ferrous fittings and the parts other than those of aluminium alloy and stainless steel, shall be hot dip galvanized in accordance with IS: 2629-1985 or the latest version thereof or any other national or international standards that ensures at least equal or better quality to the standard mentioned above, will also be acceptable.

10.5.5 Tests

10.5.5.1 The disc insulator fittings shall comply with the following tests as per IS: 2486 (Part I) or any other equivalent national or international standards.

1. Type Test:

- Verification of Dimensions,
- Visual Examination Test
- Slip Strength Test
- Mechanical Test
- Electrical Resistance Test
- Heating Cycle Test
- Galvanizing Test

2. Acceptance Tests:

- Verification of dimensions
- Galvanizing Test
- Mechanical Tests

3. Routine Tests:
- Visual Examination Tests
- Routine Mechanical Test

10.5.6 Marking

10.5.6.1 The tension clamp shall be marked on it following:

a) Name or trademark of manufacturer
b) Name of the Purchaser as follows: "NEA-NEC''

10.6 Galvanised Steel Bolts, Nuts And Miscellaneous Fastening Components

10.6.1 Scope

This Specification covers the fabrication and supply of galvanized steel bolts and nuts, as specified herein, for use in overhead electric line construction.

10.6.2 Material

10.6.2.1 The bolts and nuts shall be manufactured and tested in accordance with IS: 1363 (Part I)-1984 or the latest version thereof or any other national or international standards that ensures at least equal or better quality to the standard mentioned above, will also be acceptable.

10.6.3 General

10.6.3.1 Bolts and nuts shall be furnished in the types, diameters and lengths specified in the Schedules of Rates and Prices. However, the dimensions and length of threading of bolt must be confirmed with the Project prior to manufacture.

10.6.3.2 Thread forms shall be consistent with all material/items listed herein and shall not strip or slip under sustained tensile loading equal to the design tensile strength of the threaded material item.

10.6.3.3 The manufacturer must have been accredited with ISO 9001:2000 with design and manufacturing quality certification.

10.6.4 Machine Bolt and Nut

10.6.4.1 Each machine bolt shall be furnished with two (2) hexagonal nuts and two (2) plain washers assembled thereon.

10.6.5 Double-Arming Bolt and Nut

10.6.5.1 Each double-arming bolt shall be furnished with four (4) hexagonal nuts and two (2) washers assembled thereon.

10.6.6 Galvanizing

10.6.6.1 The stranded stay wire shall be galvanized after fabrication in accordance with IS: 2629-1985 or any revision thereof or other equivalent national or international standard provided that ensure at least equal or better quality to the standard mentioned above will also be acceptable.

10.6.7 Tests

10.6.7.1 The bolt and nut shall undergo type and routine tests in accordance with the relevant governing standard.

10.7 Crossarms And Bracing Angles

10.7.1 Scope

This Specification covers the fabrication and supply of galvanized steel cross-arms and bracing members commonly used in overhead power line construction.

10.7.2 Material

10.7.2.1 The steel cross-arms shall be fabricated from hot rolled channels and angles.

10.7.2.2 The steel channels and angles shall be fabricated and tested in accordance with Indian Standards IS: 226-1975 and IS-808-1964 or any revision thereof or other equivalent national or international standard provided that ensure at least equal or better quality to the standard mentioned above will also be acceptable. The minimum tensile strength of the steel shall be 4200 kg/cm^2.

10.7.3 Description

10.7.3.1 The steel cross-arms and bracing angles shall be of sizes shown in the Table 1: Cross-arms and bracing angles, contained herein.

10.7.3.2 Conceptual hole pattern and size of holes on cross-arm channels are shown in appropriate drawings herein, however, the Supplier must confirm with the Project the locations and sizes of holes prior to the manufacture.

10.7.3.3 The surface of the steel shall be flat after drilling or (punching) and free of dimpling or imperfections. The hole edges shall be broken by reaming. The holes shall be full dimension after galvanizing and no minus tolerance of specified hole size will be accepted.

10.7.3.4 The steel cross-arm and bracing angles shall be furnished reasonably smooth on all surfaces and free of burrs or sharp projections.

10.7.4 Galvanizing

The steel cross-arms and bracing angles shall be galvanized after fabrication in accordance with IS: 2629-1985 or any revision thereof or other equivalent national or international standard provided that ensure at least equal or better quality to the standard mentioned above will also be acceptable.

10.7.5 Tests

Apart from the tests indicated herein in the referenced standards, the channels and angles shall undergo following tests:
- Visual Inspection;
- Verification of Dimensions

S.No.	Description	Type	Dimension in mm
1.	11KV, Single Pole, Triangular: 1.1 Pole Top 1.2 Standard	 Channel Channel	 100 x 50 x 6.4 x 5 x 300 100 x 50 x 6.4 x 5 x 1200
	11KV, Double Pole: 4.1 Standard 4.2 Bracing Member 4.3 Bracing Member	 Channel Angle Angle	100×50×6.4×5×2390 40×40×5×2071 40×40×5×2719
3.	Transformer Platform Complete set	Channel Channel	100 x 50 x 6.4 x 5 x2500 100 x 50 x 6.4 x 5 x 1200
4.	Lightening Arrester and Cut-out Support (at Transformer Platform): 5.1 Support	Channel	100 50 x 6.4 x 5 x 2348

10.8 Flat Crossarm Brace

10.8.1 Scope

This Specification covers the fabrication, testing and supply of flat, galvanized steel cross-arm braces.

10.8.2 Material

10.8.2.1 The flat cross-arms brace shall be fabricated out of hot rolled steel flat.

10.8.2.2 The steel flat for cross-arms brace shall be fabricated and tested in accordance with Indian Standards IS: 226-1975, and IS-1731-1971 or any revision thereof or other equivalent national or international standard provided that ensure at least equal or better quality to the standard mentioned above will also be acceptable. The minimum tensile strength of the steel shall be 4200 kg/cm^2.

10.8.3 Description

10.8.3.1 The brace shall be furnished reasonably smooth on all surfaces and free of burrs or sharp projections.

10.8.3.2 The surface of the steel shall be flat after drilling or (punching) and free of dimpling or imperfections. The hole edges shall be broken by reaming. The holes shall be full dimension after galvanizing and no minus tolerance of specified hole size will be accepted.

10.8.3.3 The brace shall have a minimum tensile strength of 3182 kg at the bolt-hole and bolt slot.

10.8.3.4 The brace shall be capable of being bent 10 degrees at the bolt hole or slot and 140 degrees at any point between hole and slot without cracking of the base metal on the outside of bent portion.

10.8.3.5 The brace shall be drilled and dimensioned in accordance with Dwg. CA10 attached herein.

10.8.4 Galvanizing

The flat cross arm brace shall be hot dipped galvanized after fabrication in accordance with IS: 2629-1985 or any revision thereof or other equivalent national or international standard provided that ensure at least equal or better quality to the standard mentioned above will also be acceptable.

10.8.5 Tests

Apart from the tests indicated herein in the referenced standards, the flat cross arm brace shall undergo following tests: - Visual Inspection; - Verification of Dimensions

10.9 Pole Clamps

10.9.1 Scope

This Specification covers the fabrication and supply of galvanized steel pole clamps with nuts, bolts and washers for use on overhead power line construction.

10.9.2 Material

10.9.2.1 The pole clamp shall be fabricated out of hot-rolled steel flat.

10.9.2.2 The steel flat for pole clamp shall be fabricated and tested in accordance with Indian Standards IS: 226-1975, and IS-1731-1971 or any revision thereof or other equivalent national or international standard provided that ensure at least equal or better quality to the standard mentioned above will also be acceptable. The minimum tensile strength of the steel shall be 4200 kg/cm^2.

10.9.3 Description

10.9.3.1 Outline details of pole clamps are shown in the drawings Dwg: CA13. Dimensions may be changed to comply with the final pole sizes selected. Therefore, the dimensions must be confirmed with the Project prior to manufacture.

10.9.3.2 Two (2) numbers of galvanized, 16 mm. (dia.) × 60mm. (length), fully threaded bolts with two (2) nuts and washers shall be provided with each pole clamp.

10.9.3.3 The fittings shall be free of burrs, splinters, splits, sharp points and edges, which may damage conductors or show evidence of poor workmanship.

10.9.3.4 The surface of the steel shall be flat after drilling or (punching) and free of dimpling or imperfections. The hole edges shall be broken by reaming. The holes shall be full dimension after galvanizing and no minus tolerance of specified hole size will be accepted.

10.9.3.5 The pole clamps shall have a minimum tensile strength of 3182 kg at the bolt-hole and bolt slot.

10.9.4 Galvanizing

The pole clamps and nut, bolts and washers shall be galvanized after fabrication in accordance with IS: 2629-1985 or any revision thereof or other equivalent national or international standard provided that ensure at least equal or better quality to the standard mentioned above will also be acceptable.

10.9.5 Tests

Apart from the tests indicated herein in the referenced standards, the pole clamps shall undergo following tests:
- Visual Inspection;

- Verification of Dimensions

10.10 Surge Arrester

10.10.1 Scope

This specification covers the general requirements of the design, manufacture, testing, supply and delivery of Surge Arrester of Gapless Metal-Oxide type commonly installed on overhead
11kV power lines of the Nepal Electricity Authority.

10.10.2 System Parameters

a)	Nominal Voltage	11kV
b)	System Highest Voltage	12kV
c)	System frequency	50Hz
d)	No. of Phases	3
e)	Neutral Earthing	Effective
f)	System fault current	20kA rms

10.10.3 Service Condition

a)	Ambient temperature	-5 to 55 deg. C
b)	Annual average ambient temperature	30 deg. C
c)	Maximum relative humidity	99%
d)	Environmental condition	Humid Tropical climate
e)	Operational altitude	Up to 3000m above msl
f)	Isokeraunic (Thunder Day) level	90 days
g)	Solar Radiation	1.6kW/m2

10.10.4 Applicable Standards

The equipment and components supplied shall be in accordance with the latest editions of the standards specified below and amendments thereof and the NEA Specifications specified hereafter.

a)	IEC 60099-4 Part 4 Surge Arresters	Metal-oxide surge arresters without gaps for a.c. systems
b)	IEC 60099-5 Part 5	Selection and application recommendations
c)	IEC 61109	Composite insulator for a.c. over headlines with a nominal voltage greater than 1000V - Definitions, test methods and acceptance criteria
d)	IEC 60507	Artificial pollution tests on high voltage insulators to be used on a.c. Systems

10.10.5 Technical Parameters

10.10.5.1 Minimum Technical Requirements

	Description	Unit	**Required ratings/features**
1	Voltage rating	kV	9
2	Nominal system voltage	kV	11
3	Maximum system voltage	kV	12
4	System frequency	Hz	50
5	Nominal discharge current	kA	10
6	Type of Housing Insulator		Polymeric
7	Creepage distance (terminal to base)	mm	390
8	Minimum power-frequency withstand Voltage		
8.1	Wet	kV	50
8.2	Dry	kV	70
9	Impulse withstand (1.2/50μsec) Voltage	kV (Peak)	95
10	Maximum discharge (residual) voltage at 10kA lighting impulse current	kV (Peak)	29
11	Steep current residual voltage	kV (Peak)	32
12	Line Discharge Class		1
13	Energy absorption Capability with (4/10	kJ/kV	Not less than 3.2

	wave)		
14	Pressure relief class		B
15	High current		for 0.2s 20 kA
16	Low current		for 0.5s 0.8 kA
17	One Second TOV withstand capability	kV	>1.15x12
1	Voltage rating	kV	9
2	Nominal system voltage	kV	11
3	Maximum system voltage	kV	12
4	System frequency	Hz	50
5	Nominal discharge current	kA	10
6	Type of Housing Insulator		Polymeric
7	Creepage distance (terminal to base)	mm	390
8	Minimum power-frequency withstand Voltage		
8.1	Wet	kV	50
8.2	Dry	kV	70
9	Impulse withstand (1.2/50μsec) Voltage	kV (Peak)	95
10	Maximum discharge (residual) voltage at 10kA lighting impulse current	kV (Peak)	29
11	Steep current residual voltage	kV (Peak)	32
12	Line Discharge Class		1
13	Energy absorption Capability with (4/10	kJ/kV	Not less than 3.2
	wave)		
14	Pressure relief class		B
15	High current		for 0.2s 20 kA
16	Low current		for 0.5s 0.8 kA
17	One Second TOV withstand capability	kV	>1.15x12

10.10.5.2 Power Frequency Voltage vs Time Characteristics

The manufacturer shall provide the power frequency voltage vs time characteristics, preheated to 60°C with no prior energy and with prior energy (specified by the manufacturer) in order to verify the TOV capability of the Arrester.

If a particular manufacturer is unable to meet the TOV condition of 1.15Ur (rated voltage of the Arrester) for 1 sec. duration, has the option of offering of an Arrester of a higher rating.

10.10.6 Basic Features

10.10.6.1 Design

The Surge Arresters shall be designed for outdoor service conditions stipulated above. They will be connected between phase and earth to protect distribution transformers and switchgear. It shall be complete with the following:

a) Clamps suitable to receive Copper/Aluminum (Line) Conductors from 4 mm-16mm
b) The mounting clamps suitable for bracket mounting on a structure made out of 100x50x6mm Channel Iron.

10.10.6.2 Manufacture

The Surge Arrester shall be of the non-linear metal-oxide resister type without spark gaps and the non-linear metal-oxide resister shall be housed in a hermetically sealed insulator casing to prevent ingress of moisture.

10.10.6.3 Insulator Details

The housing insulator of the surge arrester shall be of polymeric type and the insulator sheds shall be designed to minimize trapping of contamination.

The complete arrester shall withstand a 1000h salt fog test at continuous voltage as described in IEC 61109/IEC 60507. Additional cycle tests as described in IEC 61109 shall also be passed satisfactorily.

10.10.6.4 Moisture Sealing

The manufacturing procedure shall include an effective leak test and the manufacturers shall carry out the Special Thermal Stability Test as specified in IEC 60099-4.

10.10.6.5 Partial Discharge

Each surge arrester shall be tested to prove absence of partial discharge contact noise as specified in IEC 60099-4.

10.10.6.6 Arrester Disconnector

The Surge Arrester shall have a device for disconnecting it from the system in the event of arrester failure to prevent a persistent fault in the system and it shall give a visible indication when the arrester has failed. The arrester disconnector shall be tested as per IEC 60099-1.

10.10.6.7 Insulating Bracket

A robust insulating bracket together with suitable mounting clamps to mount the Surge Arrester to 100x50x6mm Channel Iron Cross Arms shall be supplied with the Surge Arrester. The power frequency withstand voltage of the insulating bracket shall not be less than 20kV.

10.10.7 Additional Requirements

10.10.7.1 Rating Plate Markings

The following ratings and data of the arresters shall be provided and it shall be weather proof and corrosion proof. The plate shall be positioned at the bottom flange base and visible from the ground level.

(a) Number and year of the standard adopted
(b) Rated voltage / frequency
(c) Continuous operating voltage
(d) Arrester type and discharge class
(e) Nominal discharge current
(f) Manufacturer's identification
(g) Year of manufacture
(h) Serial number
(i) Contract No.

10.10.7.2 Packing

Each set of Surge Arrester shall be packed in a suitable box. Number of these boxes shall be held together in a firm position and measures shall be taken to avoid damage against jerks and collision between adjacent units during transportation.

Each packing shall contain a copy of installation instruction in English Language. The voltage rating, manufacturer's name/identification, Country of Origin, and the quantity shall be clearly marked on each packing.

10.10.8 Inspection And Testing

10.10.8.1 Acceptance Test

The successful Bidder shall make necessary arrangements for pre-shipment inspection and tests by the nominated NEA Inspectors to carry out in his presence the necessary Sample/Acceptance tests conforming to the relevant IEC on equipment and materials offered. Routine test report for all the items shall be furnished for the observation of the Inspector.

The acceptance tests as per IEC shall be witnessed by the NEA Inspector. (a) Power

frequency reference voltage test
(b) Partial discharge test.
(c) Lightning Impulse Residual voltage test. (d)
Thermal Stability test

10.10.8.2 Routine Test

The Routine Tests shall be carried out on all the arresters as per the relevant IEC and the test report shall be made available for the observation of the NEA Inspector at the time of inspection.

(a) Power frequency reference voltage test.
(b) Residual voltage tests.
(c) Partial discharge test.
(d) Leakage test

10.10.9 Bid Documentation

10.10.9.1 The following shall be furnished with the offer.

(a) Product Catalogues/Technical literature describing the constructional features, materials used for components, operational feature of the equipment, indicating the model number etc.
(b) Energy withstand capability & a description of the test carried out to measure the same.
(c) Power frequency withstand voltage versus time characteristic curve covering the time range from 0.1 sec. to 24 minutes.
(d) Dimensional drawings of the bracket mounting base, live conductor clamps, earth lead and automatic earth disconnecting device and overall dimensional drawing.
(e) Drawing of name plate to scale incorporating the particulars called for.
(f) Completed Schedule of Guaranteed Technical Particulars
(g) A copy of the Manufacturer's ISO 9001 Certificate conforming to design and manufacture
(h) Type Test Certificates: The Type Test Certificates shall be from an Accredited Independent Testing Authority acceptable to the Purchaser.
(i) Copy of the Governing Standards

(j) Technical Literature in English Language on installation, operation and maintenance with necessary circuit diagrams and drawings.

10.10.9.2 Type Test Certificates

Following Type Test certificates conforming to IEC 60099-4, IEC 60507 and IEC 61109 shall also be submitted with the offer.

(a) Insulation withstand test,
(b) Residual voltage tests,
(c) Long duration current impulse
(d) Operation duty test
(e) Tests of arrester disconnector,
(f) Partial discharge test,
(g) Seal leakage test,
(h) Tracking & erosion test for polymeric insulation

Test Certificates shall clearly identify the equipment concerned showing the manufacturer's identity, Type, Model and Serial Number of the equipment tested. Type Test Report shall include complete drawings and the model/type of the offered Arrester. Type Test Report shall be from a recognized accredited independent testing authority acceptable to the purchaser.

10.11 Distribution Cutout (Drop-Out Fuses)

10.11.1 Scope

This Specification covers the general requirements of the design, manufacture, testing, supply and delivery of drop out fuse complete with fuse carriers and mounting brackets commonly used on the primary side of 11 kV distribution transformers as protective device.

10.11.2 System Parameters

a)	Nominal Voltage	11kV
b)	System Highest Voltage	12kV
c)	System frequency	50Hz
d)	No. of Phases	3
e)	Neutral Earthing	Effective
f)	System fault current	20kA rms

10.11.3 Service Condition

a)	Ambient temperature	-5 to 55 deg. C
b)	Annual average ambient temperature	30 deg. C
c)	Maximum relative humidity	99%
d)	Environmental condition	Humid Tropical climate
e)	Operational altitude	Up to 3000m above msl
f)	Isokeraunic (Thunder day) level	90 days
g)	Solar Radiation	1.6kW/m2

10.11.4 Applicable Standards

The equipment and components supplied shall be in accordance with the latest editions of the standards specified below and amendments thereof and the NEA Specifications specified hereafter.

a)	IEC 60282-2	H.V. Fuses - Expulsion and similar fuses
b)	IEC 60071-1	Insulation co-ordination.- Part I Definitions, principles and rules
c)	IEC 60071-2	Insulation co-ordination - Part 2 - Application guide
d)	IEC 60273	Characteristic of indoor & outdoor post insulators for systems with nominal voltages greater than 1000V
e)	IEC 60694	Common Specifications for high-voltage switchgear & control gear standards
f)	IEC 60060-2	High-voltage test techniques -Part 2 Measuring systems

10.11.5 Technical Parameters

10.11.5.1 Minimum Technical Requirements

S.N.	Description	Unit	Required ratings/features
1	Rated Voltage	kV	12
2	Rated Frequency	Hz	50
3	Rated Continuous Current	A	100
4	Dry Impulse withstand voltage (peak)		
4.1	Across isolating distance of the fuse base	kV	85
4.2	To earth and between poles	kV	75
5	Power Frequency withstand voltage (Wet 1min)		
5.1	Across isolating distance of the fuse base	kV	32
5.2	To earth and between poles	kV	28
6	Minimum power frequency withstand voltage		
6.1	Dry	kV	35
6.2	Wet	kV	30
7	Mounting Angle (to vertical plane)	deg	~15-20
8	Interrupting Rating		
8.1	Symmetrical Interrupting rating (min) rms	kA	8.0
8.2	Asymmetrical Interrupting rating (min) rms	kA	9.6
8.3	X/R ratio		4.0
9	Interrupting capacity	kA	10
10	Temperature Rise Limit (In air)		
10.1	Copper contacts silver faced	deg. C	40
10.2	Terminals	deg C	30

10.11.6 Basic Features

10.11.6.1 Design

The Dropout Fuse shall be of Class A as per IEC 60282-2. It shall be suitable for use in outdoor circuits under tropical conditions. The Dropout Fuse shall be complying with the minimum technical requirements stipulated above.

10.11.6.2 Manufacture

a) The Dropout Fuse shall be designed with a solid core, bird proof, one-piece Porcelain Insulator and should robust enough to withstand shocks due to frequent operations. The fuse carrier shall drop-out immediately following the blowing of the fuse.
b) Dropout Fuse within the same voltage class shall be so designed that fuse carrier together with mounting assembly shall be dimensionally compatible to facilitate the interchange of fuse carriers of the cutouts of corresponding rating.
c) The Dropout fuse shall be able to mount on a single channel iron cross arm (100mm x 50mm x 6mm) at an angle of 15 to 20 degrees to the vertical. The whole unit shall be complete with long mounting bracket, bolts, nuts & washers.
d) Fuse carrier shall be made of high strength fiberglass filament wound tube or suitable insulating material and it shall be protected from weather and environment by ultraviolet resistant coating. Inside liner of the fuse tube shall be constructed of a synthetic arc quenching material.
e) Copper Arc Shortening rod shall be attached to the cap of the fuse tube to obtain higher interrupting rating. A removable button head type fuse link having M6x1 thread shall be able to fix to the arc shortening tube.
f) The installation and removal of the fuse carrier shall be facilitated by inserting the operating rod into a lifting eye at the hinge end (lower) of the fuse carrier when it is in the dropped-out position. An operating lever eye shall be provided at the top of the carrier to facilitate a downward pull by the operating rod to release the latch incorporated in the stationary upper contact.
g) All castings such as upper and lower moving and fixed contacts, clamp type terminals, toggle mechanism shall be of phosphor bronze, silicon bronze, aluminum bronze or Silver- plated brass.

10.11.6.3 Stationary and Movable Contacts

a) The Stationary and Movable Contact surfaces shall be silver plated to minimize the contact resistance.
b) The upper stationary contact assembly shall be provided with a safety latch to prevent the fuse carrier from dropping due to vibration and the upper contacts shall be protected from any airborne contaminants.
c) A back up spring made out of stainless steel or phosphor bronze shall be provided to ensure constant pressure between the upper stationary contact and the upper movable contact of the fuse carrier.
d) The lower stationary contact support and the fuse carrier shall be machined at the swiveling or axle point to enable the fuse carrier with the fuse link to be correctly guided into the latching position by an operating rod. The hinge at the stationary contact shall be so designed to prevent the dropping off of the fuse carrier in the drop-out position,

due to shock and vibration.
e) A suitable guiding arrangement shall be provided in the upper contact to ensure easy engagement of the fuse carrier.
f) The Asymmetrical breaking current ratings shall be permanently marked on the upper metal part.

10.11.6.4 Terminals

a) The upper and lower terminals shall be of Bi-metallic type, suitable to accommodate Copper/Aluminum Conductors of Sizes from 5mm to 14mm diameter.
b) The upper terminal shall be positioned to receive the conductor from either side or upward direction while the lower terminal shall be able to receive the conductor from either side or downward direction.
c) The maximum temperature rise for contacts (movable and stationary) shall not be more than 40°.C and, for terminals the temperature rise shall not be more than 30° C.

10.11.6.5 Galvanizing

All iron and steel parts such as mounting and support brackets, bolts and nuts, washers etc. shall be galvanized after processes such as sawing, shearing, drilling, punching, filling, bending and machining are completed. Galvanizing shall be the hot-dip process to comply with the standard ISO 1461.

10.11.7 Additional Requirements

10.11.7.1 Rating Plate Markings

The ratings and data of the Dropout Fuse shall be provided in the rating plate, which shall be weather and corrosion proof. The main rating plate near the supporting bracket of the insulator base shall carry the following information:
a) Number and year of the Standard adopted
b) Rated voltage/Rated maximum current
c) Class designation/Manufacturer's name or trademark,
d) Asymmetrical current rating/Symmetrical current rating/X/R Ratio.
e) Year of manufacture
f) Contract No.

The following information shall be marked on the fuse carrier.
a) Manufacturer's name or trademark
b) Rated Voltage/Rated frequency
c) Rated maximum current
d) Rated breaking capacity (Asymmetrical/Symmetrical current rating & X/R Ratio).

10.11.7.2 Packing

The pre-assembled dropout fuse unit (Dropout Fuse Base, Fuse Carrier and Mounting Bracket) shall be packed in a suitable hardboard box and the rated voltage of the unit shall be clearly marked on the box. Spare fuse carrier shall be supplied in suitable hardboard boxes, the quantity and the voltage rating applicable shall be clearly marked on the boxes.

10.11.8 Inspection And Testing

10.11.8.1 Acceptance Test

The successful Bidder shall make necessary arrangements for pre-shipment inspection and tests by the nominated NEA Inspectors to carry out in his presence the necessary Sample/Acceptance tests conforming to the relevant IEC on equipment and materials offered. Routine test report for all the items shall be furnished for the observation of the Inspector.

The acceptance tests as per IEC shall be witnessed by the NEA Inspector.

(a) Dimensional Verification
(b) Dielectric tests
(c) Mechanical Tests
(d) Measurement of resistance of fuse-links

10.11.9 Bid Documentation

10.11.9.1 The following shall be furnished with the offer.

(a) Product Catalogues/Technical literature describing the constructional features, materials used for components, operational feature of the equipment, indicating the model number etc.
(b) Energy withstand capability & a description of the test carried out to measure the same.
(c) Power frequency withstand voltage versus time characteristic curve covering the time range from 0.1 sec. to 24 minutes.
(d) Dimensional drawings of the bracket mounting base, live conductor clamps, earth lead and automatic earth disconnecting device and overall dimensional drawing.
(e) Drawing of name plate to scale incorporating the particulars called for.
(f) Completed Schedule of Guaranteed Technical Particulars
(g) A copy of the Manufacturer's ISO 9001 Certificate conforming to design and manufacture

(h) Type Test Certificates. The Type Test Certificates shall be from an Accredited Independent Testing Authority acceptable to the Purchaser.
(i) Copy of the Governing Standards
(j) Technical Literature in English Language on installation, operation and maintenance with necessary circuit diagrams and drawings.

10.11.9.2 Type Test Certificates

Following Type Test certificates conforming to IEC 60282-2, IEC 60060 at a reference frequency of 50 Hz. where applicable shall also be submitted with the offer.

a) Dielectric Tests
b) Temperature Rise Tests
c) Artificial Pollution Tests
d) Mechanical Tests
e) Breaking Tests
f) Interrupting Tests
g) Beam Strength of Porcelain Base

Test Certificates shall clearly identify the equipment concerned showing the manufacturer's identity, Type, Model and Serial Number of the equipment tested. Type Test Report shall include complete drawings and the model/type of the offered Arrester. Type Test Report shall be from a recognized accredited independent testing authority acceptable to the purchaser.

10.12 Fuse Link

10.12.1 Scope

This Specification covers the supply of button head fuse links commonly used in the protection of distribution transformers with the Distribution Cutouts above.

10.12.2 Description

The button-head fuse link shall be fabricated in full compliance with the relevant IEC, or latest revision thereof or any other international standards that ensures at least a substantially equal quality to the standard mentioned above, will also be acceptable.

The fuse link shall have fast characteristics and shall be suitable for protection of distribution transformers. The fuse link shall be supplied in accordance with the type and ratings shown in the bid package.

10.12.3 Tests

The distribution cutout and surge arrester shall be tested in accordance with the relevant provisions of the governing standard.

10.12.4 Bid Documentation

The Bidder shall furnish copies of governing standards for fabrication and testing of fuse links
The Bidder shall furnish copies of catalogue of fuse links.
The Bidder shall furnish a clause-by-clause commentary on specification, specifying compliance and deviations, if any.
The Bidder shall also furnish with the Bid copies of the following data with respect to the fuse links furnished:

a) Time-Current (TC) characteristic curves at 30°C, including minimum melting time and total clearing time.
b) Preloading adjustment factors or curves.
c) Ambient temperature adjustment factors or curve

All data, drawings, catalogues and other technical documents shall be bound separately from the Bid documents

10.13 Distribution Panel Board

10.13.1 Scope

This Specification covers the design, fabrication, testing and supply of Distribution Panel Boards to be used in the Low Voltage Overhead Distribution system of the Nepal Electricity Authority (NEA) to provide overload and short circuit protection for Distribution lines up to Customer Distribution Panel.

10.13.2 Description

The panel board shall be pole-mounted and used in conjunction with pole-mounted distribution transformers to house moulded case circuit breaker (MCCB) feeding 400/230 Volt circuits.

The panel board shall be rectangular in shape with an entrance door in the front of the panel board. The panel board shall be equipped with interior standoffs suitable for mounting MCCB and for supporting cables. The panel board will be fixed to the pole by exterior mounting brackets attached to the back of the panel board. Details of these components shall be as specified in the following text.

The panel board shall be fabricated to prevent ingress of moisture due to rainfall and dripping. The panel board shall be provided with means for natural ventilation.

10.13.2.1 Material

The panel board case and door shall be fabricated out of steel sheet of minimum 2 mm. in thickness and pole mounting brackets shall be fabricated out of mild steel flat of 6 mm. in thickness. The interior standoffs shall be fabricated of steel sheet of sufficient thickness to support installed circuit breaker and cables without lateral movements.

10.13.2.2 Construction

The panel board case and all interior and exterior attachment shall be spot-welded. All welding shall be of the highest quality. The panel boards shall be formed and welded square and all attachments to the interior and exterior surfaces shall be welded square and perpendicular to the panel attached.

The panel board shall be so constructed as to be water tight from blowing of free-falling rain. There shall be no apertures in the panel board case other than those provided for the entrance door, cable fittings, or ventilation. The top extension and bottom shall be so formed to provide a drip edge and prevent water from flowing on the respective under-surfaces.

All individual pieces of metal shall be edge finished prior to assembly to provide surfaces and edges which are free from sharp points and edges. After welding in place, all welds shall be finished to smooth condition.

10.13.2.3 Panel board Front

The front panel shall be fabricated as a separate piece containing the panel board door and doorframe. The front shall be attached to the panel board housing by suitable bolting arrangements to provide a watertight and dust tight seal at the perimeter.

The door shall be equipped with a gasketed removable door, door-handle lock, and suitable hinges. The door and panel frame shall be so fabricated to provide an integrated structure which is warp-resistant and which will maintain dust-tight and watertight seal. Gasketing material shall be heat-resistant and shall retain its resilience over time to precluded degradation of dust-tight and watertight properties.

The insertable (and removable) door handle shall provide a door a locking function. The handle shall be insulated.

The door hinge may be continuous type or separate hinge units. However, the type of hinge furnished must accommodate, and not degrade, the dust-tight and watertight characteristics and must provide adequate door alignment and support over time.

10.13.2.4 MCCB Standoffs

The standoffs shall be shaped and dimensioned to accommodate the MCCBs as required by Bid Packages. The standoffs shall be precisely located.

10.13.2.5 Cable Standoffs

The cable standoffs shall be properly shaped and dimensioned. The standoff shall have the metal edges contoured and smoothed to prevent abrasion of applied cable serving. The standoff shall be located within the panel board to make allowance for cable bending radii and the location of other components.

10.13.2.6 Bus bars

The neutral and phase bus bars shall consist of copper bus bar insulated from the panel board by 600 V porcelain insulators. The copper bus bar shall be of proper size (ampere capacity) and properly dimensioned. The bus bars shall be located within the panel board to provide adequate clearance for the installation and correct functioning of all items.

If it is required to drill or penetrate the panel board back to install 600 V insulators, the outside of the panel board shall be permanently sealed over the attachment to retain water-tightness.

10.13.2.7 Cable Entrance Fittings and Knockouts

Knockouts for cable entrance fittings (bushings) shall be provided in the bottom of the panel board. All necessary cable entrance fittings shall be supplied for proper connection of all circuits to fulfil the requirement of the Bid Package. The fittings shall be designed to be suitable for exposed cables entering the panel board from below and shall secure the cable with inserts to prevent lateral and longitudinal movement of the cables.

The fittings shall be threaded multi-piece construction which when installed securely locks the fittings to the panel board. The fittings may be of metal or polymer material. Metal fittings shall be galvanized or plated as appropriate. The fitting inserts may be single or multi pieces and shall be of material sufficiently elastic and resilient to securely grip the PVC cable sheath without damage. The fitting components shall enable capturing of the inserts to preclude insert creep and fallout due to clamping pressure.

10.13.2.8 Ventilation

The panel board shall be provided with apertures for natural draft ventilation in the panel board bottom and in the top overhang. The ventilation apertures shall be covered with bronze screen materials of a mesh sufficiently to preclude passage of small insects. The edges of the bronze screening shall be surely fastened to the panel board by means of soldering or epoxy adhesive. The mesh shall be protected during panel board fittings to preclude clogging of mesh openings by finished materials.

10.13.2.9 Pole Mounting Bracket

The panel board shall be provided with two (2) pole mounting brackets. The size of poles will be confirmed by the purchaser before manufacturing.

10.13.2.10 Grounding Stud

The panel board shall be provided with a brass grounding stud located in an approved location. The grounding stud shall be fitted to the panel board to insure low resistivity and water tightness of the installation. The grounding stud shall be complete with pressure washer, lock washer, and nuts.

10.13.2.11 Finish

After fabrication, the panel board shall be thoroughly cleaned of all dirt, grease, mill scale, and weld slag on all interior and exterior surfaces and all surfaces of all component. After thorough cleaning of panel board one (1) coat of red oxide metal priming paint and two (2) finish coats of paint color shall be thoroughly applied. The paint color shall be of light grey (RAL 7032). The finish coats shall be of oil based or epoxy paint. Alternatively, powder coating of panel board may also be acceptable.

The bronzed screen ventilation holes, working surfaces of door hinge and door lock, and outside face of grounding stud shall be free from all finishing materials.

10.13.3 Bid Documentation

The following shall be furnished with the offer.

(a) The Bidder shall furnish fabrication drawings showing all views, section, and dimensions of individual components and assembled panel board.
(b) The Bidder shall furnish complete description of all materials to be used, including cable entrance fittings and finishing materials.
(c) The Bidder shall furnish a clause-by-clause commentary on specification, specifying compliance and deviations, if any.
(d) All data, drawings, catalogues and other technical documents shall be bound separately from the Bid documents.
(e) Completed Schedule of Guaranteed Technical Particulars
(f) A copy of the Manufacturer's ISO 9001 Certificate conforming to design and manufacture
(g) Technical Literature in English Language on installation, operation and maintenance with necessary circuit diagrams and drawings.

10.14 Moulded-Case Circuit Breakers (MCCB)

10.14.1 Scope

This specification covers the design, manufacture and testing of Moulded Case Circuit Breakers (MCCB) used with Distribution Panel Board in the Low Voltage Overhead Distribution system of the Nepal Electricity Authority (NEA) to provide overload and short circuit protection for Distribution lines up to Customer Distribution Panel

10.14.2 System Parameters

a)	Nominal Voltage	400/230V, 3 Phase and Neutral
b)	System Highest Voltage	440/250V, 3 Phase and Neutral
c)	System frequency	50Hz
d)	Method of Earthing	Solidly earthed neutral
e)	System fault current	25kA

10.14.3 Service Condition

a)	Ambient temperature	-5 to 55 deg. C
b)	Annual average ambient temperature	30 deg. C
c)	Maximum relative humidity	99%
d)	Environmental condition	Humid Tropical climate
e)	Operational altitude	Up to 3000m above msl
f)	Isokeraunic (Thunder day) level	90 days

g)	Solar Radiation	1.6kW/m2

10.14.4 Applicable Standards

The equipment and components supplied shall be in accordance with the latest editions of the standards IEC 60947 and amendments thereof and the NEA Specifications specified hereafter.

10.14.5 Technical Parameters

10.14.5.1 Minimum Technical Requirements

S.N.	Description	Unit	Requirements
1	No. of Poles		3
2	Rated frequency	Hz	50
3	Rated operational voltage (Ue)	V	400/230
4	Rated insulation voltage (Ui)	V	750
5	Impulse withstand voltage (Uimp)	kV	8
6	Continuous Current Rating (In)	A	80, 160, 250, 320, 500
7	Ultimate Short Circuit Breaking Capacity (Icu) (up to 100 A)	kA	25
8	Ultimate Short Circuit Breaking Capacity (Icu) (above 100 A)	kA	50
9	Operating Short Circuit Breaking Capacity (Ics)		50 % of Icu
10	Utilization Category		A
11	Rated duty		uninterrupted
12	Trip device		Thermal adjustable magnetic
13	Rated current adjustment		(0.8-1)In
14	Instant opening current adjustment		10 x In
15	Mechanical Life Operation		>15000
16	Electrical Life Operation		>10000
17	Line load reversibility features		Yes
18	Interrupting Capability		(IEC category P2)
19	Thermal Rating declared at 50 deg C		Yes
20	Operating Range		-5 to 55 deg. C
21	Creepage distance suitable for		Pollution Degree 3 and suitable for isolation
22	Suitable for isolation		Yes
23	Trip Characteristics		inverse time and instantaneous
24	Universal Accessory Fitting		Yes
25	External Accessory		Rotary Operating Handle (Extended for >200A) Suitable Extended Terminals Phase Barriers Mounting Screws

10.15 Steel Tubular Pole

10.15.1 Scope

This Specification covers the design, fabrication, testing and supply of swaged type galvanized steel tubular poles to be used to support overhead electric lines and equipment.

10.15.2 Description

10.15.2.1 The steel tubular pole shall be manufactured and tested in accordance with IS:2713. The poles shall be fabricated of seamless tubes of suitable lengths as specified in **Table 1** made out of welded tubes, swaged and joined

together. The diameters of various sections of the fabricated pole shall be as specified therein. A bid not conforming to the requirements of **Table 1** shall be rejected as being non responsive.

10.15.2.2 There are some numbers of poles which shall be of folding type. The folding type poles shall be fabricated in such a way that the bottom section and middle section of the poles could be securely fixed by two sets of galvanized nuts/bolts of suitable size and length at 90^0 each other. All other design requirements and parameters for folding type poles shall be as per section above and IS:2713.

10.15.2.3 The separate galvanized steel pole cap shall be provided with top section of the pole. The bottom section of the pole shall be provided with a base plate. The base plate shall be square of size 300x300 mm and 10 mm thick and it shall be welded at the bottom of the pole. The base plate shall have a hole of dia. approx. 50 mm in the center, for draining out of water.

10.15.2.4 The total supply quantity of steel tubular poles (total of non-folding type and folding type) are given in the Price Schedule. Supply quantity of folding type poles shall be finalized after pre- construction survey.

10.15.3 Material

3.1 The poles shall be fabricated from steel having tensile strength not less than 410 N/mm^2. The pole shall be composed of three sections in diminishing diameters and minimum diameter and thickness and lengths of poles shall be as shown in **Table below.**

3.2 The steel tubes shall confirm to the requirements of IS:2713, or latest revision thereof or other recognized international standards that ensures at least a substantially equal quality to the standard mentioned above.

4. **Manufacture**

4.1 All tubes forming the part of the pole shall be made from hot finished seamless or continuously welded steel in accordance with IS 2713, or equivalent international standards. Following tolerances shall be maintained.

a) Tolerance on outside diameter: +/- 1%

b) Tolerance on length: +/- 40mm on any section

+/-25mm on overall length c) Tolerance on weight: No negative tolerance

d) Tolerance on thickness: No negative tolerance

e) The out-of-straightness of the finished pole shall not exceed 1/600 of its length.

4.2 All welding of the poles shall be carried out at the manufacturers' plant.

4.3 Each section of the pole shall have only one longitudinal weld. No circumferential joints/welds of the tubes are permitted. All welds shall be capable of withstanding, without failure or cracking the stresses in a pole when subjected to its ultimate design loads.

4.4 The pole shall have hole configurations and sizes as shown in the drawings attached to this specification. The hole sizes and the locations of the hole must however be confirmed with the Project prior to manufacture.

5. **Corrosion Protection**

5.1 All sections of the pole shall be galvanized both internally and externally. Galvanizing shall be applied by the hot dip process, and shall be done in single bath (single dip) to result in a uniform thickness both internally and externally. Galvanizing of the poles shall be done after completion of fabrication process. Drilling, punching, cutting, bending and removal of burrs shall be completed before galvanizing. The preparation for galvanizing and the galvanizing process shall not adversely affect the mechanical properties of the material being coated. All galvanizing shall be in accordance with ISO 1461 or IS:4736 or an equivalent international standard, and shall result in uniform thickness galvanization and be free from defects. The pole cap and the base plate shall also be galvanized.

5.2 The minimum thickness of the zinc coating shall not be less than 500 g/m^2 (equivalent to 70 microns) of zinc for all surfaces of steel including the base plate and the pole cover.

6. **Marking of Pole**

6.1 The pole shall have an identification marked with indelible paint on the pole at a position approximately 3.5 m. from the butt end, which is clearly and indelibly marked with:

a) Date of manufacture and identification mark of manufacture.

b) Length of pole in meters and its design working loads as defined in this specification. c) Name of the Employer

d) Contract Number.

6.2 The pole shall be marked with a permanent horizontal line at a point 1/6th of the pole height from the butt end of the assembled pole.

7. Earthing Lug, Base Plate and Pole Cap

Each pole shall be provided with earthing lug at 300 mm above the ground level. Separate pole cap shall be provided for each pole. The plate for pole cap shall be of 3 mm. minimum thickness.

8. Tests

8.1 The following test(s) shall be performed on finished poles. All testing shall be fully documented and certified test reports shall be provided to the Project.

- Test for dimensional and structural properties, and for the physical requirements of the finished poles
- Test for galvanization
- Tensile test and chemical analysis test

- Deflection test
- Permanent set test, and
- Drop test.

8.2 Poles selected for tests shall be a representative sample from each lot. The number of poles selected for conducting deflection, permanent set and drop tests shall be as follows.

S.N.	Lot size	No. of poles
1.	Up to 500	5
2.	501-1000	8
3.	1001-2000	13
4.	2001-3000	18
5.	3001 and above	20

8.3 The number of poles selected for conducting tensile test and chemical analysis tests shall be as follows:

S.N.	Lot size	No. of poles
1.	Up to 500	1
2.	501-1000	2
3.	1001-2000	3
4.	2001-3000	4
5.	3001 and above	5

8.4 The above test shall be performed as per IS:2713 or other recognized international standards. The following particulars shall be recorded:

a) Manufacturer's name and plant location;
b) Batch No. of steel plate or tubing;
c) Test date;
d) Pole type;
e) Dimensions of pole;
f) Increments of load and the deflections at each increment of load;
g) Permanent deflection;
h) Load of failure;

For deflection test, each pole shall be rigidly supported for a distance from the butt end equal to the length the depth to which it to be planted in the ground. It shall then be loaded as cantilever and the appropriate deflection load applied at right angle of the axis of pole 300 mm from the top of the poles for poles up to 9m length and 600 mm for poles over 9m length. The temporary deflection at the point of application of the applied load shall not exceed 157.5 mm

8.6 The permanent set test shall be carried out immediately after the deflection test, on the same test sample. After application of the proper load, the permanent set measured from the zero position at the point of application of load after the release of the applied load shall not exceed 13 mm.

8.7 To perform the drop test, the pole shall be dropped vertically with the bud end downward, three times in succession from a height of 2 m onto a hardwood block 150 mm thick laid on a concrete foundation. The pole shall not show any signs of telescoping or loosening of joints.

8.8 Should any of the poles first selected fail to pass any of the tests specified above, two further poles shall be selected for testing from the same batch i.e. same pole length manufactured on the same day from the same steel plate or tubing in respect of each failure. Should one or both these additional poles fail, the test material represented by the test samples shall be deemed as not complying with this specification.

9. Quality Assurance Program

9.1 Along with the Bid the Bidder shall furnish quality assurance program of the manufacturer which includes the Quality System and the Quality Plans, which shall include, among others, information to meet the following requirement, failing which the Bid shall be liable for rejection.

i. The structure of the organization;
ii. The duties and responsibilities assigned to staff ensuring quality of works;
iv. The system for purchasing, taking delivery and verification of materials;
v. The system for ensuring quality of workmanship;
vi. The quality assurance arrangement shall conform to relevant requirements of ISO9000;
vi. Statement giving list of important raw materials, names of manufacturer for the raw materials, list of standards according to which the raw materials are tested, list of test normally carried out on raw materials;
vii. List of manufacturing facilities available;
viii. List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections;
ix. List of testing equipment available with the manufacturer for final testing of equipment specified and the test plant limitation, if any, vis-à-vis the type, special, acceptance and routine tests specified in the relevant standards.

9.2 The manufacturer shall perform, among others, the following inspections/test on each consignment of raw steel, prior to fabrication. A certificate shall be provided to the Employer showing the test results:

i. Visual, dimensional and mechanical tests, to identify the steel meets the required strength/grade ensure

compliance with the relevant Standards, and to ensure the absence of rust and surface imperfections. If the steel does meet the strength or grade required, the batch shall be rejected.

ii. Dimensional tests to ensure that the material is within the production tolerances of IS 2713 or BS 4360 and BS 6323 or equivalent Standards. One sample shall be taken from each batch for which a certificate is provided. If the first sample fails the test, a second sample shall be taken. If the second sample fails the test, the batch shall be rejected.

10. Packing

Poles shall be stacked together and banded securely to ensure that each individual bundle does not break or the shifting of individual poles does not take place during transportation and handling. Any loose items shall be suitably banded together or packed to avoid loss during transportation and storage.

11. Bid Documentation

11.1 The Bidder shall provide with the Bid copies of the governing standards for selection of tubing, fabrication and testing of Steel Tubular Poles and copies of all other relevant standards referenced therein.

11.2 The Bidder shall provide a complete design, description and certified dimensional drawings of each type of pole.

11.3 A clause-by-clause commentary on specification, specifying compliance and deviations, if any.

11.4 All data, drawings, catalogues and other technical documents shall be bound separately from the Bid documents.

Table 1: Pole Attributes

S.N.	Description	Unit	Value	
			For 11m Pole	For 9m Pole
1	Overall Length	m	11	9
2	Pole Designation		410 SP-52	410 SP-31
3	Section Length			
3.1	Top (h1)	m	2.7	2.0
3.2	Middle (h2)	m	2.7	2.0
3.3	Bottom (h3)	m	5.6	5.0
4	Outside Diameter			
4.1	Top (h1)	mm	114.3	114.3
4.2	Middle (h2)	mm	139.7	139.7
4.3	Bottom (h3)	mm	165.1	165.1
5	Thickness			
5.1	Top (h1)	mm	3.65	3.65
5.2	Middle (h2)	mm	4.50	4.50
5.3	Bottom (h3)	mm	4.50	4.50
6	Crippling Load	kgf	307	367
7	Approximate Weight (excluding the weight of galvanization, base plate and pole cap)	kg	175	147
8	Application of load from top of pole	m	0.6	0.3
9	Planting Depth	m	1.8	1.5

10.16 Pre-Stressed Concrete (PSC) Pole

10.16.1 Scope

These specifications apply to design, manufacture, and testing of rectangular pre-stressed concrete poles for use in electrical distribution.

10.16.2 Description

The pre-stressed concrete pole shall be designed and fabricated in full compliance with IS:1678-1978, or latest revision thereof or any other national or international standards that ensures at least equal or better quality to the standard mentioned above, will also be acceptable.

10.16.3 Load

The working loads of various pole categories are as per the design parameters. The design ultimate strength shall be calculated using a safety factor of 2.5. Pole Attributes are listed in the design parameters.

10.16.4 Materials

10.16.4.1 **Cement**

Cement to be used in the manufacture of pre-stressed concrete poles shall be ordinary for rapid hardening Portland cement confirming to IS: 269-1976 (Specification for ordinary and low heat Portland cement) or IS: 8041 E-1978 (Specification for rapid hardening Portland cement).

10.16.4.2 **Aggregates**

Aggregates to be used for the manufacture of pre-stressed concrete poles shall confirm to IS:383 (Specification for coarse and fine aggregates from natural sources for concrete) The nominal maximum sizes of aggregates shall in no case exceed 12 mm.

10.16.4.3 **Water**

Water should be free from chlorides, sulphates, other salts and organic matter. Potable water will be generally suitable.

10.16.4.4 **Admixture**

Admixture should not contain Calcium Chloride or other chlorides and salts which are likely to promote corrosion of pre-stressing steel. The admixture shall conform to IS: 9103.

10.16.4.5 **Pre-stressing Steel**

The pre-stressing steel wires should confirm to the IS 1785 OR IS 6003. The plain wire should be of 4 mm in diameter with a guaranteed ultimate strength of 175 kg/mm^2. The strands shall be made from cold-drawn non-alloy steel (high carbon content) wires. The seven-wire strand consists of a group of wires arranged in stranded formation and shall have the following properties. The seven-wire strands shall confirm to IS:6006-1983, or latest revision thereof or any other equivalent national or international standards.

Geometrical Properties:

Type of material:	Seven-wire strand
Nominal diameter of strand	7.9 mm (7/2.6mm)
Nominal cross-sectional area of strands	37.4 mm^2

Mechanical Properties:

Nominal mass of strand:	64.50kN
Minimum breaking load:	294 g/m
0.2% proof load	54.70 kN

Long Term Behavior:

Maximum relaxation after 1000 h of operation at initial load equivalent to 60%, 70% and 80% of breaking load shall not be higher than 1.0%, 2.5% and 4.5% respectively.

10.16.4.6 **Concrete Mix**

Concrete mix shall be designed to the requirements laid down for controlled concrete (also called design mix concrete) in IS: 1343-1980 (Code of practice for pre-stressed concrete) and IS: 456 – 1978 (Code of practice for plain and reinforced concrete).

10.16.5 Design

10.16.5.1 The poles shall be as per following design parameters and the dimensions shall be shown in Drawing.

Design Parameters:

Concrete mix:	M40
Minimum diameter of pre-stressing wire:	Refer Table 2
Working Load:	Refer Table 1
Depth of Plantation:	Refer Table 2
Point of Application of Load	Refer Table 2

10.16.5.2 The minimum strength of concrete in the pole shall meet the requirements laid down in IS:1343-1960 and IS:456-1964 or in any other equivalent national or international standards.

10.16.5.3 The pre-stressing strands shall be accurately positioned and satisfactorily protected against the formation of rust or other corrosion prior to the placement of the concrete. All pre-stressing strands shall be free from loose rust, dirt, grease, oil and other lubricants or substance that might impair their bond with the concrete.

10.16.5.4 The cement employed shall be the Ordinary Portland Cement (OPC), which shall conform to the chemical and physical requirements as set forth in IS 269, or any other equivalent national or international standards.

10.16.5.5 The amount of concrete cover on the outside of the pre-stressed reinforcement shall be not less than 20 mm.

10.16.5.6 Concrete shall be compacted by spinning, vibrating, shocking or other suitable mechanical means. Hand compacting shall not be permitted.

10.16.5.7 The concrete shall be covered with a layer of sacking, canvass, Hessian or similar absorbent material

and kept constantly wet up to the time when the strength of concrete is at least equal to the minimum strength of concrete at transfer of pre-stress. Thereafter, the pole may be removed from the mould and watered at intervals to prevent surface cracking of the unit the interval should depend on the atmospheric humidity and temperature. The pre-stressing wires shall be detentioned only after the concrete has attained the specified strength at transfer (i.e. 200 or 210 kg/cm² as applicable). The cubes cast for the purpose of determining the strength at transfer should be coursed, a sear as possible, under condition similar to those under which the poles are cured. The transfer stage shall be determined based on the daily tests carried out on concrete cubes till the specified strength indicated above is reached. Thereafter the test on concrete shall be carried out as detailed in IS: 1343(code of practice for pre-stressed concrete). The manufacture shall supply, when required by the owner or his representative, result of compressive test conducted in accordance with IS: 456 (Code of practice for plain and reinforced concrete) on concrete cubes made from the concrete used for the poles. If the manufacture so desired, the manufacture shall supply cubes for test purpose and such cubes shall be tested in accordance with IS: 456 (Code of practice for plain and reinforced concrete).

10.16.5.8 The pole shall include cast-in holes. Typical hole patterns are shown in the drawings. Hole patterns must be confirmed with the NEA prior to manufacture.

10.16.5.9 All poles shall be unpolished but free of roughness, chips, excess cements, and other surface irregularities. All poles shall present a straight and symmetrical appearance after erection. The corners of all the poles shall be rounded so that they do not present a dangerously sharp edge, which could cause tearing or excessive wearing of safety belts.

10.16.5.10 All poles shall be provided with lifting hooks at two points for loading and unloading of poles.

Table 1

Working Load

S.N.	Pole Length (m)	Design Load (kgf)
1	11	350
2	9	200

Table 2

Pole Attributes

S.N.	Description	Unit	9m PSC Pole	11m PSC Pole
1	Standard		IS 1678	IS 1678
2	Length of PSC Pole	m	9	11
3	Size	mm	300*150*140	400*180*150
4	Approximate Weight	kg	680	1150
5	Working Load	kgf	200	350
6	Ultimate Load	kgf	500	875
7	Concrete Grade		M40	M40
8	Pre-stressing Wire			
8.1	Diameter	mm	7.9 mm (7/2.6mm)	7.9 mm (7/2.6mm)
8.2	Standard		IS 1785	IS 1785
9	Factor of Safety		2.5	2.5
10	No of tensioned wire		6	8
11	No of stirrups (6mm MS)		12	12
12	Depth of Plantation	m	1.5	1.8

13	Point of Application of load from pole top	m	0.6	0.6

10.16.6 Tests

Definition of various types of loads:

Working load = Expected Load

Design Working Load = Expected Load x Factor of Safety (FOS)

Ultimate Transverse Load (UTL) = Load when applied at specified point of the pole, the failure occurs.

Minimum Ultimate Transverse Load (MUTL) = Load when applied at specified point of the pole, the first crack appears.

Design Transverse Load (DTL) = Design Working Load

Design Ultimate Transverse Load (DUTL) = Design load at the transverse direction at which the first crack expected to appear (given by the Designer after calculation)

The **Design Ultimate Transverse Load (DUTL)** is less or equal to Ultimate Transverse Load

10.16.6.1 Transverse Strength Test

The pole shall be rigidly supported at the butt end for a distance equal to the specified planting depth. The load shall be applied at a point specified in Table 2 from the top of the pole and shall be steadily and gradually increased to the design transverse load until the occurrence of the first crack. The deflection is then measured. Prior to the application of the design transverse load there shall be no crack.

The load shall then be reduced to zero and increased gradually to a load equal to the first crack load plus 10% of the minimum ultimate transverse load, and held for 2 minutes. This procedure shall be repeated until the load reaches the value of 80% of the minimum ultimate transverse load and thereafter increased by 5% of the minimum ultimate transverse load until failure. Each time the load is applied, it shall be held for 2 minutes. The ultimate transverse load shall not be less than the design ultimate transverse load.

10.16.6.2 Measurement of Cover

The cover shall be measured at 3 points, one within 1.8m from the butt end of the pole, second within 0.6m from the top and the third at the intermediate point. The mean value of the measured cover should not differ by more than +/-1mm from the specified value, and the individual value should not differ by more than+/-3mm from the specified value.

10.16.6.3 The number of poles selected for testing and their conformity criteria shall be as follows:

Lot Size	**Sample Size**	**Permissible No. of Defective Samples**	**No. of Poles for Transverse Strength Test**
Up to 100	10	1	2
101 to 200	15	1	3
201 to 300	20	2	4
301 to 500	25	3	5

10.16.6.4 All the poles selected in 5.3 shall be tested for overall length, cross-section and up-rightness. The tolerance shall be +/-15mm on overall length, +/-3mm on cross-sectional dimensions, and 0.5% on uprightness.

10.16.6.5 The number of poles which do not satisfy the requirements of overall strength, cross-section and uprightness shall not exceed the number given in 5.3. If the number of such poles exceeds the corresponding number, all poles in the lot shall be tested for requirements, and those not satisfying the requirements shall be rejected.

10.16.6.6 All the poles tested for transverse strength test shall satisfy the requirements of the test. If one or more poles fail, twice the number of poles originally tested shall be selected from those already selected and subjected

to test. If there is no failure among these poles, the lot shall be considered to have satisfied the requirements of the test.

10.16.7 Marking

The poles shall be cleanly and indelibly marked with the following:

a) Month and year of manufacture, at approximately 3m from the butt end;
b) Specified working load in kg, at approximately 3m from the butt end; and
c) The design lifting point.
d) The pole should be marked with the Identification of the Project/Contract at approximately 5m from the butt end.

10.16.8 Bid Documentation

10.16.8.1 The Bidder shall furnish following documents together with Bid;

a. Two (2) clear copies of the standards, governing fabrication and testing of pre-stressed concrete poles and two (2) clear copies of other standards indicated in the specifications.
b. Two (2) clear copies of detailed design and drawings of each type of pole.
c. Two (2) clear certified copies of all tests performed on similar poles of same sizes and similar working loads.
d. A clause-by-clause commentary on specification, specifying compliance and deviations, if any.

10.16.8.2 The Bidder shall provide the following details:

a) Pole dimensions in cross-section and pole taper;
b) Location and size of pre-stressing strands;
c) Hole locations;
d) Design ground line;
e) Marking of the lifting point;
g) Minimum ultimate transverse load;
h) Transverse load at first crack
i) Concrete design mix and cement specification
j) Specifications of the pre-stressing strands, their tensile strength and sizes

10.17 Porcelain Insulators and Fittings

10.17.1 Scope

This Specification covers the Type Test, fabrication and supply of pin insulators, disc insulators stay insulators, disc insulator fittings and insulator pins as herein specified for use on overhead power line construction.

10.17.2 General

10.17.2.1 General Requirements of Insulators

Insulators shall be fabricated and tested in accordance with the Standards referenced for each type of insulator or equivalent standards.
The Type Test shall be conducted in the recognized laboratory.
Porcelain shall be sound, free from defects, thoroughly vitrified and smoothly glazed. The glaze shall be brown in color. The glaze shall cover all exposed parts of the insulators.
The design of insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. The porcelain shall not engage directly with hard metal.
The cement used in construction of insulators shall not give rise to chemical reaction with metal fittings and its thickness shall be as uniform as possible.
The insulators should be manufactured in automatic temperature-controlled kilns to obtain uniform baking and better electrical and mechanical properties.
The preferred make of disc, pin and stay insulators and fittings are Allied Ceramics Pvt. Ltd., BHEL, Aditya Birla Insulators Ltd., Hindustan Chemicals Ltd. or equivalent reputed.

10.17.2.2 General Requirements of Disc Insulators fittings

The disc insulator fittings shall be designed, manufactured and tested in accordance with IS:
2486 or any other national or international standards that ensures at least equal or better quality to the standard mentioned above, will also be acceptable.

The disc insulator fittings shall be supplied with ball and socket couplings and twisted straps. The insulator fittings shall conform to the shape and dimension as per the governing standards

Disc insulator fittings like ball and socket, nuts and bolts shall be made of hot rolled steel and the twisted cross arm strap shall be made of MS sheet metal. Cotter bolts and U-bolts shall be of galvanized steel. Cotter pins shall be of stainless steel.

All forgings and castings shall be of good finish and free from flaws and other defects. The edges on the outside of fittings, such as the ball socket and holes, shall be rounded. The nominal dimensions of the ball and socket, ball eye and twisted cross arm straps, shall be as per the governing standards.

All ferrous fittings and the parts other than those of stainless steel, shall be hot dip galvanized as per IS: 2629 or equivalent international standards.

10.17.2.3 General Requirements of Insulator Pins

The insulator pins specified herein shall be fabricated from hot rolled steel. The pin shall be a single piece obtained preferably by the process of forging. It shall not be made by jointing, welding, shrink fitting or any other processes from more than one piece of material. It shall be of good finish free from flaws and other defects. The finish of the collar shall be such that a sharp angle between the collar and the shank is avoided.

All ferrous pins, nuts and washers except those made of stainless steel shall be hot dip galvanized. The threads of nuts shall be cut after galvanizing and shall be well oiled and greased. The galvanizing shall conform to IS 2629-1985 or equivalent national or international standard.

All insulator pins shall be reasonably smooth on all surfaces and free of sharp projections.

10.17.3 Specific Requirements

10.17.3.1. Pin Insulator

The pin insulator shall be manufactured and tested in accordance with IS: 731 and IS:3188 or the latest version thereof or any other national or international standards that ensures at least equal or better quality to the standard mentioned above, will also be acceptable. The lead thread shall be compatible with the insulator pin specified in these documents.

The pin insulator shall have following ratings and features:

S.N.	Description	Unit	11 kV pin insulator
1	Highest system voltage	kV	12
2	Rated voltage	kV	11
3	Creepage distance (minimum)	mm	265
4	Wet power frequency withstand voltage	kV	35
5	Impulse withstand voltage	kV	75
6	Puncture power frequency voltage (minimum)	kV	105
7	Visible discharge voltage (Effective)	kV	9
8	Cantilever strength	kN	5
9	GI pin head		Small

10.17.3.2 Disc Insulator

The disc insulator shall be manufactured and tested in accordance with IS: 731 or latest version thereof or any other national or international standards that ensures at least equal or better quality to the standard mentioned above, will also be acceptable.

The disc insulator shall be ball and socket fitting type. The disc insulator shall have the following ratings and features:

S.N.	Description	Unit	Value
1	Highest system Voltage	kV	12
2	Rated Voltage	kV	11
3	Porcelain Diameter (minimum)	mm	255
4	Spacing	mm	145
5	Creepage Distance (minimum)	mm	320
6	Power Frequency Puncture withstand Voltage		1.3 x Actual dry flashover voltage
7	Wet Power Frequency Withstand Voltage	kV	35
8	Impulse Withstand Voltage	kV	75
9	Puncture Power Frequency Voltage (minimum)	kV	105
10	Visible Discharge Voltage	kV	9
11	Mechanical Strength	kN	45
12	Ball and Socket Size		16 mm B
13	Applicable Standard for Special Characteristics		IS: 3188

10.17.3.3 Stay Insulator

The stay insulator shall be manufactured and tested in accordance with IS: 5300 or latest version thereof or any other national or international standards that ensures at least equal or better quality to the standard mentioned above, will also be acceptable.

The stay insulator shall have the following ratings and features:

S.N.	Description	Unit	Stay Insulator for 11 kV and 400V Line
1	IS Designation		A
2	Length	mm	90
3	Diameter	Mm	65
4	Cable Hole Diameter	mm	16
5	Creepage Distance (minimum)	mm	41
6	Minimum failing load	kN	44
7	Power Frequency Withstand Voltage		
7.1	Dry	kV	18
7.2	Wet	kV	8

10.17.3.4 Insulator Pins

The insulator pins to be supplied shall conform to IS: 2486 or equivalent international standards and to the shape and dimensions shown in the drawings contained in this specification. The insulator pin shall be furnished with a spring steel split lock washer and nut assembled on the insulator pin. The ratings and features of the insulator pins shall be as follows:

S.N.	Description	Unit	Required ratings/features for 11 kV
1	Head type		Small S165P
2	Total length	mm	315
3	Stalk length	mm	165
4	Shank length	mm	150
5	Minimum failing load	kN	5
6	Applicable standard		IS: 2486 or equivalent international standard.

The insulator pins shall be compatible with the insulators specified above.

10.17.3.5 Disc Insulator Fittings

Disc insulator fittings like Ball and socket, nuts, bolts shall be made of hot rolled steel and the twisted cross arm strap shall be made of MS sheet metal. Cotter bolts and U-bolts shall be of galvanized steel. Cotter pins shall be of stainless steel.

All forgings and castings shall be of good finish and free from flaws and other defects. The edges on the outside of fittings, such as the ball socket and holes, shall be rounded. The nominal dimensions of the ball and socket, ball eye and twisted cross arm straps, are given in Drawings. The ultimate strength of the fittings shall not be less than 41 KN.

All ferrous fittings and the parts other than those of stainless steel, shall be hot dip galvanized as per IS: 2629-1985 or equal internationally recognized standards.

10.17.4 Marking

Each insulator shall be legibly and indelibly marked to show the following:

a) Name or trademark of manufacturer.
b) Year of manufacture.
c) Minimum failing load in Newton
d) Name of Employer

Markings on porcelain shall be printed and shall be applied before firing.

10.17.5 Tests

The insulators and fittings shall comply with the type tests and routine tests as per relevant governing standards.

10.17.6 Bid Documentation

The Bidder shall provide with the Bid two (2) clear copies of the governing standards for fabrication and testing of pin insulator and insulator pin and two (2) clear copies of all other relevant standards referenced therein.

The Bidder shall provide certified type test results of pin insulator and insulators pin as required by

governing standards.

The Bidder shall provide standard catalogue and certified dimensional drawings of pin insulator and insulator pins.
A clause-by-clause commentary on specification, specifying compliance and deviations, if any.
All data, drawings, catalogues and other technical documents shall be bound separately from the Bid documents.

10.18 Stay Sets

10.18.1 Scope

This Specification covers the fabrication and supply of adjustable threaded, galvanized, ferrous, stay sets and nuts for use in overhead line construction.

10.18.2 Description

10.18.2.1 The stay set shall consist of mild steel; galvanized stay rod; stay tightener or adjustable head complete with stay plate a thimble of suitable dimensions

10.18.2.2 The stay rod shall be fabricated of mild steel of minimum tensile strength of 4200 kg/sq.cm. The other technical features and dimensions are given in table attached herewith.

10.18.2.3 The stay tightener shall be made of mild steel of minimum ultimate tensile strength of 42,000kg/sq.cm. The thimbles shall be made of 1.219mm (18 SWG) GI sheet, and shall be suitable for terminating steel stay wire with a preformed grip.

10.18.2.4 The stay plate shall be square type MS plate of dimensions as mentioned in Table herewith. The plate shall have a matching hole at the center to fit the end of the stay rod.

10.18.3 Fabrication

10.18.3.1 The stay rod and nut shall be fabricated to the shape and dimensions shown in table attached herewith.

10.13.3.2 The thread form at the threaded end of the rod, and that of the accompanying nut, shall be optional with the supplier. However, it shall be the responsibility of the Supplier to supply the stay rod with a thread form that shall sustain the rated loads specified in table without creep or stripping over the full life of the rod material at specified diameter.

10.13.3.3 After fabrication, the stay rod and nut shall be hot-dip zinc galvanized in accordance with IS 2629-1985, latest edition, or to an equivalent hot-dip galvanizing standard which produces equal or superior result.

10.13.3.4 After galvanizing, the nut and rod threading shall be such that the nut may be run the full length of the thread without the use of tools.

10.18.4 Tests

10.18.4.1 Apart from the tests indicated in the relevant referenced standard of steel, the stay set shall undergo following tests:

-Visual Inspection.

-Verification of dimensioned.

–Tensile strength: The stay set assemblies shall withstand a minimum tensile load specified in Table 1.

-Bend test: The stay rod shall be bend-tested over a mandrel of 19 mm millimeter through an angle of 90 degrees at any point in the un-threaded section of the rod without fracture of the steel. Temperature of the test shall be 68 degrees Fahrenheit (22.5 deg Celsius).

10.18.5 Bid Documentation

10.18.5.1 The Bidder shall furnish with the Bid a complete description of the stay sets proposed to be supplied including, but not limited to, steel classification of base metal, detailed drawings showing shape, dimensions, and threading certified type test results as required by paragraph 4 herein, the identity of the proposed manufacturer, and manufacturers catalogue number, plus catalogue cuts. The technical data furnished shall be bound separately from the Bid Document.

Table 1: Ratings and Features of Stay Sets

S.N.	Description	Unit	Stay Sets for 11 kV and 0.4 kV line
1	Length of stay rod	m	1.8
2	Diameter of stay rod	mm	16
3	Ultimate tensile strength of stay rod and turn-buckle	kg/cm^2	4200
4	Minimum breaking load	kg	6,433
5	Length of threaded portion	mm	300
6	Thimble shape		Suitable for 7/12 mm stay wire
7	Thimble section		18 SWG min.
8	Stay plate section	mmxmmxmm	300x300x6
9	Eyebolt length	mm	300

10	Eyebolt diameter	mm	16

10.19 Stay Wire

10.19.1 Scope

This Specification covers the fabrication and supply of zinc-coated steel wire for use in overhead power line as stay wire ropes for line supports (poles).

10.19.2 Description of Strands

The steel strand shall be fabricated in accordance with IS 2141 or an equivalent international standard. The steel wire strand shall have a left-hand lay. The steel wires shall have no joint throughout the whole length. Strands shall be uniform and shall have no defects such as cracks, dust encapsulation or crevices. Further details are given in Table herein.

10.19.3 Packing

The steel wire strand shall be furnished in reels holding minimum of 100 kg. Each reel shall have a weather-resistant tag securely attached showing the length, nominal diameter, number of individual wires, grade of the strand, and the class of zinc coating.

10.19.4 Bid Documentation

10.19.4.1 The Bidder shall furnish the following technical data with the Bid:
a) If the material to be offered is to be manufactured in accordance with the specified B.S. standard, full technical data for the material and the identification of the manufacturer.
b) If the material offered to be manufactured in accordance with an equivalent standard, two (2) clear copies of that standard shall be furnished in addition to the data required in
(a) above.
All technical data furnished shall be bound separately from the Bids.

10.19.5 Tests

The testing of individual wires and complete conductor shall be in accordance with the nominated standards.

Table: Ratings and Features of stay wire

S.N.	Description	Unit	Stay Wire for 11 kV and 0.4 kV Line
1	Steel Wire Size	(Nos of wire/SWG)	7/12
2	No. of Wire	Nos	7
3	Diameter of Each wire	mm	2.64
4	Strand Diameter (Overall)	mm	7.8
5	Overall Cross-Sectional Area	mm^2	44.19
6	Steel Quality		Gr.700
7	Minimum Tensile Strength of Steel	N/mm^2	700
8	Min. Breaking load of single wire	kN	3.71
9	Min. Breaking load of strand	kN	26
10	Approximate Weight	kg/km	300
11	Minimum weight of Wire in each reel	kg	100
12	Left hand Lay	Yes/No	Yes
13	Minimum Thickness of Zinc Coating	g/m^2	230

10.20 11 kV Air Break Switch

10.20.1 Scope

This specification provides for manufacture, testing at works and delivery for supply of 11 kV AB switches. The 11 kV AB switches shall conform to IS: 9920 (Part-I to IV)

10.20.2 AB Switches

The 11KV Air Break Switches are required with two poles in each phase. The AB Switches shall be supplied complete with phase coupling shaft, operating rod and operating handle. It shall be manually gang operated and vertically break and horizontal mounting type.

The AB Switch shall be designed for a normal current rating of 400 Amps and for continuous service at the system voltage specified as under: 11 KV AB Switch: 11KV + 10% continuous 50 C/s solidly grounded earthed neutral system. The length of break in the air shall not be less than
400 mm for 11KV AB Switches.

The 11KV AB Switches are required with post insulators. The AB switches should be suitable for mounting on the structure. The mounting structure will be arranged by the purchaser separately. However, the AB Switches shall be

supplied with base channel for mounting on the structure which will be provided by the purchaser. The phase to phase spacing shall be 750mm in case of 11KV AB Switches.

10.20.3 Post Insulators

The post insulators should conform to the latest applicable Indian standards IS: 2544. Creepage distance should be adequate for highly polluted outdoor atmosphere in open atmosphere. The porcelain used for manufacture of AB Switches should be homogeneous and free from flaws or imperfections that might affect the mechanical dielectric quality. They shall be thoroughly vitrified, tough and impervious to moisture. The glazing of the porcelain shall be of uniform brown in color, free from blisters, burns and other similar defects. Insulators of the same rating and type shall be interchangeable. The porcelain and metal parts shall be assembled in such a manner that any thermal expansion differential between the metal and porcelain parts through the range of temperature variation shall not loose the parts or create undue internal stresses which may affect the electrical or mechanical strength. Cap and base of the insulators shall be interchangeable with each other. The cap and base shall be properly cemented with insulators to give perfect grip. Excess cementing must be avoided.

The bidder shall in variably enclose with the offer, the type test certificate and other relevant technical guaranteed particulars of insulators offered by them. Please note that AB Switches without type test certificates will not be accepted.

Each 11kV Post Insulators should have technical particulars as detailed below:

S.N.	Particular	Value
1	Nominal system voltage KV (rms)	11
2	Highest system voltage KV (rms.)	12
3	Dry Power Frequency one minute withstand voltage (rms) in kV	35
4	Wet Power frequency one minute withstand voltage (rms) in kV	35
5	Power Frequency puncture KV (rms) voltage	1.3 times the actual dry flashover voltage
6	Impulse withstand voltage KV (Peak)	75
7	Visible discharge voltage KV (rms)	9
8	Creepage distance in mm (minimum)	320

The rated insulation level of the AB Switches shall not be lower than the values specified below:

S.N.	Standard declared Voltage	Rated voltage of the AB switch	Standard impulse withstand voltage (positive & negative polarity Isolating distance		One Minute power frequency withstand voltage KV (rms)	
			Across the Isolating distance	To earth & between poles	Across the Isolating distance	To earth & between poles
1	11KV	12kV	85kV	75kV	32kV	28 kV

10.20.4 Temperature Rise

The maximum temperature attained by any part of the equipment when in service at site under continuous full load conditions and exposed to the direct rays of Sun shall not exceed 45 degrees above ambient.

10.20.5 Main Contacts

AB Switches shall have heavy duty self-aligning type contacts made of hard drawn electrolytic copper/brass. The various parts should be accordingly finished to ensure inter changeability of similar components. The moving contacts of the switch shall be made from hard drawn electrolytic copper brass. This contact shall have dimensions as per drawing attached so as to withstand safely the highest short-circuit currents and over voltage that may be encountered during service. The surface of the contact shall be rounded smooth and silver-plated. In nut shell the male and female contact assemblies shall ensure.

a. Electro-dynamic withstands ability during short circuits without any risk of repulsion of contacts.

b. Thermal withstands ability during short circuits.

c. Constant contact pressure even when the lower parts of the insulator stacks are subjected to tensile stresses due to linear expansion of connected bus bar of flexible conductors either because of temperature variations or strong winds. Wiping action during closing and opening.

d. Fault alignment assuring closing of the switch without minute adjustments

10.20.6 Connectors

The connectors shall be made of hard drawn electrolytic copper or brass suitable for DOG/RABBIT ACSR conductor for both 11KV AB Switches. The connector should be 4 -bolt type.

10.20.7 Operating Mechanism

All AB Switches shall have separate independent manual operation. They should be provided with ON/OFF indicators and padlocking arrangements for locking in both the end positions to avoid unintentional operation. The isolating distances should also be visible for the AB Switches.

The AB Switch will be supplied with following accessories:

S.N.	Item	Size of 11 kV AB Switch
1	Operating Rod (GI dia)	Length 5.50 meter, dia 25 mm
2	Phase coupling square rod (GI)	Length 1800 mm, Size 25x25 mm
3	Hot dip galvanized Operating handle (GI)	1 No.

The AB Switches shall be capable to resist any chance of opening out when in closed position. The operating mechanism should be of robust constructions, easy to operate by single person and to be located conveniently for local operation in the switchyard. The GI pipe shall conform to ISS: 1239-68 and the vertical down rod should be provided with adequate joint in the mid-section to avoid bending or buckling. Additional leverage should be provided to maintain mechanical force with minimum efforts. All iron parts should be hot dip galvanized. All brass parts should be silver Plated and all nuts and bolts should be hot dip galvanized.

10.20.8 Arcing Horns

It shall be simple and replaceable type. They should be capable of interrupting line charging current. They shall be of first make and after break type.

10.20.9 Bush

The design and construction of bush shall embody all the features required to withstand climatic conditions specified so as to ensure dependable and effective operations specified even after long periods of inaction of these Air Break Switches. They shall be made from highly polished bronze metal with adequate provision for periodic lubrication through nipples and vent.

10.20.10 Design, Materials And Workmanship

The successful tenderers shall assume full responsibility for co-ordination and adequate design. All materials used in the construction of the equipment shall be of the appropriate class, well finished and of approved design and material. All similar parts should be accurately finished and interchangeable.

Special attention shall be paid to tropical treatment to all the equipment, as it will be subjected during service to extremely severe exposure to atmospheric moisture and to long period of high ambient temperature. All current carrying parts shall be of non- ferrous metal or alloys and shall be designed to limit sharp points/edges and similar sharp faces. The firm should submit the following type test certificate along with the certified copy of the drawing. The type test should not be older than 5 years from the date of opening of tender.

1. Test to prove capability of rated peak short circuit current and the rated short time current.

The rated short time current should correspond to minimum of 10kA and the peak short circuit current should correspond to minimum of 25kA.

2. Lightning impulse voltage test with positive & negative polarity.
3. Power Frequency voltage dry test and wet test.
4. Temperature rise test.
5. Mill volt drop tests.

10.20.11 Dimension of 11 kV AB Switches in (Max.) Tolerance 5%

S.N.	Particular	11KV AB Switch
1	MS Channel	450x75x40
2	Creepage distance of Post Insulator	320mm (Min)
3	Highest of Port shell	254 mm
4	Fixed contact assembly	
	i) Base	165x36x8
	ii) Contact	70x30x6

	iii) GI cover	110X44
5	Spring	6nos
6	Moving contract assemble	
a	Base Assembly	135x25x8
b	Moving	180x25x9
c	Bush	Bronze Metal
d	Thickness of Grooves	7

10.20.12 Terminal Connectors

The bidder should provide AB Switches with terminal connectors, set of insulators, mechanical inter works and arcing horns sets. The base channel for the mounting of AB Switches shall also be included in the scope of AB Switches. The operating mechanisms together with down pipe operating handle etc. are also included in the scope of supply.

10.20.13 Routine Test Certificate

The Routine test certificate should invariably be submitted in duplicate of each lot offered for inspection as per IS: 9920 (part-I to IV). The offers received without Routine test certificate shall not be entertained.

10.20.14 Acceptance Test

At the time of inspection following test shall be carried out:

a. Physical verification and measurement of dimension.

b. Power frequency high voltage test.

c. Temperature rise test.

d. Mechanical endurance test / operation test.

e. Milli volt drop test.

f. Galvanising test

10.20.15 Name Plate

The name plate in the following design shall be fixed on each AB Switch.

a. Name of supplier:

b. Name of purchaser:

c. Rating:

d. Serial number of units:

The size of name plate shall be 2" x 1" for 11 KV AB Switch.

10.21 LT Power Cable (PVC)

10.21.1 Scope

This Specification covers the design, manufacture, factory test and supply of 1.1 kV grade PVC insulated multicore power cables. The cables will be used for the purpose of 400V use of Nepal Electricity Authority.

10.21.2 Rated Voltage

The rated voltage of the cables shall be 1100V.

10.21.3 Service Condition

a)	Ambient temperature	-5 to 55 deg. C
b)	Annual average ambient temperature	30 deg. C
c)	Maximum relative humidity	99%
d)	Environmental condition	Humid Tropical climate
e)	Operational altitude	Up to 1000m above msl
f)	Isokeraunic (Thunder Day) level	90 days
g)	Solar Radiation	1.6kW/m2
h)	Wind Zone	Zone 4

10.21.4 Applicable Standards

The equipment and components supplied shall be in accordance with the latest editions of the standards specified below and amendments thereof or any international equivalent standards and the NEA Specifications specified hereafter.

a)	IS 1554	Specification for PVC Insulated heavy duty Electric cables for working voltages upto & including 1100 V
b)	IS 8130	Specification for conductors for insulated electric cables and flexible cords

The Bidder may propose alternative standards, provided it is demonstrated that they give a degree of quality and performance equivalent to or better than the referenced standards. The purchaser shall adjudge whether to accept or reject any standards.

The Bidder shall furnish a copy of the alternative standard proposed along with his bid. If the alternative standard is in a language other than English, an English translation shall be submitted with the standard. In case of conflict the order of the precedence shall be (1) IEC standards, (2) ISO standards, (3) European or British Standards, (4) Indian Standards, (5) Other alternative standards.

This list is not to be considered exhaustive and reference to a particular standard or recommendation in this specification does not relieve the Contractor or the necessity of providing the goods complying with other relevant standards or recommendation.

10.21.5 Technical Parameters

10.21.5.1 Minimum Technical Requirements

S.N.	Description	Unit	Requirements
1	Rated Voltage	kV	
2	Maximum System Voltage	kV	
3	Rated Voltage between two conductors	kV	
4	Power Frequency withstand voltage	kV	
5	Number of Cores		4
6	Phase Conductor		3
7	Insulation Material		PVC
8	Conductor		EC Grade Al.
9	Minimum Number of Strand		
10	Nominal Thickness of Insulation		
11	Minimum Thickness of inner sheath		
12	Type and dimensions of armor		
13	Minimum thickness of outer sheath		
14	Conductor Temperature Rise during Normal Operation	deg. C	70
15	Conductor Temperature Rise during Short Circuit	deg. C	160
16	Direction of Lay		Right Hand
17	Standard Length of Cable Per drum	m	Min. 500

10.21.5.2 Requirements of size

The required size of PVC insulated, aluminum Conductor, armored cable shall be:
4x400 mm^2, 4x300 and 4x150mm^2

10.21.6 Basic Features

10.21.6.1 Design

The power cable shall conform in all respects to highest standards of engineering, design, workmanship, this specification and the latest revisions of relevant standards at the time of offer and the Purchaser shall have the power to reject any work or material, which, in his judgment is not in full accordance therewith.

10.21.6.2 Conductors

The conductor shall be of multi-strand round aluminum of compacted circular cross-section conforming to IEC or equivalent international standards. The conductor shall be clean and reasonably uniform in size and shape and its surface shall be free from sharp edges.

10.21.6.3 Insulation

The conductor shall be provided with PVC insulation applied by extrusion. Type of insulation shall be A for general purpose PVC.

10.21.6.4 Laying up of Cores

In twin, three & multi core cables, the cores shall be laid up together with a suitable lay, the outermost layer shall have right hand lay and the successive layer shall be laid with opposite lay.

10.21.6.5 Inner Sheath

The laid up cores shall be provided with Inner Sheath applied by extrusion. It shall be ensured that the shape of Cable is as circular as possible. Inner sheath shall be so applied that it fits closely on the laid up cores and it shall be possible to remove it without damaging the insulation.

10.21.6.6 Armour

The armour wires/strips shall be applied as closely as practicable. A binder tape may be provided on the armour.

10.21.6.7 Outer Sheath

The outer sheath shall be applied by extrusion over the armouring. The colour of outer sheath is black unless otherwise specified. Thickness of outer sheath should be as per IS: 1554.

10.21.7 Cable Identification and Marking

The following shall be embossed on the outer sheath of the cable throughout the length of cable at 1.0 meter spacing. The embossing should be very clear and easily visible to naked eye. The height of the printed lettering shall be not less than 20% of the overall diameter of the conductor. Sequential length shall be marked on the outer sheath of the cable throughout the length by Printing in each meter length interval.

- Applicable Standards
- Name/Identification of the manufacturer,
- Name of the Purchaser 'Nepal Electricity Authority'
- Voltage Grade of Cable
- Type of Insulation, material of conductor
- Number of Cores and nominal cross-sectional area of conductor
- Cable Code
- Year and Month of Manufacture

Each phase of the core shall be identified with the color Red, Yellow, Blue and Black on the inner sheath.

10.21.8 Packaging

All conductors shall be furnished on non-returnable steel drums capable of withstanding all normal transportation and handling. Protective external lagging of sufficient thickness shall be provided and fitted closely on the drums. Binder consisting of steel straps shall be provided over the external laggings. The drums shall be new and sufficiently sturdy in construction to withstand ocean shipping, road transport, several loading and unloading, storage in tropics, hauling and field erection of conductor without distortion or disintegration.

Each reel of the conductors furnished shall contain only one (1) length of conductor. The minimum length of each drum shall be minimum of 500m. All drums shall be legibly marked in paint with the following information:

(i) Manufacturer's Name and Trademark (if any)
(ii) Drum Number or identification number
(iii) Type of conductor
(iv) Size of conductor
(v) Voltage Grade
(vi) Length in meters
(vii) Gross Weight
(viii) Net weight of conductor
(ix) Direction of rolling

10.21.9 Inspection And Testing

10.21.9.1 Acceptance Test

The successful Bidder shall make necessary arrangements for pre-shipment inspection and tests by the nominated NEA Inspectors to carry out in his presence the necessary Sample/Acceptance tests conforming to the relevant governing standards on the completed cables offered.

10.21.9.2 Routine Test

The Routine Tests shall be carried out on the completed cables at the manufacturer's plant in accordance with the governing standards. The test reports shall be made available for the observation of the NEA Inspector at the time of inspection.

10.21.10 Bid Documentation

10.21.10.1 The following shall be furnished with the offer:

(a) Complete description, catalogue, drawings showing general construction and size of the cables including dimensional drawing of cable drum for each type of cable.
(b) Completed Schedule of Guaranteed Technical Particulars
(c) A copy of the Manufacturer's ISO 9001 Certificate conforming to design and manufacture
(d) Type Test Certificates: The Type Test Certificates shall be from an Accredited Independent Testing Authority acceptable to the Purchaser.
(e) Copy of the Governing Standards
(f) Technical Literature in English Language on installation, operation and maintenance with necessary diagrams and drawings.

10.21.10.2 Type Test Certificates
The material offered shall be fully type tested by an independent accredited testing laboratory acceptable to the Employer. The bidder shall submit the type test reports along with the offer. The tests shall comply with relevant Standards. The Employer also reserves the right to have tests carried out by an independent agency, whenever there is a dispute regarding the quality of supply.

11 OTHER ELECTRICAL INSTALLATIONS

11.1 Water Level Indicator

11.1.1 Float less Type Level Switch In Water Tanks

The Contractor shall supply and install float less type switch probes in all water tanks as indicated below and shown on the drawings.

- High level alarm (over-flow);
- Low level alarm;
- Low level cut-out for raw water pumps;
- Earthing probe.

Each probe shall be of the correct length for the particular application and tank location. Electrodes shall be of polished stainless steel 20 mm OD. Electrode holders shall be weatherproof in all respect. The earthing probes shall be connected and wired to the building earth systems of the building.

Each set of electrodes shall be installed inside a 230 mm diameter PVC pipe acting as a wave barrier. The level switch set shall operate with a stepped down voltage at 24V maximum. Stepped down transformers shall be provided for each set of control probes and shall be installed inside centralized control cubicles inside pump room. Mechanical steel stuffing boxes shall be used.

11.1.2 Control of Duty / Standby Pumps

Operation of the duty and standby pumps shall be carried out by the following methods:

- Automatically by means of LEVEL sensor (i.e. magnetic switches);
- Manually by means of a local start/stop push buttons on pump local motor control panel and emergency stop switch.

Automatic controls shall be operated by electronic, float less type level switches.

11.1.3 Pump Indicator

Automatic controls shall be operated by electronic, float less type level switches. The following audible and visible indication shall be provided at the pump local control panels as applicable:

- Red "overflow level" indicator with buzzer for the associated water tanks;
- Amber "extra high water level" indicator for the associated water tank;
- Amber "high water level" indicator;
- Amber "low water level" indicator;
- Red "pump trip" indicator for each pump;
- Green "pump on" indicator for each pump;
- "Pump electrical supply healthy" indicator for each pump;
- Amber "remote/local" status indicator.

11.2 LT Voltage Stabilizer

Voltage stabilizer shall correct the voltage automatically as per required specification and variation limit without any distortion in the output voltage waveform.

Voltage stabilizer up to 100 kVA shall be air cooled whereas stabilizer above 100 kVA shall be oil cooled. Stabilizer shall consist of following units:

- Regulator unit
- Buck boost unit
- Automatic control unit
- Enclosure

Automatic regulator unit shall be oil cooled above 100 kVA, naturally cooled on load, stepless rolling contact type. Fittings and accessories for regulator shall be as follows:

- Radiator cooling system when oil cooled
- Lifting lugs
- Earthing terminals
- Diagram and rating plate.
- Drain valve and oil filling hole when oil
- Silica gel breather when oil cooled
- Thermometer pockets

11.2.1 Core

The magnetic circuit shall be built of transformer grade cold rolled grain oriented low loss steel stampings having high permeability and conforming to adopted standards. Stamping shall be insulated from each other with material having high inter-lamination insulation resistance and rust inhibiting property and also capable of withstanding pressure, mechanical vibration and action of heat and oil, thus reducing the possibility of sludge formation to a minimum.

The framework clamping arrangement and general structure of the cores shall be of robust construction and shall be capable of with sustained any shock to which they may be subject during transport, installation and service. The assembled core shall be securely clamped on the limbs and the yoke, to build up a rigid structure. The clamping pressure shall be uniform the whole of the core and so adjusted as to minimize noise and vibration in the core when the transformer is in service. The framework and the core bolts shall be efficiently insulated from the core so as to reduce the circulating currents to a minimum.

The core clamping frame shall be provided with lifting eyes for the purpose of tanking and untanking the core with winding mounted thereon and shall have ample strength to take the full weight of the core and winding assembly.

11.2.2 Winding

The coils used for winding shall be circular in shape made of paper insulated continuous and smooth tinned or enameled electrolytic copper conductors of high conductivity.

Liberal ducts shall be provided to prevent any hot spot temperature in the winging that may adversely affect the life of the equipment. Adequate supports wedges and spacers of hard insulating material shall be so fitted that they will neither move nor permit relative movement of any part of winding during transit of normal service or under terminal short- circuit, nor damage the winding insulation in any way. All leads and connections shall be robust, adequately insulated, protected and clamped. The winding assembly shall be dried in vacuum with tested insulating oil of approved standard. The windings shall be subjected to a through shrinking and seasoning process so that no further shrinking of windings occur during service at site. However, adjustable devices shall be provided for taking up any possible shrinkage of coils in service. The assembly shall be held in position under adequate axial compression to withstand the axial thrust likely to occur under terminal short-circuit.

11.2.3 Auto Control Unit

Auto control unit shall be mounted along with the regulator tank and shall consists of

- PCB relay/ electronic relay
- Step syn. Geared motor
- Auto/ manual switch

Set of push buttons

- Lower raise switch/ push buttons
- Indicating lights
- Input & output voltmeters
- Ammeter with selector switch

11.2.4 Technical Parameters

	KVA Rating	As per schedule of quantities
	Rated Voltage	415 VAC
	Input Volts	330 V to 460 V AC
	Output Volts	415 V ± 1%

	Rated Frequency	50 Hz.
	No. of phases for bypass system	3 Phase 4 wires system
	Load	Unbalanced
	Type of cooling	Air cooled upto 100 kVA and ONAN above 100KVA
	Maximum temperature rise	
	of oil by thermometer	44 Deg C
	of winding by resistance	55 Deg C
	of hot spot temperature indicator	65 Deg C
	Limit of hot spot temperature for which the transformer is designed to be	110 Deg C
	Service	Indoor/ Outdoor
	Automatic control gear	Consisting of one electronic relay, reversing geared motor under limit switches in order to avoid over - running highest and lowest positions, chain drive, control devices and all electrical connections. Alternatively, variac consisting of carbon brushes can be provided for Automatic regulation.
	Efficiency	Better than 94%
	Distortion at output	Not exceed 5%
	Rate of correction	Not more than 8 volts per second
	Schedule of Equipment	415 V Automatic voltage stabilizer as per technical requirements shall comprise of:
		• Rolling contact type on load voltage regulator/ variac carbon brush type. • Buck-Boost transformer. • Automatic control gear.
	Tanks and Fittings	The equipment shall be housed in a sheet steel tank fitted with radiators and mounted on bidirectional/ Unidirectional rollers. The following shall be with the equipment
		• Lifting lugs • Earthing terminals. • Rating plate. • Drain valves. • Oil filling hole. • Thermometer pocket. • Oil Level Gauge. • Silica gel breather • Filter Valve.

Note: 0-500 digital voltmeter with selector switch shall be provided for incoming and outgoing side of stabilizer.

12 ALUMINIUM DOORS, WINDOWS AND VENTILATORS

12.1 Material and sections

The aluminum work shall be carried out as per detailed specifications and conditions for the work.

All aluminum work shall be free from defect in impairing, strength durability appearance and shall be of the best commercial quality for purposes specified made with structural properties to withstand safely strains / stresses to which they shall be normally subjected. All sections shall be of approved extruded tubular anodized aluminum sections from the approved manufacturers, as per architectural drawings and as per relevant IS Specifications or equivalent. Any equivalent extrusion will be got approved from the Engineer.

The contractor shall provide all items, articles, materials, operations, mentioned or scheduled, on the drawings, including all labour, materials fixing devices, equipment and incidentals necessary as required for their completion.

The contractor shall submit shop drawings and samples of each type of doors, windows, railing and other items of aluminum work to the Project Manager for approval. The shop drawings shall show full size sections of doors and windows etc. thickness of aluminium sections, details of construction hardware as well as connections of doors, windows and other aluminium work to adjacent work. Shop drawings shall be based on actual dimensions available on site. The variation in openings and shop drawings shall not be more than + 1.5 mm.

Aluminium doors and shutters shall be manufactured by an approved manufacturer and shall be of sections, sizes, combination and details shown on the architectural drawings. The frame member shall be of one piece and glazing bars shall be threaded or interlocked as approved by the Engineer.

Glazing for doors and windows shall be of specified thickness and approved quality and shall conform to specification of glazing. Fixing of glazing shall be done with aluminum 'Snap-On' beading as per detailed drawings and instructions. Necessary rubber gaskets of approved make shall be provided.

Upon delivery of doors and windows to site, they shall be handled with care, stored on edge on level bearers and supported evenly.

The manufacturer, immediately prior to the commencement of glazing, shall adjust and set all doors and accept responsibility for the satisfactory working of the opening frames. All doors shall open or slide as indicated in drawings and schedules.

The contractor shall be responsible for the doors & window shutters being set straight, plumb and level and for their satisfactory operation after the fixing its complete.

Fittings shall retain the casements rigidly in both open & closed positions. All fittings shall be got approved from the Project Manager. The fittings and aluminium work shall be complete and shall be wrapped and protected until the complete aluminum work is washed with mild solution of non-alkali soap and water and left in complete finished conditions.

12.2 Fabrication

All fabrications shall be got done with workmen who are skilled in the trade and fully equipped to carry out phases of fabrication in accordance with the best accepted practice and as shown on the drawing. All work shall be shop fabricated and finished and then brought on site for installations. The details of the equipment possessed by the contractor shall be provided, which should conclusively prove that all facilities required to execute the work as per specifications, are available.

All aluminium works shall be deemed to include in various items, complete work including fittings, fixtures, stays, locks, handles, special hinges, floor springs, neoprene/rubber linings, gaskets, bushes, rollers, sealant etc. as directed and approved by the Engineer.

The rates quoted for aluminium works shall be inclusive of all fixtures/fittings also anodized as per main member like handles, stays, sliding gears, tower bolts, cleats, hinges etc., and their weight shall not be considered in the finished product. The payment shall be given only for the members used measured centre to centre of the sections.

All windows, glazing etc shall be made completely water proof to the satisfaction of the Engineer and necessary Silicon / Polysuphide sealants etc. shall be provided. No payment shall be made for providing necessary Silicon / Polysuphide sealant etc. to items under this sub-head.

In the items of aluminum glazing in doors and windows etc. work shall include the provision of mullions, coupling bars as required to join various units of glazing in windows and doors etc. to form larger glazing in doors or door-cum-windows as required and as per drawings.

Taking into consideration varying profiles of aluminum sections being extruded by approved manufacturers and their availability in time as required the contractor shall prepare detailed shop drawings using suitable sections based on architectural design/drawings and adequate to meet the performance and other specifications parameters laid down for the work.

The section profile weight and suitability to meet the requirement/specifications as proposed by the manufacturer and detailed shop drawings shall be subject to approval of the Engineer who should be satisfied that if fully meets the design. In case it is proposed to provide substitute for any aluminium sections, which is specified for any aluminium glazing, this would be subjected to approval of the Engineer who is to be satisfied regarding the suitability of the alternative section and it having no financial variation.

Aluminium sections used for doors and openable windows including sliding windows, fixed glazing, curtain walls, glazing frame work, extruded wall paneling of certain hand rails etc. shall be suitable for use to meet architectural designs of relevant works and shall be subject to approval of Project Manager who would require to be satisfied about their being appropriate on technical, functional and aesthetic considerations.

All joints shall be accurately fabricated and be hairline in appearance. The finished surface shall be free from visible defects.

All aluminium shall be anodized/powder coated as specified. Anodizing powder coating shall be of approved colour and conform to IS 1868-1968 and shall be of AC 15 grade with minimum thickness of 15 microns, when measured as per IS: 6012- 1970, and density shall be at least 32 least 32 mg/sq cm. All sections are to be matt anodized/powder coated in colour as per sample approved by the Architects.

The anodized coating shall be properly sealed by steam or boiling in de-ionised water as per IS 1868-1968 and of IS 6057. Sealing quality shall be tested in accordance with DIN 50949 or similar standards.

Colour anodizing would be done only by electro colour process.

Colour fastners shall be as per 1868-1968 grading-B.

No visual variation in shade shall be permitted. The fabricator shall clearly indicate the shade variation tolerance as measured by standard equipment.

Each glazing shall be tailor made as per opening at site. No cutting and making good of concrete surface shall be permitted.

Doors, windows or fixed glazing frames shall be fixed to concrete or brick work with approved metal fasteners. Method of fixing shall be approved by the Project Manager before mass fabrication.

Samples of typical glazing shall be made and got approved from the Project Manager before fabrication.

All hardware used shall conform to the relevant IS specifications. Design, quality, type number and fixing of the hardware shall be got approved from the Engineer.

A thick layer of the clear transparent lacquer based on Methacrylates or cellulose Butyrate shall be applied on the anodized glazing before they are brought on the site. The lacquer shall be removed on completion of erection.

All screws shall be stainless steel screws threads of machine screws used shall conform to IS: 4218 or otherwise approved by the Project Manager. Gaskets for retaining glass shall be of heavy extruded neoprene.

The corners of the frame being fabricated to a true right angle. Both the fixed and opening frames shall be fabricated out of sections which have been cut to length mitered and mechanically jointed. All members shall be accurately machine milled and fitted to form headline joints. The joining accessories such as cleats, brackets, etc shall be such material as not to cause any bimetallic corrosive action.

All the frame members shall be in plumb and level and jointed in such a way that maximum expansion and contraction will not cause distortion or leakage. The contractor shall be responsible for their satisfactory performance/operation after fixing is complete.

All aluminium work shall be washed with a suitable thinner and left in a finished condition in approved uniform appearance and free from all marks and blemishes. The glass panes shall be thoroughly washed and cleaned before the work is handed over.

The requirements provisions for all anodized aluminium work shall conform to requirements specifications and parameters given in this tender, drawings, instructions and shall at least provide for or conform to IS codes relating to materials workmanship, fabrication, finishing, erection, installation etc. In this connection relevant IS codes including Nos. 1868-1973, 6012-1970, 1285-1975,7400-1974 as deemed applicable by the Project Manager shall be considered.

Suitable sections with lighter/heavier weights as may be required and approved by architect shall be provided by the contractor. No variation in quoted rates shall be made for change in section or weights given as a guide.

12.3 Glass

12.3.1 Clear Glass

The glass shall be float glass of Modi Float or equivalent. Glass used in glazing, openable and fixed doors, windows etc shall provide clear, completely undistorted vision and reflection. It shall be free from any bubbles, waves or blemishes. Glass used shall be of required size as per drawings. No extra payment shall be made for use of glasses of any size having an area up to 32 sq.ft (in one piece) for 5mm thick glass.

12.3.2 Tinted Glass

Tinted glass shall have same quality and specifications as indicated above for clear glass. It shall however be transparent glass to Bronze/Blue/Green/Smoke gray shade as required and would be expected to absorb to absorb a greater proportion of sun's radiant heat and reduce transmission than clear glass.

12.4 Drawings/ Documents

Prior to fabrication, Contractor shall submit 1 copies of shop drawing indicating details of all members, sections and hardware for Engineer's approval. All certificates against tests for anodising and other physical properties of material shall

be produced to the Engineer for acceptance.

12.5 Notes

1. All the fittings shall be anodised aluminium (finish compatible with original frame) type unless otherwise specified.
2. Single leaf door shutters and ventilator shutters of more than 0.80 m width shall be provided with one extra hinge.
3. Where height of window shutter and door leaf exceeds 1.2 m and 2.15 m respectively one extra hinge shall be provided for every additional height of 0.5 m or part thereof and length of top bolt shall be increased by the height of the shutter/leaf above 2.15 m from floor level.
4. In double leaf shutters of doors, two tower bolts shall be fixed to the first shutter at top and bottom and one to the closing shutter at the top.
5. All hardware shall conform to the applicable Indian Standards.

12.6 Measurement for Payment

Generally, the items shall be measured in-situ. The method of measurement shall be based on the following:

No payment shall be released till the thickness of the anodic coating is found to be minimum 15 microns and sealing quality appropriate everywhere. The testing shall be done by Eddy Current method as per IS: 6012-1970, for thickness and relevant DIN for sealing. Likewise, colour variation measurements shall also be carried out. If any material is found sub-standard this shall be totally rejected. Requisite tests shall be done at the site. 100% checking, as instructed by the Engineer may be resorted to.

Unless stated otherwise in the BOQ, payment for windows and doors shall be made by frame area for each type with same specific section. If items scheduled call for measurement by area, architraves linings, sills etc. shall not be measured separately but shall be considered as being included in the area of the opening closed by the window, door, shuttering or any other specified closure.

Unit area openings shall be considered only if standard weights of specified aluminium section shall be within the permissible limit of variation of the section. The permissible limit of variation for aluminum works shall be + 5% over the standard weight.

All costs for hardware and fittings shall be included in the unit rate of the relevant bill items.

13 FRENCH SPIRIT POLISHING

Pure shellac conforming to IS 16 varying from pale orange to lemon yellow colour, free from resin or dirt shall be dissolved in methylated spirit at the rate of 140 gm of shellac to 1 litre of spirit. Suitable pigment shall be added to get the required shade. Readymade polish conforming to IS 348 can also be used.

13.1 Polishing New Surface

13.1.1 Preparation of Surface

The surface shall be cleaned. All unevenness shall be rubbed down smooth with sand paper and well dusted. Knots if visible shall be covered with a preparation of red lead and glue size laid on while hot. Holes and indentations on the surface shall be stopped with glazier's putty. The surface shall then be given a coat of wood filler made by mixing whiting (ground chalk) in methylated spirit at the rate of 1.5 Kg of whiting per litre of spirit. The surface shall again be rubbed down perfectly smooth with glass paper and wiped clean.

13.1.2 Application

The number of coats of polish to be applied shall be as described in the item. A pad of woolen cloth covered by a fine cloth shall be used to apply the polish. The pad shall be moistened with the polish and rubbed hard on the wood, in a series of overlapping circles applying the mixture sparingly but uniformly over the entire area to give an even level surface. A trace of linseed oil on the face of the pad facilitates this operation. The surface shall be allowed to dry and the remaining coats applied in the same way. To finish off, the pad shall be covered with a fresh piece of clean fine cotton cloth slightly damped with methylated spirit and rubbed lightly and quickly with circular motions. The finished surface shall have a uniform texture and high gloss.

13.1.3 Measurements

The length and breadth shall be measured correct to a cm. The area shall be calculated in sqm (correct to two places of decimal), except otherwise stated.

Small articles not exceeding 0.1 sqm of painted surfaces where not in conjunction with similar painted work shall be enumerated.

Area of painting on hand rail shall be calculated by multiplying single running meter to gross height of hand rail (no deduction shall be made to any kind of post.

14 MISCELLANEOUS

Unless specifically otherwise mentioned in case of repair and maintenance work, all the applicable codes & standards published by the Indian standard Institution & all other standard which may be published by them before the date of receipt of Bids, shall govern in all respects of dosing workmanship quality & propitious of materials & methods of testing, method of measurements etc. Wherever any reference to any Indian Standard specifications occurs in the documents relating to this contract, the same shall be inclusive of all amendments issued to or revisions thereof, if any, up to the date of receipt of Bids.

In case there is no Indian Code of Standard specification for the particular work (for repair and Maintenance), such work shall be carried out in accordance with the instructions in all respects, & requirements of the Engineer. Wherever any reference to any Indian standard specification occurs in the documents relating to this contract, the same shall be inclusive of all amendment issued there to or revisions thereof, if any, up to the date of receipt of Bids.

14.1 Surface Discharge Plate

Unless otherwise mentioned in Schedule of Requirements, surface discharge plates are to be made of at least 16 – 25 mm thick M.S. plate having sufficient strength to support entire weight of the pump set and the hydraulic pressure on it. The surface plate consists of a pipe bend of size sufficient to discharge the rated flow of water. The discharge bend has welded or casted flanges in both ends. The size of the surface discharge depends on the outer diameter of the tube-well and the shape may be either rounded or rectangular.

14.2 Turfing

Turfs shall be interpreted as grass that is seasonally dormant during cold or dry seasons and is capable of renewing growth after the dormant period. The turfs shall be brought by the Contractor from areas where the top soil is reasonably fertile and contain a high percentage of loamy topsoil. Turfs shall be cut or stripped from living, thickly matted turf relatively free from weeds or other undesirable foreign plants, large stones, roots or other materials which might be detrimental to the development of the turf or to future maintenance. Turf including the soil containing the roots shall be planted in a neat and systematic way.

The top soil on which Turfing is to be done shall be free of admixture of sub-soil, stone, gravel, clay lumps, plants or their roots, sticks or other extraneous material exceeding 50 mm. diameter. It shall be clay loam. The top soil shall be approved by the Engineer before being placed.

The strips of turf shall be in uniform widths not less than 230mm and length not more than 460 mm. Such lengths should be readily lifted without breaking, tearing or loss of soil. The turfs shall be transplanted within 24 hours from the time it is stripped unless storing is necessary. If stored, turfs shall be stacked, kept moist and protected from exposure to sun.

Turfs shall be cut and moved only when the soil mixture conditions are such that favorable results can be expected. Turfing shall be performed only during the seasons when satisfactory results can be expected. Turfing may be transplanted during drought free periods with the approval of the Engineer provided the turf bed is watered to moisten the soil to a depth of at least 100 mm immediately prior to laying the turf.

The turf shall be carefully placed by hand, edge to edge with staggered joints, in rows at right angle to the slopes, commencing at the base of the area to be turfed and working upward. The turf shall immediately be pressed firmly into contact with bed by tamping to provide a true and even surface. Screened soil of good quality shall be used to fill all cracks between turfs. The quality of fill soil shall not cause smothering of the grass.

The Contractor shall provide general care for the turfed area, protect against traffic and shall continue care until final inspection and acceptance of the work. If the surface become gullied or otherwise damaged during the period the affected area shall be repaved to established grade and condition as directed.

It shall be measured in square meter on the ground surface including 150 mm. thick materials and labour.

14.3 Sand Filling

Sand filling in floor or other place as mentioned or directed by engineer shall be in specified thickness as per drawing or BOQ. The sand layer shall be 75mm layers after sprinkling with water and ramming to full consolidation. Sand filling shall be done with sand confirming Clause 2.3.3.4 in layers not exceeding 75mm. Each layer shall be well watered and rammed to full consolidation with iron rammers. Other procedures shall be for earth filling described in Clause 2.2.

Rates for sand filling shall cover the cost of the provision of suitable material for any lead, placing in layers, watering and compacting as specified will measured as the volume between ground levels before and after the filling and the rate will include forming embankments, terraces, etc.

14.4 Brick bat filling

The brickbats shall be from brick of first class well burnt or slightly over burnt bricks. The bricks bats shall be laid in flat

and sand shall be spread over the bricks bats and compacted to the required depth after sprinkling water. Unless and otherwise mentioned in drawing, each layer of the brick bat shall be so laid that the final compacted depth after sand blinding and watering shall not exceed 150mm. The compaction shall be carried out either manually or mechanically to the satisfaction of the Engineer. The sand and water used in brick bat filling works shall confirm Clause 2.3.3.4 and 2.3.3.3.

Rate for Brick bat filling shall cover the cost of the provision of suitable material, placing in layers, watering and compacting as specified will measured as the volume between ground levels before and after the filling and the rate will include forming embankments, terraces, etc.

14.5 Transportation of Surplus Materials

Excavated materials surplus after backfilling shall be disposed off immediately after the completion of backfilling works at a location as directed by the engineer as per Clause 2.2.8.

14.6 Geotextile

Geotextile shall be made of polyethylene or polyster or similar fibres, either woven or nonwoven. Unless otherwise shown on the drawing, the geotextile shall:

14.6.1 sustain a load of not less than 10kN/m at break and have minimum failure strain of 10 percent when determined in accordance with BS:6906 or shall have a grab tensile strength more than 0.4 kN/m and grab elongation corresponding to this limit in accordance with ASTM D4632.

14.6.2 have apparent opening size as shown on the Drawing. If no size is shown on the Drawing, then the apparent size shall be 0.1 mm.

14.6.3 allow water to flow through it at right angles to its principal plane, in either direction at a rate of not less than 50 litres/sq.m./sec. under a constant head of 100 mm, determined in accordance with BS:6906 (part 3) or ATSM D4491, unless otherwise shown on the Drawing. The flow rate determined in the test shall be corrected to that applicable to a temperature of 150C using data on variation in viscosity of water with temperature.

14.6.4 have a minimum puncture resistance of 200N when determined in accordance with ASTM D 4833.

14.6.5 have a minimum tear resistance of 350 N determined in accordance with ASTM D 4533.

14.7 Gas Vents

When specified, gas vent flaps or vent pipes shall be installed in accordance with the drawings or as instructed by the Engineer to provide adequate venting for the liner system. The venting pipe should be fitted with required fittings and cowling.

14.8 Electro-fusion Welding Machine

Type - Automatic with Bar Code Reader, Automatic Operations & Data Logging:

S. No.	Parameters Description	Specification Range
Input		
1	Operating Temperature	-10 to + 50 deg C (Ref. Manual)
2	Mains Voltage	230V (-15% to + 10%)
3	Supply Current	15 Amp AC (Peak -26 Amp)
4	Frequency	50±10 Hzs.
5	Supply Power	Min. - 5KW
Output		
1	Controlled Welding Voltage	8 - 48 V AC
2	Welding Power	8 to 3120 VA
3	Welding Current	1 to 65 Amp AC (100 Amp short term)
General Features		
1	Manual Operations	Should be Possible
2	Barcode Reader	Pen or Scanner
3	Automatic Temp Compensation	Must be achieved in Automatic mode
4	Environmental Protection Type	IP65
5	Electrical Protection	Class 1 Earthed
6	Overload protection	Thermal 16 A (for 230 V versions)
7	Length of connector cable - Output Cable	3 Meters

8	Length of mains cable- Input Cable	4 Meters
9	Connectors Diameter	4mm F
10	Adapters Diameter	4.7mm F / 4mm M
11	Ambient Thermometer Precision	± 1º C
12	Standard	ISO 12176 - 2:2008
13	Data Logging - In & Out	USB Port - With 1GB Pen drive to download & Data memory - 2000 Welds
14	Cooling Time display	Activated
15	Maximum Welding time	3600 Seconds
16	Dimension (W/D/H/)	Not to exceed 30 Cm x 30 Cm x 40 Cm
17	Weight with cables	Not to exceed 20 Kg
18	Display	4 Line with Backlight & High contrast. It shall be possible to view on display, any kind of information regarding malfunctions that could occur before or during welding
19	Carrying Case	Metallic Box (Transport Case). Strong Aluminium case with SS fittings
20	Warranty	12 Months from the date of purchase
21	Service Centre & Calibration Services	Shall be available locally
	TPI certification	Should have any third party independent agency certification

14.9 Manual scraper

1) Blade in hardened steel, with sharp scraping edge.
2) Blade must have interchangeable 4 scraping edges.
3) The blade must have been fixed on a plastic handle inclined at an angle of 450 with the plane of the blade.
4) The minimum width of the blade should be 50 mm.
5) Weight should not exceed 0.50 kg.

14.10 Pillar Type Saddle Clamp (Top Loading) – For Pipe Size 63 to 315 MM.

1) Manufactured from Zinc plated steel. Strong welded construction & Zinc plated steel to avoid bending, damage & rusting.
2) Suitable to work with tapping saddles (Tapping Tees), branch saddles.
3) Designed to hold saddles onto pipe with top load of 1000 to 1500 Newtons, before and during the Electro-fusion process.
4) Designed to hold saddles on 63 to 315mm diameter PE pipe.
5) The Pillar Clamps shall be supplied in two size range: 63-125mm and 63-250 mm.
6) Simple operation, Load cell with Calibrated long life spring shall be used. Encapsulated load cell to avoid malfunctioning of Spring due to mud, grit & muck. Lubrication inside the load cell to ensure smooth clamping & less wear / tear of rotating & rubbing surfaces during heavy load conditions of 1500 Newton.
7) Load spring and indicator to show correct load has been applied.
8) The loading arm must slide easily up and down the pillar, allowing quick assembly of the joint.
9) The V block / foot of the clamp to allow the tool to swivel and negotiate the pipe orientation in pit / allowing access in a confined space.
10) The Size must be less than 60 cm x 20 cm x 10 cm
11) Weight must be less than 10kg.
12) Tool must be complied with the requirements of the National Grid Transco specification GIS/PL2-5: 2006. Specification for Polyethylene pipes and fittings for natural gas and suitable manufactured gas. Part 5: Electrofusion ancillary tooling

14.11 Strap Type Saddle Clamp (Top Loading) – For Pipe Size 63 to 630 MM.

1) Manufactured from Zinc plated steel. Strong welded construction & Zinc plated steel to avoid bending, damage & rusting.
2) Suitable to work with tapping saddles (Tapping Tees), branch saddles.

3) Designed to hold saddles onto pipe with flexi-strap with top load of 1000 to 1500 Newtons, before and during the Electro-fusion process.
4) Designed to hold saddles on 63 to 630mm diameter PE pipe with the flexi-strap locked with quick-fix / quick-release buckles.
5) Simple operation, Load cell with Calibrated long life spring shall be used. Encapsulated load cell to avoid malfunctioning of Spring due to mud, grit & muck. Lubrication inside the load cell to ensure smooth clamping & less wear / tear of rotating & rubbing surfaces during heavy load conditions of 1500 Newton.
6) Load spring and indicator to show correct load has been applied.
7) The stirrup at the top of the clamp to allow the tool to swivel and negotiate the pipe orientation in pit / allowing access in a confined space.
8) The Size must be less than 20 cm x 20 cm x 20 cm
9) Weight must be less than 3kg.
10) Tool must be comply with the requirements of the National Grid Transco specification GIS/PL2-5: 2006. Specification for Polyethylene pipes and fittings for natural gas and suitable manufactured gas. Part 5: Electrofusion ancillary tooling

14.12 Pipe Restraining, Alignment and Re-rounding Clamps

1) Shall be suitable for pipes of diameter d 63,60 ,75, 90,110,125,140 160 & 180 in one clamp, with interchangeable plastic insert sleeves for each size.
2) Shall be suitable for Straight, Elbow and Angular joints.
3) In one clamp pipe restraining, alignment and re-rounding features shall be available.
4) Design must be light weight (in aluminium material)
5) Design must be flexible for ease clamping of fittings.

14.13 Pipe Cutter- Wedge type

1) Suitable for Cutting PE pipes of diameter d20 to 63 mm.
2) Manufactured from steel with Zinc plating or powder-coating. Strong construction to avoid bending, damage & rusting.
3) Sharp cutting edges in hardened steel.
4) Amplified leverage for reducing cutting efforts.
5) Positive locking for accidental release of pipe during cutting.

14.14 Apparatus and Equipment for Water Quality Laboratory

14.14.1 pH Meter

Analytical Method	Electrometric Method; APHA 4500-H+ B
Type	Bench top
Range	-2 to 16 PH : -200 to 1200C
Resolution	0.01 ppm, 0.10C
Accuracy	± 0.1PH ± 0.01 PH , ±0.2 mv, ,± 1mv , ± 0.20C
Calibration	Automatic up to 5 point calibration with 7 standard buffer solutions
Temperature Compensation	Manual or Automatic from -20.0 to 120.00C
Electrode	pH electrode: glass, interchangeable, min. 1 m cable (included); Temperature electrode: min. 1 m cable (included)
Operating environment	minimum 0 – 50 °C; RH 95%
Other features	USB interface Plastic moulded rust proof, water-proof body Data logging up to 200 records Plastic electrode holder Ready indicator GLP features

14.14.2 Lab Nephelometer (Turbid meter)

Principle of operation	Nephelometric
Analytical method	Compliance with ISO 7027 or USEPA Method 180.1 or APHA 2130 B
Range	0.0 to 9.99, 10.0 to 99.9, 100 to 4000 NTU
Range selection	Automatic
Resolution	0.01 on lowest range
Light source / Life	Tungsten filament lamp / greater than 1 00 000 readings
Accuracy	±2 % of reading plus 0.02 NTU
Calibration	Automatic 3-points calibration with memorized buffers; calibration solutions included
Repeatability	±1% of reading
Turbidity standards	< 0.1, 15, 100 and 2000 NTU
Operating environment	0 – 50 °C; RH 95%
Other features	USB PC interface minimum 10ml or 20 ml sample volume minimum 4 empty sample vials Log memory 200 records

14.14.3 Electrical Conductivity Meter

Analytical method	Laboratory Method; APHA 2510 B.
Range	to 29.99 µS /cm ,30.0 to 299.9 µS /cm, 300 to 2999 µS /cm 30 to 200 ms/cm up to 500.0 mS/cm
Resolution	0.01 µS/cm; 0.01 mS/cm
Accuracy	± 1% of reading ± (0.5 µS or 1 digit, which greater)
Electrode	conductivity probe with temperature sensor and min. 1 m cable (included)
Temperature	-5.0 ... +105.0 °C
Salinity	to 400.0% NaCl
Calibration	1 Point offset calibration (0.00 µS/cm in air):1 point slope calibration In EC standard 84 µS/cm
Operating environment	minimum 0 – 50 °C; RH 95%
Temperature Compensation	Automatic temperature compensation
Other features	Simultaneous display of temperature / 200 data memory Rechargeable battery that can last at least 6 hours

14.14.4 Handheld Pocket Residual Chlorine Analyser

Analytical Method	DPD Colorimetric, Method APHA 4500-Cl G
Range	0.01 – 5 ppm
Optics	Dual LED light source optical system with narrow band wavelength filters and photo detectors
Accuracy	Dual wavelength, 530 nm
Wavelength Tolerance	±2 nm
Data point memory	min. 1000
Filter bandwidth	10 nm
Operating environment	minimum 0 – 50 °C; RH 95%
Reagent	Supplied with reagent pack for free and total chlorine – 200 tests
Operating Temperature	0°C – 50°C
Power supply	2×1.5V AA Batteries. Auto switch off setting

Other features	Stability indicator feature that prompts when to take the reading " Hold" feature that freezes the display for easy and accurate recording 25 nm diameter test tube

14.14.5 Thermometer

The lab thermometer shall be equipped with non-mercury red alcohol and white back permanently fused markings. Length of the thermometer shall be minimum 300mm. The range of the capacity is from -10^0C to 150^0C with a division of 1^0C.

14.15 Resilient Bearing Strip

When specified, gas vent flaps or vent pipes shall be installed in accordance with the drawings or as instructed by the Engineer to provide adequate venting for the liner system. The venting pipe should be fitted with required fittings and cowling.

Resilient Bearing Strip is a bearing pad shall be manufactured by all new (unused) materials and composed of multiple layers of prestressed 50/50 cotton-polyester blend duck, 8.1 ounce per net square yard, duck warp count 50 ± 1 threads per inch and filling count 40 ± 2 threads per inch, impregnated and bound with a high quality, oil-impervious nitrile rubber compound, containing rot and mildew inhibitors and anti-oxidants, compounded into resilient pads of uniform thickness.

Pads can withstand compressive loads perpendicular to the plane of laminations of not less than 12,000 psi before breakdown.

Pads meet AASHTO standard specification for fabric-reinforced bearing pads. Low coefficient of friction via PTFE surface

PTFE pad shall be minimum nominal thicknesses of 6.3 mm.

14.16 Stainless Steel Strip

Stainless Steel Strip used in saddle posts, anchor blocks, thrust blocks and other structure shall be as per IS 6911-1992 and dimension shall be as per the drawing. The weight of steel sheet and strips shall be taken from relevant Indian Standards based on 7.85 kg/m2 for every millimeter sheet thickness. For rolled sections, steel rods and steel strips, weight given in relevant Indian Standards shall be used.

14.17 Specification for Single Dosing Chlorination Unit

A. Chlorination Dosing Unit with Single Chemical Dosing Pump

S.N.	Description	Specification	Quantity
1	Chemical Mixing Motor with Gear Box	0.5 HP, 220- 230 V,50 Hz, 210 RPM	1 No.
2	Chemical Dosing pump	The pump shall work for flow rates minimum 4 lit/hr and max.8lit/hr with min. 2 bar and max. 12 bar pressure with inbuilt level senser which trips the pump in case of low level of chloine dosing tank. Pump Heas: PVDF, Diaphragm: PTEF, Stroke Per minute: 160, Suction Discharge: 4/6mm	1 No.
3	Chlorine Mixing Tank	PVC tank of Size at least 200 ltr	2 No.
4	Chemical Mixing Agitator	made of 304 grade stainless Steel 3'x6" 2 mm thickness with 2" Dia, speed at least 210 rpm	1 No.
5	Metal(MS) Structure with Primer and Enamel Coating with Nut Bolt of at least 90 kg weight		1 Set
	>Stand for Chemical Mixing tank	2 mm thickness Stand for Chemical Mixing tank, Height 48"Width of 32"X32"	1 No.
	>Angel Stand for rising chemical mixing motor	1.1/2" Angel Stand with 2 mm thickness and 50" Height from bottom of Chemical mixing tank	1 No.
	>Angel Stand for Chemical solution tank	1.1/2" Angel Stand for Chemical solution tank-32"x32" and 6" Height from ground level to the bottom of Chemical solution tank	1 No.
	>Ladder with platform	40"x 18" Ladder with 18"x 18" platform	1 No.
	>Cover for Motor and chemical dosing pump to protect from rain	Metal cover for Motor to protect from rain	2 No.
6	UPVC pipe and fittings with Ball Valve tank, Union, Nipple	½ connection for chemical injection port in existing water pipe to tank	
	>Tank nipple	25mm size, for flushing and outlet of chlorine tank	2 No.
	>Tank nipple	40mm size, for flushing and outlet of mixing tank (inlet of chlorine tank)	2 No.
	>Ball Valve	25mm size, for flushing and outlet of chlorine tank	2 No.
	>Ball Valve	40mm size, for flushing and outlet of mixing tank (inlet of chlorine tank)	2 No.
	>Union		1 No.
	>Female Thread Adopter	25mm size, for flushing and outlet of chlorine tank	2 No.
		40mm size, for flushing of mixing tank	1 No.
	>Pipe and fittings	40mm size length 1.5m	1.5m
	>Pipe and fittings	25mm size length 1.5m	1.5m

7	Electric Works	Electric Power Cable covered with insulated pipe length- 25 mtr, dosing pump should be automatic onwhile water pump is on and off when water pump is off.	1 set
		Electric Power cable to chemical mixing motor with motor starter switch	
8	Chlorine dosing demonstration	Bleaching power 25 kg bag, quality as specified in the document, shall be used for the demonstration of whole chlorine dosing system after installation.	1 bag
9	Installation, Testing and Commissioning of Chlorination unit as instructed by engineer (all complete)		1 job

B. Specification for Bleaching Powder

1. The bleaching powder should be Grade 1, manufactured by chlorination of slaked lime.

2. Stable bleaching powder shall be white to slightly yellowish-white in appearance and shall be free from hard lumps and any visible impurities.

3. The material shall be dry and free-flowing

4. The available chlorine in the bleaching powder should be more than 30 percent by weight.

5. Moisture content of bleaching powder should not be more than 0.3 percent by weight.

6. The material shall be packed in airtight galvanized steel drum or other air tight containers, dry and free from grease, dirt or other foreign matter likely to cause decomposition of the material.

7. The containers shall be securely closed and marked with the name of the manufacturer, grade, weight of the material in the container, recognized trade-mark, if any and month and year of manufacture.