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STANDARD SPECIFICATIONS

1.0 ITEMS OF GENERAL APPLICATION

1.1 SCOPE

These Technical Specifications cover principles, responsibilities, and requirements for items that will be applicable to all civil, electrical, mechanical, and building works pertinent to the Contract.

They shall be read in conjunction with the Conditions of Contract, the Bills of Quantities (BOQ) and the Drawings.

The specifications provided in the Specification 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 Scope of Contract

Details of scope of Contract are as described in the Supplementary information.

1.1.2 SCOPE OF WORKS

Project Specific Details

The activities to be undertaken by the Contractor within these Contracts include the following:

a. To supply all materials and equipment required for construction of the Works, except items supplied by the Employer. The Contractor's supply items may include manufacture, 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 with 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 inspections for quality control.
b. To provide all necessary staff (including 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. Where appropriate, the contractor shall provide all suitable facilities and accommodation for the staff and workmen and he shall make provision for all costs related to such provisions and for medical, re-location, taxes or other expenses.
c. To provide all equipment, machinery, tools etc. and related spares, maintenance and consumables necessary for implementation of the Works.
d. To provide all site offices, stores, workshops and facilities necessary for use by the Employer, Engineer and support staff and for the Contractor himself and his support staff
e. 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.

f. To prepare documentary records of the Works in the form of "as-built" drawings, schedules etc.

g. 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 land owners, and there shall be no outstanding matters requiring attention

1.1.3 DEFINITIONS

a) 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 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.

b) 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.

c) 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.

1.2 FACILITIES FOR 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 m^2
2. Office :- 9 m^2
3. Toilet with commode, washbasin, mirror, towels holder, etc. 4 m^2
4. Storage room 9 m^2

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 have preferably concrete floors or 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.
iv. 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 ENGINEERS 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 Contractors 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 should be new plain-coloured four wheel drive with double cab having A/C with heating and demisting. It should have Indirect injection turbocharged intercooled diesel engine with 4 no of cylinders. The minimum piston displacement of the engine shall not be less than 2000 cc with tolerance of 1%. The engine shall have a dry type heavy duty air intake filter. The minimum torque of the engine shall not be less than 250Nm at the optimum rpm. 4 Forward and 1 Reverse gear are required. The Vehicle should have Hydraulic Power Assisted steering type. Front double wishbone type with Torsion Bar and Rear Parabolic leaf springs should be provided with hydraulic double acting Telescopic type at Front and Rear shock Absorbers. Front Disc Brake and Rear drum brake is required. Vehicle should have 2 front and 2 rear wheels with 1 spare. It should have a minimum ground clearance (unladen) of 200mm. It should have 12 volts negative earth system voltage having 12V 75AH battery. The capacity of fuel tank should not be less than 55 litres.

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 authorised by the Engineer, together with any authorised 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 and with a minimum of 5 years verifiable experience as a driver of similar vehicle types. The Contractor shall provide fuel, oil and maintenance in conformity with the vehicle manufacture's recommendations and shall clean the vehicles inside and outside as required during the period of the Contract. A suitable replacement shall be provided for any vehicle out of service for more than 24 hours.

The vehicle to be supplied is for the purposes of Project implementation and subsequent operations. Therefore, the supplied vehicle shall ply within the district limits of the Project. However, in cases where it is deemed essential to ply the vehicle beyond the district boundaries for the sole purpose of the concerned Project, the Engineer shall instruct the contractor accordingly. No additional payment shall be made for this purpose.

1.3 ACCESS TO AND POSSESSION OF SITE

1.3.1 THE SITE

The Site is: That land purchased or for which a right of way has been acquired by the Employer.

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 shall be subject to any restrictions mentioned in the Contract.

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

1.3.2 TEMPORARY WAY LEAVES, ACCESS COSTS

The Contractor shall be responsible for obtaining temporary way leaves.

The cost of obtaining way leaves, 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 COORDINATION WITH OTHER AUTHORITIES, in connection with any temporary working area and shall give to the occupier of each such area seven days 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

Unless otherwise provided in the Contract, no separate measurements and/or payment shall be made for all materials and works required under this clause (Clause 1.3). All cost in connection with the work specified herein shall be considered to be included with other related items of works in 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 housing with all necessary amenities and facilities for his staff and labour. The type of housing, such as accommodation containers, pre-fabricated or in-situ buildings or even rental is entirely up to him. Also the choice of one central camp or of various sub-camps is up to him as this depends greatly on the approved work program

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.

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 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 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.

1.4.4 WATER SUPPLY

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

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

Water for drinking purposes shall be of drinking water quality.

1.4.5 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 Medical Officer of Health or other competent authority.

1.4.6 SEWAGE AND WASTE DISPOSAL

The Contractor shall make provision for the discharge or disposal from his camp, offices and the Works of all water 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.

1.4.7 POLLUTION

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

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 operations.

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 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.

Firewood may be obtained on the open market. Under no circumstances shall the Contractor cut down trees for 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 bonded 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.

1.4.10 TEMPORARY TELEPHONE CONNECTIONS

The Contractor shall arrange at his own cost for temporary telephone 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.

1.4.11 FIRST AID

The Contractor shall make his own arrangements for treatment of casualties on the Site in such first-aid units as may be thought necessary. The Contractor shall be responsible for the construction of such first-aid units and their management and operation and the 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.

1.4.12 FIRE PROTECTION

No naked fire shall be used by the Contractor on or about the Site otherwise than in the open air without the permission in writing of the Engineer. 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 fire fighting 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.

1.4.13 CONTRACTOR'S CANTEEN

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

1.4.14 TESTING FACILITIES, LABORATORY

The Contractor shall provide a laboratory equipped and furnished with all testing facilities required to perform all mandatory tests stipulated in the various specific clauses of these Technical Specifications.

1.4.15 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 specially 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.

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, footpath, etc., it shall be of the type required by and shall be erected to the satisfaction of the authority concerned.

All open excavations along pipelines 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.

The contractor shall provide safety equipments, such as safety helmets, gloves, boots, safety ropes, etc., in requires and sufficient numbers to Engineer's staff, Contractor's staff, Contractor's skilled as well as unskilled labours at all times.

1.4.16 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.

1.4.17 SIGNBOARDS

Signboard of size 3mx2m shall be placed at an approved location giving information in English and Nepali about the name of project, Employer, Engineer and Contractor. 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.

1.4.18 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.

1.4.19 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.

1.4.20 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.

1.4.21 MEASUREMENT AND PAYMENT

Unless otherwise provided in the Contract, no separate measurements and/or payment shall be made for all materials and works required under this clause (Clause 1.4). All cost in connection with the work specified herein shall be considered to be included with other related items of works in 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.

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.

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 provided 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.

1.5.3 PROTECTION OF ADJOINING PROPERTY

1.5.3.1 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 endeavour 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.

1.5.3.2 Buildings and other Structures

The Contractor shall be responsible and take all measures in order to protect adjoining property including buildings 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.

The measurement for payment of the repair of the damages to the building, if ordered, shall be made at actual quantities of activities carried out. All costs related to the assessment, protection etc. are deemed to be included in the unit rates of other items, and shall not be paid separately.

1.5.4 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.

1.5.7 MEASUREMENT AND PAYMENT

Unless otherwise provided in the Contract, no separate measurements and/or payment shall be made for all materials and works required under this clause (Clause 1.5). All cost in connection with the work specified herein shall be considered to be included with other related items of works in the Bill of Quantities.

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 payment will be made for these activities as they are deemed to be included in the rates of other items.

1.7 SUBMISSIONS BY THE CONTRACTOR

1.7.1 PRE-CONSTRUCTION SURVEYS AND SETTING OUT

The Contractor shall agree and record with the Engineer, prior to his first entry thereon, the surface topography and ground conditions along the transmission and distribution mains as per Drawings of Tender Document to the extent considered necessary by either the Engineer or the Contractor. The agreed record is to include photographs and spot levels as necessary and written descriptions of the site conditions.

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

Access roads, detours, bypasses, and protective fences or barricades also should be laid out and constructed as required in advance of drainage construction.

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

Upon commencement of the Works the Contractor shall carry out all additional survey activities necessary for setting out the Works.

The Contractor shall establish all setting out necessary for the performance of the Work to the approval of the Engineer including levels of the original ground surface at the Site and final surveys of the completed Works for the final measurement. Levels shall close within 25 mm times the square root of the length of the circuit in km.

Ground levels shall be taken jointly by the Contractor and the Engineer both prior to commencing and after completion of earthworks. The result of the survey shall be recorded in the manner agreed between the Engineer and the Contractor and be signed by both as being a correct record.

Where cross sections are ordered these shall be at 25 m intervals or at such other spacing as may be ordered by the Engineer. The location of the first cross section shall be approved by the Engineer and each cross section shall extend a minimum distance of 10 m beyond the limits of the Works.

From the centre line and grades established, the Contractor shall furnish and place all additional stakes, templates and bench marks necessary for marking and maintaining points, lines and sections for layout of the Works. The Contractor shall give 2 working days notice in writing whenever he will require the assistance of the Engineer for laying out any portion of the Work.

The Contractor's methods of recording survey data shall be subject to approval and field books and tabulated data shall be well maintained and made available for inspection and checking by the Engineer when ordered.

Instruments and equipment for surveys shall be subject to rigorous inspection by both the Contractor and the Engineer and any item found to be defective, in the opinion of the Engineer, shall be promptly replaced, repaired or adjusted as directed. All surveying shall be done under the direct supervision of a qualified surveyor or engineer who, as an employee of the Contractor, shall be subject to the approval of the Engineer at all times during the progress of the work.

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 and presented in separate attached volume. 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 Bidding Documents. All levels indicated or proposed are based on survey prepared by the Engineer but may 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 profiles, reinforcement detail drawings and bending schedules, shop drawings for structural steel and miscellaneous metal work, working drawings for mechanical plant, architectural items and electrical 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 14 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 not be smaller than 420 x 297 mm (DIN A3) or larger than 841 x 1189 mm (DIN A0) but preferably in 420 x 297 mm (DIN 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

The Contractor has to submit the detailed 'As Built Drawings" of completed works incorporating all 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. After approval of the As Built Drawing the Contractor shall supply an electronic copy of the drawing.

The As Built Drawings shall be presented on the basis of three dimensional coordinates, connected to the national grid or shall be taken from the GPS equipment for entire network and structures.The GPS Coordinate of Major Structures and each and every control points shall be presented.

As built Drawings shall be presented in both hard copy and soft copy.2 sets of hard copy shall be presented in A3 size paper and softcopy in pen drive.

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.

1.7.5 CONSTRUCTION PROGRAMME AND PROGRESS OF WORKS

1.7.5.1 Construction Programme

In amplification of the requirements of Clause 14 of the Conditions of Contract, the programme 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:

- Data of the construction methods
- Equipment Utilization Schedule
- Manpower Utilization Schedule
- Subcontracting Schedule
- 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 Reporting Progress

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 programme for the next fortnight. The programme 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 determined by 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 1.7.5.2;
(c) Updated S-curves for physical progress at different sections of the works;
(d) 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 report month.

1.7.6 OPERATION AND MAINTENANCE MANUAL ALONG WITH TESTING AND COMMISSIONING

The contractor shall operate and maintain the entire system for the testing and commissioning of entire system continuously for ninety(90) days/three months. During this testing and commissioning period, all the system shall operate smoothly with required flow and pressure/design discharge. Any shortcomings shall be rectified by contractor immediately.
The Defect Liability Period shall start only after successful Testing and Commissioning of the entire system and issuing of work completion certificate. Within the period of Testing and Commissioning for three months, the contractor shall submit Operation and Maintenance Manuals of each equipment(Pumping /Electromechanical system) to operate .During this testing period,manpower mentioned in BoQ shall perform after the required training to them(

Pump /Electromechanical operator, meter reader etc.) If the contractor fails to provide the training to the staff nominated by WUC and Employer before starting the testing and commissioning period,five times cost quoted by the contractor for training or twenty lakhs Nepalese Rupees whichever is high shall be deducted .Without training to the referred person, the testing and commissioning shall not be verified by Joint Team of Employer and WUC and Similarly without the testing and commissioning of system,the Project Completion certificate shall not be issued and DLP shall not be started.

1.7.7 RECORD / PROGRESS PHOTOGRAPHS

The Contractor shall arrange each month for 24 Nos. of photographs (Digital) to be taken by a professional photographer as Record Photographs and shall provide the soft copy and 3 colour prints each on glossy paper un mounted and of a size not less than postcard size 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.

1.7.8 MEASUREMENT AND PAYMENT

Unless otherwise provided in the Contract, no separate measurements and/or payment shall be made for all materials and works required under this clause (Clause 1.7). All cost in connection with the work specified herein shall be considered to be included with other related items of works in 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.

Within 30 days from the start date, the Contractor shall submit for approval a Quality Control Plan and Quality Assurance 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.

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 eitheron 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 suppliers for correction or replacement as appropriate.

Any construction material requires Third Party Inspection, as per Employer’s prerogative, the Contractor has to give uninterrupted access to the site/factory, either at the source of material

or at the construction site, to the Independent Third Party Inspector appointed by the Employer. The cost of third party inspection shall be borne by the Employer.

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 supplier'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 suppliers 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 LOG BOOK

The Contractor shall keep a Daily Log Book at each location where major construction activities are taking place. This Daily Log Book 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)
(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, etc.)
(i) visitors at Site.

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

1.8.7 MEASUREMENT AND PAYMENT

Unless otherwise provided in the Contract, no separate measurements and/or payment shall be made for all materials and works required under this clause (Clause 1.8). All cost in connection with the work specified herein shall be considered to be included with other related items of works in 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 tenders 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 German, British, American, Nepalese or Indian Standards shall apply, or others, if so approved.

The Contractor may propose, at no extra cost to the Employer, the use of any alternative relevant authoritative internationally recognized Reference Standard, which shall be no less exacting, in the opinion of the Engineer, than the corresponding standard quoted in the Specification. The Contractor shall demonstrate to the Engineer that the alternative standard is suitable and equivalent to the specified standard, as well as provide proof of previous successful use. 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. The Engineer shall decide whether or not the use of such alternative will be allowed as a Reference Standard.

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 :

NS Nepalese Standardization Office, Balaju, Kathmandu, Nepal

ISO International Organization for STANDARDIZATION, Rue de Varembe, Geneva, Switzerland

DIN Deutsche Industrie 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.

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, Colourado 80235, U.S.A.

IS Indian Standards, ManakBhawan - 9, Bahadur Shah Jafar Marg, New Delhi, 11002.

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 MEASUREMENT AND PAYMENT

Unless otherwise provided in the Contract, no separate measurements and/or payment shall be made for all materials and works required under this clause (Clause 1.9). All cost in connection with the work specified herein shall be considered to be included with other related items of works in the Bill of Quantities.

2.0 CIVIL ENGINEERING WORKS, BUILDING CONSTRUCTION

ACTIVITIES

2.1 SITE CLEARANCE

2.1.1 SCOPE

This specification covers the removal of vegetation, boulders 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

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

1 General
2.2 EARTHWORKS

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 tendering.
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 MATERIAL

Material obtained from clearing and grubbing and from the demolition of structures shall be disposed of in borrow pits 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.

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 without the written permission of the Engineer. 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 not be used by the contractor for any purpose, 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.

Individual trees indicated and marked by the Engineer as trees to be preserved shall be left standing and uninjured. An amount of NRs 5,000/- 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 material resulting from the clearing
c) the removal of all rocks and boulders of size up to 0.2 m^3 that are lying on the surface to be cleared or exposed during the clearing operation.
d) where fences have to be taken 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 the finished level and at least 100 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 Demolition of Structures

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 demolition shall become the property of the Contractor and shall be destroyed or removed from the Site.

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

Except as noted below, debris arising from demolition shall be removed from the Site promptly and disposed of in a place and in a manner acceptable to the local municipality.

Underground structures shall be broken out to a depth of 1 meter 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 200 mm.

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.

Demolition 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.

2.1.6 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 in terms of Clause 2.1.5.1 Areas to be Cleared and Grubbed, 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.

Demolition of structures, buildings etc, shall be measured as a sum for demolition of the identified structure.

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 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:

1 General
2.1 Site Clearance
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 Technical 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.
Borrow - Material obtained from various sources such as borrow pits.
Borrow pit - An excavation made for the purpose of procurement of material.
BulkExcavation –An excavation made from original ground level to reduced site or platform level.
Catchwater 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.
Overbreak - 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.
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 containing organic components that can support vegetation
Unsuitable materialshall 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 can not 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 (Filling)

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 rockfill, gabions and stone pitching shall be hard, tough, sound, 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 topsoil for such purpose shall be free from any foreign materials.

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

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 unauthorised 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 Clause 22 of the Conditions of 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 metres of any building or structure.

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 1.4.15 Site Safety 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 overbreak 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.

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.

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 protection as specified. The Contractor shall follow the requirements of the Department of Roads.

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 Detours and Traffic Control 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 depth 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.

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 catchwaters 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 approved 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 metres. 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:

- Routes, diameters, depths and materials of proposed pipelines.
- Design of proposed holding lagoons.
- Proposed daily average, and maximum pumping/discharge rates.
- Effect on any existing disposal systems proposed to be used.
- 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.

The Contractor shall make good with suitable material or concrete as may be directed :

- any excavation greater than the net volume required for the Works.
- any additional excavation at or below the bottom of foundations to remove material which has become unsuitable.

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 to trim 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.

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.

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.

Fill in embankments terraces etc.

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 stormwater 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.

Backfilling

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 Finishing, 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 300 mm.

If ordered by the Engineer, grass or other vegetation shall be planted after topsoiling 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 and construction.

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

2.2.6 Tolerance in Positions, Dimensions, Levels, etc.

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

a) <u>Excavations</u>

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

b) <u>Embankments, terraces,etc</u>.

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

c) <u>Moisture Content and Density</u>

(i) OMC in field during compaction: +1% and –2%
(ii) 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 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 daywork.

The Contractor shall carry out sufficient tests to satisfy himself about the consistency of material placed in embankments and as backfill.

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 bulk excavation shall cover the cost of excavating, forming 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.

Rates for excavation shall cover the cost of excavating and re-use of the excavated or imported material in backfilling, forming embankments, terraces, shoring and supporting excavations, protection of structures, provision for existing services, dealing with storm and ground water, protection of slopes, the cost of disposal of any surplus and unsuitable material, and the import of any suitable material required for backfill.

Rates for filling shall cover the cost of the provision of suitable material, placing in layers, and compacting as specified.

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

The rate for excavation in rock shall be extra over to normal excavation.

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 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:

1 General
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) <u>General</u>

Adverse weather. Cold weather, or weather in which the ambient temperature is above 45° 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° 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° C but not higher than 15° 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° C.
Normal weather - Weather conditions in which the ambient temperature is higher than 15° C and less than 25° C.

b) <u>Quality</u>

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 days 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.
Sample (of concrete) - The minimum volume of uncompacted freshly mixed concrete required for a designated test as specified in BS 1881.
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

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 28daystest results obtained on cubes of concrete of the same grade can be expected to fall.
Designed Mix - A design mix is designated by its specified strength followed by the size of aggregate used in its manufacture.
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 28daystest results.)
Valid test result - The average result obtained from the testing of two test cubes of concrete as defined in BS 5328 Part 4.

d) Exposure conditions

Mild conditions -Conditions under which the concrete is protected from the weather and is exposed only to air.
Moderate conditions – Conditions under which the concrete is sheltered from severe rain and is not subject to freezing when wet, or buried in non-aggressive soil, or continuously under fresh water.
Severe conditions – Conditions under which the concrete is exposed or subject to any of the following: driving rain, alternate wetting and drying out, freezing when wet, fresh condensation of water, aggressive soil, salt-laden air.
Very severe conditions – Conditions under which the concrete is exposed to any of the following: water containing sulphates or chlorides, highly corrosive fumes.

e) 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"

2.3.3 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 Ordinary Portland Cement (OPC) complying with NS, ISO, or BS standards. 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 determined in accordance with NS 49-2041.

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 for his approval.

The Contractor shall conduct preliminary and works tests as required by the Engineer to determine fineness, compressive strength (mortar cube) at 3 days and 28 days, initial and final setting time and soundness of the cement, as described in NS 49-2041.

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.

2.3.3.3 Water

The water used for making and curing concrete, grout and mortar shall comply with NS 223-2047 and shall be from a source approved by the Engineer. Water shall be clean and free from injurious amounts of acids, alkalis, organic matter and other substances that may impair strength, durability or appearance of the concrete. At the time of use shall be free from polluting matter in any quantity which:

(a) affects the initial setting time of the cement by more than 30 minutes or reduces the compressive strength of test cubes by more than 20% when tested in accordance with NS;
(b) prevents the achievement of the specified test cube strengths at 28 days for the appropriate class of concrete;
(c) produces discolouration or efflorescence on the surface of the hardened concrete.

The water shall be free from hydrocarbons and from suspended organic matter. Inorganic matter in solution shall not exceed 500 mg/l by weight and in suspension shall not exceed 50 mg/l by weight.The water which the Contractor proposes shall be tested by the Contractor to the approval of the Engineer before use in the Permanent Works.

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

All aggregates shall comply with the requirements of NS 305-2050 & NS 403-2054 Specification for aggregates from natural sources for concrete and the additional requirements of this Specification. The Contractor shall undertake all necessary testing to demonstrate compliance with NS 305-2050.

Fine aggregate shall consist of natural sand. The Engineer will permit the addition of suitable crushed rock fine aggregate, as necessary, to the sand where in his opinion it is impracticable to obtain the specified grading of the combined aggregates otherwise than by such addition.

Coarse aggregate shall comply with the requirements of NS 305-2050 & NS 403-2054 for single sized aggregates to the nominal maximum size specified for the appropriate class of concrete and shall be made up of the following grading:

(a) 40 mm single sized
(b) 20 mm single sized
(c) 10 mm single sized.

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 samples shall be taken in accordance with NS 298-2050. Testing of all aggregates in accordance with NS 305-2050 for compliance with all specified requirements shall be performed by the Contractor for each source of aggregate at each grading.
Any rejected aggregate shall be promptly removed from Site.

2.3.3.5 Admixtures

Admixtures shall not be used in any concrete without prior 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.

2.3.3.6 Reinforcement

Unless otherwise stated reinforcement shall be Type 2 deformed bars; Type R (mild steel plain bars) may also be scheduled. All reinforcement shall comply with NS 191-2046.

Fabric reinforcement shall comply with BS 4483.

The contractor shall supply the Engineer with certificates from the manufacturer issued in accordance with relevant NS, for all the required tests including the rebend test in respect of each consignment delivered to Site.

The reinforcement at the time of incorporation in the Permanent Works shall be clean and free from damage, oil or grease, loose mill scale and loose rust. Bars which have become bent shall not be straightened or rebent for incorporation in the Works without the approval of the Engineer.

Steel reinforcement shall be stored clear of the ground and supported to prevent distortion. The Contractor shall supply samples of reinforcement from the stocks on Site when required by the Engineer.

2.3.3.7 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.

2.3.3.8 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.

2.3.3.9 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 or similar approved material of minimum 250mm width. 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 waterstop made on Site shall be kept to a minimum.

Where waterstop 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 waterstop at a factory-made splice shall be at least 90% of the waterstop's tensile

strength, when tested according to BS 903, or equivalent standard, with the spliced joint in the middle portion of the dumb-bell test specimen and the tensile force applied normally to the direction of the splice.The tensile strength of a waterstop spliced at the Site shall be 80% of the original strength of the waterstop.The edge bulb section shall be circular for waterstops installed within concrete sections; trapezoidal for waterstops installed at the base of slabs.

The Contractor shall supply the manufacturer's test certificates for each consignment of waterstops 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.

2.3.3.10 Joint Filler

Unless otherwise specified, joint filler shall be of expanded polystyrene, resin or bituminous bonded cork, or similar. 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.

2.3.3.11 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 Polysulphide sealers shall comply with BS 4254.

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.

2.3.3.12 Waterproof Compound/Membrane

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 OR shall be of two part acrylic modified waterproofing system consisting of a liquid polymer and powder-based on selected cements & aggregate and special fillers and glass fibres, which when mixed, produces a brush-applicable mortar, which, on curing becomes an extremely tough and durable waterproofing coating.

The Water proofing compound shall be of cement based silicon or natural volcanic deposits typed waterproofing compound. The material 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.

2.3.3.13 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.

2.3.3.14 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.

2.3.3.15 Bituminous Paint

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

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 Batching Equipment

The Contractor shall proportion the ingredients of each batch of concrete by weight. The measuring equipment should give an accuracy of± 3% for each ingredient. The water shall be added to the aggregates and cement in a mechanical batch mixer. The device for measuring the water shall show accurately the weight required with a given moisture content of the aggregate and shall be so designed that the water supply will be automatically stopped when the correct quantity has been discharged into the mix.

The storage of aggregates shall be segregated to prevent contamination of the aggregates.

In the case of automatic equipment, the weighing scales shall be so interlocked that a new batch of materials cannot be delivered until the weighing hoppers have been completely emptied of the previous batch and the scales are in balance. Where discharge of materials from the hoppers is manually controlled, a method of signalling shall be employed to ensure that ingredients are not omitted, or are not added more than once, when a batch of concrete is being made up.

Admixtures shall be used in liquid or powder form and shall be measured by volume or weight in the case of liquids and by weight only if in powder form and shall be dispensed through equipment capable of measurement within the tolerance specified. Tanks or drums containing liquid admixtures shall be clearly labelled for identification purposes and stored in such a way as to avoid damage from contamination. Agitation shall be provided for liquid admixtures which are not in stable solutions.

2.3.4.3 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.

2.3.4.4 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.

2.3.4.5 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.

2.3.4.6 Casting Beds and Moulds

All casting beds for precast concrete shall be properly aligned and leveled. 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 discoloured 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

Reinforcing bars shall be bent to the shapes and dimensions shown on the drawings and bending schedules. All bars shall be bent cold around an appropriate former. Bending shall be done slowly, a steady, even pressure being used without jerk or impact.

Steel shall, at the time of the placing of the concrete, be free from loose or powdery rust, scale, oil, or other coatings that may reduce the bond between steel and surrounding concrete, affect the durability of the concrete, or initiate corrosion of the reinforcement. If any substance other than water is used for lubricating the formwork, every precaution shall be taken to avoid contamination of the reinforcing steel by such substance.

Reinforcing steel shall be positioned as shown on the drawings or as directed and maintained in those positions within the tolerances specified. It shall be secured against displacement by tying at intersections with annealed wire of nominal diameter 1.25 or 1.6 mm, or by the use of acceptable clips or, if permitted by the Engineer, by welding. Reinforcing bars shall be supported and aligned in their correct position by means of hangers, chairs, spacers or saddles of approved design.

Unless otherwise shown on the drawing or directed by the Engineer, the minimum cover of concrete over reinforcing bars, measured from the outside of the most outer bar or stirrup, shall be 25 mm for mild exposure conditions, 35 mm for moderate exposure conditions, and 50 mm for severe exposure conditions or the diameter of the bar to which the cover is measured, whichever is greater. Cover shall be maintained by the use of plastic spacers

The Contractor shall ensure that reinforcement including stirrups, links, and tying wire does not encroach into the specified cover. Splices or joints in reinforcing bars shall be made only as and where shown on the drawings or as otherwise approved.

If left exposed for future bonding of extensions to the Works, reinforcing steel shall be protected from corrosion as directed. For precast units, reinforcement shall, where practicable, be preformed into rigid cages. For this purpose, spot welding of bars shall be carried out only by skilled and experienced welders.

2.3.5.2 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 III as defined in terms of clause 2.3.6 Tolerances.
b) Class F2 Smooth: Imperfections such as small fins, bulges, irregularities, surface honeycombing, and slight surface discolourations shall be made good and repaired by approved methods. The finish of the concrete shall be accurate to Degree of Accuracy II.
c) Class F3 Special. Special finishes shall be as indicated on the drawings.

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 columns1 day
(ii)Slabs with props left underneath 7 days
(iii) Beam soffits with props left under 14 days
(iv) Slab props, including cantilevers 21 days
(v)Beam props, including cantilevers 21 days

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

(i)Beam sides, walls, and unloaded columns 2 days
(ii)Slabs with props left underneath 14 days
(iii) Beam soffits with props left under 21 days
(iv) Slab props, including cantilevers 28 days
(v)Beam props, including cantilevers28 days

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

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.

2.3.5.3 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.

2.3.5.4 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.

2.3.5.5 Concrete

2.3.5.5.1 Quality

Concrete shall comply with the requirements for strength concrete by proper mix design. The contractor shall perform mix design for all grades of concrete mixes and shall get the prior approval from the Engineer.For precast concrete, the mix shall be of grade M20 unless another grade is shown on the drawings.

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 following table

Requirements of Classes of Concrete

Class	Cement content (kg/m^3)		Maximum W/C ratio	Workabilit	Cube crushing strengths (N/mm^2)		
	Minimum	Maximu			Target	Minimum of 4	Minimu
35A/40	325	400	0.55	Medium	46.5	38.0	32.0
35A/20	325	400	0.55	High	46.5	38.0	32.0
30/40	245	400	0.65	Medium	41.5	33.0	27.0
30/20	275	440	0.65	High	41.5	33.0	27.0
30/10	315	460	0.65	High	41.5	33.0	27.0
20/20	220	440	0.65	Medium	31.5	23.0	17.0
10/20	220	-	0.70		16.0	12.0	8.0

Notes: 1Water cement ratio is the ratio of free water to cement in the mix based on aggregates being in a saturated surface dry condition.

2. The specified characteristic compressive strengths for the minimum individual test result and the mean of four consecutive test results are derived from Clause 3.16.2 and Table 1 of BS 5328 : Part 4 : 1990.
3. High workability: slump 65 to 135mm

Medium workability: slump 50 to 100mm

Unless otherwise specified or agreed by the Engineer for concrete Grade 30 and above the proportions of coarse and fine aggregates shall be selected to achieve one of the grading curves defined in the following table within an allowable tolerance of generally 5%. A change from a maximum positive tolerance to a maximum negative tolerance in consecutive sieve sizes shall be avoided.

Combined Aggregate Grading :

Sieve size (mm)	40 mm maximum aggregate size grading curves			
	1	2	3	4
50	100	100	100	100
37.50	95	97	99	100
20	50	59	67	75
10	36	44	52	60
5	24	32	40	47
2.36	18	25	31	38
1.18	12	18	24	30
0.60	7	12	17	23
0.30	3	7	11	15
0.15	0	0	2	5

Sieve size (mm)	20 mm maximum aggregate size grading curves			
	1	2	3	4
37.5	100	100	100	100

20	95	97	99	100
10	45	55	65	75
5	30	35	42	48
2.36	23	28	35	42
1.18	16	21	28	34
0.60	9	14	21	27
0.30	2	3	5	12
0.15	0	0	0	1.5

The Contractor shall submit details of the source of all material and the proposed quantities of each ingredient per cubic metre of fully compacted concrete. The Contractor shall then make trial mixes for each class of concrete using the same type of Constructional Equipment and the same materials as are proposed for the Permanent Works. The Contractor shall give 24 hours' notice of such trials to enable the Engineer's Representative to attend. For each trial mix, three separate batches of concrete shall be made by the Contractor and will be tested at 28 days all in accordance with NS 511-2060. Such trial mixes shall not be the first batch through the equipment in any one sequence of concrete production.

The Contractor shall not commence concreting in the Permanent Works until details of trial mixes and test results for each class of concrete have been submitted to, and approved by, the Engineer.

A trial mix design will be approved by the Engineer with respect to strength if the average compressive strength of the nine cubes so tested is more than the target mean strength appropriate to the class as given in Table above.

The Contractor shall not alter the approved mix proportions nor the approved source of supply of any of the ingredients without having previously obtained the approval of the Engineer.

During production the Engineer may require trial mixes to be made before a substantial change is made in the materials or in the proportions of the materials to be used.

2.3.5.5.2 Batching

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. (See 2.3.5.1).

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.

Volume-batching of cement will in no case be accepted.The Contractor may, however, so proportion the mix that each batch shall use a whole bag or bags of cement, the weight of which is known precisely. All gauge boxes shall be accurate and strongly constructed and due allowance shall be made for bulking of the aggregates in assessing the correct volume to be used. The aggregates and the cement shall be thoroughly mixed in a clean mechanical mixer for a period of time agreed with the Engineer and the water added on the basis of the approved mix.

2.3.5.5.3 Mixing

The following requirements shall apply to the mixing of concrete at the construction location:

a) Mixing of materials for concrete shall be conducted by an experienced operator.
b) The sequence of charging the mixing equipment shall have been approved before mixing commences and, unless otherwise directed, the approved sequence shall be maintained.
c) The total volume of material per batch shall not exceed the rated capacity of the mixer.
d) Before any concrete is mixed, the inner surfaces of the mixer shall be cleaned and all hardened concrete shall be removed. A slurry of cement, sand, and water containing cement and sand in a ratio of 1:2 and in sufficient quantity to cover the entire inside surface of the mixer shall be produced in the clean mixer and discharged immediately before the charging of the mixer with materials at the commencement of each concrete production run.
e) The period of mixing shall be measured from the time when all the materials are in the drum or pan to the commencement of discharge. Subject to the provisions of (f) below, the mixing period for each batch of 1.5 m^3 or less shall be at least 1.5 min and 1 min for drum-type and pan-type mixers respectively, and shall be increased by 20 sec and 15 sec respectively for each additional cubic metre or part thereof. During this period, the drum or pan shall be rotated at the speed recommended by the manufacturer of the mixer. The maximum continuous mixing times at the recommended mixing speed shall not exceed 10 min and 6 min per batch for drum-type and pan-type mixers respectively.
f) Discharge shall be so carried out that there is no segregation of the materials in the mix. The mixer shall be emptied completely before it is recharged. If the mixer has been out of use for longer than 30 min, it shall be thoroughly cleaned out, particular attention being paid to the removal of any built-up of materials in the drum, in the loader, and around the blades or paddles.

The Engineer will advise whether the production of concrete at a central concrete production facility other than on the construction location is permitted and whether the test results obtained by such a production facility as part of its quality control system are acceptable.

2.3.5.5.4 Transportation

Mixed concrete shall be discharged from the mixer and transported to its final position in such a manner that segregation, loss of ingredients, and adulteration are prevented and that the mix is of the required workability at the point and time of placing.

2.3.5.5.5 Placing

The Contractor shall give the Engineer 3 days notice of his intention to place concrete. The concrete shall be placed within 1hrsof the time of its discharge from the mixer. Concrete shall not be retempered by the addition of water or any other material. The forms to be filled shall be clean internally. All excavations and other surfaces of an absorbent nature that are to come into contact with the concrete shall be dampened with water. There shall be no free water on the surfaces against which concrete is to be placed.

Wherever possible, the concrete shall be deposited vertically into its final position to avoid segregation and displacement of reinforcement and other items that are to be embedded.

Deposited concrete shall not be so worked (whether by means of vibrators or otherwise) as to cause it to flow laterally in such a way that segregation occurs. Where possible, the concrete shall be brought up in horizontal layers of compacted thickness not exceeding 450 mm and heaping shall be avoided.

Where a chute is used to convey the concrete, its slope shall be such as will not cause segregation, and a suitable spout or baffles shall be provided for the discharge of the concrete.

Concrete shall not be allowed to fall freely through a height of more than 2 m, unless otherwise approved.

Placing of concrete under water will be permitted only under exceptional circumstances when it is, in the opinion of the Engineer, not practicable to dewater before placing. No concrete shall be placed in flowing water. When the placing of concrete under water is permitted, it shall be placed by means of a tremie. During placing, the lower end of the tremie shall be continuously immersed in the concrete being deposited. To maintain the desired properties of the concrete the quantity of cement in the concrete mix shall be increased by 20%. Full details of the method proposed and of the adjusted concrete mix proportions shall be submitted to the Engineer for his approval before placing commences. During and after concreting under water, pumping or dewatering operations in the immediate vicinity shall be suspended.

Waterstops shall be carefully maintained in the position shown on the drawings and properly protected from damage and the harmful effects of light and heat during all stages of

construction. The stop-boards on each side of the waterstop shall be accurately wrought to match the profile of the waterstop. The concrete shall be carefully compacted under and around the waterstop so as to leave no cavities.

Joint filler material of the thickness specified shall be cut to shape and fixed to fill the whole space between the concrete faces of the joint which is not otherwise filled by waterstop and joint sealer.Abutting pieces shall be placed in close contact and the joints covered on each side to prevent the passage of cement grout.

Recesses at movement joints on both faces of the concrete work except on the underside of continuously supported work and on faces backfilled with earth shall be accurately formed to the lines and dimensions shown on the drawings. The Contractor shall prepare the surfaces of the recesses and shall supply a joint sealer and fill or caulk the recess completely with it, all in accordance with the manufacturer's instructions.

The placing of concrete by pumping in any section of the Works shall be subject to the approval of the Engineer. The Contractor shall furnish the Engineer with full details regarding the mix proportions of concrete that he intends to place by pumping.

The Contractor shall not place concrete in the Permanent Works:

(a) During heavy rains or dust storms.
(b) When the air temperature is more than 43°C.
(c) When the air temperature is less than 2°C.
(d) If the temperature of the concrete on discharge from the mixer is less than 4°C or more than 32°C.
(e) When the air temperature exceeds 25°C without taking precautions and demonstrating to the approval of the Engineer that the maximum internal temperature of the concrete within 24 hours after casting in place is unlikely to be more than 30°C in excess of the ambient temperature or more than 60°C.
(f) Without the Engineer’s approval if the temperature of the shutters or reinforcement exceeds 30°C.

To keep within these limits the Contractor may, among other means, spray aggregates with water, and use chilled mixing water, or add ice direct to the mixer provided that no ice is present in the mix when discharged from the mixer.
When concreting in hot weather all material used shall be kept in the shade. Water tanks, mixers and chutes should be shaded, but where this is not possible they shall be painted white and kept white.

2.3.5.5.6 Compaction

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. 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.

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 arises 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.

2.3.5.5.7 Designated and Construction Joints

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

a) Joints when concrete is less than 24hrsold.The surface of the concrete shall be water jetted to expose the aggregate.
b) Joints when concrete is more than 24hrsbut not more than 3 daysold.The surface of the concrete shall be sandblasted or chipped with a light hammer to expose the aggregate.
c) Joints when concrete is more than 3 days old.The procedure specified in (b) above shall be followed.

Preparation before placing concrete

a) Joints when concrete is less than 24hrsold.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 is more than 24hrsbut not more than 3 days old.The surface of the concrete shall be swept clean, and thoroughly wetted but without pools of water.

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

2.3.5.5.8 Curing and Protection

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.

2.3.5.5.9 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 screeding 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 pavings, block or tile pavings 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 pavings 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.

2.3.5.5.10 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 watertightness. Should any such section of the Works fail to pass the tests for watertightness as required in terms of the Technical Specification or as ordered, or show any sign of water leakage or penetration after being taken into use, it shall be deemed defective and shall be demolished and replaced with proper one.

2.3.5.5.11 Concrete in Wet Ground

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

2.3.5.5.12 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 scabbling 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° outward from the bottom edges of each base or bedplate and the trimmed edge wood-floated to a neat finish.

2.3.5.5.13 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 pipework, 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.

2.3.5.5.14 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.

2.3.5.5.15 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.

2.3.5.5.16 Joint Sealers

(a) General

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.

2.3.5.5.17 Concrete for Benching

Concrete for benching in manholes and similar structures shall consist of Grade C20/10 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.

2.3.5.5.18 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.

2.3.5.5.19 Reservoir Roof Finish

Reservoir roof finish shall comprise:

(i) Waterproof Membrane of heavy duty either polythene film and self adhesive rubber/bitumen compound or two part (liquid polymer & powder based on selected cement, aggregate, special fillers & glass fibres) acrylic modified cementitious coat
(ii) Heat Insulation. Sand layer overlaid with thick layer of crushed rock or gravel.

(i) Waterproof Membrane

The membrane shall be laid on a clean, dry concrete surface, free from dust, primed if necessary, in accordance with the manufacturer’s instructions with at least 75 mm lap at each joint.

All materials shall be carefully protected from damage, deterioration before, during and after installation. Part or all of the heat insulation layer shall be laid as soon as possible after the completion of laying of waterproof membrane and approval by the Engineer.A solar protective material shall be installed in all locations where the membrane is not permanently covered by the heat insulation layer.

(ii) Heat Insulation

The roof membrane of the reservoir shall be covered with a 50 mm layer of sand of the same type as used for making concrete and subsequently overlaid with a 100 mm thick layer of crushed rock or gravel of 20 mm nominal size.

The Contractor shall ensure that the roof membrane is not damaged when the heat insulation is being placed. During the placing operation, the roof slab shall not be subjected to a superimposed load exceeding 150 kg over and above the weight of the granular material. The material shall be spread in even layers and not stock piled in heaps on the roof for spreading at a later date.

2.3.6 TOLERANCES

2.3.6.1 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 or 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, eg 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 classes 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.

2.3.6.2 Permissible Deviations

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

2.3.7 TESTS AND ACCEPTANCE

2.3.7.1 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 m^3 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.

2.3.7.2 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 (eg 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 days strength divided by 1.4.

2.3.7.3 Acceptance Criteria for Designed Mix concrete

Of the three cubes made from each sample of fresh concrete in accordance with relevant NS or BS 1881, one will be crushed at 7 days and the other two at 28 days. The average of the two

28-days 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 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 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, 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.

2.3.7.4 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.

2.3.7.5 Acceptance Criteria for Reservoirs Tanks etc.

Cleaning Reservoirs, Tanks etc

On completion, all water retaining structures shall be carefully cleaned by sweeping and brushing with stiff brooms, first with the minimum use of water and subsequently with water hosing, to the approval of the Engineer. The water shall be run off, bailed or pumped out after cleaning and any sediment removed to the satisfaction of the Engineer.

Testing of Water Retaining Structures

All water retaining structures with dividing walls and, each individual tank shall be tested separately. In the case of underground or semi-underground structures, the testing shall take place before any perimeter drains or filter membrane or backfilling are placed against the walls and no such placing of material against the walls shall take place until the Engineer has given his approval after the completion of satisfactory testing.

The testing shall not be undertaken until the structure to be tested has been completed structurally (including roof, if any) and has been passed by the Engineer in writing as satisfactory in all respects other than watertightness, especially in regard to the final finish of the work; no filling shall take place earlier than 28 days after the casting of the final sections of the structure which will be stressed by the filling of the structure.

The structure shall be filled with clean water to the design top water level (any overflow pipes or other openings in walls etc being temporarily but efficiently closed by means approved by

the Engineer). The rate of filling shall be reasonably constant and shall not exceed 2.5 m of the depth in 24 hours. A higher rate may be used with approval from the Engineer. After filling, the structure shall be allowed to stand full (being topped up as necessary) for at least 72 hours, for absorption of water by the concrete to take place, at the end of which period the level shall be accurately noted. The structure shall then be accepted as watertight if after a further 72 hours:

(i) No leaks or damp patches on the backs of walls are discernible during the period of the test (if the backs of walls are wetted by rainfall or any other cause the test must be delayed until they are dry for at least 72 hours). In case of individual parts of a structure being tested independently, the division walls also must be watertight.
(ii) The floor under-drainage system of the structure (if any) remains dry, or the flow in it before the test is not increased as a result of filling the structure with water.
(iii) There is no discernible change in the level of the water in the structure during the period of the test. For the purposes of this clause, the limit of discernability will be taken as 3 mm.

The roof of concrete reservoirs and tanks shall be tested for watertightness after the application of the waterproof membrane by lagooning the roof slabs to a minimum depth of 50 mm for a period of 72 hours. The roof slab shall be regarded as satisfactory if no leaks or damp patches appear on the soffit.

Should the part of the structure under test fail the above tests in any respect, the contractor shall immediately take such steps as may be necessary to ascertain the nature and positions of any defects or leakages, shall empty the structure, and remedy the defects in a manner approved by the Engineer, employing men who are specialists in this class of work. A damp patch appearing on the outside of the wall must be rectified from the water face, a repair to the outer face only will not be approved; this applies to bobbin holes also.

When the remedial work has been completed in a manner approved by the Engineer, the testing and if necessary rectification shall be repeated until a satisfactory test is achieved.

If necessary, in extreme cases of lack of watertightness, the Engineer may reject the structure, any member or section of a member of the structure.

Sterilisation of Reservoirs and Tanks

After the reservoirs and tanks have been cleaned out, successfully tested and accepted as watertight by the Engineer, sterilisation shall be carried out by either of the following methods:

(i) A solution containing 50 mg/l of chlorine shall be prepared and brushed vigorously into the internal surfaces of the structure, left for a contact period of one hour and then flushed with clean water.
(ii) The structures shall be filled to overflow pipe level or top water level with chlorinated water having a free chlorine content of 20 mg/l and left to stand for 24 hours. Above this level all internal exposed surfaces shall be treated as in (i) above.

The Contractor shall provide his employees with gas masks, goggles and protective clothing for carrying out this work.
The Contractor shall be responsible for disposing of the waste chlorine solutions in a manner as to avoid injury or damage to persons, animals, things, Works and materials.

After completion of sterilisation neither the Contractor nor his employees shall enter or interfere with the structures or pipework in any way, except with the written authority of the Engineer and only then on such conditions as the Engineer may impose.

If, after sterilisation has been carried out, any fault in a reservoir or other part of the work develops so that the reservoir or pipework has to be emptied, the Contractor shall empty the structure, carry out the repair and any watertightness testing required, and shall then repeat the sterilisation procedure described above.

2.3.8 MEASUREMENT AND PAYMENT IF NOT OTHERWISE SPECIFIED IN THE BOQ.

2.3.8.1 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 0.5 m^2.

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° up to 95°
   (ii) sloping: >10° up to 85°
   (iii) battered: up to 10°
   (iv) vertical: 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.

2.3.8.2 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, slices/lapping , chairs 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.

2.3.8.3 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, which ever 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.

Subfoundation 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 0.5 m^3 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.

2.3.8.4 Miscellaneous Items

Only designated joints shall be measured. 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.Waterproofmembrane 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. Unless otherwise mention in the BOQ no separate payment will be made for water proofing compound.

2.4 BRICKWORK/STONEWORK

2.4.1 SCOPE

This specification covers the general construction requirements for brickwork and stonework in general building construction (e.g. guard house at the reservoir site, etc.), treatment plant, in manholes and chambers for sewer and storm water drainage networks, and for curtain walls in the reservoir.

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:

1 General
2.1 Site Clearance
2.2 Earthworks
2.3 Concrete

2.4.2.2 Application

This specification contains clauses that are generally applicable to brickwork and rubble masonry construction, soling work, and associated work.

2.4.3 MATERIALS

2.4.3.1 Bricks

Bricks shall be obtained from an approved manufacturer and shall be either general purpose bricks (for buildings) or special burnt clay bricks or engineering bricks (for manholes etc.) as 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 of good quality brick earth and thoroughly burnt, and shall be of deep cherry red or copper colour. 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 underburnt lumps of any kind.They shall be uniform in size and regular in shape and have square, straight and sharp edges and even surfaces.

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.

The hollow concrete blocks shall be made of 1 part of cement, to 6 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.

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 Materials.All cement for mortar for exposed face work shall be of a uniform colour as approved by the Engineer.

2.4.3.4 Sand and Water for Mortar

Sand (fine aggregate) and water used shall be in accordance with the requirements of Clause 2.3.3 Materials, and sand for exposed face work shall be of a uniform colour as approved by the Engineer.

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 Stone

The stones to be used shall be hard, tough, sound, durable, and angular in shape. If boulders are used, they shall be broken into angular pieces. The stones should be free from iron bands, spots, sand holes, flaws, shakes, cracks, or other defects and impurities like clay, oil, etc. The stone shall not absorb water more than 5%. The specific gravity of stone shall not be less than 2.50. Except otherwise mentioned in the contract, the length of any stone shall not exceed three times its height. The breadth of the stone on the bed shall not be less than 150 mm nor greater than ¾ the thickness of the wall. The chips or spalls used including voids in the dry stone masonry shall not be more than 20% of the stone masonry by volume. In case of mortared masonry the volume of mortar and spalls taken together shall not be more than 30% of the mortared masonry.

Representative samples of the stones intended for use in the works shall be submitted to the Engineer for prior approval. Further representative samples shall be submitted for approval whenever there is a change in the type or strength of the rock that the Contractor intends to use in masonry work.

2.4.4 CONSTRUCTION EQUIPMENT

The Contractor is responsible for providing, erecting, dismantling, and removing safe and adequate lifting equipment and scaffolding where required. Mixers used for mixing mortar and grout shall be in accordance with the requirements described under Clause 2.3.4 Construction Equipment.

2.4.5 CONSTRUCTION AND WORKMANSHIP

2.4.5.1 Mortar

The mix proportion for cement mortar for masonry and plaster works shall be proportioned by volume and shall be one part of cement and 4 parts of sand or as specified in the drawings.

2.4.5.2 Workability of Mortar

The mortar shall be of a readily workable consistency with only enough water to obtain a plastic condition suitable for troweling.

2.4.5.3 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.

2.4.5.4 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 retempered by adding water and remixed. All mortar and grout shall be used within 2.5hrsof the initial mixing and no mortar or grout shall be used after it has begun to set.

2.4.5.5 Hand Mixing of Mortar

Hand mixing shall be carried out on clean, water tight platforms with approved methods.

2.4.5.6 Brick Laying

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. Special care shall be taken with stacking and storage of bricks on the Site.

The conditions governing the laying of brick masonry in unfavorable weather shall be as specified for concrete in Clause 2.3.5.5 Concrete. Exposed faces of brick masonry shall be kept moist for 10 days after 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 3hrsimmediately 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 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 colour 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.

2.4.5.7 Hollow Block Laying (Curtain Wall Blocks)

Hollow concrete block masonry and any composite masonry shall comply with the requirements of the brick masonry as stated above.

2.4.5.8 Partition Walls and Curtain Walls

Top and ends of full height partition walls 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.

2.4.5.9 Brick Manholes/Rain Inlet and House Connection 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 10 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.

The sockets of channels in manholes shall be filled in with 1:1 stiff cement mortar and the space between the channels finished off with the same mortar. Where two spigot ends abut, they shall have a layer of 1:1 cement mortar under the joint, and the space between the ends shall be filled with 1:1 cement mortar worked in and neatly finished off.

Where a pipe enters a manhole, it shall be thoroughly caulked into the wall and a 400 mm thick brick surround shall be built integral with the rest of the wall in order to ensure a watertight joint between the pipe and the manhole.

Concrete for benching in manholes shall be prescribed mix 20 with 13 mm chips. Semicircular channels and fittings, suitable for the type of pipe laid, shall be placed in position simultaneously with the concrete benching and embedded in it true to grade, level, and line.

All benching and sloping surfaces in the manhole floor shall be rendered in 20 mm thick 1:3 cement mortars and finished smooth, true with a steel trowel, and rounded at corners and edges.

Step irons in manhole walls shall be in accordance with the relevant applicable standards (e.g. BS 1247 or similar) and shall be accurately built into the straight of the wall at 300 mm centers.

2.4.5.10 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 days after it has been laid and shall be kept wet for at least 10 days.

2.4.5.11 Brick Soling

Dry brick soling in foundations and under flooring shall be laid flat 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.

2.4.5.12 Stone (Rubble) Masonry Work

The stones shall be laid in cement or mud mortar or shall be dry masonry as specified to secure close joints coming into close proximity. Construction shall be carried out in accordance with NS 389-2054. All stratified stone possessing bedding shall be laid with its natural bed as nearly as possible at right angles to the direction of load. Face-work groins shall be built to a height not exceeding one meter in advance of the main body of the work and adjacent walling stepped down on either side. Masonry face work between groins shall then be built to a height not exceeding 500 mm above the backing, which shall then be brought up level with the completed face-work. At no times shall the backing be built up higher than the face-work.

Except for dry rubble walling, all joints (gaps) shall be sufficiently thick to prevent stone to stone contact and the gaps shall be completely filled with mortar. Stones shall be clean and sufficiently wetted before laying to prevent absorption of water from mortar.

Placing loose mortar on the course and pouring water upon it to fill the gaps in stones shall not be allowed. Mortar shall be fluid, mixed thoroughly and then poured in the joints. No dry or

hollow space shall be left anywhere in the masonry and each stone shall have all its faces completely covered with mortar of the thickness as specified for joints.

The bed which is to receive the stone, shall be cleaned, wetted and covered with a layer of fresh mortar. All stones shall be laid full in mortar both in bed and vertical joints and settled carefully in place. Clean and wet chips and spalls shall be wedged into the mortar joints and bed whenever necessary to avoid thick joints or bed of mortar. Sliding one stone on top of another, which is freshly laid, shall not be allowed. Shaping and dressing of stone shall be done before it is laid in the work. Dressing and hammering of the stones, which will loosen the masonry, shall not be allowed.

In rubble masonry walls the joints shall be broken vertically and staggered bond stones shall be provided through every 1 square meter of faces in each course to the full wall thickness. More than one metre 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. Facing stones shall be uniform in size to give a good appearance, the breadth of face stone being more than the height. Face joints shall be dressed and shall be neatly done. Faces shall be true in plumb.

Finished rubble masonry works shall be wetted by water and prevented from drying out for at least seven days after construction.

2.4.5.13 Stone Soling, Paving, and Pitching

The stone soling of required thickness shall be provided taking care that stones are placed vertically and all voids are filled properly. As necessary, the joints shall be filled with broken stone/gravel so that all stone are firmly placed. The final top shall be properly levelled with sand blinding.

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.

2.4.5.14 Scaffolding

Scaffolding required for facility of brick work, stone masonry construction shall be provided by the Contractor at his own expenses. Scaffolding shall be double or single as is warranted for the particular class of masonry. But the ends of the poles should not be placed in the position of header bricks. Scaffolding shall be erected with steel sections, pipes, or bamboo poles of adequate strength so as to be safe for all measures to ensure the safety of work and working people. Any instruction of the Engineer in this respect shall fully complied with. The

Contractor shall be entirely responsible for any damage of property or injury to persons resulting from ill erected scaffolding, defective ladders and materials. Proper scaffolding shall be provided to allow easy approach to every part of the work. Put log holes shall be made good by bricks or stones to match that and all holes behind shall be solidly filled in after the work.

2.4.5.15 Curing

All brickwork and stone masonry work erected in cement mortar shall cured with clean water for at least seven days.

2.4.6 TOLERANCES

The dimensions of brickwork/stonework walls and structures such as manholes shall conform to the tolerances laid down for concrete structures (see Clause 2.3.6 Tolerances), as applicable, or as directed by the Engineer.

2.4.7 MEASUREMENT AND PAYMENT

Measurement for payment for Brickwork and Stone work walls shall be done in cu.m., and that of soling shall be done in sq.m. unless otherwise indicated in the BOQ. Deductions of all openings, any concrete works in the walls shall be done to arrive at net quantity. No deductions will be made for openings of area up to 0.5 m^2. Nothing extra shall be paid for making such openings or cuttings to suit concrete structures, walls in any shape other than straight or any cutting necessary for shaping the walls to the structural design requirements. Rate shall be inclusive of all necessary material, scaffolding, watering, labour etc. and disposal of unused materials complete.

The cost for manholes, rain inlets and house connection chambers shall be inclusive of excavation, brick soling, brick work, concrete work, formwork, shoring, plastering, bitumen painting all complete as shown in the drawing.

2.5 METALWORK

2.5.1 SCOPE

This specification covers metalwork for buildings and other structures; it includes sundry items such as metal doors and windows, etc.

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:

1 General
2.3 Concrete
2.4 Brick/stone work

2.5.2.2 Application

This specification contains clauses that are generally applicable to metal work, corrosion protection, and associated work.

2.5.2.3 Definitions

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

Coat:A single layer of a corrosion-protection material.

Coating system:The method and degree of surface preparation, the type of coating, the method of application of the coats and the requirements of the completed system.

Normal temperature:A temperature that exceeds 15ºC but does not exceed 32ºC.

2.5.3 MATERIALS

2.5.3.1 Metal Doors, Windows, Ventilators, Glazed Shutters etc.

Glazed units shall be made from galvanized steel folded sheets sections, anodized extruded aluminum 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 conformingIS 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.

2.5.3.2 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.

2.5.3.3 Collapsible Gates, 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 ie outside, inside, on, 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 centers, 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.

2.5.3.4 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.

2.5.3.5 Bolts, Nuts and Washers

Bolts and nuts shall comply with the relevant applicable standards (e.g. NS 57-2044, BS 709, BS 4604, IS 1367, IS 4000) and may be either ordinary black bolts, fitted bolts, or high-strength friction-grip bolts, as applicable. Nuts shall be of at least the strength grade appropriate to the grade of bolt or other threaded element with which they are used.

2.5.3.6 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 trace-ability, 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.

2.5.4 CONSTRUCTION EQUIPMENT

Construction Equipment used in handling, fabrication and erection of metalwork shall have enough capacity to ensure that metalwork is placed in its final position without distortion or undue stressing of members.

Construction Equipment for applying the specified coating system shall be suitable for obtaining the specified result. If, however, consistent and satisfactory results are not achieved with the Construction 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.

2.5.5 CONSTRUCTION AND WORKMANSHIP

2.5.5.1 Shop Detail Drawings

The Contractor shall prepare shop drawings for the metalwork items and submit them to the Engineer for approval in accordance with Clause 1.7.3 Working Drawings.

2.5.5.2 Fabrication

All metalwork shall, before and after fabrication, be within the tolerances specified below, and, unless required to be formed to a particular shape, be flat, straight and free from twist.Any necessary straightening or forming shall be carried out by methods that neither weaken nor deface the material.

2.5.5.3 Assembly

Before delivery to the construction Site, each piece of metalwork shall be distinctly marked, in accordance with the marking diagram, and shall bear such other marks as will facilitate assembly and erection.

2.5.5.4 Setting-out

Before the Contractor commences erection of metalwork on Site, he shall check that the setting-out and the levels of building., are in accordance with the drawings and he shall report any discrepancies immediately to the Engineer.

2.5.5.5 Erection

Before commencing erection of metalwork on Site, the Contractor shall submit to the Engineer, for his general scrutiny and information, full details of the erection procedure and methods of erection.

All pockets that are to receive HD-bolts, fittings or metalwork shall be cleaned out immediately before erection is commenced.

Metal wedges or packing or other leveling devices of adequate strength and rigidity shall be used to support the metalwork.

Before steel sections are embedded in concrete, the complete corrosion protection system shall be applied to each member down to at least 100 mm below the level of the concrete.

2.5.5.6 Grouting and Sealing

Grouting and sealing shall be proposed by the Contractor and approved by the Engineer. Immediately before being grouted or sealed, the space and all pockets under and around the metalwork shall be cleared of all debris and free of water.

2.5.5.7 Execution of Corrosion Protection

2.5.5.7.1 Safety and General Workmanship

The Contractor shall, at all times, enforce adequate safety measures in terms of the legislation applicable to the work Site.

All work shall be carried out by competent workmen under the supervision of an experienced supervisor.No cleaning or coating shall take place when Site conditions are likely to affect these operations adversely.

Equipment nameplates and identification plates shall be protected against damage or over coating.

Any areas not required to be coated shall be masked in such a way that these surfaces are protected during all coating operations.

2.5.5.7.2 Dressing and Repair During Fabrication

All surfaces of welds shall be free from slag, slag inclusions, cracks and holes.Weld profiles shall have a smooth contour, free from irregular projections, undercut and sharp edges.Areas adjacent to welds shall be free from weld spatter and such spatter shall have been removed by grinding or scraping.

All burrs and sharp edges caused as a result of activities such as guillotining, flame cutting, drilling or hole punching shall be removed by chamfering or ground to a smooth radius of at least 1 mm.

2.5.5.7.3 Preparation for Coating

Prior to any other form of preparation, all obvious harmful deposits on the surface of steelwork, such as oil, grease, chemical deposit, clay, bitumen, or mud, shall be removed by a method described below.

a) Abrasive blast cleaning (sand blasting) shall be carried out in accordance with the methods described in the relevant applicable standards (e.g. BS 4232, SIS 05 59 00). Where sprayed metal coatings are to be applied to steelwork, angular grit shall be used. Dry abrasive blast cleaning shall be carried out on a dry surface. When air is used, it shall be oil-free, clean and dry.Final blasting shall not be carried out if the steel temperature is less than 3°C above dew point.

   All blast-cleaned surfaces that are to be coated shall be so within 4hrsof blasting unless otherwise agreed to by the Engineer.

   In addition to or as an alternative to dry blast cleaning, it may be necessary to apply wet blast cleaning in order to remove soluble salts from the surface of steel that have been exposed to aggressive environments. Such wet blast cleaning is subject to the approval by the Engineer.

b) Cleaning by hand or with power tools

c) Degreasing. Liquid-solvent cleaning, solvent-vapor cleaning, alkali, and emulsion cleaning may be carried out at the discretion of the Engineer.

2.5.5.7.4 Latent Material Defects

Before the application of the first coat of a protective system, unacceptable defects such as cracks or laminations, that become evident after preparation of the steelwork, shall be ground out, repaired or the material rejected, as decided by the Engineer.

2.5.5.7.5 Cleaning of Surfaces about to be Coated

No coating shall be applied on a prepared surface that is contaminated with oil, grease, perspiration, rust, or chemical deposits until such surface has been adequately cleaned. Uncoated steel shall not be touched with bare hands. Where contamination has occurred, it shall be removed with an approved solution or cleaning solvent, degreasing shall be followed by rinsing with water to remove residues.

Where any coat has oxidized or become excessively hard, it shall be abraded to a matt finish and cleaned prior to the application of further coats. Unless otherwise approved, coats shall only be applied on moisture-free surfaces.

2.5.5.7.6 Coating System

Paint systems for the various substrates shall be as follows:

Shop applied: 1 coat high build alkyd zinc phosphate primer to a minimum dry film thickness of 75 microns followed by 1 coat alkyd based undercoat to a minimum dry film thickness of 40 microns.

Site applied: 1 coat alkyd based undercoat to a minimum dry film thickness of 40 microns followed by 1 coat decorative alkyd enamel to a minimum dry film thickness of 40 microns.

2.5.5.7.7 Application of Paint Coatings

The method of coating application shall comply with the manufacturer's recommendation and data sheets. Multi-component materials shall be applied with due care, the specified application techniques being used. All coatings shall be substantially free from tears, runs, curtaining, foreign inclusions and material surface defects and shall, in addition, be free from misses. Maximum and minimum inter coat intervals shall comply with the paint manufacturer's recommendations, taking cognizance of ambient conditions.

The colour of each coat shall be different from that of the previous coat. Surfaces that will be inaccessible for coating after fabrication or erection shall receive the full-specified coating system prior to final fabrication or erection. All coating components, particularly two-component or multi-component materials, shall be thoroughly mixed until a homogeneous mixture is achieved.The mixture shall be frequently agitated during application to keep the solids in suspension. The preparation time and pot life of these materials shall be closely adhered to.

2.5.5.7.9 Repair of Damaged Coatings

Damaged areas shall be cleaned down to a metal condition or to an undamaged coated surface.

Spot repairs shall re-instate each of the previous coats, or shall be made using an approved patching material. The patch shall extend at least 25 mm over adjacent surfaces, which shall have been prepared by feathering with suitable abrasive paper. The repair of metal coatings shall be to a procedure approved by the Engineer.

2.5.6 TOLERANCES

2.5.6.1 General

The permissible deviations (PD) on the dimensions of components (such as gusset plates, cross bracing, etc.) and on the location of bolt holes in components and elements of a structure shall be + 2 mm.All calculated PD’s shall be rounded up to the next whole millimeter. Where alternative PD is quoted the lesser shall apply.

2.5.6.2 Tolerances on Dimensions, Accuracy of Erection, etc.

The tolerances on dimensions, and accuracy of erection, shall be as given below:

a)	Length of a member	+ 1, - 2 mm
b)	Out of plumb	< 50 or H/500 mm
c)	Straightness of members	< 25 or L/500 mm
d)	Location of fixings	+ 3 mm

2.5.6.3 Dry Film Thickness

At least 90% of all coating thickness measured shall comply with the minimum requirements. Up to 10% of all readings may be below the specified thickness, but may be not less than 70% of the specified thickness. Where DFTs are less than those specified, remedial action shall be taken to build up the thickness to that specified. DFT in excess of the prescribed maxima shall not necessarily constitute a reason for rejection if the paint film is demonstrated to be sound in all respects.

The method used to measure DFT and the significance of the readings for each particular job shall be as agreed upon by all parties prior to commencement of work.

2.5.7 TESTING AND ACCEPTANCE

2.5.7.1 Testing of Metalwork

If requested by the Engineer, test certificates or cast analysis certificates (or both), pertaining to the steel 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 fabrication. Welds shall be examined visually to check that there are no uneven leg lengths, no cracking or unacceptable undercutting or porosity and that full fusion has been achieved. Dimensional checks shall be carried out in accordance with the requirements of the relevant applicable standards (e.g. BS 5153).

Only where so required by the Engineer shall welders be tested or destructive or non-destructive tests be carried out.

2.5.7.2 Testing of Coatings

Testing of coatings by the Contractor and inspections by the Engineer shall be carried out in accordance with the requirements laid down in the relevant applicable standards (eg ISO 3233) and as directed by the Engineer.

2.5.8 MEASUREMENT AND PAYMENT

Work involving metalwork will be measured in Kg., Sq. m. or as a lump sum item as specified in the BOQ, which will include all materials, fabrication, corrosion protection and installation.

2.6 PLUMBING AND HOUSE DRAINAGE WORKS

2.6.1 SCOPE

This specification covers the general requirements for plumbing and sanitary installation required in general building construction.

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:

1 General
3.3 Pressure Pipelines
3.4 Sewers

2.6.2.2 Application

This specification contains clauses that are generally applicable to plumbing, sanitary installations, house water supply and drainage work, and associated work.

2.6.3 MATERIALS

All pipes, fittings, and sanitary ware shall be of selected quality approved by the Engineer. It shall be suitable for the intended purpose and appropriately matched to each other. All pipes, fittings, and sanitaryware shall be supplied complete with all necessary fixing, coupling, and jointing material.

Pipes for water supply shall be of galvanized seamless steel, cast or spun iron, ductile cast iron, PVC, HDPE, or other method approved by the Engineer and shall be jointed by fitting, screwing, or welding, as applicable.

All fittings shall be supplied according to the pipes required, whether or not specifically called for in the drawings.

All sanitary equipment, lavatories, cisterns, urinals, toilets, water fountains, floor drains, gullies, petrol and oil traps, etc., shall conform to the relevant applicable standards as shown below or equivalent.

NS 246-2048 & NS 383-2054 : cast iron drain pipes and fittings

BS 1211	: spun iron pipes and fittings
NS199-2046	: galvanized pipes and fittings
NS 40-2040	: HDPE pipes and fittings
NS 206-2046	: PVC pipe and fittings
NS 104-2042	: covers and frames
IS 774, IS 2556	: white ceramic sanitary ware
BS 1010 part 2 or IS 781	: stopcocks & taps

2.6.4 CONSTRUCTION EQUIPMENT

The apparatus used for the line, level, and positional control of pipe laying and installation work shall be accurate, sturdy, and in good operational condition. The Contractor may use any acceptable device for such control.

In addition to the pumps, gauges, storage tank, tools, pipes, fittings, specials, and bracing necessary for the tests required, the Contractor shall provide all plugs for the temporary stopping off of pipelines for the purposes of testing.

2.6.5 CONSTRUCTION AND WORKMANSHIP

2.6.5.1 Sanitary Fixtures

All fixtures specified or shown on the drawings shall be furnished and set by the Contractor in a neat and workmanlike manner, making connections with all supply, waste, soil and vent pipes, as specified or as directed. General requirements for fixtures shall be the following:

A sample of each type of fixture shall be subject to the approval by the Engineer.The samples shall be completely fitted and set up at the building or in some other convenient approved place.

The approved fixture samples shall not be removed and shall be protected at all times during the construction period for comparison purposes. All fixtures of poorer quality than the approved samples will be cause for rejection.

All ceramic fixtures shall, unless otherwise shown on the drawings or directed, be of white vitreous china thoroughly fused, producing a white material which, when fractured, shall show a homogeneous mass with close grain and free from pores. All surfaces coming in contact with walls, floors, or surfaces of other fixtures shall be reasonably flat.

Enamelled cast iron shall be of an approved quality and thickness. Porcelain enamel coat shall be applied so that the enamel will be smooth, of even thickness, white and free from craze, discolouration and chips.Exterior exposed surfaces not required to be enameled shall be treated with one coat of filler at the factories.The Contractor shall be responsible for any revisions of connections required to adapt the roughing sleeves and openings to the particular fixture he proposes to use.

All fixtures shall bear the manufacturer's guarantee label or trademark for identification purposes.
All fixtures requiring hot and cold water shall have the cold-water tap on the right hand side of the fixture and the hot water on the left hand side of the fixture.

All fixtures shall be of the same manufacture, unless otherwise directed by the Engineer.

The location of each fixture and the fixing method of ceramic fixtures shall be as shown on the drawings or as directed by the Engineer.

After fixtures have been mounted, the Contractor shall before leaving the job, thoroughly clean all fixtures furnished and mounted under this contract, remove all plates, stickers, rust stains and other foreign matters or discolourations on fixtures, leaving every part in perfect condition and ready for use.

2.6.5.1.1

Material, fittings, appliances and structures for water supply

2.6.5.1.2General

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

2.6.5.1.3Fixtures and Appliances

2.6.5.1.4Brass 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.

2.6.5.1.5Bib 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

2.6.5.1.6Screw Down Wheeled Stop Tap

The item shall conform to the Specifications covered in Clause 0 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.

2.6.5.1.7 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.

2.6.5.1.8 Valves for Plumbing

2.6.5.1.9 Wheel Valves (Globe valves)

The wheel valves shall be of size as specified and conforming to IS: 778 (Globe Valves).

2.6.5.1.10 Gate Valves

The gate valve shall be of size as specified and conforming to IS: 778.

2.6.5.1.11 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

2.6.5.1.12 Non-Return valve (Gunmetal)

The valves shall be of quality approved by the Engineer and shall generally conform to IS: 778.

2.6.5.1.13 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 Low pressure	 12 7 11 4	 15 2 12 7	 20 3 17 8
2.	Minimum weight of ball valve including back nut, body and piston	28 3	44 6	82 3

2.6.5.1.14 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.

2.6.5.1.15 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.

2.6.5.1.16 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.

2.6.5.1.17 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.

2.6.5.1.18 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.

2.6.5.1.19 Sanitary fittings and appliances

2.6.5.1.19.1General

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.

2.6.5.1.19.2 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.

2.6.5.1.19.3 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.

2.6.5.1.19.4 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.

2.6.5.1.19.5 Bath, Lavatory and Mixing Taps

Bath, lavatory and mixing taps shall generally comply with the requirements specified for bib taps in Clause 0. 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.

2.6.5.1.19.6 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.

2.6.5.1.19.7 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.

2.6.5.1.19.8 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.

2.6.5.1.19.9 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.

2.6.5.1.19.10 Water closet

2.6.5.2 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.

2.6.5.3 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.

2.6.5.4 Measurement

Water closets shall be enumerated. Rate shall include the cost of all the materials and labour involved in all the operations described above.

2.6.6 Urinals

2.6.6.1 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 2.6.5.1.19.10 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.

2.6.6.2 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.

2.6.6.3 Measurement

Urinals shall be enumerated. Rate shall include the cost of all the materials and labour involved in all the operations described above.

2.6.7 Toilet Requisites

2.6.7.1 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.

2.6.7.2 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.

2.6.7.3 Shower

These shall be of CP finish swivel type as specified.

2.6.7.4 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.

2.6.7.5 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.

2.6.8 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.

2.6.9 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.

2.6.9.1 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.

2.6.9.2 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.

2.6.10 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.

2.6.11 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 confor

2.6.5.2 Piping

The Contractor shall submit to the Engineer a piping diagram for approval. This diagram shall show the symbols of the sanitary fixtures connected with both, the potable water supply and the drainage system. Valves, diameter of pipes, materials, etc., shall be indicated in the diagram. The limit of the work to be executed inside the building shall begin and end 1 m beyond the outer line of the structure, unless otherwise directed.

All supply lines shall be designed for a nominal pressure of 1 MPa (10 bar), unless otherwise directed.

Before covering the pipes, pressure tests shall be carried out to the satisfaction of the Engineer.

The wastewater shall be drained through septic tank, soak away drains or pits, or drainage system, as applicable, by use of vitrified clay pipes or PVC/PE pipes as directed or shown on the drawings. Great care shall be taken in setting out and determining the general levels and falls of drain pipes, so that a fall giving a self-cleaning velocity shall be obtained.

2.6.5.3 Fixing

W.C. commodes shall be fixed to the floor with C.P. brass screws or by means or 75 mm long 6.5 mm dia counter sunk bolts and nuts embedded in the concrete floor or as per the instruction of the Engineer. The base of the pedestal of the commodes shall squarely rest o n the finished floor. Any gap between the finished floor and the pedestal shall be filled with white mastic mixed with pigment to match the shade of floor or as directed by the Engineer.

The W.C. Pan (Indian or Orissa) shall be laid in floor sloping towards the pan in a workmanlike manner, care being taken not to damage the W.C. pan, etc. in the process of fixing. If damaged in any way, it shall be replaced at no cost to the Employer. The pans, etc. shall be fixed on a proper base of cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone ballast of 20 mm nominal size) taking care that the cushion is uniform and even without having any hollows

between the W.C. pan and finished floor. The work shall be neatly done and no hair cracks shall be visible. Joint between the outlet of the W.C. pan and ceramic `P' or `S' trap shall be made with neat cement, yarn, linseed oil, white lead and waterproofing compound and made leak proof. The outlet of the ceramic traps shall be centrally placed in the rubber gasket of the socket of the HDPE pipe and shall have no leakage.

Flush valves shall be installed exposed as shown on the drawing, in accordance with the manufacturer's instruction or as directed by the Engineer. The C.P. long flush bend pipe shall be fixed to the water closet with the help of a rubber adapter and shall show no signs of leakage.

Washbasins shall be supported on bracket(s) as per the manufacturer's instruction and/or on vitreous china pedestals or as directed by the Engineer. There shall not be any gap between top edge of the basin and finished face of wall.

Urinals shall be fixed to the wall by means of C.P. brass screws as per the manufacturers instruction and/or directed by the Engineer. There shall not be any gap between the back edge of the urinal and finished face of the wall.

2.6.6 TESTS AND ACCEPTANCE

All water services shall be subjected to a hydraulic test pressure 1.5 times the working pressure maintained for a period of two hours during which time there shall be no appreciable drop in pressure and no visible leakage.

All soil waste and vent pipes shall be subjected to an air test as described in Clause 3.4.7 Testing and Acceptance.

All drainage pipe work shall be subjected to a hydraulic test pressure of 150 mm head at the highest fitting, maintained for a period of four hours there shall be no appreciable drop in pressure and no visible leaks.

The Contractor shall include for providing all necessary appliances and labour at these tests.

All water service pipe work shall be flushed through upon completion of installation, to ensure cleanliness.

All drainage pipe work shall be rodded through upon completion of installation to ensure cleanliness.

2.6.7 MEASUREMENT AND PAYMENT

The transport to Site, handling, laying and jointing of pipes and fittings, including inspection, cutting, turning, welding, supply and installation of metallic tape etc., will be measured throughout the overall length without deduction for valves etc. and will be paid for by the linear meter of work performed depending on the pipe types and diameters of pipe is to be installed.

The installation of stop valves, air valves, washouts, hydrants etc. will be paid by the number installed.

Testing and disinfection of mains will be paid per linear meter of work performed depending on the pipe diameter (only when specifically mentioned in the BOQ).

An extra item will be paid for connections to be made to existing pipelines, depending on the diameter of the existing pipe.

2.7 FINISHES

2.7.1 SCOPE

This specification covers the general construction requirements for finishes, such as plastering, flooring, painting, roofing, water proofing, etc., required in general building construction (e.g. operators quarters, guardhouse, 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:

1 General
2.2 Earthworks
2.3 Concrete
2.4 Brickwork/Stonework

2.7.2.2 Application

This specification contains clauses that are generally applicable to finishes on walls, floors, and roofs of buildings and associated work.

2.7.3 MATERIALS

Cement, sand, water, and coarse aggregates required for finishing work shall be as mentioned in clause 2.3.3 Materials under concrete works.

Ceramic tiles shall be 200 x 100 x 6 mm size unless otherwise shown or specified on the drawings or directed by the Engineer. They shall either be ceramic vitreous tiles, with colours as selected by the Engineer, or approved glazed tiles conforming with IS 777 or equivalent. 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 colour.

The materials for painting and colour 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). The Contractor shall get prior approval of the Engineer of the brand and shade of all paint materials.

Pigments and other necessary additives to produce coloured 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 colour and texture indicated on the drawings or as directed by the Engineer. The sample of such colour 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.

Corrugated Galvanized Iron (CGI) sheets and ridge for the roofing shall be of 26 gauge thickness having heavy coating meeting the requirements of NS 141-2042. There should be NS mark on the sheets. Brand of the CGI sheets shall be approved by the Engineer prior to its placement.

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

2.7.5.1 Plaster

The surface to be plastered shall be brushed clean. Mortar joints of brick/stone masonry or hollow 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. The thickness of plaster in total shall not be less than 12 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.

Curing of Plaster works

Moist curing shall be accomplished by keeping the plaster uniformly damp by suitable means. Moist curing shall start during application and continue for not less than 7 days.

Approval by the Engineer of Plaster Work

All plasterwork 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.

2.7.5.2 Pointing

Where external faces of the mortared masonry work will be backfilled or otherwise permanently covered up, the mortared joint shall be finished flush to the faces of the adjacent brick/stone work.

Where mortared masonry faces will remain exposed or as specified in the drawings and BOQ, the mortar joints shall be pointed to a consistent style to the approval of the Engineer. Pointing shall be carried out using 1:3 by volume of cement and sand or as shown in the drawing. The mortar shall be filled and pressed into the raked out joints before giving the required finish. The pointing, if not otherwise mentioned, shall be ruled type for which it shall, while work is still green, be ruled along the center with half round tools of such width as mat be specified by the Engineer. The excess mortar shall, then, be taken off from the edge of the lines and shall not be unnecessarily plastered over the exposed stone/brick works.

2.7.5.3 Tiles

Wall surface shall be brushed clean, wetted, and fitted with an approximately 12 mm thick level and plumb scratch coat of cement mortar 1:3 applied. The scratch coat shall be moist cured for at least 24hrsbefore 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 min. 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.

2.7.5.4 Cast In-situ Floors, Screed, Skirting

Before placing of in-situ concrete flooring, the base shall be made rough and watered, and given a cement wash. A first concrete layer shall than be laid to the depth required.After laying, the concrete shall be compacted by hand or mechanical means, and leveled with wooden floats. Within one hour of laying the bottom layer, the second and finishing layer shall be placed and the surface tamped lightly, before finishing it off perfectly level with a straight edge float and trowel. The finishing layer shall consist of cement-sand mixed at 1:1.

Cement skirting shall consist of 20 mm thick cement mortar mixed at 1:3 (cement: sand).The cement skirting shall be applied to the wall surface to the line, levels and dimensions, and finished with a floating coat of neat cement.

Curing and protection of cast in situ floor shall be in accordance with the requirements of Clauses 2.3 CONCRETE and 2.7.5.1 Plaster.

2.7.5.5 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,but not limited, 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 8hrsafter 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.

2.7.5.6 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.

2.7.5.7 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.

2.7.5.8 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.

2.7.5.9 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 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. A second coat of paint of approved shade and manufacture shall then be evenly applied and allowed to dry. The third coat shall be carefully applied as and when required, to achieve a smooth and even surface.

2.7.5.10 French Polish

The work shall be first cleaned and sandpapered thoroughly. It then will be painted with a `filler', composed of ethylated 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.

2.7.5.11 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.

CGI roofing sheets shall be secured to the purlins firmly by using J-hooks, nuts, and bitumen washer. Side lap shall be half corrugation and the end lap shall be minimum 15 cm. Ridges of thickness same as of CGI sheets shall be fitted and fixed neatly same as of CGI sheets.

2.7.6 TOLERANCES

The tolerances for flooring work shall be as described in Clause 2.3 CONCRETE and for paintwork as described in Clause 2.5 METALWORK, 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 1.5 m². Separate items will be scheduled for each type of finish, and for different location of application, if such location will substantially effect the pricing. Doors, windows, glazed partition walls will be paid for by area measured across the whole surface, without deducting unpainted fillings such as glazing, plastic coated boards, etc. Measurement for payment of CGI roofing shall be on area of roofing. The rate shall include the cost of side and end lap, ridge, hooks, washer etc. and workmanship all complete.

2.8 CARPENTRY AND JOINERY WORKS

2.8.1 SCOPE

This specification covers the general construction requirements for timberwork, carpentry and joinery, required in general building construction (e.g. guardhouse and operators quarters at reservoir sites).

2.8.2 INTERPRETATIONS

2.8.2.1 Supporting Specifications

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

1 General
2.3 Concrete
2.4 Brick/stone work

2.8.2.2 Application

This specification contains clauses that are generally applicable to timber works, carpentry and joinery for buildings and associated work.

2.8.3 MATERIALS

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.

Unless specified elsewhere or otherwise directed, the frames, architraves, etc., of doors and windows, etc., shall be of well-seasoned wood free of knots, fissures, and decay. Local wood of equivalent quality shall be used whenever possible.

Door shutters shall be of chipboard or blackboard of approved quality having both sides faced with either commercial ply 5 mm thick or other approved veneering.Samples of such shutters shall be submitted for approval.

The fittings and fixtures like hinges, hooks, anchors, locks, handles, key plates, keys, doorstops, etc., shall be of brass and of best quality and manufacture. The Contractor shall submit samples of such fittings and fixtures well in advance for approval.

Timber and other wood material shall be straight, sound, bright, or mature growth, well-seasoned and conditioned to suit the particular purpose, for which it is to be used.The material shall be cleanly sawn, square edged, and free from injurious shakes, splits, warps, wanes and knots, soft spots and rot, incipient decay and all other defects.

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 ovendry 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 chipboards, all surfaces to be veneered or seal coated shall be adequately closed.

Wooden fiberboards, veneers, coating slabs and coating foils of plastics shall be suitable for their intended applications.

Adhesives (glues) shall not cause any discolouration or other damage.

Sealing compounds shall be resistant to atmospheric influences, shall not harden and shall not be aggressive.All fittings such as hinges, hooks, anchors, locks, handles, key plates, keys, etc., shall be submitted to the Engineer in good time for approval.

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.

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.

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.

2.8.4 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.

2.8.5 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:

DIN 1052 Timber Structures
DIN 68365 Timber for Carpenters' Work, Quality Specifications
DIN 4074 Timber for Wood Building Components
DIN 68800 Timber Protection in Building Construction
DIN 17440 Stainless Steel; Quality Specification
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 meters shall be accurately fitted. The surface exposed to view shall be trimmed, e.g. by planning 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, wood-chipboards and composite slabs 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 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.

2.8.6 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.

2.8.7 MEASUREMENT AND PAYMENT

Generally, the items shall be measured in-situ. The method of measurement shall be based on the following:

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. Wooden frame shall be measured in unit rate per cubic meter. Where as the doors and window shutter shall be in unit rate per square meter. In case of fixed glazing work frame work in cubic meter and glazing work in square meter shall be measured separately

Wall panels or linings will be paid for by area. The unit rate shall include all substructure, fasteners, doweling etc.

All costs for hardware and iron ironmongery shall be included in the unit rate of the relevant bill item.

2.9 ELECTRICAL INSTALLATIONS

2.9.1 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. All materials and workmanship on the NEA power system shall be as per NEA practice.

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:

1 General
2.2 Earthworks

2.9.2.2 Application

This specification contains clauses that are generally applicable to electrical installations and associated work.

2.9.2.3 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	-	DeutschesIndustrieNormen
IE	-	Indian Electricity Rules
IEC	-	International Electro-technical 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	-	mega volt 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

2.9.3 MATERIALS

2.9.3.1 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 rustproofed, 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 has 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.

2.9.3.2 Fuses

Fuses shall be categorised as AC 80, 660 volt to IS 13703.Fuse carriers and bases shall comply with IS 13703 Part 2.

2.9.3.3 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.

2.9.3.4 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.

2.9.3.5 Cables

All cables shall be manufactured to Nepalese Standards

(i) **Low voltage (600/1 000 V grade) :**PVC/SWA/PVC and XLPE/SWA/PVC multi-core cable. Installed direct in the ground, in ducts, on tray or clipped direct. Aluminium wire armouring shall be used for single core cables.
(ii) **Low voltage (600/1 000 V grade) :**PVC/PVC multi-core 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 multi-stranded copper conductors, solid polyethylene insulation with aluminium-mylar pair screening including drain wire, with collective aluminiummylar 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 multi-stranded copper conductors, solid polyethylene insulation collective aluminiummylar 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.

2.9.3.6 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 adaptation, 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 mm^2 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 baseboard, within the compartment, of suitable size to accommodate all necessary control gear, cable terminations and looping type fuse service cut out. The baseboard shall be securely fixed within the pole.

Cutouts 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 mm^2. shall be fixed to the base board adjacent to the cut-out.The terminal block may be incorporated within the cutout.

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.Tapings 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 infused 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 mm^2 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 aluminium alloy suitable for side entry spigot mounting.The luminaries shall be complete with polished aluminium 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 hours 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.

2.9.3.7 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 mm^2 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:
   1.Reflection
   2. Diffuser
B. Incandescent type:
   1. Reflection/Shade
   2. Diffuser
   3. Water proof

4. Bulk head

2.9.3.8 Lamps

Tungsten lamps shall be coiled coil pattern to IS 418 and IS 6701. 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).

2.9.3.9 Lighting Switches

Lighting switches for domestic and office purposes shall comply with IS 3854. They shall be of approved manufacture with shuttered outlets.

2.9.3.10 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.

2.9.3.11 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.

2.9.3.12 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 galvanised type or PVC wire-wound type with cadmium plated mild steel couplings.

2.9.3.13 Earth Electrodes

Earth electrodes shall be 38 mm diameter galvanised iron rods made up in sections to the required length. Couplings joining rods shall be silicone bronze aluminium, 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.

2.9.3.14 Standard Make

The standard make of equipment, fixture, cables etc shall be as per following or their equivalents:

MCCB	Seimens / Legrand /Terashaki
MCB	Seimen/Legra/Terashaki
Wiring cable	Nepalese cable with NS Mark
Light switch	Unbreakable - Legrand/ M
Switch socket	Unbreakable - Legrand/ MK
Fluorescent/CFL tube light fixture	Wipro / Philips
Outdoor light fixture/ Flood light fixture	Wipro / Philips
Incandescent light fixtures	Decon / Homedec
Power Cable	Poineer/Prakash/Trishakti/Janata
Lightening Arrestor (11 kV)	Japanese
Do-fuse	Japanese
Transformer	Crompton/ Alstom/ Ekrat
Diesel Generator	Cumins/ Perkins/Kirloskar/Crompton &Greeves

2.9.4 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.

2.9.5 CONSTRUCTION AND WORKMANSHIP

2.9.5.1 Regulations and Standards

The electrical installation shall comply with all relevant IS regulations, statutory instruments and regulations current at date of tender (unless otherwise indicated) some of which are listed within the detailed description in Appendix A.

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.

2.9.5.2 Cable Installation

Cables to lighting and small power circuits shall be of one of the following sizes unless indicated otherwise:

(i) 1.5 mm^2 single core PVC for circuits loaded less than 1 kW.
(ii) 2.5 mm^2 single core PVC for circuits loaded up to 3 kW.
(iii) 4 mm^2/6 mm^2 2 core PVC for circuits loaded above 3 kW
(iv) 1.0 mm^2 light duty multi-core PVC for control circuits.

Cables shall be segregated into the following categories:

- power (less than 1 000 V phase to phase)
- instrumentation/telemetry
- control
- 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.

	HVpower (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.Multi-core 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 600/1 000 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 1 000 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) In 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 fibre, 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□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 manufacturers 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 galvanised 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 block work, 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 galvanised 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.

(v) 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.

(vi) 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.

2.9.5.3 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 galvanised 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.

2.9.5.4 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.

2.9.5.5 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.

2.9.5.6 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.

2.9.5.7 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 boards, 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 6mm^2 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 6mm^2.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.

2.9.5.8 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 galvanised 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.

2.9.5.9 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 aluminium 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.

2.9.6 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).

2.9.7 MEASUREMENT AND PAYMENT

Work shall be measured according to types as an all inclusive rate.

3.0 DRAINAGE, PIPELINES AND RELATED ACTIVITIES

3.1 PIPE TRENCHES

3.1.1 SCOPE

This specification covers earthworks for trenches for all types and sizes of pipes.It covers excavation, the preparation of a trench bottom, 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:

1 General
2.1 Site Clearance
2.2 Earthworks

3.1.2.2 Application

This specification contains clauses that are applicable to earthworks for pipe trenches associated with the proposed sub-project.

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 excavation of material will, for purpose of measurement and payment, be classified as specified in Clause 2.2.3.1 Classification for Excavation Purposes, above.

For selected fill material, the requirements given in Clause 3.2 PIPE BEDDING 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 Minimum Base Width, 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 dealing with water, the requirements of Clause 2.2.5.2.2.2 Excavations to be Kept Free of Water, 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 Clause 1.5.2 Detours and Traffic Control, 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 Existing Services, 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 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 Minimum Base Width

Unless otherwise shown on the drawings, or as directed, the base width of a trench shall be not less than the external diameter of the pipe barrels plus twice the side allowance as shown below:

ND up to600 mm side allowance300 mm
ND over600 mmup to 1000 mm side allowance400 mm
ND over 1000 mmup to 2000 mm side allowance500 mm
ND over 2000 mm side allowance600 mm

The minimum base width for pipes not exceeding 125 mm and laid at a depth not exceeding 1.5 m may be less than 600 mm for flexible continuous piping that, in terms of the specification or schedule, requires no bedding or jointing in the trench.

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 Site Clearance

The Contractor shall clear the working strip, in accordance with Clause 2.1 SITE CLEARANCE. 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.

3.1.5.4 Excavation

The length of pipe trench excavated by a gang shall not extend more than 200m beyond the start of excavation or the completed backfill unless approved by the Engineer. 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 Minimum Base Width, 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 as nearly vertical as possible for at least the height of the bedding.
When cutting through bituminous surfaces, the edges of the existing bitumen base and/or wearing courses shall be cut back vertically to straight lines.

In densely built-up areas with restricted and confined space, such as in urban areas, the stockpiling of excavated material adjacent to the trench for use as backfill material may not always be possible. In such cases the Contractor transport such material to and stockpile it at a distance away from the point of excavation, at locations suitable and approved by the Engineer.

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°

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.

3.1.5.5 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 levelled 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 side allowances given in Clause 3.1.5.2 Minimum Base Width, above and in conformity with the applicable tolerances specified.

3.1.5.6 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 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.

3.1.5.7 Compaction

In normal areas backfill shall be in accordance with Clause 2.2.5.2.3 Placing and Compaction.

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.

3.1.5.8 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 300 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 that is left raised of the surrounding ground to allow for initial settlement shall be not more than 150 mm above the surrounding ground

In the 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 150 mm, and of quality equal to that of the existing road surface compacted to at least 95% modified AASHTO. 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 have been removed and the surface shall have been approved and prime coated at 1.0 l/m2 of MC30 cutback bitumen. The bituminous surface will have a tolerance of -0+6 mm after compaction.

The Contractor shall maintain the reinstated surfaces and shall make good, at his expense, any damage due to any subsidence, pothole or other unevenness immediately after it occurs during the period of the contract or during the defects liability period.

Where, during the execution of the activities, any road or paved surface adjacent to a trench 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 Tolerance in Positions, Dimensions, Levels, etc. shall apply.

3.1.7 TESTING AND ACCEPTANCE

The Contractor shall prove: 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 any necessary re-testing and 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.

Demolition of structures, buildings etc, shall be measured as a sum for demolition of the identified structure.

Rates for reinstatement of the Site shall include preparing the working strip to receive topsoil, placing topsoil, disposal of surplus materials, planting and seeding, reinstatement of land drains. Additional payment will be made for work in roads according to type.

Reinstatement and work in roads shall be measured as the length of pipeline with no deduction for chambers.

Rates for trench excavation and preparation of bedding Class S shall cover the cost of excavating and re-use of the excavated or imported material in bedding and backfilling, forming embankments, terraces, shoring and supporting excavations, protection of structures, provision for existing services, dealing with storm and ground water, protection of slopes, the cost of disposal of any surplus and unsuitable material, and the import of any suitable material required for backfill. Additional payments will be made for bedding of different type.

Trench excavation and bedding will be measured as the length of pipeline with no deduction for chambers.

Excavation for chambers, abutments, columns, thrustblocks, and anchors shall be measured as the volume of excavation, on accordance with Clause 2.2.8 Measurement and Payment, outside the nominal trench dimension.

Excavation in rock shall be measured extra over normal excavation and measured as a volume.

3.2 PIPE BEDDING

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:

1 General
2.1 Site Clearance
2.2 Earthworks, as applicable
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 Selected Fill Material below.

Selected granular material - Material that complies with the requirements of Clause 3.2.3.1 Selected Granular Material 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 semi-rigid.

3.2.3 MATERIALS

3.2.3.1 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	80-100
5	40-100
2.5	20-80
0.6	
0.315	0-20
0.075	0-5

3.2.3.2 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	40-100
2.5	20-100
0.6	5-100
0.315	0-70
0.075	0-10

3.2.3.3 Bedding

Rigid Pipes

Bedding for rigid pipes shall be of Class A, B, or C. The bedding cradle for Class A bedding shall be concrete. Bedding cradles for Class B and C bedding shall be of selected granular material. The material for the selected fill blanket shall be selected fill material.

Flexibleand Semi-rigid Pipes

Bedding for flexible and semi-rigid pipes shall be of Class S or B. The bedding and blanket for Class S shall be selected fill material. Bedding cradles for Class B bedding shall be of selected granular material and blanket 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 bedding or 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 Construction and Workmanship, below.

The Contractor shall also provide the necessary test equipment for performing on Site the tests referred to in Clause 3.2.7 Testing and Acceptance, 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 criteria for ductile iron is given in the following table.

Pipe Diameter	Bedding Type	
	Class S	Class B
	Pipe cover	
1400	> 4.0m	>4.0m
1100	>4.1m	>4.1m
1000	>4.3m	>4.3m
900	>4.7m	>4.7m
800	>5.1m	>5.1m
700	>5.8m	>5.8m
<600	>6.0m	>6.0m

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 Class A bedding and 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 listed above, the Contractor shall construct the bedding for rigid pipes in accordance with the following requirements:

a) **Class A**. The pipes shall be supported on a continuous cradle of concrete having a 28 days compressive strength of at least 20 MPa. During pipelaying and before the placing of the concrete bedding, the pipes shall be suitably supported. Care shall be taken during the placing of the concrete to prevent movement or flotation of the pipes. In the case of pipes with flexible joints, concrete shall not be allowed to enter the joints during casting of the bedding and a positive vertical expansion joint in the bedding cradle shall be formed at each pipe joint. The selected fill blanket shall not be placed in any section until a period of 24hrshas elapsed after placement of the bedding cradle in that section.

   The main fill shall not be placed in any section until the bedding cradle in that section has achieved a compressive strength of at least 15 MPa.

b) **Class B**. The pipes shall be bedded on a continuous bed of selected granular material, the material being placed in accordance with the details, as relevant, and the bedding constructed in the manner shown, as relevant. To ensure that each pipe will be fully supported throughout the length of its barrel on the bedding cradle, joint holes shall be formed in the bedding cradle for pipe sockets and couplings.

c) **Class C**. The pipes shall be placed directly on the trench bottom after this has been hand-trimmed to ensure that each pipe will be fully supported throughout the length of its barrel. Joint holes shall be formed in the trench bottom for slings, pipe sockets, and couplings.

Any material that is used to support a pipeline temporarily during construction or does not comply with the requirements for bedding cradle shall be removed before the selected fill for Class B or C is placed.

After the pipes have been laid and tested, selected fill material shall be carefully placed into the spaces between the pipe and the sides of the trench to the level of the crown of the pipe. The material shall be thoroughly packed and rammed by careful hand tamping in layer 100 mm thick before compaction to the density specified in Clause 3.2.5.1 General.

Placing and tamping shall proceed equally on both sides of the pipe. A further layer of the same material at least 300 mm thick after compaction and the full width of the trench shall be placed over the crown of the pipe in equal layers, each layer being compacted to the density specified in Clause 3.2.5.1 General.

3.2.5.3 Placing and Compacting of Bedding for Flexible and Semi-Rigid Pipes

In addition to complying with the requirements of Clause 3.2.5.1 General, above, the Contractor shall construct the bedding for flexible and semi-rigid pipes in accordance with the following requirements:

a) **Class B** Flexible and semi-rigid pipes shall be supported on a cradle as indicated on the engineer's drawings. Initially continuous bed of selected granular 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 General. 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 General.

After completion of the bedding cradle, selected fill blanket 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 General up to a height of at least 300 mm above the crown of the pipeline.

b) **Class S** Flexible and semi-rigid pipes shall be supported on a cradle as indicated on the engineer's drawings. Initially continuous bed of selected fill material of compacted depth indicated shall be placed in 100 mm layers and covering the full width of the trench. The fill material shall be compacted to the density specified in Clause 3.3.5.1 Handling of Pipes and Fittings. After laying of the pipeline, additional selected fill 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 General.

After completion of the bedding cradle, selected fill blanket 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 General, up to a height of at least 300 mm above the crown of the pipeline.

When placing and compacting the bedding particular care shall be exercised to prevent damage, deflection, or displacement of the pipeline and the polyethelenesleeving.

3.2.5.4 Concrete Surround for Flexible and Semi-Rigid Pipes

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 days after the concrete has been placed or until the concrete has attained a 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 recompaction 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 Measurement and Payment.

3.3 PRESSURE PIPELINES

3.3.1 SCOPE

This specification covers the transportation to Site, installation and testing of ductile iron pipe, valves, fittings and plastic sleeving supplied by the Employer.

It also covers the construction of valve chamber, thrust blocks and other structures required for the operation of the bulk distribution mains.

3.3.2 INTERPRETATIONS

3.3.2.1 Supporting Specifications

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

1 General
2.1 Site Clearance
2.2 Earthworks
2.3 Concrete

3.1 Pipe Trenches
3.2 Pipe Bedding
2.4 Brickwork

3.3.2.2 Application

This specification contains clauses that are generally applicable to the construction of ductile iron pipelines and appurtenances.

3.3.2.3 Definitions

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

Fitting - A special or a valve, 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 (0.3Bar) 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.

3.3.2.4 Abbreviations

For the purpose of this specification the following abbreviations shall apply:
DI Ductile iron
IRHD International rubber hardness degree
PTFE Polytetrafluor ethylene

3.3.3 MATERIALS

Ductile cast iron pipes, specials, polyethelenesleeving and valves, shall comply with the specification as mentioned in Clause **Error! Reference source not found.**. They shall be capable o f withstanding the applicable test pressure specified in Clause. 3.3.7.1 General 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 colour 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 3.3.5.8 Covers for Chambers.

3.3.4 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

3.3.5 CONSTRUCTION AND WORKMANSHIP

3.3.5.1 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 be required to compensate the Employer.

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.

3.3.5.2 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's representative.

The trench bottom shall be prepared as specified in Clause. 3.1 PIPE TRENCHES.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 pipeline shall be tape wrapped or sheathed in polythene sleeve for protection. 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.

Soil Corrosivities	Ground Condition	Protection System
Aggressive	• Natural soils with resistivity between 15 and 25 Ωm with seasonal water table or permanent water logging. • Natural soils with a pH range 5< pH<6 without water table.	Standard pipe coating plus PE sleeving
Highly Aggressive	• Natural soils with resistivity below 15 Ωm with seasonal water table or permanent water logging. • Natural Soils with a pH range 5< pH<6 with seasonal water table or permanent water logging.	Standard pipe coating plus 25 mm overlap
	• Made up ground with heavy chemical contamination	Standard pipe coating plus tape wrap 55% only.

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.

3.3.5.3 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 glandring 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 moulding putty and tape wrapping.

3.3.5.4 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 moulding compound to produce smooth contours, the prepared fitting shall then be wrapped in protective tape.

3.3.5.5 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.

3.3.5.6 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 C20 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.

3.3.5.7 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.

3.3.5.8 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. Covers and frames shall conform to NS 104/2042.

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 minimise 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 and year of manufacture shall be embossed in all covers.

3.3.5.9 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. The rate included in the Bill of Quantities shall cover the cost of either operation.

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.

3.3.5.10 Permanent Pipeline Markers

Permanent pipeline marker posts shall be installed at all changes of horizontal alignment, and at 200m intervals along the straight lengths of pipe. Marker posts shall be positioned as close as

possible to a 2 m offset from the pipe centre line. In the case of twin pipelines the marker posts shall be installed along the centre line of the twin pipes.

Permanent marker posts shall be of precast concrete Class 30/20 to the dimension shown on the Drawings

3.3.5.11 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.

3.3.5.12 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 effected 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 neutralise the chlorine by the use of sodium thiosulphate prior to disposal.

3.3.5.13 Provision of Training/Participation in Construction & Installation of Electromechanical Works

The Contractor shall involve the persons recommended by Employer and WUSC in the construction time at construction site to built up their capacity regarding the construction and operation of Water Supply System.Contractor shall be liable for giving solution to their question or queries to enhance their capacity regarding successful operation of project .Water users Committee shall give their priority to such persons as a human resource for testing and commissioning of the constructed water supply system as per provided in BoQ.

3.3.6 TOLERANCES

3.3.6.1 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:

(i) the cover above the crown of the pipe to ground level shall be as shown on the Drawings, but in no event shall be less than 1000 mm in green areas, 1200 in the verge or carriageway of roads and 1500 mm where crossing roads.

(ii) 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.

3.3.6.2 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 $\pm$ 5 m, scour valves shall be located at the lowest points in pipelines and air valves at the highest points.

3.3.6.3 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, which ever 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.

3.3.6.4 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.

3.3.6.5 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;

(i) Bitumen Coating

Damage to bitumen coating will be repaired by preparing and repainting the damaged area in accordance with the pipe manufacturers instructions.

(ii) 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.

(iii) 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.

3.3.7 TESTING AND ACCEPTANCE

3.3.7.1 General

Except where otherwise specified pipelines and pipework shall be subjected to hydraulic pressure tests in the presence of the Engineer which shall comply with BS 8010 or CP 312.

Testing shall be carried out in two stages:

(i) test of sections as construction proceeds;
(ii) a final test of the whole of the pipework or pipeline on completion.

The Contractor shall submit to the Engineer, in advance of the time for tests, details of his proposals. The proposals shall include details of temporary works to resist test pressures and methods for carrying out the test. Proposals for testing where thrusts on structures are involved, even where thrust collars on the piping are installed, shall be submitted, with the calculations of the forces to be carried, to the Engineer for approval.The proposal shall include details for transporting the test water from the point of supply to the pipeline to be tested. No connections to the pipeline or pipework which would involved cutting, tapping or otherwise permanently altering the Permanent Works, will be allowed.

3.3.7.2 Procedure

Each section of the pipeline or pipework to be tested shall be capped or blanked off at each end and securely strutted or restrained to withstand the considerable forces that will be exerted when the test pressure is applied. Testing against closed valves will not be permitted. Hydrants, washout valves and isolation valves shall be fitted with blank flanges and these together with in-line valves shall be left open. Air valves already fitted shall be permitted to function during the test. The air valve manufacturer's confirmation shall be obtained that the valves are capable of withstanding the test pressure involved.

The section under test shall be filled making certain that all air is displaced through an air valve installed at the high end of the line. The section shall then remain under constant moderate pressure – 10 to 20 m head of water – for a period of several hours until the pressure can be maintained without additional pumping. Pipes of materials liable to absorb water, eg concrete and asbestos cement, shall be allowed to become saturated under this moderate pressure for 24 hours.

The pressure shall then be slowly increased to the full test pressure and pumping discontinued for 3 hours or until the pressure has dropped by 10 m, whichever occurs earlier. Thereafter pumping shall be resumed and continued until the test pressure has been restored. The quantity of water pumped to restore the pressure shall be the measure of leakage from discontinuation of pumping until its resumption.

The pipe section shall be considered as having passed the test if the leakage is not more than 0.365 l/mm of pipe diameter per kilometre per 24 hours for each 100 m head of pressure applied.

Notwithstanding the satisfactory completion of the hydraulic test, if there is any discernible leakage of water from any pipe or joint the Contractor shall, replace the pipe, repair the pipe or re-make the joint and repeat the hydraulic test all at his own cost.

No line shall be accepted until and unless the leakage of any section of the lines tested is not more than the rate of leakage specified above.All activities required to locate leaks and their repair and the repeat of the hydraulic test shall be at the Contractor's expense.

Pipelines shall be tested as above except where the Engineer issues such instructions as are necessary for testing parts of the Works that have been designed for stresses limited by considerations other than those applying to the pipeline systems.

3.3.7.3 Test Pressures

Test pressures are to be measured at the centre of the blank flange situated at the lowest end of the pipeline under test. All pipelines shall be tested to a pressure corresponding to a hydraulic grade of 1452 masl.

The contractor shall submit a schedule of pipeline test pressures to the Engineer for approval prior to commencing testing.

3.3.7.4 Sectional Hydraulic Test

The Sectional Hydraulic Test shall be carried out after the pipeline or pipework section to be tested has been laid, jointed and backfilled to a depth sufficient to prevent flotation of the pipeline. The sections to be tested shall be to the approval of the Engineer and shall be not longer than 2,000 m or 500 m when either the pipeline is laid adjacent to or underneath the carriageway.

In addition to the above requirements the Contractor shall perform a hydraulic test on the first 200 m length of pipeline of each diameter to be laid under the Contract. This test shall be undertaken within one month of the Contractor commencing the laying of pipes. Should the pipeline fail the test or the Contractor fail to undertake the test, all laying work for that diameter shall come to halt until that section of pipeline passes the hydraulic test.

3.3.7.5 Hydraulic Test on Completion

The test on completion shall be carried out after all the pipeline sections have been joined together on completion of sectional testing. The joints between sections shall be backfilled once the test is satisfactorily completed.

3.3.8 MEASUREMENT AND PAYMENT

The rates for pipelaying and installation shall include for transportation of the, cutting and repairing pipes, installation of polythene sleeving, laying and jointing of the pipe, testing & commissioning, protection of flanges, the provision and placing of bedding material, dewatering, and backfilling of trenches and disposal of excess material and spoil, and demonstration of laying as specified in Clause 3.3.5.2 Laying.

Pipe laying and installation will be measured as the distance along the centreline of the pipeline with no deductions for chambers etc, according to the depth to invert of the pipeline.

Valve Chambers will be measured separately according to type.No separate payment will be made for, provision of materials, construction of the chamber, installation of valves and specials supplied by the Employer, backfilling and disposal of excess material.

3.4 SEWERS AND STORMWATER DRAINAGE

3.4.1 SCOPE

This specification covers the general construction requirements for sewerage and stormwater drainage systems including connecting sewers, manholes, and the like, but excluding sewer pressure mains, pump stations, treatment works, and ancillary works.

3.4.2 INTERPRETATIONS

3.4.2.1 Supporting Specifications

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

1 General
2.1 Site Clearance
2.2 Earthworks, as applicable
3.1 Pipe Trenches
3.2 Pipe Bedding
2.3 Concrete
2.4 Brick/stone work

3.4.2.2 Application

This specification contains clauses that are generally applicable to sewer and stormwater drainage construction.

3.4.2.3 Definitions

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

Expansion pipe joint - A pipe joint that allows relative longitudinal movement between adjacent pipes without the occurrence of fracture or leakage.

Flexible pipe joint - A pipe joint that allows relative angular (radial) and longitudinal movements between adjacent pipes without the occurrence of fracture or leakage.

Geofabric blanket - A blanket so woven from synthetic fibres that it is capable of acting as a filter that retains some or all of the solid particles carried by a fluid but, with varying degrees of restriction, allows the passage of the fluid.

Invert slab - The slab, normally of concrete, that forms the bottom of the culvert.

Prefabricated culvert units - Portal or rectangular culvert units that have been prefabricated from reinforced concrete.

Rigid pipe joint - A pipe joint that allows no relative movement between adjacent pipes without the occurrence of fracture or leakage.

3.4.2.4 Abbreviations

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

AC	Asbestos cement
CI	Cast iron
CID, DN	Constant inside diameter
COD	Constant outside diameter
PVC	Polyvinyl chloride
uPVC	Unplasticized polyvinyl chloride
CP	Machine made concrete pipe
RCP	Reinforced concrete pipe

3.4.3 MATERIAL

3.4.3.1 Pipes, Fittings and Pipe Joints

For drainage and sewerage prefabricated concrete pipes NP2 or NP3, built according to provisions of NS80/2042 or equivalent shall be used.

The concrete pipes shall have circular cross-section and jointed using a collar. The concrete pipes must be of uniform condition. They must not exhibit any damage or be affected in any way likely to impair their serviceability, their strength, water tightness and service life.

All the pipe used in the Works will be from the same manufacturer. The manufacturer must be a nationally recognized and specialized concrete pipes manufacturer. On first starting production the manufacturing plant must demonstrate, prior to delivering concrete pipes that the pipes comply with the requirements of NS 80/2042. The tests necessary for this purpose must be carried out by an accredited testing agency having suitable testing equipment at its disposal.

The collars must be matched to the dimensions of the pipes and must be included in the delivery of the pipe. The dimensions of the collars must comply with NS 80/2042 or equivalent.

3.4.3.2 Alternative Materials

Should the Contractor proposes to use pipes and fittings of material other than those referred to above, he shall submit for approval detailed specifications including full details of the type

of joints and specials he proposes to use with such pipes and fittings. The Contractor shall not use such pipes or fittings until he has obtained approval for their use from the Engineer.

3.4.3.3 Bedding

The requirements for bedding of specification Clause 3.2 PIPE BEDDING shall apply.

3.4.3.4 Culvert Units and Pipes

Prefabricated culvert units and pipes shall be either precast concrete pipes, or portal and rectangular precast concrete culvert units, as applicable.

3.4.3.5 Concrete

Concrete, cast-in-situ or precast concrete, shall comply with the relevant requirements of specification Clause 2.3 CONCRETE.

3.4.3.6 Manholes, Catchpits and Accessories

Bricks and mortar shall comply with the relevant requirements of specification Clause 2.4 BRICKWORK/STONEWORK.

Prefabricated manhole sections may be of spun concrete, asbestos cement, glass-reinforced polyester, PVC, or such other material as are approved by the Engineer. Covers and frames for manholes and grid inlets shall be supplied in matching sets, each set bearing a serial number to enable it to be identified.

Step irons shall comply with the applicable requirements of BS 1247 or equal approved and shall be of suitable length for the wall of the manhole into which they are to be built.

3.4.3.7 Geofabric Blanket

The synthetic fibres of a geofabric blanket shall consist of at least 85 % by mass of polyester, polyethylene, or polypropylene, or a combination of these polymers, and shall contain such additives as are necessary to render the geofabric blankets resistant to the effects of ultra-violet radiation and heat.

The Engineer's approval of the make and grade of the geofabric shall be obtained by the Contractor before he orders any geofabric or uses it on the Works.

For normal application, and if not otherwise directed by the Engineer or specified in the Particular Specification, geofabric blankets shall be of the non-woven, needle-punched type with a specific weight of approximately 270 g/m^2.

3.4.4 CONSTRUCTION EQUIPMENT

The equipment and rigging equipment used by the Contractor for the handling and placing of pipes shall be of the type recommended by the pipe manufacturer and subject to the approval by the Engineer and shall be such that no pipe is overstressed during any operation covered by the specification.

The Contractor may use any acceptable device, including one incorporating a laser beam, to control the alignment and laying of the pipeline.

The Contractor shall provide all the equipment, materials, tools, and fittings required for the performance of the tests given in Clause 3.4.7 Testing and Acceptance, below, and shall provide suitable equipment for the location of faults up to the date of issue of the final certificate.

3.4.5 CONSTRUCTION AND WORKMANSHIP

3.4.5.1 Trench Bottom

The trench bottom shall be prepared as specified in Clause 3.1 PIPE TRENCHES.Trenches shall be kept sufficiently dry to allow proper and safe bedding, laying, and jointing of pipes and kept dry until the pipeline has passed the required tests and construction of the selected fill blanket over the pipes has been completed.

For the laying of culvert elements, the trench bottom shall be excavated to a depth of 75 mm in soil, or 200 mm in rock, or such other depth as may be shown on the drawings, below the level of the underside of the precast invert slab or to the level of the underside of the cast-in-situ invert slab, as applicable, and this space shall be filled with granular material, compacted, and shaped to enable the culvert units to be bedded properly.

Where, because soft, soggy, spongy, or otherwise unsuitable material is encountered, the bottom of the trench as excavated does not provide a suitable firm foundation for the culvert, the unsuitable material shall be excavated to a depth below the bottom of the culvert indicated by the Engineer and replaced with gravel or other approved granular material compacted to at least 90 % of modified AASHTO maximum density. When so ordered, the Contractor shall construct a layer of concrete blinding, at least 75 mm thick, to provide a suitable working floor.

3.4.5.2 Bedding, Laying and Backfilling

Each pipe and fitting shall be thoroughly cleaned out and carefully examined for damage immediately before laying. The onus of detecting damaged pipes and fittings before installation shall be on the Contractor. Should any damaged pipe or fitting be found in the sewer after it has been laid, the damaged item shall be removed and replaced at the Contractor's expense.

Pipes shall be laid on the specified bedding cradle true to designated line and level, and the bedding shall be placed and compacted in accordance with the applicable requirements of

Clause 3.2.5 Construction and Workmanship. Designated invert levels shall take precedence over design depths shown on drawings.

The completed sewer or stormwater drain shall have no bends or undulations except where directed. Should pipes be allowed to have any deviation from straightness, they shall be so laid that preference is given to level over line.

The method of laying and bedding shall be such that barrels of pipes bear evenly on the bedding for their full length, that no packing is used under the barrels, and that no socket or coupling bears on the bedding.Where the slope of a pipe is greater than 1 in 10, anchor blocks shall be constructed according to the details provided.

Pipes shall be so cut as to obtain a clean and square end, and, where pipes and fittings of different material shall be jointed, shall be so only with special adaptors recommended by the pipe manufacturer(s).

All pipe openings shall be sealed by the Contractor to ensure that no water, stones, or other foreign matter enters the sewer during or after laying.

The sewer or stormwater drains shall be so jointed to the pipes built into the manholes that there is a flexible joint positioned as close as possible to the manhole.

Precast units shall be lifted and handled only by means of lifting devices approved by the manufacturer.

The Contractor shall exercise due care not to damage, overstress, or displace any culverts by the imposition of any loads such as may be caused by the movement of his own vehicles or compaction equipment. Where superimposed moving loads in excess of those prescribed in the applicable road traffic ordinance are, during the construction of the Works, likely to pass over completed culverts, the Contractor shall provide sufficient additional cover over the culverts to ensure that the design stresses on the culverts are not exceeded.

Any units that become deformed or cracked, or that are not constructed to the required lines, levels, and grades, or that become displaced in the course of the work, shall be removed and replaced by the Contractor at his own expense.

Cast-in-situ invert slabs for portal or rectangular culverts shall be constructed to the dimensions and at the locations shown on the drawings or as directed. They shall be reinforced as detailed on the drawings. The units of the upper portion of precast portal culverts shall be placed accurately on the invert slabs, with a thin layer of 1:3 cement: sand mortar between the horizontal contact surfaces to ensure a firm and uniform support. The units of the upper portion shall be butt-jointed end to end and each joint shall be covered with geofabric blanket placed symmetrically over the joint.

Pipe culverts shall be laid and bedded to the level and alignment shown on the drawings or as directed. They shall be laid hard up against each other longitudinally to obtain tight joints and they shall be supported evenly throughout the barrel length. Holes or grooves of adequate size

to allow for jointing and for bedding thickness under joints, shall be cut in the bottom of the trench.Pipes shall be laid centrally in the trench in such a manner that the side allowances specified in Clause 3.1 PIPE TRENCHES are available as working space for the proper bedding of the pipes in terms of Clause 3.2 PIPE BEDDING.For ease of inspection pipes shall be laid with the manufacturer's class and quality identification marks visible from the top of the trench unless, in the case of larger pipes, the position of lifting eyes renders this impractical.

Each pipe shall be cleaned out and carefully examined for possible damage immediately before laying. The onus on detecting damage shall rest on the Contractor. Should any damaged pipe be laid, it shall be removed and replaced at the Contractor's expense and to the satisfaction of the Engineer.

Joints of butt-ended pipes shall be externally wrapped with either 2 layers of 0.5 mm thick plastics dampcourse or one layer of geofabric blanket.The wrapping shall be at least 200 mm wide and be centrally placed over each joint.

Ogee type pipes need not be wrapped but shall be laid with the spigot ends pointing downstream.

Spigot and socket pipes with rubber ring joints shall, unless another method is directed or approved by the Engineer, be jointed in accordance with the manufacturer's instructions.

Backfilling of pipes and pipe culverts shall comply with the applicable requirements of specification Clause 3.1 PIPE TRENCHES.

Material for backfilling of portal or rectangular culverts shall comply with Clause 3.1.3 Materials, and shall be obtained by the Contractor from approved borrow pits, if necessary.

Backfill alongside the walls and over the top of culverts shall be watered, mixed, placed, and compacted in layers not exceeding 150 mm after compaction, to a density at least equal to that required for the material in the adjoining layers of fill, subgrade, and subbase, as applicable, or to at least 90 % of modified AASHTO maximum density in the case of excavation made in natural ground.

Backfilling shall be carried out simultaneously and equally on both sides of the structure to avoid unequal lateral forces.

3.4.5.3 Manholes, Inspection Chambers, Catchpits etc.

Manholes, inspection chambers, catchpits, inlets, outlet structures etc., shall be constructed of cast-in-situ concrete, precast concrete, brickwork, as shown on the drawings or as directed by the Engineer.

Manholes shall be provided in following situations:

- changing of direction,
- changing of slope,

- changing of diameter
- interception of secondary lines,
- interception of house connections,
- on main lines at a distance of max. 80 m.

Manholes shall comply with the requirements of NS 80/2042.

The incoming and outgoing pipes shall be fixed in position as detailed before concreting. The concrete surrounding these pipes shall be placed in a single operation and particular care shall be taken to ensure that it fills the whole space beneath and around the pipe.

Benching shall be left completely smooth to the satisfaction of the Engineer. The concrete surround shall be formed using properly constructed formwork.

Selected material shall be carefully filled in and compacted behind the concrete and made solid after the concrete has hardened sufficiently and the protective coating has cured and been properly protected.

Cover slabs shall not be placed until 24 hours after the placing of the concrete manhole surround. This time may be increased or decreased to the discretion of the Engineer.

3.4.5.3.1 Step Irons

Step Irons shall be of cast iron of mild steel and they will be built into concrete as the work proceeds at 300 mm apart vertically.

The entire steps shall be corrosion protected as specified to the approval of the Engineer

3.4.5.3.2 Manhole and Chamber Covers

All covers and frames shall comply with Clause 3.3.5.8.

3.4.5.4 Concrete Casing to pipes

In special cases, and where ordered by the Engineer, pipes shall be encased in concrete of the specified grade, generally of at least 15 MPa. The lower part of the encasement shall be constructed in the manner specified for Class A bedding (see Clause 3.2 PIPE BEDDING). Once the sewer or stormwater drain has been tested and approved, the pipes shall be surrounded 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. Use shall be made of poker vibrators to ensure proper filling with concrete of all spaces under and around the pipe, and displacement or flotation, or both, shall be prevented. All temporary supports provided for the pipes shall be removed as concreting progresses. No earthfilling over the concrete shall be commenced until at least 5 days after the concrete has been placed or until the concrete has attained a strength of at least 10 MPa.

3.4.5.5 Raising or Lowering of Existing Manholes

Where an existing manhole is required to be raised or lowered, the work shall be so carried out that the finished manhole complies with the applicable requirements of Clause 3.3.5.3 above. Where practicable, the same cover shall be used, which shall, on completion of a manhole be flush with the surface of the finished road, shoulder, or sidewalk, as the case may be.

3.4.5.6 Connecting Pipes

Connecting sewers or stormwater drains shall be laid from junctions provided in the main lines to the positions and depths as shown on the drawings or as directed.

The Contractor shall record all relevant data (eg street name, number of plot, location measurements and distances in relation to boundary peg(s), size of connection, depths of invert at connecting point and end of connection etc.) for the preparation of "as-built" drawings, and shall make these records available to the Engineer.

3.4.5.7 Action to be Taken During and After Testing

The Contractor shall make good any defects that may be found while the pipeline is under test and after that the tests shall be repeated at his expense until the pipeline is found to comply with the specification.

After the sewer or stormwater drain has passed the tests all access lids shall be properly sealed with bitumen or by any other approved method in watertight manner.

3.4.5.8 Reinstatements of Existing Drains

The existing drains damaged by the works shall be relocated and connected into new drains as required. Existing drains shall be cleaned out from the new drain trench face and any disturbed pipe relaid to ensure a free discharge into the new drain. The disused end of the intercepted drains shall be sealed with puddle clay or other approved materials.

Where an existing land drain is exposed and temporarily severed by trench excavation, the position of the drain shall immediately be marked and recorded. The normal functioning of the drain until permanent restoration is made shall be maintained by the construction of a watertight conduit adequately supported across the trench.

Without limiting the Contractor’s liability for restoration of damage, the Contractor shall notify the Engineer of any drain which is blocked or is otherwise defective when the drain is first exposed.

When the line of an existing drain interferes with a pipeline, the Contractor shall deal with the drain as directed.Drains shall be reinstated on their original line, unless the Engineer orders otherwise.

When backfilling is being done the temporary conduit shall be removed and the ground below the line of the drain shall be compacted. The positions of the ends of the drains shall be marked and the trench reinstatement completed. The trench for the drain shall be re-excavated and the drain reinstated with approved material laid on supports. The line, level and grade of the original drain shall be maintained.

The supports shall be of durable material and shall be bedded firmly at 500 mm into the undisturbed ground on the trench sides. The supports shall be of suitable timber having a cross section not less than 150 x 65 mm or such section as would be required to permit the laying of the new drain without deflection.

3.4.6 TOLERANCES

3.4.6.1 General

Tolerances will be determined on the basis of permissible deviations from designated location, alignment, grades, and levels. The Contractor shall construct each of the various parts within the limits set out below.

3.4.6.2 Manhole and Catchpit Locations

The permissible deviation of the location of manholes and catchpits (other than kerbside catchpits) in plan of the designated position shall be half the pipe length longitudinally and ± 200 mm laterally, except where locations are dimensioned from fixtures such as fences, kerbs, and the like, in which event the permissible deviation in each direction will be ± 50 mm.

Such manholes or chambers shall be constructed at the meeting points of intersecting pipelines subject only to such deviations as can be tolerated by the junction channels or specials.

3.4.6.3 Invert Levels

The permissible deviation from the designated level of the invert at each manhole shall be ± 50 mm but, should the fall between any two successive manholes be less than 90 % of that specified, the said permissible deviation shall be reduced to a value such that the fall is at least 90 % of that specified.

The permissible deviation of the level of the invert of a culvert from the designated level shall be ± 25 mm.

3.4.6.4 Alignment and Grade

Subject to the permitted manufacturing tolerances applicable to the pipes being laid, the line of the pipe invert shall at no point between successive manholes deviate from a straight line by more than 5 % of the nominal diameter of the pipe, or be lower than at any other place closer to the lower manhole.

The permissible deviation of the alignment and grade of each culvert shall be ± 25 mm from the designated line and level, when measured over any 6 m length, and all such deviations shall be gradual.

3.4.6.5 Manholes and Chamber Structures

The dimensions of walls and roofs of manholes and chambers shall conform to the dimensions specified, subject to the allowable tolerances laid down for concrete structures (see Clause 2.3)

3.4.6.6 Kerbside Catchpits, Kerb Inlets or Grid Inlets

The permissible deviations of the longitudinal location shall be half a kerb length or 0.5 m, whichever is the greater and the permissible deviations of the lateral location from the designated distance from the centre line of the road shall be ± 25 mm, except that any open grid or grid frame shall be truly parallel to and within 5 mm of the face of the kerb.

3.4.7 TESTING AND ACCEPTANCE

3.4.7.1 General

Tests described below apply to sewers and stormwater drain and references to a sewer apply equally to a drain.

All acceptance tests shall be carried out in the presence of the Engineer and at such times and in such manner as the Engineer may direct.

No pipe joint or fitting shall be covered until the tests applicable have been completed and the Engineer has authorized such covering.

The sewer or any section of it shall be inspected by the Contractor who, if he deems it ready to be tested, shall advise the Engineer of his intention to subject the sewer or the said section of it to the appropriate tests.

The sewer shall be tested in sections between manholes or chambers, as applicable, the section being tested being isolated from other sections by means of suitable plugs or stoppers that have been braced adequately.

Notwithstanding any authorization by the Engineer as described above, the Engineer may, after backfilling and compaction have been completed, order that the sewer be retested to check that it has not been disturbed or damaged during backfilling.

The Engineer may order one of the following to be carried out on the sewer or any section of it:

a) an air test on pipes, other than concrete pipes, of all sizes; or in the case of pipes, other than concrete pipes, of diameter up to 600 mm, an air test followed by a water test
b) a water test in the case of pipes of diameter up to 750 mm
c) a visual internal inspection in the case of pipes of diameter greater than 750 mm.

The Contractor shall provide all labour and apparatus (including expandable plugs and flexible bag stoppers) that may be required for carrying out the tests.

All test results shall be recorded in the manner directed, whether or not the pipeline or section of pipeline has passed the test.

3.4.7.2 Tests and Acceptance/Rejection Criteria

a) Air test: An approved air testing machine shall be used to raise the gauge pressure in the section of the pipeline under test first to 3.75 kPa.After a 2 min stabilization period the pressure shall be reduced to 2.5 kPa. The machine shall than be switched off and the time taken for the pressure to drop from 2.5 to 1.25 kPa shall be measured. The time taken shall be at least 2 min for ND 100, 3 min for ND 150, 4 min for ND 200, 4.5 min for ND 250, 6 min for ND 300, 8 min for ND 400, 10 min for ND 500, 12 min for ND 600, and 14 min for ND 700. Times applicable for other diameters may be interpolated.

b) Water test: The section of the pipeline under test and the manhole at the upper end of the said section shall be filled with water to such depth that every portion of the pipeline is subjected to a pressureof not less than 12 kPa and not more than 60 kPa.During the test there shall be no discernible leakage of water. An appropriate period, which shall be at least 12 min, shall be allowed for initial absorption, and the loss of water over the next 30 min shall be noted. The amount lost, in litres, per 100 m of pipeline per hour, shall not exceed the following values: 6 for ND 100, 9 for ND 150, 12 for ND 200, 15 for ND 250, 18 for ND 300, 23 for ND 400, 29 for ND 500, 36 for ND 600, and 44 for ND 700. Amounts applicable for other diameters may be interpolated.

c) Tests on existing pipes shall be carried out in accordance with the above unless directed otherwise by the Engineer.

Should any section of the pipeline fail to pass the water test, a re-test will be permitted and, in such case, acceptance or rejection of the section will be determined on the result of the re-test.

3.4.7.3 Rejection

In the case of AC, vitrified clay, and fibre pipes, failure under the air test will be deemed to be cause for rejection. After such rejection the Contractor may apply a water test to locate the source of failure, rectify the pipeline, and re-apply the air test. In the case of concrete, failure under the water test will be deemed to be cause for rejection.

3.4.7.4 Testing of Connecting Sewers

Each connecting sewer shall be tested between its upper end and the junction at the main sewer. The upper end of the connection shall be kept securely closed with expanding plugs during the test. Where practicable the Contractor may test the main and connections simultaneously if he so wishes. On completion of the test, the upper end of the connection shall be permanently sealed by means of a plug stopper suitable for the type of pipe.

3.4.8 MEASUREMENT AND PAYMENT

The rates for pipelaying and installation of sewers and storm drains shall include for supply of the pipes, laying and jointing of the pipe, the provision and placing of bedding material,
, and backfilling of trenches and disposal of excess material and spoil, and testing of the sewer or drain. Pipe laying and installation will be measured as the distance along the centreline of the pipeline with no deductions for manholes etc, according to the depth to invert of the pipeline. Manholes, catchpits, inlets will be measured separately according to type.No separate payment will be made for, provision of materials, construction of the manhole, catchpit or inlet, backfilling and disposal of excess material.

4.0 ELECTRO-MECHNICAL EQUIPMENT AND REALETED WORKS

4.1 TRANSFORMER

The transformer shall be manufactured and tested in accordance with international code IEC-60076.

4.1.1 TANK

The transformer tank shall be of robust construction, which shall be oil tight and silica-gel breathing system. The tank cover shall be bolted and grounding pads complete with clamp type terminal connector shall be provided on the tank wall near the base.

4.1.2 CORE

The transformer core shall be constructed of high quality, non-aging, high permeability sitcom steel. The steel shall be clamped with positive locking devices to ensure adequate mechanical strength to support the windings and reduce vibrations to a minimum during operation.

4.1.3 WINDINGS

The windings of the transformer shall be of copper such that the completed assembly of core and coils give efficient performance during operation. The core and coils assembly shall be dried in a vacuum for ensuring complete elimination of air and ingress of moisture within the insulting materials. After the drying process, the assembly shall be immediately impregnated with dry oil. The transformer shall be provided with a oil conservator tank.

4.1.4 SHORT CIRCUIT CAPACITY

The transformer shall be able to withstand the mechanical and thermal stress produced due to short circuit current which should be limited by the impedance of the transformer.

4.1.5 TAP CHANGER

The transformer shall be furnished with an externally operational tap changer at no load. The tap changer shall have an operating handle, visible indication of tap position and lockable.

4.1.6 INSULATING OIL

The insulating oil shall be refined mineral oil and the transformer shall be supplied with first filling of the oil.

4.1.7 BUSHINGS

The bushings shall be made of porcelain. The H.T., L.T. and neutral bushings shall have bolted terminal lugs suitable for terminating 10 – 35 sq. mm. aluminium conductor.

4.1.8 TEMPERATURE RISE

The average winding temperature rise above the maximum ambient temperature of 45°C while carrying maximum continuous rated kVS shall not exceed 55°C.

4.1.9 ACCESSORIES

The transformer shall be equipped with the following accessories:

a) Lifting lug
b) Name plate
c) Tank grounding terminal connector
d) Conservator tank
e) Silicagel breather
f) Silicagel vent
g) Tap changer
h) Oil drain valve
i) Upper oil sampling valve

4.2 DIESEL GENERATOR

4.2.1 TECHNICAL REQUIREMENTS

The diesel generator (DG) shall be installed at appropriate location as instructed by the Engineer for power supply in case of NEA, 11/0.4 kv mains failure. This standby diesel generator shall supply the pump load, which is normally operational from 14 hours a day. The generator in-feed circuit breaker can be closed if and only if the mains incoming breaker is open and vice-versa.

The diesel generator shall be for instantaneous starting and loading in cold condition through an electric starter motor. The loadbility of the DG set after cold start shall be immediately 75%, after 30 seconds, 90% and after 5 min 100%.

The speed controlling device of the set shall be automatic with a setting range of ± 10% of rated speed.For stop of the engine a closed magnetic fuel valve and manual fuel valve shall be used.

4.2.2 The Fuel System

A standard storage fuel oil tank shall include a filling and supply piping with valves, level indicator and low level alarm device. The day capacity tank shall be of at least 14 hours operation of the engine at rated load.

The diesel engine shall have a complete lubrication system low lub-oil pressure trip device. The combustion air intake shall be through an air filter. The exhaust system shall have the necessary silencer piping, heat insulation and flexible joint to absorb vibration.

The engine shall be closed loop water-cooled type with a radiator and a mechanically driven fan behind it. The starting system shall include, an electric started motor, a started battery 24 V DC, a battery charger and a low voltage alarm relay for battery voltage.

4.2.3 Generator

The generator shall be rated as specified in the BOQ or Particular specification with star connected synchronous machine for three phase 400 v, 50 Hz supply at 0.8 power factor. The neutral point shall be of easy bolting type.

4.2.4 Exciter and Voltage Regulator

The generator shall have a rotating brush-less exciter and a static voltage regulator. The output voltage from the regulator shall not deviate more than ± 2.5% of the nominal valve in any loading conditions and voltage settings shall be ± 10%.

4.2.5 Control Cabinet

The diesel generator set shall have complete equipment for automatic start and stop sequences in case of mains supply break and return. The automatic starting equipment shall make three consecutive starting attempts and alarm after the third unsuccessful attempt.
A time-lag relay shall be included to delay the start from 1 to 10 sec. (adjustable) in order to prevent unnecessary starts during short mains failure.

The automatic switching over from mains and back shall be made by the generator circuit breaker and mains circuit breaker, which are electrically interlocked. The switchover back to

mains shall be made after 1 minute once the mains have recovered. After switchover back to mains the set shall run on no-load long enough to prevent damage due to post heat for about 5 minutes.

Manual start / stop equipment and an OFF / MANUAL / AUTO switch shall be included.

4.3 SUBMERSIABLE PUMPSET WITH ACCESSORIES

4.3.1 GENERAL

4.3.2 SELECTION OF SUBMERSIBLE PUMPSET

Submersible pumpset installed vertically in the sump well have been selected because in this case separate pumphouse need not be constructed, and priming of the pump is not necessary as the pumpset is already submerged in water. This arrangement also makes the provision of suction pipe, valve and fittings unnecessary.

Submersible pumpset shall consist of a centrifugal pump directly completed to a submersible motor, complete with all necessary accessories and suitable for the horizontal installation of the submersible pumpset inside the sump well/water reservoir. The pumpset shall be suitable in all respects for pumping drinking water.

4.3.3 OPERATING TECHNICAL PARAMETERS

Operating technical parameters such as rated discharge capacity of the submersible pumpset; Capacity of motor, Combined / overall efficiency at rated duty point, etc shall be as described in the supplementary specification or as described in the BOQ.

Submersible pumpset shall have ISI making and fully conform to IS – 8034 – 89 in all respects. The manufacturers of the submersible pumpset shall be an 950, 9001 or 9002 certified Company.

4.3.4 PUMP DESIGN

The pump shall be a multistage centrifugal pump with dynamically balanced impellers of radical/mixed flow design. A non-return valve shall be located at the pump discharge point.

The submersible motor shall be capable of withstanding heavy demands made on it in respect of reliable insulation and bearing loads. It shall consist of water filled, required cage type induction motor, sealed by radial seal rings to avoid mixing of well water and the fill water.

The pump shall be provided with sleeve bearings and the motor with sleeve and thrust bearing. All the bearings shall be water lubricated and protected against structural elements. Mitchell type thrust bearing shall Mitchell type trust bearing shall be provided to withstand axial thrust loads; and a suitable reflex pressure compensating device shall be incorporated the

overpressure, which may arise as a result of the thermal expansion of the fill water when the temperature of the windings rises.Power shall be supplied through a special cable passing through a watertight sealing gland, protected by means of metal sheath along the length of the pumpset shall be suitably chemically treated to protect them from water corrosion.

The design and operating conditions which shall govern in the selection of pumps are based on the actual improved yield achieved after the drilling of deep tubewells. Complete equipment shall be suitable for the condition of submergence in liquid. Pump characteristic curve allowable tolerances shall be in accordance with the Hydraulic Institute Standard. Shutoff head allowable tolerance shall not exceed 3 percent. Negative tolerances in design head and efficiency are not permissible. The final head curve for all pumps shall rise steadily and at a slope rate from the design point to pump shutoff.

Engineer reserves the right to change the pump design TDH within $\pm$ 5 percent prior to fabrication without any price increase, as long as TDH remains a function of impleller size. All pumps shall be designed to withstand 1.5 times of the pump shutoff pressure. All pumps supplied under this specification shall be capable of both intermittent (start-stop) and continuous operation under the operating conditions from minimum flow to runout condition.

Design and construction of each pump shall permit full voltage starting of driving motor. Shaft's critical speeds shall be at least 10 % higher than the max. operating speed. The maximum limits for vibration shall be kept without those limits stated in the HIS standard. Normal and maximum permissible operating vibration amplitude limits shall be provided by Contractor/Manufacturer, and if required, the Contractor shall provide the vibration detector with switch monitoring shall be carried out.

4.3.5 MATERIALS OF CONSTRUCTION

Materials of construction of pumpset shall be as given below:

S.No.	Part	Materials
1.	Suction Casing	Cast Iron
2.	Bowl / Stage Casing	Cast Iron
3.	Impeller	Zinc Free Bronze
4.	Pumpshaft	Stainless Steel
5.	Water lubricant Bearing	Bronze
6.	Thrust Bearing Plate	Bronze

Submersible type pumping equipment shall be single stage, non-clog centrifugal pump capable of pumping continuously the liquids identified previously and conforming to the specified pumping heads and flows. Pump casing shall be manufactured at least 11% chrome iron ASTM A532 class III type A, heat treated to a hardness of 400 Brinnel. The casting shall have ample thickness, capable of prolonged resistance to the abrasive actions of solids or foreign matter contained in the liquid passing through the pump. The pump casing shall be hydrosatically tested under a hydrostatic head of at least 50 meters of water. Discharge flange connection shall have the appropriate size in accordance with the pump, flat faced and drilled according to ANSI B 16.5.

Each pump & motor shaft shall be made of stainless steel with ample provision to compensate for pump thrust and for the overhand load on the impeller.

Impeller shall be at least 10% chrome iron head treated to a hardness of 400 Brinell, nonclog, symmetrical, balanced type with a minimum of vanes or blades having a wide suction, Impeller vanes shall be free from sharp edges and waterways with smooth contours and well-rounded entrances. The impeller shall not have port for reduction of thrust on impeller. The impeller shall be held securely to shaft method permitting easy removal of impeller. The impeller shall be capable of holding securely in event of pump reversal to full runways speed.

The electric motors shall be squirrel cage induction type suitable for full voltage starting designed for a Class I. Groups C and D. Division I hazardous location in air or submerged in liquid rated for continuous duty in the liquid or in air. Power supply shall be 400 volt or as required, 3 phase 50 hertz.

All electrical parts shall be housed in a cast-iron, watertight enclosure. The cable leads shall be epoxy sealed. Cable leads shall be a minimum 15 meters long. Lifting eyes shall be cast into the motor housing and shall be of adequate strength to lift the entire pump motor assembly. Lifting chains shall be provided for each submersible type of pumping unit.

Length of each chain shall be minimum 15 meters. The motors shall be supplied with dandem mechanical seals. The upper seals shall have carbon rotating faces, ceramic stationary faces with Buna N elastomers or better. The lower seals shall have solid tungsten carbide rotating and stationary faces with viton elastomers or better.

Electric motors shall be tested for the following characteristics prior to shipping and certified copies of the test report shall be forwarded to the engineer for review:

- Full load heat run
- Percent slip
- No load current
- Locket rotor current
- Starting torque
- Efficiency at 100%, 75% and 50% of full load nameplate rating
- Power factor at 100%, 75% and 50% of full load nameplate rating
- Winding resistance
- High postdental
- Bearing inspection

Each submersible type of pumping unit will be equipped with two float type level switches which shall control the operation of the pumping unit's electric motor at high liquid level and stop the motor at low liquid level.

4.3.6 STANDARD ACCESSORIES

Standard accessories supplied along with the submersible pumpsets shall include, but not limited to, the following matching items as recommended/ supplied by the manufacturer of the pumping set:

- Bearing pedestals
- 2 Nos. of water reservoir for use in horizontal installation ofpumpset
- Suitable expansion joint
- Suitable bend
- Submersible cable of sufficient length, flat type, continuous without any splices
- Suitable pressure gauge with isolating valve
- Dry run cut out electrode with cables
- Motor started panel as mentioned in the Tender Document.

4.3.7 TECHNICAL DOCUMENTS

4.3.7.1 Drawings and Documentation to be submitted with Proposal

Tenderer shall submit with proposal the following drawings and documentations in addition to the information required by other section of this specification. The drawings where applicable, shall show the terminal points of Contractor's scope of supply.

Technical Data

All blank space in the technical data sheets in other section of specification, shall be completely filled in with the required information or where not applicable to Contractor's, offer a horizontal line shall be drawn and if any more necessary shall be added.

Drawings and Document

- Outline drawings showing dimension, for pump, motor, instrument panel, if any.
- Sectional drawings of major equipment
- P & I diagrams including terminal points, if sealing, cooling or lubricating are required.
- Loading diagrams for civil work
- Characteristic curves
- Recommended operating logic diagrams
- Available delivery schedule
- Test and inspection schedule
- Spare part list
- Special tool list
- Motor (or electrical power consumption) list.
- Instrument and set-point list
- Experience or reference list
- Manufacturer's catalogues and literature to supplement the drawings and illustrate the equipment, instrument, fitting, furnishing, etc.
- Control schematic and wiring diagram if required.
- Any other drawings or data not specifically called for, but necessary to fully describe the offer.

4.3.7.2 Drawings and Documents to be Submitted After Contract

- Contractor shall furnish for approval the indicated drawings and data within the time limit set forth in the purchase order.
- Drawings and documents called for below, shall be a guideline of drawings and documents to be provided by Contractor.
- Contractor shall resubmit all data and drawings, which were submitted with proposal, for approval after contract.
- Contractor shall submit the technical data and drawings for electric motor as per specification of electric motors.
- Lists and schedules
- Master drawing list showing the submission schedule
- Spare part list with sectional and/or outline drawing
- Special tool list with sectional and/or outline drawings
- Clearance and tolerance list

Detail drawings

- Assembly drawings of all equipment
- Dismantling drawings
- Detail drawings showing construction of all valve type and dimensions for all size.

Procedures and manuals

- Test and inspection procedure
- Installation manual
- Initial start-up procedure including check list and typical format
- Optical manual
- Maintenance manual
- Test and Inspections Reports
- As-Built Drawings

As Built Drawing

Contractor shall submit to the Engineer as-built drawings, which were submitted for approval and for construction.

4.3.8 ENGINEER'S PRE-APPROVAL

The Contractor must obtain the pre-approval of the Engineer regarding the make/ model, capacity, quantity of the submersible pumpset and related accessories to be procured / supplied by the Contractor; and also for the planned installation and erection work of the submersible pumpset along with the necessary accessories.

4.3.9 SITE VISIT

Before testing the submersible pumpset Service Engineer/Expert of the manufacturer shall visit the manufacturer shall visit the installation site to check for the correct installation and operation of correct installation and operation for the pumpset; and shall issue a formal letter to this effect to the Engineer. The total cost for this job shall be fully borne by the Contractor only.

4.3.10 CLEANING AND PAINTING

All manufacturing waster, such as metal chips and filings, welding rods and studs, waster, rags-debris etc; shall be removed from the interior of each component. All loose mail scale, rust, oil grease, chalk, crayon, paint marks, and other deleterious material shall be removed from interior and exterior surfaces. At time of shipment, product shall be clean inside and outside.

All centrifugal pumps and accessories shall be thoroughly cleaned and shop painted in accordance with the following cleaning procedure and painting system(s). All centrifugal pumps and accessories installed outdoors shall be prepared for priming in accordance with SSPC-SP 10 near white blast cleaning. Stainless steel of galvanized steel surface shall not be painted. Interior and exterior surface shall be painted in accordance with general technical requirements.

4.3.11 TAGGING OF EQUIPMENT

A corrosion-resistant nameplate shall be securely attached to each completely assembled piece of equipment, at an easily accessible point of each pump and shall contain the following data: Manufacturer's name, serial number, shop order number, project identification number, type of equipment, tag number, rated horsepower, speed, total head, capacity and direction of rotation.

Name plate shall be chromium plated bronze unless otherwise. Description on the plates shall be engraved with black filled lettering in English. The armatures shall be fitted with circular stainless steel name plates, having engraved back letting in English for which the armature is intended and giving the armature number.

4.3.12 SPARE PARTS, TOOLS AND CONSUMABLE

Contractor shall provide in the manner and within the time limits as set forth in the purchase order, its list of spare parts and special tools if necessary for installation, operation and maintenance for three (3) years operation of pump set and accessories furnished by him.

Unless otherwise, recommended spare parts shall be accompanied by Manufacturer's expected lifetime of wearing parts and description sufficiently detailed to identify the spare parts and the specific item or items for which it applies. Manufacturer shall indicate the minimum recommended inventory for routine maintenance and installation, start-up and continuous operation. Contractor shall indicate whether the recommended spare is a stock item of special item, location of nearest supply point and approximate lead time required for shipment.

The list of special tools shall be accompanied by description sufficiently detailed to identify the function of the tool and the specific item or items for which it applies, Contractor / Seller shall indicate whether the tool is required for installation, and prepared by suitable means for storage by greasing or storage. The spare parts ordered shall be delivered with the main equipment but in separate boxes clearly marked "SPARE PART".
The contractor shall submit a priced list of each Spare Parts for the Engineer's approval. For approval and supplied Spare Parts the contractor be paid from the provisional sum.
Contractor shall submit sectional and / or outline drawings for spare parts and special tools at the time of shipment of the spare parts and special tools. The number of copies and reproducible of each drawing to be submitted shall be in accordance with general technical requirements.
Contractor is required to supply the lubricating oil for first fill.

Contractor shall provide a specification for the lubrication of the equipment. The number of different oils and grease recommended should be kept at a minimum. The types or nipples should be reduced to a minimum.

4.3.13 TEST AND INSPECTION

a) General

Equipment testing shall be within the guideline of the approved test code and to the standard for centrifugal pumps to the satisfaction of employer / engineer.

b) Material Tests

Certified mill test reports for pressure retaining parts shall be provided in accordance with relevant material specifications and shall include mechanical and chemical properties.

c) Shop Tests

i) Hydrostatic tests

Pressure retaining parts, shall be hydrostatically stated at 150 % of shut-off pressure at design speed. The test pressure shall be held for a minimum 5 minutes.

ii) Performance tests

Each pump shall be performance-tested at design speed and rated suction conditions.

The final performance curve shall be based on not fewer than five (5) test points at rated speed. The specified guarantee point, the runout point, and the shut off point are three (3) mandatory test points. The remaining two (2) point shall be evenly distributed between the guarantee point and the shut off point.

d) Test reports

Certified test reports shall be prepared and submitted to Engineer shall include test arrangement, instrumentation and calibration data, test data.

Result of the performance tests shall be summarized in curve form with total generated pressure, efficiency, and power absorbed. The guaranteed design performance, maximum run-out operation, and test water temperature shall be stated on the curve.

e) Field Tests

Acceptance field tests, after equipment is completely installed, may be performed by Contractor to demonstrate performance requirements. If specially requested by the Engineer.

When the adjusting is terminated, new tests shall be carried out at the Contractor's expenses, except expenses of fuels, electric power and water in case of the Engineers field test.

f) Criteria for Rejection

At design point, deviation from guarantee values by more than:

- Delivery rate %:+10/-0
- Delivery head, % :+5/-0
- Efficiency, % :-0

On completion of the installation and erection of the submersible pumpset with accessories and after the required initial setting of the electro-mechanical works the Contractor shall notify the Engineer at least 7 days in advance about his readiness to demonstrate and commission the submersible pumpset along with the transformer, stand-by diesel generating set and the pipeline works with valves and fittings. This demonstration work shall show that the electro-mechanical items / systems meet the specified specifications and performance criteria as mentioned in the Contract Document.

For carrying out the testing and commissioning works the Contractor shall provide the following items fully at his own cost.

- All skilled and qualified staff and labour as required.
- Provision and disposal of all services and consumables, e.g. lubricants, fuels, electricity, water, etc.
- All measuring and testing instruments (e.g. gauges, flow-meters, multi-meter), hand tools, etc) required to demonstrate that the items / system are operating to the required performance criteria.

4.3.14 Acceptance Certificate

Only upon successful testing and commissioning of the electro-mechanical works an acceptance certificate shall be issued by the Employer / Consultant.

4.3.15 Warranty Period

The Contractor shall provide warranty for the installed distribution transformer, standby diesel generator set, submersible pumpset, motor control panels, change over switch, etc. and for their relevant accessories to be free from defects in design, quality of material and workmanship under the normal use and service for a period of one year from the date of issue of Acceptance Certificate. Any fault arising due to defects in design or quality of material or workmanship during the Warranty period shall be promptly made good by the Contractor fully at his own cost, failing which the Performance Bend of the Contractor shall be forfeited.

4.3.16 Training

After the successful testing and commissioning of the electro-mechanical works the Contractor shall provide training to the 4 personnel of the Employer for a period of 7 days. Suitable training shall be given by approved Experts at project site regarding the proper operation, maintenance and repair of the stand-by diesel generator set, submersible pumpsets, motor control panels, change-over switch, valves and gauges of the pipeline works, etc. The cost of this training shall be fully borne by the Contractor.

5.0 PIPES, FITTING AND RELATED ACCESSORIES

5.1 GENERAL

5.1.1 MATERIALS

The term materials shall mean all materialsand articles of every kind, raw, processed or manufactured, which are used in the manufacture of goods to be used under the Contract.

All materials shall be new and of the kinds and qualities described in the clauses hereof appropriate to the particular item and shall be at least equal to approved samples except that alternative materials may be accepted provided the Contractorhas at the time of tendering :

a) Drawn particular attention to the deviation from the Specification in his bid and provided particulars of the alternative material offered at the time of tendering, and

b) Substantiated, to the satisfaction of the Engineer, that the material offered is equal or superior to the material specified for the use to which it is to be put and has obtained from the Engineer’s approval in writing to its use. Where materials to be used for any component have not been laid down in the Specification the Contractor shall use only thosematerials in such compositions as have been proven in actual service to be the most suitable for the particular purpose.

All pipes and assembling parts selected under this Contract must be of first quality, truly circular, of a uniform thickness, free from scale, lamination, honeycombs, and other defects, and shall be designed to withstand the stated pressures and temperatures. They shall be of service proved products of specialized manufacturers.

Each pipe length should be as long as indicated in the drawings. When not indicated, the length should be as long as practicable to keep the number of joints to a minimum.

Where the coating of pipes is damaged, 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.

5.1.2 EQUIVALENCY OF STANDARDS AND CODES

Wherever reference is made in the Contract to specific standards and codes to be met by the goods and materials 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.

5.1.3 STANDARDS AND CODES

All workmanship, materials and components throughout shall, where applicable and unless otherwise stated in the Contract, comply either (a) with the relevant International Standard ISO, (b)with the relevant British Standard or Code of Practice current on the date fixed for receipt of tender, (c) comparable Indian Standards, (d) with the relevant Nepal Standard or as per Engineer’s approval.

The following is a list of some nationally and internationally accepted standards and codes and some associations concerned with the standardization of products and abbreviations below will be used in the following text.

5.1.4 TEST CERTIFICATES

Certificates in triplicate shall be provided by the Contractor for each material such as valve, pipe, and fitting 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 valves, pipes and fittings giving the process of manufacture, chemical analysis (where relevant) and the results of specified tests.

The materials shall be suitably marked to enable them to be identified from references on the certificates.

5.1.5 SAMPLES OF MATERIALS AND TESTS ON SAMPLES

The Contractor shall provide to the Engineer three 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.

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 labour, 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.

5.1.6 INDEPENDENT AND LOCAL TESTS

The Engineer 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. In addition to any relevant clause in the General Conditions 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.

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 corrections are permitted by the Engineer

5.1.7 REJECTED GOODS

Any Goods delivered to the site which have been rejected by the Engineer shall immediately be removed from the site. Replacement of rejected Goods shall be made as soon as possible but in no case exceeding thirty (30) days from the time of rejection.

Any pipes 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 may be submitted for retest following the correction of any defects, where such correction is permitted by the Engineer.

5.2 DUCTILE IRON PIPES AND FITTINGS

Pipes and Fitting

General

Ductile iron pressure pipes and fittings shall comply with ISO 2531(2009).

All pipes are socket and spigot unless otherwise specified and up to a diameter of 300mm shall be Class C40,pipes with diameters from 350 to 600mm shall be Class C30and pipes greater than 600mm shall be Class C25.

All fittings (spigot, socket and flanged) shall be PN 16. All socketed fittings shall meet the requirements of 4.2.1.3 of ISO 2531(2009).

Considering the geometric design of road of the Kathmandu Valley, the effective length of the pipe shall be 5.5 to 6.0m. However, smaller required length as per site condition, would then be modified at site without damaging the properties of the pipe and with no extra cost and time.
The manufacturer should be equipped with a specific devise in order to control the wall thickness of pipes. All DI fittings have to produce by Sand Mould cast 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

Materials

The materials used in the manufacture pipes and fittings shall comply with ISO 2531(2009).

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.

Joints

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 angular deflection certified by the manufacturer shall not be less than the allowable angular deflection 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 withdrawal.

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.

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.

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.

Nuts, Bolts and Washers

Hexagonal Nuts, bolts and plain washers shall be of product grade C suitable for use with ISO 2531(2009)
or BS EN 1092-2 flanges and shall be made of steel with hot dipped galvanization.

Bolts shall be of sufficient length that one thread shall show through the nut when in the fully tightened condition.

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 50 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.

Underground Warning Tape:

The underground warning tapes shall be non-detectable, color blue, 10cm wide,4mm thick made of PVC or Polyethylene, The Tape shall be printed with the words " WATER LINE BELOW" at intervals not exceeding 500mm. The tape shall have a minimum tensile strength of 1750 psi.

Puddle and Thrust Flanges

Puddle and thrust flanges shall comply with Clause 6.4.1 but remain un-drilled.

Internal Linings

Pipes

The pipes shall be internally lined in the factory with 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 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.

Fittings

The fittings shall be internally lined in the factory with fusion bonded epoxy coating of 250microns, in accordance with EN 14901-2006. The epoxy coating shall be suitable for potable water by test certificate from an international health institute, shall be abrasion resistant, and shall be subject to the 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.

External Coating

General

Unless otherwise specified, ductile iron pipes and fittings shall be zinc coated with a 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.

Zinc Coating

Zinc coating shall comply with ISO 8179-1and shall be applied as a spray coating. The mass of sprayed metal shall not be less than 130 g/m2 when measured as described in Clause 4.5 of ISO 8179-2.

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 as per the manufacturer's instructions after removing any remaining loose coating and wire brushing and rusted areas of pipe.

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.

Pipes and Fittings Marking

In addition to the marking required to comply with ISO 2531, the pipes and fittings shall additionally bear readable and indelible marks as follows:

- A unique identification number
- Employer's Name (Kathmandu Upatyaka Khanepani Limited)

Spigot ends will show control marks for ease in connection.

Pipes which are gauged to allow them to be cut shall be marked by a two diametrically opposed longitudinal lines each at least 20mm wide.

5.3 HDPE PIPES AND FITTINGS

5.3.1 GENERAL REQUIREMENTS

5.3.1.1 Materials

Term "materials" shall mean all materials and articles of every kind whether raw, processed or manufactured which are used in manufacture of the Goods to be supplied under the Contract.

5.3.1.2 Composition

The pipes raw materials shall be PE - 100 or equivalent approved compound consisting of virgin polythene as described in NS 40 in which carbon black and a suitable non-toxic anti-oxidant are evenly dispersed.

The Client may ask to the suppliers to produce certificate of evidence of the original raw materials used for producing pipes and also the evidence of these materials imported or purchased.

All materials shall be new and of the kinds and qualities described in the clauses hereof appropriate to the particular item and shall be at least equal to approved samples except that alternative materials may be accepted provided the Supplier has at the time of tendering:

a) Drawn particular attention to the deviation from the Specification in his tender and provided particulars of the alternative material offered at the time of tendering; and
b) Substantiated to the satisfaction of the Purchaser that the material offered is equal or superior to the material specified for the use to which it in to be put and has obtained from the Purchaser approval in writing to its use.

Where materials to be used for any component have not been laid down in the Specification, the manufacturer shall use only those materials in such compositions as have been proven in actual service to be the most suitable for the particular purpose. All pipes shall be smooth, clean and free from all defects.

The supplier must name the manufacturer(s) at the time of tendering 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 supplier 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 supplier, the Purchaser 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 Purchaser.

5.3.1.3 Samples of Materials and Tests on Samples

The Contractor shall provide to the Purchaser 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 Purchaser.

In addition, when and if required by the Purchaser, 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 by the Purchaser at the place of manufacture or at a laboratory approved by the Purchaser and shall provide to the Purchaser 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 Purchaser. The Supplier 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 Purchaser 14 days notice in writing of the date on which any of the samples will be ready for testing or inspection and unless the Purchaser shall attend at the appointed place within the said 14 days, the test may proceed in his absence.

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

5.3.1.4 Test Certificates

Test certificates in triplicate shall be provided by the Supplier 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 Supplier 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 before the Purchaser has received a satisfactory Test Certificate shall be at the Supplier's risk.

5.3.1.5 Independent Tests

The purchaser or his designated agent reserves the right to inspect and 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 manufacturing in the plant 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 Supplier at no extra cost to the Purchaser.

The cost of making any such independent tests shall be borne by the Purchaser, unless it is shown that the workmanship or materials under test are not in accordance with the Specification, in which case the cost of the tests shall be borne by the Supplier.

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.

5.3.1.6 Rejected Goods

Any Goods delivered to the Site which have been rejected by the Purchaser shall immediately be removed from the Site by, and at the expense of, the Supplier. Replacement or rejected Goods shall be made as soon as possible but in no case exceeding forty- five (45) days from the time of rejection.

Any pipes, 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 may be submitted for retest following the correction of any defects, where such correction is permitted by the Purchaser.

5.3.1.7 Standards

All materials, workmanship and components shall, where applicable and unless otherwise stated in the Contract, comply with either:

(a) a relevant Nepal, Indian, current on the date fixed for receipt of tenders, or

(b) any other internationally accepted equivalent standards which, in the opinion of the Purchaser, are equal to or better than the specified standards.

Nepal Standard NS: 40 – 2042(Fourth Revision 2074) published by Nepal Bureau of Standards and Metrology

Indian Standards IS : 4984 - 1995 published by Bureau of Indian Standards, Manak Bhawan, New Delhi, India;

The acceptance of a tender based upon a Standard or Code of Practice proposed by the Supplier shall only signify the Purchaser's general approval to the use of such Standard or Code of Practice and shall not signify acceptance by the Purchaser of any materials or workmanship subsequently found to be inferior to that specified in the corresponding Standard or Code of Practice.

5.3.1.8 Supply and Marking of Pipes

The Pipes shall be supplied as coils with a minimum inner diameter of 25 times the DN of the pipes (PN 6) for DN sizes of 16 mm to 50 mm as given below and for higher DN sizes in lengths of five/six meters. The pipes may also be supplied in other lengths where so agreed between the Supplier and the Purchaser. The ends shall be cut at right angles to the pipe axis and shall be plugged or covered.

Three equispaced longitudial stripes of width 3 must be indelibly and clearly marked along the pipe surface according to the following code:

Pressure Rating	Colour
- PN - 6	Green line
- PN - 10	Yellow line

- PN - 12.5	Purple line
- PN - 16	White line

Each pipe shall also have the following inform ation marked on it: On every meter length.

i. Item number; pipe size - outer diameter; Presssure rating PN; Length; NS, IS, etc or relevant authoritative Standards mark.

ii. The method of marking shall be such as to ensure that all of the information will remain legible after shipping, local haulage and storage in the open.

5.3.2 Testing of Pipes before Delivery

5.3.2.1 Tests

At the place of manufacture; hydraulic tests, reversion tests and internal pressure creep tests shall be carried out on ten random samples from each pipe series and diameter spaced throughout the manufacturing period.

The requirement may be reduced where a small length of a particular pipe diameter and series is to be supplied.

Pipe shall be classified by pressure rating (PN) corresponding to the máximum permisible working pressure at 30°C, as follows :

Pressure Rating	Working Pressure
PN - 6	0.60 MPa (6 kgf/cm^2)
PN - 10	1.00 MPa (10 kgf/cm$^{2)}$
PN - 12.5	1.25 MPa (12.5 kgf/cm$^{2)}$
PN – 16	1.60 MPa (16 kgf/cm$^{2)}$

Tests shall be witnessed by an independent inspection agent/ or purchaser's agent, to be appointed by the Purchaser, who shall approve the tests on behalf of the Purchaser.

5.3.2.2 Site Inspection and Testing

All Goods will be inspected after delivery to site and the Purchaser will reject any item which is damaged or not complying with the specifications.

5.3.2.3 HDP Fittings

All HDP fittings shall be manufactured by Injection Moulding Process in accordance with IS: 8008 (Part I-VII) - 1976 or equivalent to join HDP pipes to IS: 4984 - 1978 or equivalent. All

fittings shall be moulded from a compound consisting of virgin polyethylene in which carbon black and suitable non-toxic anti-oxidant are evenly dispersed and shall be suitable for butt - welding at fusion temperature 200^0C- 220 ^{0}C. All HDP fittings shall conform corresponding to working pressure rating of PN 16. Fittings supplied must have a clear marking indicating the relevant pipe size(s) indelibly on each item.

5.3.2.4 Jointing

All HDP pipes and fittings shall be jointed with the automatic butt-welding fusion machine at fusion temperature of 200^0C- 220 ^{0}C. The welding shall be as specified by the welding machine and as per manufacturer's specification.

Before joining it has to be ensured that equipment is clean, in good condition, regularly maintained and within required calibration/service. The cutter/blades and scarpers should be clean and in good condition. Mechanical Scrapers must be used wherever possible and the restraining clamps should be in good condition. Clean and dry place to place tools and equipment should be checked before during electro fusion process. The joining process should not be started unless it can be completed in one go.
Shelter and ground sheet, both in dry and wet condition should be used in order to minimize contaminations. Clamps should be used for alignment/restraining/re-rounding. Voltage should be ensured compatible with fittings..

5.4 GALVANIZED MILD STEEL PIPES AND FITTINGS

5.4.1 MATERIALS

The term materials shall mean all materials and articles of every kind, raw, processed or manufactured, which are used in the manufacture of goods to be supplied under the Contract.
All materials shall be new and of the kinds and qualities described in the clauses hereof appropriate to the particular item and shall be at least equal to approved samples except that alternative materials may be accepted provided the Supplier has at the time of tendering:-

(a) Drawn particular attention to the deviation from the Specification in his tender and provided particulars of the alternative material offered at the time of tendering, and

(b) Substantiated, to the satisfaction of the Engineer, that the material offered is equal or superior to the material specified for the use to which it is to be put and has obtained from the Engineer approval in writing to its use.Where materials to be used for any component have not been laid down in the Specification the Supplier shall use only those materials in such compositions as have been proven in actual service to be the most suitable for the particular purpose.

5.4.2 STANDARDS

All workmanship, materials and components throughout shall, where applicable and unless otherwise stated in the Contract, comply either

(a) with the relevant Nepal, Indian or British Standards or Code of Practice current on the date fixed for receipt of tenders, or

(b) with other internationally accepted equivalent Standards or Codes of Practice which are equal or superior than the specification.

The acceptance of a tender based upon a Standard or Code proposed by the Supplier shall only signify the Engineer's general approval to the use of such Standards or Codes and shall not make the Engineer liable to accept a Standard or Code subsequently found to be inferior to that specified in the corresponding Standard or Code of Practice.

5.4.3 TEST CERTIFICATES

Certificates in triplicate shall be provided by the Supplier for each valve, pipe and fitting 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 valves, pipes and fittings giving the process of manufacture, chemical analysis (where relevant) and the results of specified tests.

The materials shall be suitably marked to enable them to be identified from references on the certificates.

5.4.4 INDEPENDENT AND LOCAL TESTS

The Engineer reserves the right to carry out any independent or local tests he may deem fit on the completed goods 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 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.

5.4.5 REJECTED MATERIALS

Any goods delivered to site, which are rejected by the Engineer, shall immediately removed from site by the Supplier free of costs.

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 corrections are permitted by the Engineer.

5.4.6 MANUFACTURE AND TESTING

Tube shall be made from tested quality steel manufactured by any approved process.

The manufacture and testing of all galvanized steel pipes and fittings shall comply with the current edition of NS, IS, BS or equivalent. Galvanized steel pipe shall be of the class specified in the Bills of Quantities.

Ends of pipes shall generally be screwed at both ends as per IS 554 - 1975, BS 21 threads or equivalent or as requested by the Engineer. Ends of pipe specials and fittings shall be screw socketed suitable for screwing to IS : 554 - 1975 or BS : 27 threads or equivalent pipe threads.

Where flanged pipe work is specified this shall be suitable for jointing with other flanged pipe work and valves.

5.4.7 PROCESS OF MANUFACTURE

"Medium" and "Heavy" duty galvanized steel pipes and sockets shall be either welded or seamless as agreed to between the Engineer and the manufacturer.

5.4.8 STANDARD AND NON STANDARD LENGTHS

The pipe shall be supplied in standard lengths of 6 metres each.Each pipe shall be provided with a corresponding size of one socket at one end and a plastic ring (cover) at the other end for protection of the threads of the pipes.

Non standard lengths shall be approximately 3 metres in length or as required by the Engineer. One socket to be provided with each pipe at one end and a plastic ring on the other end as mentioned above.

In both the cases, the total lengths for each class and diameter shall bethe sum of the pipe lengths measured excluding the sockets.

5.4.9 PIPE DIMENSIONS AND TOLERANCES

The pipe wall thickness and outside diameter of the pipes shall comply with Section 2.4 of BS 1387 or equivalent.

The weights per metre in Kgs. of Screwed and Socketed Galvanized Mild Steel Tubes (including sockets) shall not be less than:-

Dia (mm)	Heavy Duty Kg/m	Medium Duty Kg/m	Light Duty, Kg/m
15	1.51	1.28	1.02
20	1.97	1.65	1.48
25	3.07	2.54	2.11
32	3.97	3.27	2.72
40	4.59	3.77	3.41
50	6.39	5.32	4.33
65	8.21	6.82	6.11
80	10.52	8.87	7.21
100	-	12.69	10.49

5.4.10 HYDRAULIC TESTS

Each pipe and fitting shall be tested at the place of manufacture to a hydraulic test pressure of 50 bar without showing defects of any kinds, the pressure being maintained sufficiently long (in any case not less than three minutes) for proof and inspection.

5.4.11 GALVANIZING

After hydraulic testing of each item has been completed, pipes, fittings and flanges shall be thoroughly descaled, washed as required and then dipped in a bath of molten zinc, containing not less than 98.5% by weight of zinc at a temperature suitable to produce a complete and uniformly adherent coating of zinc. Where tubes are required to be galvanized, the zinc coating on the tubes shall be in accordance with IS : 4736 - 1968 or equivalent. Pipes and fittings which are to be screwed shall be screwed after galvanizing has been completed.

5.4.12 TESTS ON FINISHED PIPES

The Supplier shall arrange and carry out tests on the galvanizing in accordance with Appendix A of BS 1387 or equivalent. One pipe per batch of 500 pipes shall be sampled for this test.

The Supplier shall also arrange and carry out bending and flattening tests on pipes above 50 mm nominal diameter in accordance with Section 2.9 of BS 1387 or Section 14 of IS : 1239 (Part I) - 1979. Two pipes per batch of 500 pipes shall be subjected to these tests.

5.4.13 PIPE SPECIALS AND FITTINGS

Galvanized mild steel pipe specials and fittings shall conform to the appropriate dimensions given either in BS 1387 or BS 1740 or IS : 1879 - 1987 or equivalent. The material used for the manufacture of malleable cast iron fittings shall conforms any of the grade specified in IS : 2107- 1977 or IS : 2108 - 1977 or equivalent. Outlets of fittings shall be threaded to dimensions and the tolerances as specified in IS : 554 - 1975 or equivalent. Fittings shall be galvanized to meet the requirements ofIS : 4759 - 1985 or equivalent. Pressure test shall be as per section 13 of IS : 1879 - 1987 or equivalent. The dimension and weight of all fittings shall be as per the corresponding section of standards e.g. IS : 1879 - 1987 or equivalent. The ends of all pipe specials shall generally be screw socketed. If the supplier offers screw spigot ended pipe specials, a matching screwer socket shall be provided for each end of the pipe specials. All standard lengths shall be supplied with one coupling and the price quoted shall include for this.

5.4.14 FLANGED JOINTS

Flanges shall be the boss screwed type in accordance with BS 4504 Table 16/4 or equivalent suitable for screwing to BS : 21 pipe threads or equivalent. Each flange to be supplied with one set of jointing materials.

Each set of flange jointing materials shall be supplied complete with nuts, bolts, washers and joint rings with an additional 10% as spares.Body bolts and nuts shall be galvanized, joint rings shall be of flat section 3 mm thick, medium rubber reinforced with two-ply flax fabric and complying with BS 5292 or equivalent and shall not extend beyond the bolt circle.Bolts and nuts shall be hexagonal and shall be in accordance with BS 4190 or equivalent.

5.4.15 MARKINGS

Each standard length Medium Class galvanized pipe shall be marked with two blue bands 50 mm wide (one band at each end of the pipe) the nominal diameter, the length of pipe and the relevant manufacturing standard.Similarly for light class pipes except that the band colour shall be brown or yellow and that for heavy class red bands colour.

5.4.16 PROTECTION AGAINST DAMAGE IN TRANSIT

Pipes and specials shall be protected with a suitable varnish throughout their entire length.Straight pipes shall be bundled together into convenient lots (for transport) by rope or 105 WC wire or other suitable material in at least three places. Sockets and other small fittings shall be packed in strong wooden boxes.

The threads of all pipes shall be effectively covered with a good quality grease or other suitable compound and each pipe above 50 mm diameter shall have a protecting ring affixed to the screwed spigot end. Rates should include for all packaging.

5.5 VALVES, STOP COCKS AND FERRULES

5.5.1 GENERAL

All valves shall be manufactured to an internationally recognized standard and full details concerning such standards shall be provided by the manufacturer for approval before manufacture commences. Where British or Indian Standards are quoted in this specification an equivalent internationally recognized standard is acceptable.

Cast iron shall have properties not inferior to those specified for Grade 14 of BS 1452 or equivalent and shall withstand the test pressure specified. All castings shall be carefully cleaned and dressed off. No stopping or plugging will be permitted in the case of holes or flaws appearing therein, and casting shall be made from first running.

Gunmetal and bronze shall be of such compositions as have been proved in actual service to be the most suitable for the particular purpose. If any casting, forging, bearing or other part should prove to be defective, the Engineer shall have the power to reject it and the Supplier shall replace it at no extra expense to the Engineer.

5.5.2 INTERCHANGEABLE COMPONENTS

All similar equipment shall be strictly interchangeable as a whole and as regards their component parts.

5.5.3 PROTECTION AGAINST CLIMATIC CONDITIONS

Valves supplied shall be of the appropriate grade and quality for and shall be adequately protected against the tropical climatic conditions. The supplier shall take those conditions into account in deciding what grade, quality and protection is required. Cast iron and steel surfaces of all valves, hydrants, and fittings shall be painted with at least two coats of approved bituminous paint. Failure to comply with the requirements of the above will result in rejection by the Engineer. Valve bodies, protecting tubes, surface boxes and all other casting shall be

coated in accordance with BS 5163 or equivalent, for tropical conditions. Where this is not applicable, they shall be thoroughly cleaned and given one coat of bituminous paint. Machined surfaces shall be covered by a suitable rust inhibitor, such as a high melting point grease of approved quality.

All submerged moving parts of the valves, or the pins and spindles etc of submerged moving parts, or faces etc in contact with them shall be of non-corrodible materials. Any parts that show signs of corrosion or wear during the Period of Liability shall be replaced by non-corrodible material of special quality for the purpose at no extra expense to the Engineer. Care shall be exercised in the choice of metals for use in the valves to reduce the effects of bi- metallic corrosion to a minimum. The foregoing shall apply also to the moving parts of valves exposed to the weather.

5.5.4 WORKS TESTS

All valves shall be hydrostatically tested at the place of manufacture to the pressures specified and valves shall satisfactorily pass the specified tests before they are packed for delivery.

All valves shall be body tested to twice the working pressure stated in the Bill of Quantities. Seat tests to the working pressure stated in the Bill of Quantities shall be carried out on all sluice valves and stop valves.

All sluice valves and stop valves shall be subjected to "open end" test in accordance with BS 1218 or equivalent and each valve shall be subjected to three separate hydrostatic tests as follows:

(a)Seat Tests

(i) The tightness of seats shall be tested as follows:with the wedge closed and with the valve fixed at one end only the test pressure shall be applied to one face of the wedge, the other face being at atmospheric pressure. There shall be no visible leakage past the wedge at the hydrostatic test pressure (gauge) specified;

(ii) The above procedure shall be repeated but with the valve fixed at the other end and with the pressure applied to that end of the valve.

(b) Body Test

With the wedge open the test pressure (gauge) specified shall be applied to the whole body of the valve. There shall be no visible leakage. The test durations for all tests shall be as in the table below:

NOMINAL DIAMETER MM	MINIMUM TEST DURATION (MINUTES) FOR	
	BODY	SEAT (IF APPLICABLE)
50 and under 65 to 150	0.25 1	0.25 1

200 to 300	2	2

All valves shall be marked with cast-on or stamped lettering stating the body test pressure in meters head of water. The cost of testing shall be included in the contract rates.

5.5.5 VALVES GENERALLY

Valves shall have adequate provision for lubrication, shall cause the minimum of head loss in the open position and shall seal the water passage completely when shut.

All valves shall be closed in a clockwise direction unless otherwise specified. Direction of closing to be shown on the hand wheel.

All valves shall be suitable for use with water in the temperature range -10°C to 70°C and for working pressure of 10 bar or as otherwise specified.

Each flanged valve shall be supplied complete with nuts, bolts, washers, and joint rings. Joint rings shall be of that section complying with BS 4190 or equivalent and shall not extend beyond the inner edges of the bolt holes.Bolts and nuts shall be hexagonal complying with BS 4190 or equivalent.

All materials which may come in contact with raw or potable water shall be free from toxic substances and shall not foster microbiological growth or give rise to taste, cloudiness or discolouration of the water with which they are or could be in contact.

Rubber used in valves shall be ethylene propylene rubber (EPDM or EPM) or styrene butadiene rubber (SBR), which complies with the above requirements, and is suitable for making a long term flexible seal and is resistant to mechanical, chemical, or bacteriological attack leading to deterioration of the flexible seal.

5.5.6 FLANGES

Flanges for pipe work connections shall in all respects be in accordance with BS 4504 PN 16 or equivalent unless otherwise specified.

5.5.7 BIB COCKS

Bib cocks shall be of brass and shall be nominal 15 mm diameter con- forming to BS 1020 or IS : 781 - 1984 or equivalent. Inlets shall be male screwed suitable for joining to 15 mm GI socket. Outlet shall be plain ended. Top shall be round turned crutch.

5.5.8 GLOBE VALVES

Globe valves shall be gunmetal, rising stem, hand-wheel operated with screwed female ends; conforming to IS : 778 - 1984 Class 1 or equivalent.

5.5.9 GATE 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.

5.5.10 FERRULE COCKS

Ferrule cocks shall be of gunmetal square head of 15 mm internal diameter swivel balancing screw down ferrules with male inlet and single male outlet; conforming to IS: 2692 - 1984 or equivalent.

5.5.11 AIR VALVES

Single orifice air valves shall be of cast iron body, reliable in action and shall operate in such a manner that the balls of the valves cannot be held against the orifice by air pressure alone. Each air valve shall be supplied with an approved isolating device. The inlet shall be male screwed 15 mm diameter suitable for connection to a GMS riser pipe. Maximum operating pressure will be 100 meters head of water.

5.5.12 MARKING AND PACKING

Each valve shall be indelibly marked with the diameter, weight and pressure rating and shall in addition carry a unique reference number to enable each item to be clearly identified to works fabrication records, works test certificates, delivery notes and the like.

All valves shall bear the authorized Standard mark cast on showing to which Standard specification they have been manufactured.

Whenever possible the identification marks except for the "Standard mark" shall be painted on the outside of the item but where there is insufficient smooth surface area to accommodate the identification marks they shall be put on rust proofed metal tags secured to the item with galvanized wire.

Flanges shall be protected with wooden discs attached by service bolts or other approved means. Service bolts shall not be incorporated in the works.

All items shall be properly prepared and packed for delivery and shipping. In particular, small items such as small valves, parts of operating gear, bolts, nuts, gaskets, and other joint components shall be crated for delivery. Each crate shall contain a detailed packing list in a waterproof envelope. The outside of the crate shall bear a general description of the contents and identification mark relating it to the detailed packing list.

All valves and fittings shall be securely packed in crates or boxes for protection against damage during transit. The costs of packing shall be included in the contract rates. None of the packing will be returnable.

5.5.13 UNIONS

Unions shall either be brass or galvanized malleable iron, as specified in bill of quantities, manufactured in accordance with a recognized international standard. The manufacturer shall produce full details concerning the standards to which his goods are produced. All unions shall be suitable for joining GMS pipes manufactured to BS 1387 or IS: 1239(part 1) - 1990 or equivalent with threads to BS 21 or equivalent.

5.5.14 FLEXIBLE/DETACHABLE COUPLINGS

Flexible/detachable joints are required for repairs to existing GMS pipes of medium class manufactured to BS 1387 or equivalent specification. They shall be similar to 'Viking Johnson Couplings' without central register and shall be capable of withstanding a pressure of 250m head of water.They shall be supplied complete with all bolts and gaskets and shall be suitably protected against corrosion by an approved coating. Sizes required in the range of pipe sizes ND50 to ND100. Full details to be supplied for approval before manufacture.

5.5.15 OTHERS

5.5.15.1 Float Valve

Float valve shall be of heavy duty type for break pressure chamber and conforming to standard IS: 1703- 1977 (horizontal plunger type or equivalent. The pressure rating shall be 14 Kg/m^2 and male thread shall be as per corresponding standard.

5.5.15.2 Nipples

Nipple of various length as required by the Engineer shall be manufactured of Medium/Heavy duty galvanized mild steel pipes conforming to IS : 1239 (Part I) - 1990 or equivalent. Threads to conform with IS : 554 - 1975 or equivalent. The standard lengths are :

- 100 mm upto 25mm nominal bore
- 150 mm for 32 mm & 65 mm nominal bore
- 200 mm for 80 mm & 100 mm nominal bore

5.5.15.3 Brass Union

Brass union shall be used to join HDP pipe and equivalent G.I. Pipe. Dimensions for HDP pipes are as per IS : 4987 - 1979 equivalent and GI pipes as per IS : 1239 (Part I)- 1990 or BS : 1387 - 1967 make threads or equivalent. Type of joint : Expansion joint consisting of :

a. union body
b. brass ring
c. brass expansion plunge (for insertion into the HDP pipe)

d. neoprene ring for insertion into union body &
e. flat rubber coaster. Each set to be supplied assembled.

5.5.15.4 Flange Set (For HDP - GI Jointing)

Flange set to join HDP pipe as per IS : 4984 - 1978 or equivalent to IS : 1239 (Part I) - 1990 or BS : 1387 - 1967 GI pipe (make threads) shall consist of :

a. female threaded flange
b. plain unthreaded flange
c. HDP flange adaptor
d. duty rubber gasket and
e. nuts, bolts and washers (adequately lightened)

5.5.15.5 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.

5.5.15.6 GI Valve Box

GI Pipe Boxes shall be manufactured according to sample made available or the Drawing and GI pipe used must be medium duty conforming to NS: 199 -2046 or IS : 1239 (part) - 1990 or equivalent. As shown in the drawing one end of the GI pipe shall be fitted with one set of GI flange and GI blank flange complete with nuts and bolts. The bottom of the GI pipe shall be slotted to allow it to slip over the pipeline and locked into place with 300 mm long M.S. bar by passing through two 10 mm holes drilled near the base.

5.5.15.7 GI Valve Key

The Valve Box Keys shall be manufactured according to sample or drawing made available to the manufacturer. Valve Boxes Keys to be manufactured of light duty pipe conforming to Nepal Standard NS: 199 - 2046 or Indian Standard IS: 1239 (Part I) - 1990 or equivalent. Other required reducers shall conform to IS: 1879 - 1987 or equivalent.

5.5.15.8 CI Manhole Cover and Frame

CI Manhole cover and frame shall be manufactured as per drawing or samples made available to the manufacturer conforming to NS: 104 – 2042 or IS: 1726 of latest edition or equivalent.

CI manhole covers and frames are to be provided and fixed on the top RCC slab as per drawing with minimum 100mm thick M150 RCC.

The CI manhole cover shall be laid as such so that top of the manhole cover should be the same of the top of the road surface or finished level of Manhole shall match with the finished level of surrounding structure.

The CI manhole cover shall be measured in numbers unless otherwise mentioned in the BoQ.

The rate shall include cost of material, transportation, laying , fixing and other necessary associated parts including necessary form works, PCC, reinforcement, curing, etc. as instructed by the Engineer.

5.6 HOUSEHOLD CONNECTION WATER METERS

5.6.1 GENERAL

All meters to be supplied under this Contract shall be service proved products of specialised manufacturer's.

The Suppliers will be deemed to have obtained manufacturer's complete instructions with respect to the products to be supplied under this Contract. He shall adhere carefully to such instructionsand shall wherever necessary employ manufacturer's specialist assistance in the performance of the works.

The provisions of this article shall not be construed as releasing the Supplier from his responsibility under the Contract.

5.6.2 WARRANTIES AND CERTIFICATES

The Supplier shall guarantee all materials and equipment furnished under this Contract in conformity with the stipulations in the Agreement, the General Conditions and these Specifications.

Before shipment of any consignment, the Supplier shall submit manufacturing certificates and third party inspector's showing the materials, workmanship, functions and performance to be in accordance with the reference standard and more specifically with the requirements of this Contract. Any form of certificates of the manufacturer or recognised agency may be submitted.

The certificates shall be accomplished by the manufacture/s design calculations and of the required test.

Factory Warranty of the meter shall be at least 1 year after successful delivery

5.6.3 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.

Materials in contact with the water shall be non-toxic and shall not affect the quality of the water.

5.6.4 DESIGN AND CONSTRUCTION

Meters shall be designed for use in tropical climate and for measuring the water described in Project Information with temperatures up to 50 degree C, and shall comply to the requirements of ISO 4064 or equivalent.

Meter shall have a modular design, consisting of and outlet case and separate measuring chamber. The measuring chamber shall be removable and rapidly exchangeable without removing the body.

Registration shall be by direct reading digital counter, with a singly to show the smallest measurements.

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.

Meters shall have a means of adjustment by a by-pass chamber side 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.

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 rotor shall have smooth surfaces, protected where necessary to prevent encrustation.

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.

Water meters shall be designed for a lifetime of 10 years under normal operating conditions.

5.6.5 MARKINGS

The following markings shall be provided on the meters:

- at least one arrow cast onto the body indicating direction of flow.
- nominal size cast on the body.
- model identification, individual serial number, year of manufacture, engraved on the housing or indelibly marked on the dial.
- manufacturer's name and serial number, engraved on the lid or otherwise suitably marked.

5.6.6 METER PERFORMANCE

General 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:

Qs = starting flow rate.
Below this flow rate the register will not show any reactions.

Qm = minimum flow rate for reliable registration. The error shall not exceed plus minus 5%.

Q1 = limiting flow rate for increased accuracy of registration. For flow rates above Q1, the error shall not exceed plus minus 2%.

Qn = nominal flow rate for continuous or intermittent function of the water meter. The error at Qn shall not exceed plus minus 2%,

Qmax = maximum flow rate at which the meter may function for limited time without exceeding a metering error of plus minus 2% and without exceeding permissible head loss.

For domestic type water meter Qmax should be 2 x Qn.

The Supplier shall include with his Bid the information in a format set out in the Technical Data Sheets regarding the above performance.

5.6.7 SPECIFICATIONS

Water meters in this category shall be of 112" (15mm) size or their nearest metric equivalent.

They shall be the **Rotary Piston Type** with completely waterproof encased gear train, magnetic couplings and register. The inlet and outlet shall have a common axis.

The meters shall have the following minimum performance characteristics:

- Approx nominal flow rate Qn (m3/h) 1.5
- Minimum capacity of register (m3/h) 104
- Minimum readable quantity (litres) 1

Otherwise they should comply to Class C EEC or ISO standard.

Domestic water meters shall have a non-return valve on the outlet end to prevent back flow.

Domestic water meters shall have water tight dismantling coupling on each side to allow easy removal of the unit from the pipe work.

Their design and materials shall afford reasonable safeguards against destruction. Attention in this regard shall be given to the strength of the glass and the lid.

The pressure rating of domestic water meters shall be PN 10 (10 bar).

The meter housing (body) shall be manufactured from bronze.

Domestic water meters shall be suitable for mounting in both the horizontal and in the vertical positions.

5.6.8 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 form 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 ship 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 than 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) reading sand 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.

5.6.9 SPARE PARTS

The Supplier shall submit a fully detailed list of the spare parts of the meters to be offered.

Assembly Drawings, Operation and Repair Manuals for Water Meters

The Supplier shall submit assembly drawings and other related information of meters. The assembly drawings shall contain all necessary information and construction. The assembly drawings shall be accompanied by instruction manuals and any other information which may assist in interpretation of the drawings and forming an appreciation of the materials offered.

The Supplier shall submit the operation and repair manual in 2 (two) copies in English Language. The manuals shall contain the data and meter assembly and than 57 (fifty seven) % copper.

Domestic water meters shall be suitable for mounting in both the horizontal and in the vertical positions.

5.6.10 MEASUREMENT AND PAYMENT

The supplied household connection water meters shall be measured in nos unless otherwise mentioned in the BoQ. The rate shall include cost of material, transportation, installation, testing & commissioning, necessary associated parts as instructed by the Engineer.

6.0 BORE-HOLE DRILLING

6.1 GENERAL

6.1.1 DESCRIPTION OF THE WORKS

As described in Supplementary Specifications.

6.1.2 REQUIREMENTS, SPECIFICATION, STANDARDS AND BRAND NAMES

The contractor shall fulfill all requirements and obligations under all Clauses of the specification applicable to the construction work involved in the contract.Neither the following Clauses of this specification the detailed description therein nor the quantities shall limit the obligations of the contractor under the accompanying conditions of contract.

Where items are not included in Bill of Quantities for any such requirements or obligations, the cost of such requirements or obligations shall be deemed to be spread over all the items of the Bill of Quantities.

All the standards mentioned herein shall be deemed to form part of this specification.All references to such standards shall be to the latest edition or revision thereof unless otherwise stated.Where a specific standard is referred to in this specification another standard will be acceptable, provided that it ensures an equal or higher quality of materials and workmanship than the standards referred to.If the contractor intends to use such alternative standard, he shall notify the Engineer thereof, submitting with his notice of the proposed standard, and shall not order any material or perform any work unless and until he has obtained the Engineer's approval of such standard.Brands name where used in the specification is only intended to define a standard of quantity and performance and the contractor may use other equivalent products approved by the Engineer.

6.1.3 CONTRACTOR'S WORK PROGRAM

Work program for the drilling and installation of deep tubewell, purchase of casing and well screens, development and pumping test etc. showing all the stages proposed by the contractor must be submitted at the time of agreement.

After approval by the Engineer, the works program shall be binding to the contractor.Changes in the program may be made by the contractor only after prior approval of the Engineer.

The Project shall be entitled at any time to demand change in the work program as he deems necessary for the proper and expedient performance of the works.

6.1.4 OTHER WORKS

The contractor shall note that during the continuance of the contract other works, not covered by this contract, will be executed by the Engineer or by other contractors.The contractor shall cooperate with the Engineer or other contractors, to ensure the satisfactory completion of the project as a whole.

6.2 MATERIALS

6.2.1 GENERAL

The contractor shall provide all the required material for the construction of tubewell completely.Materials provided and used in the works shall be new and conforming to the qualities and kinds specified herein and or equal to approve samples.Inrespect of all materials used in the works currently practiced relevant standard specifications such as British standard specification (or other equivalent standard specification) shall be generally applicable.
If the contract document conflict in any way with any of the above standards, the contract documents shall have precedence and shall govern.

6.2.2 INSPECTION AND TESTING

All materials used in the works shall be subject to inspection and tests as the Engineer may direct from time to time as the work proceeds.Only materials which are considered satisfactory by the

Engineer shall be used and materials condemned or not approved by the Engineer shall be removed from the works at the contractor's cost.

6.2.3 STANDARD SPECIFICATIONS

Where in this specifications any material or work is required to be supplied or done in accordance with a certain standard specification, the contractor will be permitted to supply such material or to do such work in accordance with an alternative standard of his choice, provided that he has informed the Engineer and obtained the approval from the Engineer.The contractor shall not order any material or perform any work unless and until he has obtained the Engineer's approval of such standard.

6.3 HOUSING, CASING AND SLOTTED PIPES

Unless and otherwise mentioned in BOQ, the size of housing pipe shall be of mild steel (heavy class) of thickness 7.0 mm with pipe lengths of 6 m. the Pipe shall be plain/ beveled ends or mild steel socketed end suitable for welding. The housing pipe shall project a distance of 400 - 600 mm above the ground level during installation. The top of the housing pipe shall have a flange welded on to which a blank flange shall bolted on at all time when the well is not attended by the Contractor.

The size of casing pipe shall be as specified in the bill of quantities and of mild steel (heavy class) of thickness 7.0 mm with pipe length 3 to 6 m. having plain/ beveled ends or mild steel socketed end suitable for welding.

The housing pipe and casing pipe shall be joined by electric arc welding with MS collar/reducer of one size bigger size pipe.

The housing pipe shall be 300mm diameter and 7 mm thick and 200 mm dia and 7.0 mm thick for casing pipe. Mild steel pipe with mild steel socketted ends suitable for welding. The housing pipe shall project a distance of 500 mm above the ground level. The top of the housing pipe shall have a flange welded on to which a blank flange shall be bolted.

The well screen shall be of the continuous slot wedge wire design, Johnson type,fabricated of special–shaped, manufactured in the all welded to support rod construction with electronically controlled welding system, ensuring greater fusion strength between the profile wire and support rod maintaining accurate slot opening tolerance. The wire and rods shall be of the identical material. The material shall be of SS 304 stainless steel conforming to the requirements of AISI.

The well screen shall have adequate strength to resist the external forces to which it will be subjected during and after installation. Screen openings shall be V-shaped, widening inwardly to avoid clogging during the development of the well.

The well screen shall be of heavy construction strength to set in the 200m depth. The screen shall be pipe size. Overall length shall be 3 m, end fitting shall be weld/rings, inside diameter of screen shall be 205mm, outside dia.219 mm, slot opening aperture shall be 1.3mm to 1.5mm continuous slots SS 304 stainless steel material, the percentage of slot opening shall be minimum 25 percent, wrap wire size 2.3mm x 3.5mm, supports rod size 3.8mm/42nos.

There must be a minimum length of 2 m to 6 m of 200 mm dia. casing pipe below the lowest screen pipe as a sand trap and this must be fitted with welded on conical steel plug with a solid point.

All pipes and screens shall be of the best quality and the contractor shall submit full detail concerning the specifications and sources of supply of these for approval before bringing the materials on site,

All housing and casing pipes shall be thoroughly cleaned or descaled before assembly lowering and shall be painted internally and externally with one priming coat and one top coat of an approved non toxic corrosion inhibiting paint.

All welds shall be allowed to cool before applying the necessary paint to the joints. The paint must dry before lowering the well assembly down the bore hole.

6.4 TUBEWELL CONSTRUCTION

6.4.1 GENERAL

The contractor shall drill and install the required numbers of tubewell at the site defined by the Engineer. The drilling point will be assigned by the Engineer.The contractor shall be familiar with the environment of the working place and make the necessary arrangements to complete the work in time.

The contractor shall make his own camping arrangement and find necessary access to the site and drilling site.After completion of work, the area shall be cleared by the contractor of all unnecessary materials used during construction period.

The contractor shall necessarily mobilize suitable drilling rig and accessory machineries and equipment to ensure timely completion of the said work.

The tubewell shall be drilled to the depth specified by the Engineer and shall be electrically logged, cased, screened, gravel packed, sealed, developed, tested and completed as production well.

6.4.2 DRILLING

Drilling can be done by any of the following methods:

- Direct rotary drilling method
- Reverse rotary drilling method, and
- Percussion drilling method

It is upto the contractor to choose the suitable drilling method to drilled in the formation of the area according to their machineries and equipment bearing in mind that the works mentioned in this contract shall be completed within the stipulated time.

At first pilot hole drilling shall be carried out upto the required depth using an appropriate size drill bit.

The record of the strata encountered during the course of pilot hole drilling shall necessarily be maintained by the contractor.The lithologic samples each of 0.5 kg at an interval of 1.5 m or at the change of strata shall be collected in plastic bags.These samples should be submitted to the Engineer at the earliest possible along with lithologic log records.

After completion of drilling the pilot bore hole, the contractor, in presence of the Engineer shall carry out down the hole electrical logging (resistivity &self potential) for the verification of visual lithologic samples. Based on the lithologic samples and electrical logging data and

interpretation results, the contractor shall submit the proposed well assembly (well design).Approval of this proposed design from the Engineer, must be received in written by the contractor before installation of the tubewell.

The pilot bore hole shall be enlarged (reamed) by using the appropriate diameter drill bits upto the designed depth approved by the Engineer.

The final bore hole shall be reconditioned so that all the drill cuttings shall be removed completely from the bore hole.

Verticality of the bore hole must be checked after the drilling of pilot hole and then while lowering the approved well assembly using centralizers at a maximum of 12 m spacing.The number of centralizers in each set should be three.In no case the axis of the well assembly should deviate more than 30 mm from an imaginary plumb line.
A successful tubewell should be able to yield in the range of discharge of 20-30 liters/sec to be accepted by the Engineer.

6.4.3 TUBEWELL ASSEMBLY

Immediately after drilling and reaming the bore hole to the specified diameter and depth, the contractor shall make necessary arrangement for lowering the well assembly in accordance with the design approved by the Engineer.

The Contractor shall provide all necessary materials required for the complete well assembly including housing pipe, casing pipe, well screen, collar, plug, centralizes etc. All the materials of well assembly shall be as specified and as per the prevalent practice, if not specified. Well assembly shall be approved by the Engineer before installation.

The well assembly shall be installed in the bore hole in the presence of the Engineer. After installation a verticality test shall be carried out and the permissible limit shall be 1 cm. in 40m.

6.4.4 GRAVEL PACKING

The gravel pack material to be used in gravel packing, shall be composed of hard, non-calcarious, durable, well rounded particles containing no clays, silt, organic or any foreign materials.The size of gravel shall be in between 3 to 8 mm in diameter.

Immediately after lowering the well assembly into final position, the contractor shall fill the annular space between the well assembly and the wall of the bore hole with pea gravel approved by the Engineer using the continuous backwashing method to prevent bridging and reduce the possibility of damage to the tubewell assembly by sudden collapse of bridged gravel.

The gravel packing process should be continuous until the entire annular space is filled with the gravel, and then clean water should be pumped in through the casing to remove drilling mud.
Tubewell sounding must be carried out to ensure well clearance upto bottom and also the verticality of well assembly.

6.4.5 WELL DEVELOPMENT

After the well assembly installation and gravel packing, the well shall be developed by the contractor using the combination of the following four methods.Well development shall be carried out for a minimum of 72 hrs or as directed by the Engineer using suitable equipment of sufficient capacity.

- Backwashing (inner and outer washing)
- Hydraulic Jetting (water jetting)
- Air lift pumping (air compressor development)
- Over pumping by submersible pump

The completion of the well development shall be certified by the Engineer only when the water becomes clear and contains less than 5 (five) PPM of silt or sand particles.

6.4.6 PUMPING TEST

Following the satisfactory completion of well development, the contractor shall carry out the drawdown and recovery tests by using a suitable pump of not less than 6" dia bowl assembly.The pumping test should be carried out for a minimum of 72 hrs or as directed by the Engineer.

The contractor shall perform (a) Step drawdown test,(b) Constant drawdown test and (c) Recovery test.

a) The contractor shall perform the Step drawdown test by pumping water at four different constant discharge rates of approximately 30%, 60%, 90% and 120% of the anticipated yield of well after development at the instruction of the Engineer. For each step, the contractor shall carefully and accurately record simultaneous readings of water level, time since commencement of pumping and discharge (flow) at the intervals of 10 minutes for the period of 4 hours for each step.

b) The contractor shall perform the Constant drawdown test by pumping water at a constant discharge rate of the tubewell as guided by step drawdown test. The constant pump discharges shall be measured and recorded by the contractor using a standard v notch weir or discharge meter at the interval of 1/2, 1, 1 1/2 , 2, 3, 4, 5, 7, 9, 10, 15, 20, 25, 30, 35, 45, 60, 90, and 120 minutes till the water level stabilizes itself.

c) On completion of test, the contractor shall cease pumping and accurately record the simultaneous readings of water levels in the well and the time since cessation of pumping, at the same time intervals of the pumping test, until the static water level has attained its pre-pumping level.

All test results with interpretation and graph plotted shall be handed over to the Engineer and the whole pumping test should necessarily be conducted in presence and close coordination with Engineer.

6.4.7 WELL DISINFECTION

After completion of all tests the well shall be thoroughly disinfected by means of placing a hypochlorite solution in the well. The Contractor must submit full details of his proposals for disinfection for approval by the Engineer before carrying out well disinfection. Disinfection shall be carried out by circulation of heavily chlorinated water within the well.

6.4.8 STANDARDS

IS 4270 Specification for steel tubes used for water wells.
IS 2800 Code of practice for tube well construction.
IS 4097 Specification for gravel for use as pack in tube wells.

6.5 MEASUREMENT AND PAYMENT

If provided in the Contract, the measurement of the work under this Clause shall be measured and paid in units and contract rates as specified in the Bill of Quantities for completed works as directed and accepted by the Engineer. The cost and payment shall be deemed to have full and final compensation for all labour, equipment, tools and incidentals necessary to complete the work.

7. GROUND WATER/SURFACE WATER TREATEMENT PLANT

7.1 SLOW SAND FILTER MEDIA

7.1.1 FILTER SAND

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 (d_{10}) shall be between 0.15-0.35 mm.The uniformity coefficient (d_{60}/d_{10}) should be preferably between 2 to 3.5 and shall not exceed 5.

7.1.2 FILTER GRAVEL

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 no 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 test should not exceed the following limits:

a. For gravel sizes 10 mm or larger 10% solubility
b. For sizes smaller than 10 mm 5% solubility

8. SITE DEVELOPMENT AND MISCELLANEOUS WORKS

8.1 GABION WORKS

8.1.1 SCOPE

This clause covers the furnishing of materials, fabrication of gabion boxes and construction of gabion works that may be required as per the drawings and as located and instructed by the Engineer.

8.1.2 MATERIALS

Gabions shall consist of steel wire mesh crates. The steel wire shall be mild steel complying with NS: 169-2045. All wires used shall be galvanized with heavy coating of zinc in accordance with NS: 163-2045. Zinc coating shall be uniform. Tolerance on diameter of wire shall be +/- 2.5%. The tensile strength shall be between 300 to 550 N/mm^2.

The mesh-wire as specified in the BOQ shall be woven into a hexagonal mesh of specified size as indicated in the BOQ with a minimum of three twists. All edges of the crates shall be finished with a selvedge wire as specified in the BOQ. Diaphrams shall be fabricated as per the parent gabion box and shall have selvedge wire throughout the perimeter.

Stones used for filling shall be clean, hard, sound, unweathered and angular rock fragments or boulders. The specific gravity of the stone shall be not less than 2.50 and the stones shall not absorb water more than 5% when tested as per IS: 1124. The length of any stone shall not exceed three times its thickness. The smallest dimension of any stone shall be at least twice that of the longer dimension of mesh of the crate.

8.1.3 WORKMANSHIP

Before filling any gabion boxes, the Contractor shall submit samples of gabion boxes assembled, erected and filled with approved quality of stone, for approval of Engineer; which, when approved, shall be retained for reference and comparison with the gabions built as part of the permanent works.

The bed on which the gabion boxes are to be laid shall be even and well dressed. The level of the bed shall be checked and approved by the Engineer before placing of gabion boxes. Gabion boxes shall placed such that vertical joints are not continuous, but staggered. The gabion boxes shall be laid in such a manner that the hinges of the lid will be on the lower side on the slopes and on the outer side in walls. The boxes shall be stretched out to their perfect position and all sides shall be tied together using binding wire of thickness as specified in BOQ. The diaphrams shall be secured in their positions by binding the same way to the approval of the Engineer.

The crates shall be placed in their final position before filling commences. They shall be stretched to their full dimension and securely pegged to the ground or wired to the adjacent gabions before filling. Before filling commences, the selvedges of the crate shall be bound to the selvedges of the adjacent crates with binding wire. Before filling with stone, gabions shall be inspected by the Engineer to ensure that the tie/wiring has been properly carried out.

The filling shall be carried out by placing individual stones into the gabion crate by hand in courses in such a manner that the stones are bedded on each other and bonded as in dry random rubble masonry. No loose stones shall be tipped into the crate and the practice of coursing and bonding the outer layer and filling the interior with unlaid stones shall not be permitted.

The gabion boxes shall be over filled by 50 mm above their tops to allow for subsequent settlement. The lids shall then be tied down with binding wire to the tops of all partition panels. The lids shall be stretched to fit the sides exactly by means of a suitable tool but due care shall be taken to ensure that the gabions are not so full that the lids are overstretched.

8.1.4 TEST AND STANDARD OF ACCEPTANCE

The gabion wire shall be tested for mass, uniformity and adhesion of zinc coating and tensile strength of the wire corresponding with NS: 169 and 163-2045. The Contractor shall produce the test certificate of the supplied wire before fabrication of gabion boxes.

The tolerance limit permitted in size of gabion boxes shall be +/- 3% on each dimension prior to filling. The tolerance on the wire mesh opening shall be +/- 10% on the nominal dimension.

8.1.5 MEASUREMENT AND PAYMENT

Measurement for payment of the gabion work shall be done in volume (cubic meter) of stone filled gabion boxes. The rate shall include the cost of gabion boxes (including the cost of wire and fabrication), transportation to the site, placing in position, supply and filling of stone and tying/covering work all complete as per the drawing and instruction of Engineer.

8.2 SUPPLY OF TOOLS AND EQUIPMENTS

8.2.1 SCOPE

This clause requires supply of tools and equipments as mentioned in the BOQ and as further required by the Project. The Tools and Equipments shall be provisioned under contingency item and shall be supplied as per the instruction of the Engineer.

8.2.2 DETAILS OF SUPPLY CONDITIONS

The lists of tools and equipments to be supplied have been enlisted in the BOQ. However, actual requirement can be changed as decided by the Project and instructed through the Engineer. Basic rate of the Contractor shall be equally applicable for the increased or decreased quantity.

Quality of the tools and equipments shall be as mentioned in the BOQ. Where not mentioned, the quality shall be those having IS or NS mark or as instructed by the Engineer. Before procurement and delivery of tools and equipments, the Contractor shall reconfirm the stipulated quantity and shall get approval of the brand/quality with the Engineer. The Engineer shall have the right to disapprove the inferior quality tools and order for their replacement if required.

8.2.3 MEASUREMENT AND PAYMENT

Measurement for payment of the tools and equipment shall in Number for each individual tool or a set of tools as indicated in the BOQ. The rate shall include the cost of tools, their transportation and delivery to the WUSC store as directed by the Engineer.

9. Testing and Commissioning Requirement

NA

ADDITIONAL SPECIFICATIONS

10 VALVES AND GATES

General

All valves shall be flanged if not specified otherwise. All flanges of the valve shall be according to DIN 2501 and in accordance with the required test pressure of DIN 3230 and shall satisfy the requirements stated in these DIN standards. The leakage rate has to be in accordance with DIN 3230, Degree 1.

The face-to-face dimensions of all flanged valves shall comply with the DIN 3202 Part 1.

All valves shall belong to a class which can withstand the maximum pressure they will attain in service including any surge pressures, but all valves shall be tested at not less than their Nominal Pressure Rate.

Valves shall be capable of withstanding the same test pressures as the pipe line on which they operate. All nuts and suds subjected to vibration shall be fitted with spring washers or locking taps.

Valves shall carry identification marks and/or plates in accordance with DINIEN 19.
All materials used in the manufacture of the valves shall conform to the following minimum standards:

Cast Iron	DIN 1691 Mat. No. 0.6025
Gunmetal	DIN 1705 Mat. No.
2.1096.01 Aluminum	Bronze DIN 1725
Stainless Steel	DIN 17440 Mat. No. 1.4571

Extended spindles and headstocks shall be provided where necessary and where indicated in the drawings. Valves above 100 nun bore except non return check valve shall be fitted with indicators so that it may be clearly seen whether the valves are open or shut. In the case of those valves fitted with extended spindles indicators shall be fitted body to the extended spindles and to the valve.

10.1 Non-return Valves

Non-return valves shall comply with BS:1414 or equivalent and be of double flanged cast steel
type, unless otherwise specified.

They shall be of the quick acting single door type, designed to minimize the losses at the event of pump shut down, and shall have gunmetal flaps and seating faces, and be fitted with external levers for back flushing, the levers so arranged, as to assist in the closing by the addition of weights if necessary.

The door hinge pins shall be of stainless steel and preferably square in section to ensure, positively, location of the doors and back flushing levers, and the hinge pins shall be extended through a sealing gland located at the side of the bodies.

The flaps and external weights shall be positively and securely fixed (grub screws, pins or clamps are not acceptable). All internal fixing devices shall be of stainless steel.

All reflux valves shall be suitable for operating in the vertical plane unless otherwise specified. Covers shall be provided o allow ample access for cleaning and service and shall be supplied complete with tapped boss fitted with air release cocks.

The design of the valve bodies shall be such that there is adequate clearance around and at the back of the doors to minimize jamming by rags, etc. Stops shall be provided to limit the back lift of the doors and in such a position to prevent fouling by rags.

11 MOTOR CONTROL PANEL

Motor control panel shall be indoor type suitable shaped and sized IP 54 or equivalent standard self supported or wall mounted box made of mild steel sheet at least 1.6 mm thick painted with one coat of primer and two coats of anti corrosion paint .

Motor control panel shall consists of a fully automatic air break type motor starter and devices to operate and protect the motor from overloading and dry running. The type of starter shall be AUTO TRANSFORMER.

The auto Transformer Starter (ATS) shall have 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

Major items in motor control panel with AUTO TRANSFORMER starter shall consists , but may not be limited, of the following :

S.No.	Descriptions	Quantity
1	Moulded case circuit breaker (MCCB) of 1.5 x line current capacity	1 no
2	Fully automatic (with electronic timer) air break type autotransformer starter , tap setting 65% , 80%, and 100% , with magnetic contactors, capacity	

	at least 2 times the phase current with coil voltage : 220 V 50 Hz , suitable capacity bi-metallic over current (load) relay approximately 80% to 120 % of nominal line current rating of the motor	1 unit
3	Low water level guard / floatless switch	1 no
4	Single phase preventor and phase sequence relay	1 no
5	Volt meter with selector switch between all phases	1 set
6	Suitable C/T ammeter with selector switch between all phases	1 set
7	Push button switches for START and STOP the motor	1 set
8	Indicating lamps for various actions (e.g. over load, low water level , phase failure etc….)	1set
9	Cable connectors at least 2 x line current capacity	2 set
10	Control fuses	1 set
11	Probe for water level guard	1 set
12	Phase indicating lamps	1 set
13	Spare parts : a) Electronic timer – 1no b) Magnetic contactor – 1 no c) Single phase preventor – 1 no	1 lot

12.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).

13 Bus-bars

13.1 The bus-bars shall be of copper, liberally fixed for the specified current ratings (both short circuit and continuous currents). Minimum temperature of the bus and connection shall be limited to 70 °C.

13.2 Buses shall be spaced with adequate clearance between phases and between phase and ground.

13.3 All bus works shall be braced to with-stand stresses due to short circuit current for1 second thermally.

Appropriate color code shall be used to identify the various phases of bus bars and the neutral.

13.4 Specific Requirements

The molded case circuit breakers (MCCBs) and miniature circuit breakders (MCBs) used shall be of panel mounting type.

13.5 Molded Case Circuit Breakers (MCCB)

It shall have all the live parts enclosed in a molded case and all contacts shall be silver plated. The breakers shall be trip free and with quick-make and break operating mechanism. The molded case circuit breakers shall be provided with magnetic short circuit protection and thermal overload device. The characteristic curve of these protections shall be

furnished along with the offer. The protection device of the incomer MCCB shall be coordinated with feeder MCCB. Each breaker shall have a common trip, causing an overload on one pole to trip all other poles.

The MCC handle, after tripping due to a fault shall occupy a mean position. The breaker shall be capable of interrupting a RMS current corresponding to the fault level of the system to which the main switch board is connected.

It shall be possible to close and trip the breaker without opening the compartment door. The breaker shall be provided with properly marked mechanical ON-OFF indicator at the front. Each circuit breaker shall be provided with an auxiliary switch. The rating of the MCCB's shall be so selected that maximum standardization consistent with the economy is possible.

13.6 Cable Termination: Main switch boards shall be designed to facilitate cable entry from bottom. Removable plates shall be furnished with compression type terminals. The glands shall be made just tight such that no weight is transferred on the terminals. The glands shall be suitable for terminating cable armour neatly.

Sufficient space shall be provided to avoid sharp bending and ease in connection. A minimum space of 200 mm from the gland plate to the nearest terminal block shall be provided.

13.7 Ground Bus

Grounding terminals on the main switch boards shall be provided at either end for connecting ground conductor to earth electrode.

13.8 Nameplates

Nameplates showing "Feeder Designation" shall be provided at front door top. Material for nameplate shall be plastic sheets, 3 mm thick or approved equivalent. The letters shall be white on black background.The name plate shall be held by self tapping screws.

14 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 in layers not exceeding 75mm. Each layer shall be well watered and rammed to full consolidation with iron rammers.

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.

15.HOUSING, CASING AND SLOTTED PIPES

Unless and otherwise mentioned in BOQ, the size of housing pipe shall be of mild steel (heavy class) of thickness 7.0 mm with pipe lengths of 6 m. the Pipe shall be plain/ beveled ends or mild steel socketed end suitable for welding. The housing pipe shall project a distance of 400 - 600 mm above the ground level during installation. The top of the housing pipe shall have a flange welded on to which a blank flange shall bolted on at all time when the well is not attended by the Contractor.

The size of casing pipe shall be as specified in the bill of quantities and of mild steel (heavy class) of thickness 7.0 mm with pipe length 3 to 6 m. having plain/ beveled ends or mild steel socketed end suitable for welding.

The housing pipe and casing pipe shall be joined by electric arc welding with MS collar/reducer of one size bigger size pipe.

The housing pipe shall be 300mm diameter and 7 mm thick and 200 mm dia and 7.0 mm thick for casing pipe. Mild steel pipe with mild steel socketted ends suitable for welding. The housing pipe shall project a distance of 500 mm above the ground level. The top of the housing pipe shall have a flange welded on to which a blank flange shall be bolted.

The well screen shall be of the continuous slot wedge wire design, Johnson type,fabricated of special–shaped, manufactured in the all welded to support rod construction with electronically controlled welding system, ensuring greater fusion strength between the profile wire and support rod maintaining accurate slot opening tolerance. The wire and rods shall be of the identical material. The material shall be of SS 304 stainless steel conforming to the requirements of AISI.

The well screen shall have adequate strength to resist the external forces to which it will be subjected during and after installation. Screen openings shall be V-shaped, widening inwardly to avoid clogging during the development of the well.

The well screen shall be of heavy construction strength to set in the 200m depth. The screen shall be pipe size. Overall length shall be 3 m, end fitting shall be weld/rings, inside diameter of screen shall be 205mm, outside dia.219 mm, slot opening aperture shall be 1.3mm to 1.5mm continuous slots SS 304 stainless steel material, the percentage of slot opening shall be minimum 25 percent, wrap wire size 2.3mm x 3.5mm, supports rod size 3.8mm/42nos.

There must be a minimum length of 2 m to 6 m of 200 mm dia. casing pipe below the lowest screen pipe as a sand trap and this must be fitted with welded on conical steel plug with a solid point.

All pipes and screens shall be of the best quality and the contractor shall submit full detail concerning the specifications and sources of supply of these for approval before bringing the materials on site,

All housing and casing pipes shall be thoroughly cleaned or descaled before assembly lowering and shall be painted internally and externally with one priming coat and one top coat of an approved non toxic corrosion inhibiting paint.

All welds shall be allowed to cool before applying the necessary paint to the joints. The paint must dry before lowering the well assembly down the bore hole.

16.Specification of Seamless Carbon steel pipe and Fittings

16.1 Code and Standards:

This referenced Codes and Standards are intended to provide acceptable level of quality for Materials, Product and Workmanship. All materials workmanship and components shall, where applicable and unless otherwise stated in the Contract, shall comply with anyone of the following Standards.

The latest relevant version of ANSI (American National standard Institution), BS (British Standard) or IS (Indian Standard) shall be used for Material, Product and Workmanship requirements.

Followed Standard Code should be mentioned and should be agreeable to the Employer before supplying the Pipes..

16.1.1 Composition:

According to the relevant Standard Tables of Chemical Composition Requirements of the relevant Standard followed by the suppliers.

16.1.2 Permissible variation in wall Thickness:

The minimum wall thickness at any point shall not be more than 12.5% under the nominal wall thickness specified in the code

16.1.3 **Tensile Strength requirements** of pipe material viz Grade A, B and C should be according to the relevant tables available in the Standard Code, choosen by the Supplier. The relevant Grade shall be matched with the employer's requirement. The minimum tensile strength shall not be less than 485 Mpa.

16.1.4 Requirement of Test

16.1.4.1 Chemical Test

The seamless carbon steel pipe shall conform to the requirements of chemical composition of the relevant Standard followed by the supplier.

16.1.4.2 Hydrostatic Inspection Test:

Hydrostatic pressure shall be maintained for not less than 5 secs. for all sizes of seamless pipes. Each length of pipe shall be subjected to Hydrostatic Test without leakage. Pipe shall be stuck while under pressure with 1 Kg. hammer or its equivalent near the weld at 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./Cm^2

S= fiber stress in Kgf./ Cm^2 (75.80% of specified min. yield strength)

t= specified will thickness in mm.

D= specified outside diameter in mm.

16.1.4.3Transverse Tension Test

16.1.4.4 Flattening Test

16.1.4.5 Physical test

16.1.5 Length of pipe:

The pipe shall be supplied in Standard lengths of 5 to 6 meter each. Both ends of each pipe shall be plain end-beveled.

16.1.6 Test Certificate:

Certificates in triplicate shall be provided by the supplier for pipes and fittings supplied, clearly mentioning the process of manufacture and the results of specified test.

Similar certificates to be provided in materials to be used in the manufacture of pipes and fittings giving process of manufacture, chemical analysis (where relevant) and the results of specified tests.

The material shall be suitably marked to available them to be identified from references on the certificates.

16.1.7 Independent Tests:

The purchaser reserves the right to carry out any independent or local test 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 Condition of Contract , any material, workmanship or completed pipe and fitting which are shown by such independent tests not to be in accordance with the Speciation shall be rejected notwithstanding any previous certificate which may have been provided.

16.1.8 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 to re-test following the correction of any defects, where such correction is permitted by the Purchaser.

16.1.9 Fittings

Fittings required for jointing the specified pipes shall be compatible with the size of pipes and shall be as prescribed in the relevant standard.

16.1.10 .Marking

The pipes shall be marked with the following particulars

a) Manufacturer's name and trade mark
b) Size
c) Weight per meter
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.

17.Electrical Items

17.1 Steel Tubular Pole

17.1.1 Construction

The steel tabular pole shall be swaged type. The poles shall be made in accordance with IS practice or equivalent standards. The poles shall be made from steel having a minimum tensile strength of 42 kgf/mm^2.

- The poles shall be Electric Resistance welded type. The lengths of joints on the pole shall not be less than shown in the drawing. The upper edge of joint shall be chamfered off at an angle of 45° to the horizontal to shed water when the pole is erected.

- The pole shall be complete with a cast iron plain top beret type cap finials with 3 nos. of 3 mm dia. grub screws.

- Base Plate: Each pole shall be completed with base plate, nut-bolts with washers and welded lugs for earth connection. Size of the base plate shall be 6 mm thick and 3000 mm x 3000 mm area welded at the base of the pole.

- Length of the Pole:

a) Each 11 m pole shall be of 11 m in total length made by welding together the following pieces of seamless steel poles.

   i. Bottom section 5.4 mm thick, 165.1 mm outer dia x 5.6 meter long
   ii. Middle section 4.5 mm thick, 139.7 mm outer dia. x 2.7 meter long
   iii. Top section 3.65 mm thick, 114.3 mm outer dia. x 2.7 meter long

b) Each 9 m pole shall be of 9 m in total length made by welding together the following pieces of seamless steel poles.
   i. Bottom section 4.5 mm thick, 139.7 mm outer dia x 5 meter long
   ii. Middle section 3.65 mm thick, 114.3 mm outer dia. x 2 meter long
   iii. Top section 3.25 mm thick, 88.9 mm outer dia. x 2 meter long

- Each pole shall be coated internally throughout with black bituminous paint and externally upto the level which goes inside the earth with the same paint. The remaining exterior portion shall be painted with two uniform coat of red-oxide primer.

17.1.2 Tolerances

a) Outside diameter:

The poles shall be as nearly circular as possible, and their outside diameters shall not vary from the specified value by more than ± 1 %.

b) Thickness:

The thickness of any section shall not fall below the specified values by more than 10 percent.

c) Mass:

The mass of a single column shall not be more than 75% below the standard value.

d) Straightness:

The completed pole shall not be out of Straightness by more than 1 in 600 of its length.

e) Test for Poles:

The tests shall be conducted on finished pole as per IS: 2713 - 1980: And certificate shall be submitted.

f) Drawings:

The drawing of the above pole 410 SP-54 and 410 SP-28 with details are in drawing no. DRG No. 38/3&5.

17.2 Steel Cross Arms

17.2.1General

This specification covers the supply and installation of steel cross arms with all necessary bracing, clamps, nuts and bolts with washer as used by Nepal electricity authority.

17.2.2Code and Standards

The steel cross arms shall be fabricated and tested in accordance with ASTM or NEA practice.

17.2.3 Scope of Works

The works includes, but is not necessarily limited to the following:

a) Fabricate cross arm from 50 mm x 100 mm x 6 mm MS channel of adequate length as per requirements of this specification.

b) Prepare complete detailed shop drawings according to NEA practice and submit for approval of the Owner/Engineer.
c) Furnish all materials, labour, tools, plant, consumable, etc. including bolts, nuts, washers for fabrication in shop and on site and for erection.
d) Fabricate and deliver to job site, unload, store and erect cross arm on steel pole/steel H-pole with clamps made from 50 mm x 8 mm flat iron.
e) Assemble, at job site fabricated members for erection.
f) Erect fabricated materials and connect by field bolting.
g) Align and level erected steel cross-arm.

17.2.4 Technical Requirements

- The steel cross arm for the installation shall be so fabricated that the erection works can be done with ease and exactness.

- Steel cross-arms dimensions, number, size and length of bolts, thickness details to fabricate each piece shall be shown on the approved detail drawings (DRG No. 38/5). No change shall be made without the written approval of the Owner/Engineer.

- Bolts shall have hexagonal heads and hexagonal nuts with the same dimension between flats on bolt heads and nuts. Bolt holes are not to be more than 1.5 mm larger in diameter than the corresponding bolt diameter. The design is to be such as to keep the number of different parts as small as possible and is to facilitate transport, erection and inspection.

- No welding will be permitted in steel structure fabrication.

- Workmanship shall be first class throughout: All pieces must be straight, true to detail drawings and free from defects and burrs.

- Threads of bolts and nuts shall be cleanly rolled or cut and the face and head of nut shall be truly at right angle to the axis of the bolt.

- After fabrication has been completed and accepted, all materials shall be clear of rust, loose scale, dirt, oil, grease and other foreign substances.

- All materials shall be heavily galvanized as specified.

- The material shall not be hammered or otherwise straightened in a manner that will injure the protective coating. If the material has been harmfully bent or wrapped in the process of fabrication or galvanizing, such defects shall be cause for rejection.

- Bolts and nuts shall be galvanized and fitted with spring washers. Taper washers are to be added where necessary, threads of bolts shall be spun galvanized and threads of nuts shall be oiled.

17.2.5Tests

The following shop test shall be performed with relevant provisions of ASTM or equivalent.

a) General inspection
b) Material test
c) Assembly test
d) Galvanizing test

Owner/Engineer shall have the right to inspect any material, workmanship etc. of the equipment and may reject any item defective or unsuitable for the use and purpose intended or not in accordance with the intent of the Owner/Engineer.

Drawings

The contractor shall submit drawing and guaranteed performance data.
The shop detail drawings shall show the details of all parts to be fabricated.

Cross arms or members of steel structure shall not be dropped or dragged on the ground and shall not be set on the ground for and extended period of time.

17.3 9 KV Lightning Arresters

The lightning arresters shall confirm to IS 3070 (Part I) 1974 or equivalent BS.

17.3.1 Type:

Outdoor service pole mounting Distribution valve type.

A) Rated Voltage: 9 KV rms
B) Rated Current: 5 KA
C) Rated Frequency: 50 Hz

17.3.2Characteristics:

a) Minimum Sparkover Voltage: 13.5 KV rms
b) Impulse Sparkover Voltage

i) 1.2/50 micro second wave : 32.5KV crest (Max)
ii) For Steepness of wave front 75 KV/micro-second: 38 KV crest (Max)

c) Maximum residual voltage at 8/20 micro second,
5 KA discharge current : 32.5 KV (Max)
d) Nominal discharge current at 8/20 micro second wave: 5 KA (Max)
e) Voltage withstand test of arrester insulation

i) Dry power frequency withstand Voltage: 35 KV
ii) Wet Power frequency withstand Voltage: 30 KV

f) Withstand discharge current

i) High current short duration (4/10 micro second wave): 65 KV (crest)
ii) Low current long duration (1000 micro second) : 75 KV (crest)

17.3.3 Construction:

a) Insulator: Insulator used for the lightning arrester shall be of high strength wet process porcelain and coloured brown.

b) Connection terminal: Line and earth.

Standard Applied: The lightning arrestor should be tested and manufactured in accordance with the IS 3070 (Part I) 1974 or BS equivalent.

Packing Case: Arresters shall be contained in a carton box. Suitable numbers of the carton boxes shall be packed in a wooden case.

17.3.4Test

Tests shall be performed as specified hereunder.

a) Routine Tests:

Each lightning arrestor shall be subjected to the following tests.

- Construction test.

- Power frequency sparkover and withstand voltage test.
- Insulation resistance test and leak current test.

17.4 11 KV Gang Operated Air Break Switch

General:

A triple pole gang operated air break switch (GOAB) shall be installed ahead of existing 11 KV cutout fuse switch at each and every NEA supply point to DWSS. This shall help in providing safety in replacing the high tension fuses; whenever blown, causing quick restoration of interrupted water supply system.

The GOAB shall be triple pole verticle mounting type designed for single through and outdoor installation for mounting over tubular H pole for 11 KV distribution circuit with manual operating accessories.

The GOAB switch shall be for the purpose of commonly installing on overhead 11 KV feeder as a fast point. The GOAB switch shall be designed for normal operation at 45 °C maximum ambient temperature at 1500 m altitude.

The rating of the GOAB switch shall be as enumerated below:

System voltage	- 11 KV
Rated voltage	- 12 KV
Nominal voltage	- 11 KV
Rated frequency	- 50 Hz
Rated normal current	-. 100 A
Rated short time current	-. 10 KA
Basic insulation level	- 75 KV

The GOAB switch assembled shall comprise of the following components and corresponding materials.

a) Stationary and moving contacts in Silver plated copper alloy.
b) Insulators : TR 205, porcelain according to ANSI C29.9-1983
c) Blades: Copper alloy tube type
d) Terminal pads and connectors: Tin plated copper alloy
e) Mounting frame and accessories: Hot dip galvanized steel (ASTM A 153)
f) Operating mechanism and accessories: Hot dip galvanized (Steel ASTM 153)

The complete GOAB switch shall comprise of three single pole switches units, interrupting knife blade insulators, interrupting blade holders and mounting frame and accessories with earthling terminal together with operating pipe and handle with necessary clamps.

The switch set shall be subjected to routine test and a copy of type test certificate shall be furnished by the tenderer for the approval of the Engineer/DWSS.

17.5 Cutout Switch

Scope

This specification covers the testing and supply of open disconnecting cutout switch commonly installed on overhead pole lines.

Description

- The dropout cutout shall be suitable for use on a three phase. Delta-connected unigrounded, 11 KV, 50 Hertz distribution circuit at an altitude of less than 1000 meters.

- The dropout cutout shall be tested in full compliance with International Electrotechnical Commission Standards 282-2-1970, or an equivalent national standard.

- The dropout cutout shall be made of wet-process glazed porcelain. The insulator shall display in an indelible manner, manufacturer, type, and voltage rating.

- The fuseholder shall accomodate a non-expendable cap or an expendable cap determined by interrupting rating.

- The dropout cutout shall have the capability of interchanging fuseholders and 100 ampere switch blades.

- The dropout cutout shall be furnished with a galvanized steel mounting bracket which may be adapted for steel angle crossarm mounting.

- The dropout cutout shall have clamp type terminals to accept copper or aluminum conductors of 16/30 mm sq. in cross-section.

Ratings

The dropout cutout shall have the following electrical characteristics:

a)	Maximum design rating	- 15 KV
	(Slant Rating)	(7.8/15)
b)	Minimum withstand – Dry	- 58 KV
	- Wet	- 32 KV
c)	Impulse withstand (BIL)	- 95 KV
d)	Creepage Distance	- 235 mm

The fuseholder shall be of 10 ampere rating.

17.6 High Tension Fuse Link

Scope

This specification covers the supply of Buttonhead fuse links commonly used in the protection of 11 KV overhead apparatus.

Description

The Buttomhead fuse link shall be fabricated in full compliance with American National Standard Specification ANSI C 37.42-1981, or an equivalent national standard.

The fuse link shall be supplied in accordance with the type, ratings, and quantities shown in the Bid package.

Bid Documentation

The Contractor shall provide with the Bid the identification of the manufacturer and the catalog numbers of the fuse links offered.

The Contractor shall furnish the following data with respect to the fuse links furnished:

a) Minimum melting time and total clearing time,
time - current characteristics curves at 30 degree C.
b) Preloading adjustment factors or curves.
c) Ambient temperature adjustment factors or curves.

17.7 Cable

17.7.1 General

This specification covers the design, manufacture, factory test, supply, delivery, field test and installation of all power, submersible power and control cables required for the project.

The cables shall be furnished in accordance with specification:

a) 600 volt power cable
b) Submersible power cable
c) Control cable

The Contractor shall be responsible for estimating and supplying the quantity of various types and sizes of the cables.

17.7.2 Design Requirement

600 Volt Power Cable

a. General
The low voltage cables shall be 600 V grade polyethylene insulated, armoured and PVC sheathed. Low voltage power cables shall be suitable for grounded neutral with phase to phase voltage level of 400 V DC system.

b. Conductor
Conductor shall consist of stranded annealed copper/aluminum wires. They shall comply with IEC publication. The cable is intended for use at normal conductor operation temperatures not exceeding 75 deg.C.

c. Insulation
The electrically and thermally stable polyethylene insulation shall be extruded onto the conductor so as to prevent contamination and voids in the insulation.

d. Current Rating
The maximum continuous current ration for the cable routes and conditions of installation shall be stated for low voltage power cable by the contractor.

e. Jacket
The cable core assembly shall be covered with a flame retardative and moisture resistant PVC jacket which is free-stripping from the insulation. The overall jacket shall be clean, dry, and free of grease and shall be suitable for ink or paint application.

f. Identification
Each cable shall have a printed legend on the overall jacket with a manufacturer's name, voltage class, the number and size of conductors, type of insulations.

The colors for core identification and colors sequence shall be in accordance with follows:
• Twin-core : Red and Black, • Three-core : Red, Yellow and Black
• Four-core : Red, Yellow, Blue and Black

600 Volt Submersible Power Cable

a. General
The low voltage cables shall be 600 V grade polyethylene insulated and PVC sheathed. Low voltage submersible power cables shall be suitable for delta connected load with phase to phase voltage level of 400 V and overall flat configuration to pass easily through the groove cut on collars of the rising main pipe line.

b. Conductor
Conductor shall consist of stranded annealed copper wires. They shall comply with IEC publication. The cable is intended for use at normal conductor operating temperatures not exceeding 75 deg.C.

c. Insulation

The electrically and thermally stable polyethylene insulation shall be extruded onto the conductor so as to prevent contamination and voids in the insulation.

d. Current Rating
The maximum continuous current ratio for the cable routes and conditions of installation shall be stated for low voltage power cable by the contractor.

e. Anti-termite Covering
Anti-termite protection shall be applied to the cable and shall consist of a non- magnetic metallic barrier.

f. Jacket
The parallel cable cores assembly shall be covered with a flame retardative and moisture resistant PVC jacket which is free-stripping from the insulation. The overall jacket shall be clean, dry, and free of grease and shall be suitable for ink or paint application.

g. Identification
Each cable shall have a printed legend on the overall jacket with a manufacturer's name, voltage class, the number and size of conductors, type of insulations.

The colors for core identification and color sequence shall be

• Three-core : Red, Yellow and Blue

Control Cable

a. General
All control and instrumentation cable shall be 600 V grade as per IEC multi conductor, color coded, PVC insulated, armoured cable. Each multi-core cable shall have not less than 20 percent spare or 4 spare cores whichever is the greater.

b. Conductor
The conductor shall consist of stranded circular non-compacted copper of minimum cross-section of 2.5 sq.mm.

c. Insulation
The electrically and thermally stable polyethylene insulation shall be extruded onto the conductor so as to prevent contamination and voids in the insulation.

d. Assembly
Multi-conductor cables shall be assembled in accordance to IEC standard.

A flame retardative binder tape may be used underneath the overall jacket of multi- conductor cables, for flame retardative characteristics. Tapes, used, shall be of non hydroscopic type.

e. Anti-termite Covering

Anti-termite protection shall be applied to the cable and shall consist of a non- magnetic metallic barrier.

f. Jacket

The cable assembly shall be covered with a flame retardative and moisture resistant PVC jacket which is free-stripping from the insulation. The overall jacket shall be clean, dry, and free of grease and shall be suitable for ink or paint application.

Cable jacketing and the interstices within the jacket shall be free of water. Evidence of water shall be grounds for rejection of the cable.

g. Identification

Each cable shall have a printed legend on the overall jacket with a manufacturer's name, voltage class, the number and size of conductors, and a unique number or code indicating the production run or batch. The identification shall remain legible for the life of the cable.

17.7.3Special Requirement

Small cut piece lengths of cables will not accepted. Cables up to 500 meters in length or as approved by Owner/Engineer shall be of one length shipped in a drum of adequate size. For higher quantities, multiple lengths/drums may be shipped subject to the approval of Owner/Engineer.

17.7.4Test

Routine and Design Tests

Routine test shall be carried out for each drum of cable. Type test and acceptance test as per standards shall have to be carried out to prove the general qualities and design of a given type of cable and for the purpose of acceptance of the lot. The test certificate shall be approved Owner/Engineer before shipment.

The following tests shall be included in the routine test by the manufacturer at the factory as minimum requirements for this specification:

a) Conductor resistance test
b) High voltage test
c) Insulation resistance test
d) Physical and aging test for insulation and jacket

Field tests

After installation at site, cables shall be subjected but not limited to the following tests:

a) Measurement of insulation resistance
b) DC dielectric test

17.8 Main Switch Board

a. General

This specification covers the design, manufacture, assembly, testing at manufacturer's works, supply and delivery, of the main switch board (type A, and B). Each Borehole pump unit shall be furnished with a standard main switch board, generally comprising of a manual changeover switch for selecting NEA supply/stand-by supply. The switch board shall be sheet steel fabricated and designed with compartments for housing NEA time of the day (TOD) meter with MCBs and C.Ts etc.

The changeover switch incorporated in the new main switch-board shall be directly connected to TPN Cu. bus-bar through which loads of outgoing circuits to borehole submersible pump motors, light and power circuits. The supply to borehole pump motors is however controlled through motor control centre (MCC) also to be housed in DG room.

b. Standards

The main switch-board shall be designed, constructed, and tested in accordance with the latest IEC specification. The equipment conforming to any other standard which insures equivalent quality are acceptable. In such situation the contractor shall clearly indicate the standard adopted and furnish a copy of the English version of the standard along with the proposal. Should there be any dispute on design standard the most stringent one shall be followed.

c. Main Switch Board

i. The switch-board must have a room for accommodating NEA TOD meter with MCBs and C.T. (230 x 460 x 620 mm) with a see through glass on the front of the panel having sealing holes.
ii. The switch- board must have an adequately rated manual changeover switch with three positions, one for NEA source, one for DG source and middle one for no source.
iii. The load side of the changeover switch shall be connected to TPN Cu. bus-bar of the main switch board.
iv. The main switch board must have incoming moulded case circuit breaker (MCCB) and bus- bar ratings of adequate capacity.
v. The main switch board shall be complete with instruments like ammeter and voltmeter with selector switches
vi. The main switch board shall be wall mounted complete with mounting brackets and fixing rawal bolts.

17.8.1 Design Requirements

The main switch board is meant for the loads of well pumps, indoor light and power circuits and outdoor lighting supply.

The switch board shall be located indoor in a hot and humid atmosphere, so all equipments, accessories and wiring shall be provided with suitable finish for preventing fungus growth.

The AC switch board shall be designed for operation at 400 V 3 phase 4 wire, 50 Hz with ± 5% in a neutral grounded system.

The switch board shall be designed for 45° C ambient temperature, hence selection of all equipment shall be made liberally with a good margin of safety factors.

17.8.2 Construction Features

The switch-board shall be wall mounted sheet steel cubicle with following features.

a) The construction shall be compartmentalized.
b) The switch-board shall be dead front type. All MCCBs and MCBs fitted shall be operable from the front.
c) The switch-board shall be wall mounted type.
d) The switch-board shall be fabricated from a 2 mm thick sheet steel.
e) The minimum clearance of the power terminal lug from the bottom plate shall be maintained as 200 mm.
f) The switch-board shall have fully insulated neutral bus of cross-section Half the size of the main phase buses.
g) The indoor switch board shall be provided with enclosure protection of IP 50 as per IEC.

17.9 Bus-bars

a) The bus-bars shall be of copper, liberally fixed for the specified current ratings (both short circuit and continuous currents). Minimum temperature of the bus and connection shall be limited to 70 °C.
b) Buses shall be spaced with adequate clearance between phases and between phase and ground.
c) All bus works shall be braced to with-stand stresses due to short circuit current for1 second thermally.
d) Appropriate colour code shall be used to identify the various phases of busbars and the neutral.

Specific Requirements

The molded case circuit breakers (MCCBs) and miniature circuit breakders (MCBs) used shall be of panel mounting type.

Molded Case Circuit Breakers (MCCB)

It shall have all the live parts enclosed in a molded case and all contacts shall be silver plated. The breakers shall be trip free and with quick-make and break operating mechanism. The molded case circuit breakers shall be provided with magnetic short circuit protection and thermal overload device. The characteristic curve of these protections shall be furnished along with the offer. The protection device of the incomer MCCB shall be coordinated with feeder MCCB. Each breaker shall have a common trip, causing an overload on one pole to trip all other poles.

The MCC handle, after tripping due to a fault shall occupy a mean position. The breaker shall be capable of interrupting a RMS current corresponding to the fault level of the system to which the main switch board is connected.

It shall be possible to close and trip the breaker without opening the compartment door. The breaker shall be provided with properly marked mechanical ON-OFF indicator at the front. Each circuit breaker shall be provided with an auxiliary switch. The rating of the MCCB's shall be so selected that maximum standardization consistent with the economy is possible.

17.10Cable Termination

Main switch boards shall be designed to facilitate cable entry from bottom. Removable plates shall be furnished with compression type terminals. The glands shall be made just tight such that no weight is transferred on the terminals. The glands shall be suitable for terminating cable armour neatly.

Sufficient space shall be provided to avoid sharp bending and ease in connection. A minimum space of 200 mm from the gland plate to the nearest terminal block shall be provided.

17.11 Ground Bus

Grounding terminals on the main switch boards shall be provided at either end for connecting ground conductor to earth electrode.

Nameplates

Nameplates showing "Feeder Designation" shall be provided at front door top. Material for nameplate shall be plastic sheets, 3 mm thick or approved equivalent. The letters shall be white on black background.

The nameplate shall be held by self tapping screws.

Tests

Routine Test

Each MSB shall be completely assembled, wired, adjusted and tested for operation under conditions to ensure correctness of wiring and proper functioning of all equipment.

All component parts such as MCCBs, MCBs and meters, etc. shall be tested in accordance with relevant IEC specifications.

All current carrying parts and wiring shall be subjected to a high potential test. Routine tests shall be conducted on all main-switch boards.

Drawings, Data and Manuals

The following drawings and details shall be furnished by the contractor.

a) Tenderer's proposed scheme in single line diagram for all protections.

b) Tenderer's proposed typical general arrangement drawing showing constructional features and layout of individual equipment along with the following:

- Space required in the front of main switch board.
- Power cable entry points.
- Bus bar clearances, between phase to phase and phase to neutral.
- General cross-section drawing of the cubicle.

c) Technical leaflets on: MCCB, MCB and Insulators.
d) Characteristics curves of all equipment.
e) Typical routine test results on identical equipment.
f) Any other relevant drawing as specified in item 7.10 above and data necessary for approval.

18.Grounding System

General

This specification covers the supply, delivery, installation and testing of the Grounding System as described herein.

Codes and Standards

The grounding work shall be in accordance with the recommendation in the "Guide for Safety in Substation Grounding" as per NEA practice.

Equipment to be furnished

Complete installation of the earth electrodes test link grounding of Gang Operated Air-break Switch (GOAB), transformer substation Diesel-generator and other pump motors as specified herein but not be limited to the supply of grounding conductors, jointing materials and all accessories to complete this grounding installation shall be covered under this specification.

Grounding Installation Features

The installation shall be complete in all respects for efficient and trouble free service. All work shall be carried out in a first class neat workman like manner. Grounding conductors shall be handled carefully to avoid kinking and cutting of the conductors during laying and installation. All exposed ground conductor runs shall be taken in a neat manner, horizontal, vertical and parallel to building walls or columns and shall not be laid haphazardly. All connections to the earth electrodes shall be made with the bare G.I. conductor.

For all connections made to equipment or to switch boards, the earth electrode, connectors and equipment enclosures shall have good clean contact surfaces. Grounding conductor connection to all electrical equipment, switch-gear, transformers, motors, panels, conduit systems, equipment enclosures, cable trays, distribution boards, equipment frames, bases, steel structure, etc, shall be by pressure type or bolting type connector.

All grounding conductors joints shall have adequate mechanical strength as well as necessary electrical conductivity not less than that of the parent conductors of the joints. All accessories for grounding installation shall be of quality and design approved by the Owner/Engineer.

Grounding Conductor

Main Ground Grid:

The main ground system shall consist of a grounding grid buried minimum one meter below grade level. The grounding grid shall consist of one no. 100 sq.mm. (min.) Aluminium conductor.

Pipe Earth Electrodes:

The pipe earth electrodes shall be of 1.5 m long 19 mm diameter GI pipe with 38 x 19 mm reducing socket and 2.5 m long 38 mm diameter GI pipe. These shall be driven into ground as shown in typical illustration of pipe earth electrode and connected to the main ground grid DRG 38/3.

Risers:

The risers shall consist of Al conductor connected at one end to the pipe earth electrode and at the other end to the equipment.

Design Requirement

The contractor shall measure the soil resistivity and calculate the total length of buried ground conductor, number of grounding electrodes and their spacing to achieve a grounding system resistance of 5 to 10 ohm.

The contractor shall calculate the cross-section considering the maximum fault level.

Tests

On completion of the installation, either wholly or in sections, it shall be tested in compliance with relevant code by the contractor in the presence of the Owner/Engineer. The cost of any test including labour, material and equipment charges shall be borne by the contractor. The ground grid resistance to remote earth shall be 10 ohm or less. If this low resistance can not be obtained as per his design, then additional grounding conductors shall be buried in the earth, or if necessary, buried in treated soil to obtain the required low ground resistance.

Drawings

After award of the contract, the contractor shall furnish the grounding layout drawing with dimensions showing the location of earth electrodes, test link and risers backed up by necessary calculations for Owner's/Engineer's approval from the Engineer. If alternation is required for any work done before getting Owner's/Engineer's approval, the same shall have to be done by the contractor at no extra cost to the Owner.

19.Lighting System

General

This specification covers the supply and installation of the lighting system for the Small Towns Water Supply and Sanitation Section Project including all necessary supervision, labour, tools, tools, equipment and accessories, miscellaneous materials, testing and putting in according in acceptable operation of the lighting system. The office/guard house/water testing laboratory, diesel generator room shall be illuminated by using fluorescent fixtures and bracket type incandescent fixture together with two power sockets each.

Scope of Works

All equipment and fixtures shall be complete and operative in all details and shall be left in a satisfactory working condition. The contractor shall furnish and install all materials and equipment which are obviously the part of the complete illumination installation and without any additional charge to the Owner.

The miscellaneous material include, but are not limited to the conduit, wires, controls, lighting distribution boards, junction boxes, fittings, supports and other accessories required for the entire installation and satisfactory operation of the indoor and outdoor lighting system.

The contractor shall perform the following work in addition to furnishing and delivering of the equipment, materials and accessories specified hereinafter in this specification.

a) Assembling at the plant site
b) Erection and complete installation
c) Testing of all equipment
d) Commissioning of all equipment prior to trial operation
e) Trial operation and all necessary adjustments prior to initial operation.
f) Obtaining Owner's/Engineer's approval and written acceptance after satisfactory operation.

Codes & Standards

The lighting installation shall meet the requirements of the latest edition of the National Electrical code (ANSI CI) of the National Fire Protection association of America. In addition, any rules or regulations applicable to the work shall be followed. In case of any discrepancy, the more restrictive rule shall be binding.

Requirements

Illumination Level: The illumination level above working plane in various areas in lux is as specified below:

a)	Borehole Submarsible pump	: 75 lux
b)	D.G. room	: 200 lux
c)	Water testing laboratory	: 200 lux
d)	Other indoor office area	: 75 lux
e)	Outdoor equipment area	: 10 lux
f)	Road	: 10 lux
g)	Other outdoor area	: 10 lux

Protection of Work:

The contractor shall effectively protect at his own expense, such of his work, materials or equipment as is liable to injury during the construction period. All openings to any part of the conduit system, as well as associated fixtures and equipment, both before and after being set in place, must be securely covered or otherwise protected to prevent obstruction of the conduit or injury due to carelessly or maliciously dropped tools or materials, grit, dirt or any foreign matters. The contractor will be held responsible for all damages so done until his work is fully and finally accepted. Conduit ends shall be covered with capped bushings.

Method and Materials:

All work shall be done in a first-class, neat and workmanlike manner by mechanics skilled in the trade involved. All details of the installation shall be mechanically and electrically correct.

All the materials shall be new, of the best of their several kinds, and without imperfections and blemishes. All materials shall be standard products of manufacturer's latest design. Where two or more units of the same class of equipment are required, these units shall be of same manufacturer.

All conduits and equipment shall be installed in such manner as to preserve access to any other equipment installed.

Steel Conduit:

All conduits except otherwise stated shall be rigid steed hot dipped galvanized. Minimum diameter of all conduit shall be 19 mm.

Each piece of conduit shall be straight, free form blisters and other defects, cut square and taper reamed and shall be furnished in 3 meter lengths and threaded at each end. Couplings shall be cleanly cut.

In no case shall the conduit be filled by more than 40 percent

Wire & Cable:

The contractor shall furnish and install all wire and cable required for the complete installation. All wire shall be of stranded copper conductor, PVC insulated. The wire shall have a voltage grade of 600 V as per IEC. Minimum cross-section shall be 2.5 sq.mm. All wire shall be run conduit.

All outdoor circuit wiring shall be done by using power cables.

Cables and wires shall be installed without joints as far as practicable. Where splicing or joints are required they shall be made in accordance with the cable manufacturer’s recommendations.

All splicing shall be done in outlet boxes and junction boxes and not in the conduit, all connectors and splicers shall be of the solderless type and shall be self-insulated. In lieu of self-insulated type connectors and splices, the contractor may use the non -insulated type, but he will wrap the connection or splice with insulation tape to the same dielectric value as the original insulation. If

insulation tape is used, they shall be of a type as recommended by the manufacturer of the wire or cable.

Outlet and Switch Boxes:

Every Guard house/office room/Borehole pump room shall be installed with at least two nos. of 15 a 1-phase, 3 pin receptacles with switches.

All outlet and conduit fittings in exposed conduit runs shall be cast metal with integral threaded hubs ("Condulets") with appropriate covers and shall be provided with gasketed covers. Sealing fittings shall be furnished where required.

Junction and Connector Box (C.B.):

Junction and connector box for indoor use shall be made from sheet steel and shall have set-in or flange construction cover. All corners shall be placed approximately 150 mm apart. Each box and cover shall be hot dipped galvanized after fabrication. All drilling for conduits or armoured cable shall be done in the field. The box sizes shall be in accordance with the National Electrical Code.

Connector Box for outdoor use shall be similar to the above except that they shall be provided with screwed-on covers with gaskets to make them weatherproof. Conduit connections shall be made through threaded hubs or chase nipples welded to the box.

Lighting Fixtures:

The contractor shall furnish, install and wire required number of lighting fixtures to meet the various maintained illumination levels as specified in this specification. It shall be noted that the illumination intensities indicated for various areas are the maintained illumination levels (and not initial illumination level)considering a maintenance factor of not more than 0.7. The contractor shall be responsible for producing the above illumination levels for each specific area with the type of fixture specified.

Lamps-All fixtures shall have installed therein by the contractor a lamp of wattage as noted in this specification. They shall be of the incandescent filament, fluorescent or high pressure mercury type as required for each unit. Lamps shall be furnished by the contractor.

Lamps to be used shall have the longest life, from the respective kinds approved for this application. If the fixture provided has more than one lamp and it requires a ballast, then one ballast per lamp shall be furnished.

Accessories-Each fixture shall be supplied with necessary straps supports, or hangers or other miscellaneous materials and devices to install them in a satisfactory manner, and to conform to the architectural treatment in the area in which they are to be installed. All fluorescent fixtures shall be equipped with high power factor, approved ballasts and rapid start lamps.

The contractor shall prepare the detailed layout to meet the above requirement. The lighting layout and wiring drawings of the contractor shall be submitted for the Owner's/Engineer's approval.

Fixture Type I A

Fluorescent general purpose ceiling mounting type white Acrylic enamel finished with reflector and electronic starter with high power frequency ballast - 1 x 40 W.

Fixture Type I B

Ditto but 1 x 20 W

Beacon Lamp

The luminaries with bulbous floodlight lamp for beacon lighting to be fitted on top of each Over Head Tank (OHT) for use in temperature between - 45 deg centigrade to + 50 deg centigrade. The light out put peak intensity shall be about 30 cd red with 60 w/100 w lamp. Having cast aluminium, symmetric red glass lens for use in 220/230 volt supply.

Wall Bracket Lamp

Decorative wall bracket type of lamp for 60 watt incandescent bulb having Baynet cap, similar in look to FL 732 Sl Fancy of Phillips make / similar design.

Specifications of the Luminaries

Weatherproof street light luminaries comprising of single piece drawn sheet aluminium housing with high purity electro-brightened side reflectors shall be installed. The luminaries shall be fitted with high transparency clear acrylic cover held over felt gasket by adequate toggles, for side entry bracket mounting.

For the safety during dark hours, and security to the staffs life, street-lighting is envisaged, 9M long standard steel tubular poles for mounting the high pressure mercury vapour lamps of HPLN-125 watt rating with specially water tight standard fixtures of Phillips / Crompton / Bajaj are proposed.

Specification of High Pressure Mercury vapour Lamps

The lamps shall have good colour characteristics and shall withstand small vibrations without any shortening of life.

Data	
Rated Wattage	- 125 W
Voltage	- 230 V
Frequency	- 50 Hz
Operation current	- 1.15 A
Light output	- 6250 – 5800 /lm
Lamp base	- E27/B22D or E40

Fixture type for each area is as specified below:

a) Borehole / Office Room / Water Testing Laboratory / Guard House / DG Room - Indoor, fluorescent general purpose ceiling mounting white acrylic type fixture complete with one / two 40 W cool white fluorescent lamps and glow start high p.f. ballasts. Incandescent general purpose 40 deg bracket mounting type enclosed gasket type and white opal glove with reflector.
b) Other outdoor area - Outdoor area, weather-proof, beacon lamp and high pressure mercury vapour lamp complete with one (1) 125 Watt lamp, ballast, aluminium reflector.

All the fixtures shall be approved by the Owner / Engineer before shipping.

Receptacles:

The contractor shall furnish and install all receptacles/power outlets as specified herein.

The receptacles shall be of 230 V . 5 /15 amp. 3 wire. polarized with third pole grounded and multi-plug type.

The receptacles shall be provided on the walls of all the rooms at a spacing of 6 M (max.).

Local Wall Switches:

Local wall switches for controlling lighting cubicles shall be furnished and installed for each enclosed area as Borehole pump room / DG room and Guard House / Office Room / Water Testing Laboratory Room etc. All switches shall be single pole as required.

General indoor areas - Local switches mounted indoors shall be single pole and shall be rated 6 Amperes at 230 Volts.

Grounding:

Each light fitting shall be provided with a grounding terminal suitable for connection to the earthing conductor.

All metal or metal enclosed parts of the housing shall be bonded and connected to the grounding continuity throughout the fixture.

Tests

The contractor shall thoroughly test and measure insulation resistance for all cables and equipment and prove that same are free of grounds and short circuits. If a ground or short circuit is found on any cable or equipment, the faulty condition shall be eliminated or the cable and/or equipment replaced. The minimum value of insulation resistance shall be 10 megohms.

All equipment shall be demonstrated to operate in accordance with the requirements of this specification and other specifications.

All tests shall be performed in the presence of the Owner/Engineer. Contractor shall furnish all instruments and personnel for all tests.

20.All type Soil

All type of Soil refers to soil consisting of 60% Boulder mixed Soil,30% Hard Soil and 10% Soft Soil

21.Staffs for Testing and Commissioning

The Employer and Water User Committee shall recommend for recruitment of all manpower for Testing and Commissioning of the Project .Education and other Qualifucation of such manpower shall be as per the minimum requirement for such post/equivalent post for employee of Government of Nepal.

The contractor shall carry out the training of Personnel nominated by the WUSC of the concerned project in the Testing and Commissioning of the works to the extent specified in the Employer's requirement or not less than two personnel from each schemes of Project.

The programme and scheduling of the training shall be agreed with the Employer,as the contractor shall provide experienced training staff,and all training materials as instructed by the Employer. Employer shall be responsible for nominating and selecting suitable personnel for training.

22.Environment Protection Works

Environment Protection works shall be carried out as per the recommended activities in Environment Management Plan in EIA Report of Kanyam Panchakanya Water Supply Project, Ilam.

23.Cement Punning Finishing

All the materials to be used such as cement, sand, water and other materials shall be as have been described 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.

24.Specification for Chlorine Dosing Unit

A. Chlorination Dosing Unit With Singal 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 200 ltr	2 No.
4	Chemical Mixing Agitator	made of 304 grade stainless Steel 3'x6" 2 mm thickness with 2" Dia, speed 210 rpm	1 No.
5	Metal(MS) Structure with Primer and Enamel Coating with Nut Bolt of approximately 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 demostration	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

25.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.

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26.Specification for ACSR Conductor
ACSR CONDUCTOR

Scope

This Specification covers the fabrication and supply of aluminum conductors, steel reinforced (ACSR) commonly used on overhead power line construction.

Description

- The manufacturer of the ACSR conductor must have been accredited with ISO 9001:2000 (design included) quality certifications.
- The ACSR conductor shall be a concentrically stranded right-hand lay conductor.

- The ACSR conductor shall be fabricated in accordance with BS: 215 (Part 2) latest revision or any other national or international standards that ensures a substantially equal quality to the standard mentioned above, will also be acceptable.
- The following type of conductors shall be supplied:

Code Name	**Nominal Area (Sq. mm)**	**Stranding (Al/Steel)**	**Breaking Strength (KN)**	**Mass (kg/km)**	**Max. d.c. Resistance at 20° Ohm/km**	**Diameter**	
						Aluminum (mm)	**Steel (mm)**
WOLF	*150*	*30 /7*	*67.34*	*726*	*0.1871*	*2.5*	*2.59*

Packaging

- All conductors shall be furnished on non-returnable treated seasoned wooden reels. All timber shall be treated to provide protection against rot and insects. Protective external lagging of sufficient thickness shall be provided and fitted closely on the reels. Binder consisting of steel straps shall be provided over the external laggings. The reel 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 confirming to IS: 1778-1980.
- Each reel of the conductors furnished shall contain only one (1) length of conductor.
- All reels shall be legibly marked in paint with the following information:
    a) Manufacturer's name or trade mark:
    b) Contract/specification number:
    c) Size and type of conductor:
    d) Net mass of the conductor:
    e) Net mass of drum:
    f) Gross mass of the drum and conductor:
    g) Lengths of the conductor in meter:

h) Direction of rolling:

i) Drum and lot number:

j) Name and address of the consignee: NEA, PTSD

k) Supplier's Name:

- The standard length of the completed conductor in each reel shall be as per the table below:

Conductor Size (sq. mm):	150
Normal Length of the Conductor (m):	1000

Tests

- The manufactured conductor shall be tested in full compliance with the governing standard including following routine tests:

Aluminum wire

a) Tensile test

b) Wrapping test

c) Resistivity test

Steel wire

a) Determination of stress at 1% elongation

b) Tensile test

c) Torsion test or elongation test as appropriate

d) Wrapping test

e) Galvanization test

27.Specification for Pin Insulator

The pin insulator shall be manufactured and tested in accordance with IS 731 – 1971 or latest version thereof . The pin insulator shall have following ratings and features.

Highest system voltage	12 KV
Rated voltage	11 KV
Creepage distance (min)	265 mm
Wet power frequency withstand voltage	35 KV
Impulse withstand voltage	75 KV
Puncture power frequency voltage (min)	105 KV
Visible discharge voltage (effective)	9 KV
Cantilever strength	5 KN
G.I. Pin head	Small (IS ref.S 165 P)

28.Specification for Disc Insulator

For tension locations where the line is sectionalized/at heaver deviation angle/dead end , disc type insulators are used . The disc insulator shall be ball and socket fitting type . The disc insulator shall have the following ratings and features :

Highest system voltage	12 KV
Rated Voltage	11KV
Porcelain diameter (min)	255 mm
Spacing	145 mm
Creepage distance (min)	280 mm
Power frequency puncture withstand voltage	1.3 x actual dry flashover voltage
Wet power frequency withstand voltage	35 KV
Impulse withstand voltage	75 KV
Puncture power frequency voltage (min)	100 KV
Visible discharge voltage	9 KV
Mechanical strength	45 KN
Ball and socket size	16 mm B
Applicable standard for special characteristics	IS: 3188-1980 or equivqlent

29.Specification for Bleaching Powder

1. The bleaching powder shall 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.

1. 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.

30.Specification for Distribution Transformer

Distribution transformer assembly shall be consisting of :

i) Distribution transformer , capacity

ii) 11 m high steel tubular H-pole for transformer installation – 1 set (2no)

iii) Steel channels for transformer and lightning arrestor installation – each1 set
iv) 9 KV Lightning arrestor and accessories complete – 1 set (3 no)
v) 11 KV DO Fuse and accessories – 1 set (3 no)
vi) 11 KV Ground operated switch (GOS) – 1 set
vii) Pin and Disc insulators – each 1 set (3 no)
viii) Stay set – 2 set

31. 11KV D.O. FUSE UNITS

1. SCOPE: - This specification provides for supply and installation of out-door Droop-Out fuses suitable for installation in 50 Hz 11KV distribution system.

2. APPLICATION:- The D.O. Fuses are intended for use on distribution transformers for protection/isolation of the same during overload or fault conditions of lines.

3. APPLICABLE STANDARD:- Unless otherwise modified in this specification, the drop out fuse shall conform to IS:9385 (Part-I to III) or equivalent as amended from time to time.

4. CLIMATIC CONDITIONS: - The climatic conditions at site under which th equipment shall operate satisfactorily, are as follows:-

(i) Peak Ambient temperature in shade : 42 °C
(ii) Maximum average ambient temperature in 24 hours period in shade: 40° C.
(iii) Minimum ambient temperature : - 4^0 C
(iv) Maximum relative humidity : 100%
(v) Average number of thunder storm days per annum : 40 days
(vi) Average number of rainy days per annum. : 90 days
(vii) Average annual rainfall : 125 Cm
(viii) Number of months of tropical monsoon conditions per annum : 3

For the purpose of specifications, the reference ambient temperature shall be 40 C.

5. DROP OUT FUSES:- The drop-out fuses shall be expulsion type. This shall be `D' type and out-door lift off type suitable for manual operation by an operating rod from the ground level. The drop out operation will be angular in vertical plan.

5.1 The equipment offered by the tenderer shall be suitable for 11KV three phase 50 C/S solidly grounded earthed neutral systems. It shall be designed for a normal current rating of 200 Amps.

5.2 The drop out fuses are required with Post Insulators. These shall be suitable for mounting on the structure. The bracket/channel hardwares for D.O. Fuses shall be provided with adequate sizes of nuts, bolts and washer for mounting on the
structures of the purchaser.

6. POST INSULATORS: - Each 11KV D.O. Fuse shall have two nos. 11 KV Post Insulators. D.O. The insulators shall conform to IS:2544 of 1973 with latest amendments. The porcelain used for manufacture of D.O. Fuse shall be homogeneous, free from flaws or imperfections that might effect the mechanical or dielectric strength adversely. They shall be thoroughly vitrified tough and impervious to moisture. The glazing of the porcelain shall be of uniform brown colour free from blisters, burns and other similar defects. Insulators of the same rating and type shall be interchangeable.

6.1 The porcelains and metal parts shall be assembled in such a manner that any thermal expansion differential between the metal and porcelain parts through range of temperature variation shall not loosen parts or create undue internal stresses which may affect the electrical or mechanical strength and rigidity. Each cap and base pin shall be made of high grade cast steel or malleable steel casting and they shall be machine faced and smoothly galvanized. The cap and base shall be properly cemented with insulators to give perfect grip. Excess use of cement shall be avoided.

6.2 Each 11KV Post Insulators should have technical particulars as detailed below:-

(i) Nominal system voltage KV (rms) : 11
(ii) Highest system voltage KV (rms) : 12
(iii) Dry Power Frequency one KV (rms) minute withstand voltage : 35
(iv) Power Frequency puncture KV (rms) Voltage 1.3 times the actual dry flashover voltage
(v) Impulse withstand voltage KV (rms) : 75
(vi) Visible discharge voltage KV (rms) : 9
(vii) Creepage distance in mm (minimum) : 320
(viii) Cantilever strength (KN) : 6.60

7. As stated above unless otherwise modified in this specification the drop out fuse shall conform to IS:9385 (Part-I to III) and as amended from time to time.

7.1 RATED VOLTAGE:- The rated voltage shall be 11KV.

7.2 RATED CURRENT: - The rated current shall be 200 Amps

7.3 RATED LIGHTNING IMPULSE WITHSTAND VOLTAGE VALUES FOR THE FUSE BASE:-
The rated lightning impulse withstand voltage both for positive and negative polarities shall be as given below:-

a) To earth and between pole : 75 KV Peak
b) Across the isolating distance of fuse base. : 85 KV Peak

7.4 RATED ONE MINUTE POWER FREQUENCY WITHSTAND VOLTAGE (DRY AND WET) VALUES FOR THE FUSE BASE

a) To earth and between pole : 28 KV Peak
b) Across the isolating distance of fuse base : 32 KV Peak

7.5 TEMPERATURE RISE LIMIT IN AIR ABOVE AMBIENT TEMPERATURE

A	Brass contacts silver faced	65^0
a)	Terminals	50^0
b)	Metal parts acting as spring	The temperature shall not reach such a value that elasticity of the metal is changed.

7.6 RATED BREAKING CAPACITY: The rated breaking capacity shall be 8KA (Asymmetrical). Submission of type test certificate of rated breaking capacity in case of 11KV D.O. Fuse Unit is very essential (otherwise offers may be rejected).

8. MAIN CONTACTS: The main contacts of the D.O. Fuse shall be suitable for heavy duty, properly aligned, made from Brass material. These shall have good finish and smooth surface and shall be silver plated. All the sharp edges shall be rounded off. These contacts shall be so designed to withstand highest short circuit breaking current that may be encountered during service. In nut-shell the contact assembly shall ensure:-

i. Electrodynamic withstand ability during short circuit without any risk of repulsion of contact.
ii. Thermal withstand ability during short circuits.
iii. 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 or flexible conductors either because of temperature variation or strong winds.
iv. Proper alignment to ensure smooth operation of D.O. Fuse without adjustment.

9. CONNECTORS: The connectors shall be made from Brass suitable for ACSR Rabbit. The connectors should be bolted type having 4 bolts & groove to hold the conductor. All brass parts should be silver plated for corrosion resistance and efficient current flow. All ferrous parts should be hot dip galvanized as per the latest version of IS:2633. Nuts and bolts shall conform to IS:1364 and should be hot dip galvanized. Spring washer should be electro galvanized.

10. FLY NUTS:- These shall be provided at both the ends of Epoxy Resin Fiber Glass(ERFG) tube for tightening the fuse element. The nut shall be provided with one flat washer of 1 mm thickness. The arrangement shall be made to ensure that the fuse wire runs centrally inside the ERFG tube after tightening. The fly nuts should have at least 4 threads with adequate wall thickness.

11. SPRING STRIPS:- The spring strips shall be of phosphor bronze multi line brush type having a high pressure contacts and should retain its tension under minimum continuous service current of 200 Amps at 90 C.

12. OPERATING HOOKS:- The brass operating hook shall be fixed in such a way that the barrel can be removed for replacing the fuse element by operating rod from the ground level. Two number screws of size 6 mm dia shall be provided on each operating hook and barrel take out hook to hold the barrel rigidly.

The drop out fuse units shall operate efficiently; speed of operation shall not depend on the inclination of the fuse. However, the inclination of the fuse barrel shall be adjusted in such a way that the barrel does not drop by gravitational force.

13. D.O. BARRELS (CARRIER TUBES):- The carrier tube made of Epoxy Resin Fibre Glass (ERFG) and conforming to the following specification shall be used for 11KV D.O Sets:-

13.1 GENERAL:- This specification governs the requirement for an electrical grade tube with good mechanical and high heat resistance properties, made from fine woven glass fibre cloth, impregnated with epoxy resin. Tube shall be well consolidated of circular cross section and uniform wall thickness with ends trimmed smoothly at right angles to the axis of the tube. The external surfaces shall be brown in colour and shall be uniformly finished with polyuret and varnish or epoxy resin. The tube has a temperature index of at least 155 C.

13.2 APPLICATION:- Used as fuse carrier in 11KV Drop Out Fuses.

13.3 COMPLIANCE WITH:- Indian Standard Specification no.10192.

13.4 DIMENSIONS AND TOLERANCES:- ID x OD x Length of the tube shall be as under:-

Standard Sizes	**For 11KV D.O. Set**
ID x OD x Length	19mmx25mmx330mm
Tolerances on dimensions:-	
Inside Diameter (ID)	± 0.05 mm
Outside Diameter (OD)	± 0.25 mm
Wall Thickness (WT)	± 0.15 mm
Length	± 1.0 mm

13.4 WARPING:- The tube shall be placed on a flat steel plate and rolled until the maximum gap between the tube and plate occurs with both ends of the tube in contact with plate. This gap, measured by a feeler guage, when computed as percentage based on the length of the tube shall not exceed 0.1% of all the sizes of tube.

13.6 FINISH:- The tube shall have uniform and smooth finish and be free from splits, inclusions or foreign bodies visible defect and voids.

13.7 IDENTIFICATION OF SURFACE VARNISH:- The surfaces finish shall be of polythene or epoxy resin varnish when identified by informed spectra-photometer or by any conventional method**.**

13.8 TEST:- Unless otherwise specified, the tests shall be conducted and result shall be approved in accordance with the relevant methods currently adopted by Nepal Electricity Authority

32. 11 KV Distribution Class Lighting Arrestors

Technical Specifications

1. Scope of Work

The specification covers the design, manufacture, shop & laboratory testing before dispatch, supply, delivery, erection, testing & commissioning of 9 KV, static class heavy rating, gapless, metal (zinc) oxide lighting arrestors complete along with clamps, complete fitting and accessories for installation on outdoor type 11 kv switchgear, transmission lines, transformers etc.

2. Specific parameters & layout conditions

2.1 Technical Particulars

The lighting arrestors shall confirm the following standard technical requirements.
The Insulation values shall be enhanced considering the altitude of operation &
other atmospheric conditions.

2.1.1 System parameters

(i) Nominal system voltage 11Kv
(ii) Highest system voltage 12Kv
(iii) System earthing Effectively earthed system
(iv) Frequency (Hz) 50
(v) Lightning Impulse withstand Voltage (kVP) 75
(vi) Power frequency withstand Voltage (kv rms) 28
(vii) Arrestors duty
- Connection to system Phase to earth
-Type of equipment to be protected 50/ 100 KV transformers & Switchgear

2.1.2 Lighting Arrestors

(i) Type Gapless Metal oxide – outdoor
(ii) Arrestor rating (KV rms) 9

(iii) Continuous Operating
voltage (kV rms) 7.65
(iv) Nominal discharge Current: 5 Rating (KA)
(8x20 micro impulse shape)
(v) Long Duration discharge class Distribution Class
(vi) Degree of protection: IP 55
(vii) Maximum residual voltage
at 5 KA (KV peak) : 32
(viii) Maximum switching lighting residual 24 Voltage (kVp) at 1Ka
(ix) Partial discharge at 1.05 COV
not greater that (PC) 50
(x) High current impulse withstand voltage 100 at 65 kA (kVp)

2.1.3 Insulator Housing

(i) Power frequency withstand test voltage (Wet) (kV rms) : 28
(ii) Lighting impulse withstand / tests voltage (kVP) : 75
(iii) Creep age distance not less than 320
(iv) Pressure relief class B

2.1.4. Galvanization

(i) Fabricated Steel Articles

a) 5 mm thick cover Articles: 610 g/m^2

b) Under 5 mm but not less than 2 mm thickness : 460 g/m^2

c) Under 2 mm but not less than 1.2 mm thickness: 340 g/m^2

(ii) Castings Grey Iron, malleable iron 610 g/m^2

(iii) Threaded works other than tubes & tube fittings

a) Under 10 mm dia 300 g/m^2

b) 10 mm dia & above 270 g/m^2

3. Rating and Functional Characteristics

(i) Nominal system voltage 11kV
(ii) Highest system voltage 12kV

(iii) System earthing effectively earthed system
(iv) Frequency (Hz) 50
(v) Lightning Impulse withstand Voltage (kVP) : 75
(vi) Power frequency withstand Voltage (kV rms) : 28
(vii) Arrestor duty
- Connection to system Phase to earth
- Type of equipment to be protected Transformers & Switchgear

4. Performance Guarantee

The equipment along with all accessories shall be capable of performing intended duties under specified conditions. The Contractor shall guarantee the reliability and performance of the individual equipment as well as of the complete system as specified in the bid documents.

5. Design and Construction

5.1.1 Standards

5.1.1 The design, manufacture and performance of Lighting Arrestors shall comply with IS: 3070 part-3 and other specific requirements stipulated in the specification. Unless otherwise specified, the equipment, material and processes shall conform to the latest applicable Indian as listed hereunder :

IS: 2071-1993 (Part-1) : Methods of High Voltage Testing General Definitions & Test Requirements.
IS: 2071-1974 (Part-2) : Test Procedures
IS: 2629-1985 :' Recommended Practice for hot dip galvanizing on Iron & Steel.
IS: 2633-1986: Method for Testing uniformity of coating of zinc coated articles.
IS : 3070-1993 (Part-3): Specification for lighting arrestor for alternating current systems. Metal – Oxide lightening Arrestors without gaps.
IS : 4759-1996: Specification for hot dip zinc coating on Structural Steel and Other allied products.
IS : 5621-1980 : Hollow Insulators for use in Electrical Equipment.
IS : 6209-1982 : Methods of Partial discharge measurement.
IS : 6745 : Method for determination of mass of zinc coating on zinc coated iron and steel articles.
ANSi/IEEE-C.62.11 (1982) : Metal oxide, Lighting Arrestor for AC Power Circuits.

5.1.3 General Requirement

5.2.1. The metal oxide gap less Lighting Arrestor without any series or shunt gap shall be suitable for protection for 11KV side of Distribution Transformers, associated equipment from voltage lightings resulting from natural disturbance like lightning as well as system disturbances.
5.2.2. The lighting arrestor shall draw negligible current as operating voltage and at the same time offer least resistance during the flow or lighting current.
5.2.3. The lighting arrestor shall consist of non-linear resistor elements placed in series and housed in electrical grade porcelain housing / silicon polymeric of specified creep age distance.

5.2.4. The assembly shall be hermetically sealed with suitable rubber gaskets with effective sealing system arrangement to prevent ingress of moisture.

5.2.5. The lighting arrestor shall be provided with line and earth terminal of suitable size. The ground side terminal of lighting arrestor shall be connected with 25x6 mm galvanized strip.

5.2.6. The lighting arrestor shall not operate under power frequency and temporary over voltage conditions but under lighting conditions, the lighting arrestor shall change over to the conducting mode.

5.2.7. The lighting arrestor shall be suitable for circuit breaker performing 0-0.3 min-Co-3-min-CO_duty over to the conducting mode.

5.2.8. Lighting arrestors shall have a suitable pressure relief system to avoid damage to the porcelain / silicon polymeric housing and providing path for flow of rated fault currents in the event of arrestor failure.

5.2.9. The reference current of the arrestor shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.

5.2.10. The Lighting Arrestor shall be thermally stable and the supplier shall furnish a copy of thermal stability test along with the bid.

5.2.12. The lighting arrestor shall be provided with line and earth terminals of suitable size. The line side terminal shall be suitable for ACSR weasel / rabbit conductor..

5.3 Arrestor Housing

5.3.1. The arrestor housing shall be made up of porcelain / silicon polymeric housing and shall be homogenous, free from laminations, cavities and other flaws of imperfections that might affect the mechanical and dielectric quality. The housing shall be of uniform brown colour, free from blisters, burrs and other similar defects. Arrestors shall be complete with insulating bases fasteners for stacking units.

5.3.2. The housing shall be so coordinated that external flashover shall not occur due to application of any impulse of switching lighting voltage up to the maximum design value for arrestor. The arrestors shall not fail due to contamination. The 11kV arrestors housing shall be designed for pressure relief class as given in Technical Parameters of the specification.

5.3.3. Sealed housings shall exhibit no measurable leakage.

5.4 Arrestor Mounting

The arrestors shall be suitable for mounting on 4 pole/2 pole structure used for pole/ plinth mounted transformer and for incoming and outgoing lines.

5.5 Fittings & Accessories

5.5.1 The lighting arrestor shall be complete with insulating bases, fasteners for stacking units along with clamp & terminal connectors and inbuilt dis-connector.

5.5.2 The terminals shall be non-magnetic, corrosion proof, robust and of adequate size and shall be so located that incoming and outgoing connections are made with minimum possible bends. The top

metal cap and base of lighting arrestor shall be galvanized. The line terminal shall have a built in clamping device, which can be adjusted for both horizontal and vertical take off.

6. Name Plate

The nameplate attached to the arrestor shall carry the following information:

- Rated Voltage
- Continuous Operation Voltage
- Normal discharge current
- Pressure relief rated current Manufacturer Trade Mark

7. Tests :

Lightning arrester shall be tested and approved by NEA

33. Cast Steel Gate Valve

Cast Steel Gate Valve, Class 300 confirming to BS:1414 or equivalent.
Hydraulic Test pressure: Body 76 kg/cm2, Seat 55 kg/cm2, including ISOD Flange, Nut & bolt, Gasket with standard size

34. PVC Pipes and Fittings

It shall meet the requirement as of NS 206:2046 PVC pipe for drinking water supply(First Amendment)

35. STAY SET

Scope

This Specification covers the fabrication and supply of adjustable threaded, galvanized steel stay sets for use in overhead line construction.

Material

- The stay set shall consist of mild steel, galvanized stay rod, stay tightener (turn buckle) or adjustable head, eyebolt for Steel Tubular pole or two-way clamp and twisted double-eye for steel tubular pole, thimbles complete with stay plate as shown in the conceptual drawings Dwg. CSG17.
- The manufacturer of the Stay Set must have been accredited with ISO 9001 or ISO 9002 quality certification.
- The stay rod and stay tightener shall be made of mild steel of minimum ultimate tensile strength of 4200-kg/sq. cm.
- The stay plate shall be square type mild steel plate.

- The thimbles shall be made of 1.219mm (18 SWG) GI sheet.

Description

- Conceptual drawings of stay set and its associate hardware are given in Dwg. CSG17, and technical features and dimensions in Table 1.
- The stay rod is either thimble-eye type or twin-eye type. The stay rod and suitable nut shall be fabricated to the shape and dimensions shown in Dwg. CSG17. The thimble- eye or twin-eye of the stay rod shall be made by drop forged processing. 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 1 without creep or stripping over the full life of the rod material at specified diameter.
- The stay lightener shall be fabricated in accordance with the conceptual drawing shown in Dwg. CSG17.
- The eyebolt shall be oval-eye type. The eyebolt shall be made by drop-forged processing. The eyebolt shall be supplied with suitable nut and washer.
- The two-way clamp required for mounting stay set (stay tightnener) in steel tubular pole shall be made of hot-rolled steel flat. The clamp shall be two halve type and shall be provided with two numbers of nuts and bolts, diameter not less than 19 mm. The both ways of the clamp shall be suitable for accommodating two numbers of twisted double-eye fittings described in Clause 3.5 below. The two-way clamp shall be following types:
  a) Type A: Suitable for pole diameter ranging from 180-230 mm.
  b) Type B: Suitable for pole diameter ranging from 140-180 mm.
- The twisted double eye shall be made by drop-forged processing. The twisted double- eye shall be twisted in 90^0. The diameter of the steel shall not be less than 16 mm., and eye of the twisted-eye shall be suitable for accommodating sty tightener.
- The Stay plate shall be square and the plate shall have a matching hole at the center to fit the end of the stay rod.
- The thimble shall be suitable for terminating steel stay wire with a preformed grip.
- 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.