Bangladesh-India Friendship Power Company (Pvt.) Ltd (BIFPCL)

EPC Township Package

for

2 x 660 MW Maitree Super Thermal Power Project
at Rampal
District- Bagerhat, Division- Khulna, Bangladesh

(Functional Technical Specification)

TENDER DOCUMENT No.: BIFPCL/MSTPP/ EPC TOWNSHIP
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TABLE OF CONTENTS

PART – B : FUNCTIONAL TECHNICAL SPECIFICATION (FTS)

SECTION B0 : GENERAL TECHNICAL SPECIFICATION

SECTION B1 - DETAILED TECHNICAL SPECIFICATION - CIVIL

2 Detailed Scope of Work

1. General
2. Site Related Investigations
   - 2.1 Topographical / Contour Survey
   - 2.2 Geotechnical Investigation
3. Site Development Work
   - 3.1 Site clearance
   - 3.2 Site grading
   - 3.3 Boundary Wall
4. Construction Enabling Works
   - 4.1 Site Office for Contractor's Use
   - 4.2 Site Stores Complex
   - 4.3 Temporary Workshop and Garage
   - 4.4 Fabrication Yard
   - 4.5 Quality Control Laboratory
   - 4.6 Construction Staff Welfare Facilities
   - 4.7 Fuel Storage Area for Contractor's Use
5. Outdoor Civil Works
   - 5.1 Fencing and Compound Walls
   - 5.2 Roads
   - 5.3 Storm Water Drainage System
   - 5.4 Paving
   - 5.5 Horticulture and Landscaping
   - 5.6 Central Recreational Park
   - 5.7 Children Play Areas
   - 5.8 Green Belt
   - 5.9 Sewage Network
6. Residential Buildings
   - 6.1 Executive Residence – Type – A
   - 6.2 Executive Residence – Type – B
   - 6.3 Executive Residence – Type – C
   - 6.4 Staff Residence – Type – D
   - 6.5 Head of Plant Bungalow
   - 6.6 Guest House
   - 6.7 Studio Apartments
   - 6.8 Field Hostel – Staff
   - 6.9 Trainees Hostel and Training Center

7. Non-Residential Buildings
    - 7.1 Gate and Security
    - 7.2 Car Parks
    - 7.3 Nursery and High School
    - 7.4 Mosque
    - 7.5 Hospital
    - 7.6 Shopping Center with Post Office, Bank and Estate Office
    - 7.7 Temple
    - 7.8 Community Center
    - 7.9 Executive Club
    - 7.10 Non- Executive Club
    - 7.11 Swimming Pool
    - 7.12 Indoor Sports Complex
    - 7.13 Outdoor Sports Area
    - 7.14 Potable Water, Service Water and Fire Water Pump House
    - 7.15 Main Receiving Substation
    - 7.16 Distribution Substations
    - 7.17 Maintenance Store
    - 7.18 Underground Water Tank
    - 7.19 Watch Tower
8. Facilities outside Township Boundary
    - 8.1 Police Station
    - 8.2 Security Force and Army Barracks
    - 8.3 Cyclone Shelter
    - 8.4 Storm Water Retention Pond
    - 8.5 Gas Cylinder Godown
    - 8.6 Transport Center
9. Typical Requirements
    - 9.1 Township Elevations
    - 9.2 General Requirements
    - 9.3 Typical Schedule of Finishes and Joinery

3.1 Codes and Standards

3.2 Loads and Load Combinations

3.3 General Requirements

3.4 Finishes

3.5 Earthworks

SECTION B2 - DETAILED TECHNICAL SPECIFICATION - MECHANICAL

SECTION B3 - DETAILED TECHNICAL SPECIFICATION – ELECTRICAL

SECTION B4 - TENDER DRAWINGS

A. General

B. Civil

C. Mechanical

D. Electrical

PART – C : TECHNICAL SCHEDULES

Section C1	Technical Schedules - Mechanical
Section C2	Technical Schedules - Electrical

PART – D : Annexures

Section D1	Topographical Survey Report
Section D2	Soil Investigation Report
Section D3	Site Specific Seismic Study Report
Section D4	Details of Power Plant Watch Tower
Section D5	Power Plant – Plot Plan

PART – B : FUNCTIONAL TECHNICAL SPECIFICATION

SECTION – B0

GENERAL TECHNICAL SPECIFICATION

TABLE OF CONTENTS

1. GENERAL TOWNSHIP DESCRIPTION

1.1 Executive Summary

The Bangladesh Power Development Board (BPDB) and India's state owned NTPC Ltd signed a Joint Venture Agreement as Bangladesh-India Friendship Power Company (Pvt.) LTD (BIFPCL) to implement the 2x660 MW Maitree Super Thermal Power Project (Maitree-STPP) in Rampal Upazila of Bagerhat District in Khulna, Bangladesh.

1.2 Purpose of the Township

A Township shall be developed to accommodate the operating and support services staff of Maitree STPP, and will be constructed to the side of the power plant.

The contractor shall cover all works for the engineering, procurement, construction and commissioning of the whole township on turnkey basis, including rectification of construction defects.

1.3 Township Components

Township consists of Residential buildings, Non-Residential Buildings, Public Utilities, etc.

2. GENERAL SCOPE OF SUPPLY AND SERVICES

2.1 General

The scope of this specification covers all supplies and services required for meeting the purpose of the Township, even if these are not expressively mentioned in the following.

The works include the following main components, where the detailed scope of supply is given in the corresponding Sections as listed below:

- Section B1: Civil Engineering Works
- Section B2: Mechanical Engineering Works
- Section B3: Electrical Engineering Works

This specification covers design, preparation of general arrangement, construction drawings and supply of all labor, materials and construction of all civil, structural and architectural works complete.

This specification is on ENGINEERING PROCUREMENT CONSTRUCTION (EPC) basis for all buildings and structures described in the specification as mentioned including Mechanical, Electrical, ventilation works, all complete as per scope of work.

All works shall conform to relevant Standards and Codes and all local and state regulations. Where requirements are at variance, the more stringent of them shall govern.

The Contractor's work shall cover complete requirements as per relevant codes, fire safety norms, requirements of various statutory bodies, local and International Standards, best prevailing practices and to the complete satisfaction of the Owner / Owner's Engineer.

All the quality standards, tolerances and other technical requirements shall be strictly adhered to.

The Contractor shall fully apprise himself of the prevailing conditions at the proposed site, climatic conditions including monsoon pattern, soil conditions, local conditions and site specific parameters and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications.

In case of any conflict between stipulations in various provisions of the specification, the most stringent stipulation would be applicable for implementation by the Contractor without any extra cost or time to the Owner. In this specification if there is any contradiction between two or more clauses in stating a requirement, then the Bidder shall bring out to notice such contradictions and get it cleared during the bidding stage itself. If the Contractor brings to notice of the same in later stage after the award of contract then the final decision about that requirement shall lie with the Owner which the Contractor shall comply.

All works shall conform to the specification. The works shall conform to high standards of design, engineering and workmanship. Design and construction shall conform in every respect to all local and Government regulations governing such works and to stipulations of relevant Standards and other statutory requirements unless stipulated otherwise in detail specification.

The Contractor shall organize his own arrangement to transport his equipment, personnel and material so as to match the construction schedule.

Overall Project management, project control, quality assurance, site management and coordination for all technical matters, interconnections, connection to off-site facilities,

scheduling, contractual matters and obligations, etc. with suppliers, sub-suppliers, subcontractors, vendors, the Owner, authorities as required on a EPC basis for the implementation, construction and handing over of the whole project under the overall and sole responsibility of the EPC contractor.

Complete civil, structural and architectural engineering including, topographic survey and Geo-technical investigation and design, ground improvement methodology (and implementation, if required) and carry out all necessary civil and construction works at site as specified. Contractor to carry out soil resistivity test for designing of earthing system.

Supply of all information, documents, calculations, drawings, reports, etc. which are required for Owner's approval and to obtain all necessary permits, clearances, from the relevant authorities.

Provision of all labour, necessary erection equipment, temporary site facilities, temporary connections to power supply, water supply, etc. for erection and commissioning required for the fulfillment of the Contractor’s duties in connection with the works and for completion of the entire project in time.

Provision of all accommodation, transport, canteen facility, social facilities, etc. for the Contractor’s personnel employed at site.

Labour accommodation inside site boundary shall not be allowed.

Co-ordination with other agencies including with the Owner at the plant interconnections (interfaces).

Provision of supply of all documents required and specified including As-Built drawings.

Service and maintenance training of Mechanical and Electrical systems for the Owner’s Operation and Maintenance Personnel.

Any other supplies and services in connection with or related to the works so far as necessary for providing the same or reasonably to be inferred from the contract and/or required for the completion of the project.

Transport Insurance.

Safety, security of materials, gate management.

Fire fighting system during construction

Medical facility during construction

Security requirement for this project shall be engaged by the contractor.

The Engineering services refer to the complete specified Plant and covers following services:

- Basic and detail engineering
- Permit engineering

The Contractor shall actively participate in drawing-up of all required licensing applications.

All services shall be performed by the Contractor to affect the required permits complete the Township components, including but not limited to:

- preparation of all documents as required according to the pertinent laws
- clarifications with authorities
- participation in all clarification meetings
- construction permits
- fire fighting approvals
- and all other services as required.

Furthermore, all other required engineering and other services to meet the purpose of the Project and the agreed project time schedule shall be executed by the Contractor.

2.2 Scope of Works - Civil

The Scope will cover but not limited to design engineering, supply and erection of Architectural, Civil and Structural works of the following investigations / studies / buildings / structure / systems / facilities.

1. Site Related Investigations
    1. Topographical / Contour survey
    2. Geotechnical Investigation
    3. Ground improvement methodology, if required.
2. Site Development Work
    1. Site clearance
    2. Site grading
    3. Boundary wall
3. Construction Enabling Works
    1. Site Office Contractor’s Use
    2. Site Store Complex
    3. Temporary Workshop and Garage
    4. Fabrication Yard
    5. Quality Control Laboratory
    6. Construction Staff Welfare Facilities
    7. Fuel Storage Area for Contractor’s Use
    8. Construction Water
    9. Construction Power
4. Outdoor Civil Woks
    1. Fencing, Compound Walls and Gates
    2. Roads
    3. Storm Water Drainage System
    4. Paving
    5. Horticulture and Landscaping

6. Central Recreational Park
7. Children Play Areas
8. Green Belt
9. Sewage Network

5. Residential Buildings.
    1. Executive Residence – Type – A
    2. Executive Residence – Type – B
    3. Executive Residence – Type – C
    4. Staff Residence – Type – D
    5. Head of Plant Bungalow
    6. Guest House
    7. Studio Apartments
    8. Field Hostel – Staff
    9. Trainees Hostel and Training Center
6. Non-Residential Buildings
    1. Gate and Security
    2. Car Parks
    3. Nursery and High School
    4. Mosque
    5. Hospital
    6. Shopping Center with Post Office, Bank and Estate Office
    7. Temple
    8. Community Center
    9. Executive Club
    10. Non-Executive Club
    11. Swimming Pool
    12. Indoor Sports Complex
    13. Outdoor Sports Area
    14. Potable Water, Service Water and Fire Water Pump House and Tank
    15. Main Receiving Substation
    16. Distribution Substations
    17. Maintenance Store
    18. Underground Water Tank
    19. Watch Tower
7. Facilities outside Township Boundary

1. Police Station
2. Security Force and Army Barracks
3. Cyclone Shelter
4. Storm Water Retention Pond
5. Gas Cylinder Godown
6. Transport Center

Any other buildings, structures and works necessary and not specifically mentioned here but required for construction, operation and maintenance of the Township are deemed to be included in the scope of the Contractor.

The following supplies and services are included

- All necessary surveying works including all soil investigations required for safe and reliable design and construction
- Preparation of site, demolition works, removal of underground obstacles
- Earthworks, drainage, excavation and refilling works
- Piling of structures to prevent subsidence
- Concrete and reinforced concrete works, masonry and earthing
- Water proofing works
- Fire protection during construction
- Roofing; non asbestos
- Plumbing
- Facade works/glazing works; non asbestos
- Non-load bearing walls/installation partitions/dry construction works
- Flooring work
- Fire protection with plumbing; fire protector
- Painting/varnishing
- Craneway works
- Potable water, service water and waste water
- Housekeeping during construction
- Staff facilities during construction
- Transport of all dumping material to dump locations
- Performance and interpretation of soil bearing tests
- Temporary fencing of construction site
- Site offices for Employer and Employer's representatives
- The Contractor's site office
- Landscaping of areas required under this contract.

The work also includes :

- Design and preparation of construction drawings (Architectural, Civil and Structural), excavation drawings, shuttering drawings, bar bending schedule drawing and construction of all structures.

- Preparation of as-built drawings of all structures and facilities to reflect as built status of

construction AutoCAD latest version in CD / DVD and hard copies

- Plumbing & sanitary works
- Painting of all Masonry, concrete and Structural works
- Anti weed treatment in all areas / buildings.
- Anti termite treatment for all buildings.
- Handing over of completed Township to the satisfaction of the Owner.
- All temporary roads and approach roads necessary for construction purpose with adequate parking area for heavy vehicles and all permanent roads for the Township including formation over the graded site. Nearest approach is upto main power plant entrance, which is approximately 1 km from Township.
- Fabrication and installation of full Township model in a suitable scale such that it can be accommodated in the reception area of the Guest House.
- All statutory clearances / No Objection Certificate required for implementation of the project from various departments / agencies like Public Works Department, Highways Department, local bodies etc, shall be obtained by the Contractor.
- The Contractor shall fill or excavate the areas to the required formation levels as indicated in the plot plan and dispose the excavated materials as directed by the Owner, without any extra cost to the Owner.

General Requirements

All buildings / structures / areas shall be provided with the following as applicable.

Plastering, painting, plumbing, sanitation, water supply, electrification and fixtures, lighting, air conditioning (design engineering only), fire fighting, anti-termite treatment, plinth protection, damp proof course, garland drains, doors, windows, rolling shutters, ventilators, approach roads, colour and white washing, sunshades, false ceiling, flooring, water proofing, roof treatment, rain water down take pipes, stair case, lift, monorails, porch, potable water tanks, fans, etc.

2.3 Scope of Works - Mechanical

The scope of work shall include design, engineering, manufacture, assembly and testing at works, packing, dispatch and transportation to site (including transit insurance), erection, testing and commissioning of the complete mechanical system. Systems are listed below and are further detailed in subsequent sections of this specification.

1. Fire Fighting System
2. HVAC System – Design engineering only for Air Conditioning system. Complete EPC scope for ventilation system.
3. Elevators

The following supplies and services are included

- All necessary pipelines, valves, etc

- All connection elements, screws, bolts, nuts, including gaskets and seals as necessary
- All necessary support structures, hangers etc.
- All necessary base frames, mounting plates, grouted in parts, rag bolts, covers etc.
- All required steel parts embedded in concrete
- All necessary lifting equipment and hoists (hooks and provisions for chain blocks to be provided for repair work where loads exceed 50 kg, hoists to be provided for repair work where loads exceed 200 kg, and electrical operated hoist for loads exceeding 2,500 kg)
- All necessary steel structures, stairs, ladders on platforms weather protection
- All required ventilation equipment for safe operation of mechanical and electrical equipment, to be supplied
- All necessary corrosion protection measures for stored or mounted on site up to the time of commissioning of respective systems.
- Complete primer and top coatings conforming to colour code, clarified with the Employer
- Complete labelling of all plant components according to the Employers system and in plain language
- All fire protection measures
- All standard accessories and auxiliary equipment which normally form part of the scope of supplies
- All necessary tests, inspections and works acceptances as well as all certificates and reports of these
- Removal of any unused material
- Scaffolding for all work above ground level

2.4 Scope of Works - Electrical

The scope of work shall include design, engineering, manufacture, assembly and testing at works, packing, dispatch and transportation to site (including transit insurance), erection, testing and commissioning of the complete electrical system. Major equipment and systems are listed below and are further detailed in subsequent sections of this specification.

a) 11 kV indoor switchgear
b) 11 kV incoming cable from power plant to township
c) 11 kV Ring main units
d) 11/0.433 kV Distribution transformers
e) 415 V Power control centers
f) 415 V Power factor improvement capacitor banks
g) 415 V Motor control centers
h) 415 V Main Distribution Boards / Floor Distribution Boards / Distribution Boards / Essential Distribution Boards / Sub-distribution boards
i) 415 V lighting panels & receptacle panels
j) 415 V bus trunking & overhead busbar system
k) 415 V Rising mains
l) 415 V Diesel generator sets
m) Motors (associated with bidder supplied equipments)
n) Local push button station for motors
o) 11 kV Power cables
p) 1100 V grade Power & Control cables
q) Cables for telephone, television and data communication
r) 110 V DC Battery with Charger & DCDB
s) 48 V DC Battery with Charger & DCDB
t) Digital EPABX sub system

u) 230 V Uninterrupted Power Supply system (UPS)
v) Cabling system complete with cable trays, supports, conduits, glands, lugs etc.
w) Cabling for telephone, television and data
x) Fire stop cable penetration system
y) Earthing system including buried earth mat and above ground earthing.
z) Lightning protection system
aa) Illumination system (internal and external) for the complete facilities inside and outside the township boundary listed in the specification including lighting panels, poles, Masts, lighting fixtures, aviation obstruction lights, wires, switch boxes, receptacles, conduits & accessories.
bb) Ceiling fans, wall mounted fans, exhaust fans, switches, fan regulators, socket outlets, call bell
cc) Circuit wiring & Point wiring
dd) Main distribution frame, junction box, Telephone cables including fiber optic cables etc. for telephone system.
ee) Telephones of Analog type, digital type, IP Phone, ISDN phone, PC with soft phone, and Video conference device,
ff) Master antenna television system along with cables & Accessories
gg) Supporting structures for all equipment with foundation bolts
hh) Safety items like Rubber mats, First aid box, Danger plate, shock treatment chart, Sand buckets etc.
ii) Construction power supply
jj) Erection hardware
kk) Complete detailed design of electrical system.
ll) All interfacing engineering with other packages such as pumps, ventilation, firefighting, piping etc.
mm) All required interfacing engineering with Civil works.
nn) Deriving 11kV power supply from main plant EPC contractor's construction power sub-station for township construction power supply
oo) System study

The following supplies and services are included

- Complete installation material, that is wiring, cabling and piping material, all needed fastenings, conduits, brackets and other supports
- All required junction boxes and cubicles
- All cubicles, junction boxes, marshalling racks, terminal boxes, etc.
- Complete labelling of electrical equipment (also inside of cabinets)
- Lightning protection
- Electrical earthing
- Cable and cable trays
- All necessary number plates for identifying the cables (numbering code to be determined)
- All necessary fixing materials
- All necessary fire protection materials for making good the cable openings through walls and ceilings.
- All necessary plastic protecting tubes for the cable runs
- All necessary materials for laying the cables in the ground
- All necessary cable connections including compression cable lugs, fixing and clamping materials, etc.
- All necessary cable sealing ends and cable connecting sleeves including fixing materials

- All necessary compression connectors.

2.5 Scope of Works - Packaging and transportation

- Suitable packaging and transportation of the entire scope of supplies,
- free construction site, on-site transportation and temporary storage including inspections and, if necessary, ensuring the prerequisites for transportation
- Disposal of packing and transportation material
- Customs clearance
- Crane or hoisting facilities at seaport and site
- Transportation to site
- Unloading at site.

2.6 Scope of Works - Erection, commissioning and testing

- Complete erection of the scope of supply up to operational readiness:

  This includes mobilization and provision of the required supervisory staff, skilled and unskilled personnel, as well as of installation scaffolding, cranes, hoists, equipment and materials, personnel accommodation, prescribed tests and inspections.
- Commissioning and optimization of all plant components as well as conducting all necessary measurements.
- Supervision of erection, commissioning and Reliability Test Run of complete supplied equipment.
- All testing as specified.

2.7 Scope of Works - Training

The Contractor shall provide comprehensive training for Employer's engineering, operating and maintenance staff (Employer's staff) covering all aspects of the Township equipment and systems and operation and maintenance.

The Contractor shall train, instruct and supervise the Employer's staff to an adequate standard of knowledge and capability for good trouble shooting, repair and of the Township equipment as well as to an adequate standard for safe and efficient commercial operation of the systems.

The training shall at least include:

- classroom and hands on training
- on the job training during erection, commissioning and reliability test run; and

The Contractor shall submit the training plan for the classroom, on the job including schedule, place, content of lectures etc. for the Employer's approval no less than two (2) months in advance to the handing over of the systems.

Post training assessment shall be carried out and documented In case the results of the training are below the expectations, which have been agreed upon by both Contractor and Employer before training, the respective training modules shall be repeated in an improved way and the related cost for the repeated training shall be borne by the Contractor. In case the results

are below expectations (to be agreed upon by both Contractor and Employer before training) the respective training modules shall be repeated in an improved way.

2.8 Data to be Furnished by the Bidder at the Time of Bid

Details (including experience in similar projects) of Architect and Design team to be engaged for this project, meeting qualification requirement criteria.

General arrangement / architectural drawings for all buildings and structures showing dimension, levels plans, sections, elevations, loadings, materials proposed, types of framings, wall / cladding, floors, roofs types of finishes, construction methodology, design criteria etc. All architectural drawings (to be submitted along with the bid) shall be prepared by bidder's architectural team or architectural sub-contractor (who will finally do the architectural detailed engineering, post award).

No deviations permitted in the bid document.

List of equipment to be deployed by the bidder and by other subcontractors to be associated with, is to be furnished.

List of software proposed to be used against various areas, for analysis, design, construction, drawing submission etc, their source and along with validation report for the software.

The list of documents indicated elsewhere of this section to be submitted by the Contractor to the Owner for his approval and manner in which the same needs to be submitted. No construction shall commence at site without obtaining approval from the Owner on these documents. Therefore it is necessary that bar charts for building / structure / area wise shall be submitted for design / drawing activity indicating.

- A level-1 part showing the start and completion date of all civil construction activities.
- A level-2 part showing the time required for preparation of design criteria, for approval of design criteria by Owner after checking and clearance given by the Owner, time required for detailed design and drawing preparation and time required for approval of design and drawing by Owner after checking and clearance given by the Owner. This part shall take into account the construction schedule (Level-1 part).

A detail note on quality plan both for design and construction activity proposed to be adopted for obtaining quality works.

List of all sub-contractors (may be multiple options) and brand names that the bidder proposes to employ, in case the contract is awarded to him, indicating their addresses with telephone number, experience on similar jobs, name, qualification and experience of persons who shall be involved in the job on behalf of the Contractor etc shall be submitted to Owner. Only the sub-contractors and brand names approved by Owner shall be engaged by the Contractor on the job.

Contractor's Manpower Deployment Schedule for the whole duration of the project.

2.9 Inspection of Site by the Bidder

The Bidder shall inspect the site, examine and obtain all information required and satisfy himself regarding matters and things such as access to site, communications, transport, right of way, the type and number of equipment and facilities required for the work, availability of local labour, materials and their rates, local working conditions, weather, subsoil conditions, natural drainage

etc, ignorance of the site conditions shall not be accepted by the Owner as basis for any claim for compensation or extension of time.

The submission of a bid by the Bidder will be construed as evidence that such an examination was made and any later claims / disputes in regards to rates quoted shall not be entertained or considered by the Owner.

2.10 Construction Tools and Materials Supplied by Contractor

The Contractor shall provide and maintain at the site necessary number and type of machinery and equipment including survey instruments in good working condition for proper setting out and timely completion of the various works covered under this specification. All arrangements for transporting the equipment to and from the site shall be done by the Contractor at his own expense. No claim shall be entertained for mobilizing additional equipment and / or personnel to complete the work within the stipulated time.

The Contractor shall provide all fuels and lubricants required for the operation and maintenance of construction machinery and equipment as well as his transport vehicles at his own cost.

The Contractor shall ensure that the work shall proceed uninterrupted even in the event of power failure. As such, adequate number of diesel operated equipment shall be provided by the Contractor at his own cost as an alternative arrangement, in case electrically operated equipment are proposed to be brought to site.

The Contractor shall ensure continuous supply of all construction materials conforming to the specification for the duration of the contract period and extended period if any. Adequate stocks are to be ensured before the on-set of monsoon.

Adequate stocks of material shall be ensured such that there are no interruptions of works due to shortage of material at any point of time during the contract period and extended periods, if any.

All materials supplied by the Contractor shall be original, new and of the best quality and shall conform to the given specifications. Approval in writing shall be obtained from the Owner before any alternative or equivalent material is used other than what is specifically mentioned in the drawings.

The Contractor shall furnish manufacturer’s test certificate for all the manufactured items supplied by him. Representative specimens of the material shall also be submitted to the Owner and shall be tested at a recognized testing laboratory at Contractor’s cost in case the Owner so desire.

The Owner reserves the right to test any construction material supplied by the Contractor in an established testing laboratory at Contractor’s cost.

The Owner reserves the right to instruct the Contractor to remove all materials which do not meet the specification requirements.

2.11 Work Execution and Supervision

The Contractor shall have at the site accredited and qualified engineers and foremen / supervisors with adequate number of years of experience in execution of similar works and also operators of machinery and equipment, for satisfactory progress and timely completion of the works.

Contractor's engineer-in-charge of the work at site shall be capable of interpreting the specification and drawings and make adequate site decisions as and when required. He shall also take instructions from the Owner and be responsible for carrying out the instructions.

The Contractor shall be fully responsible for the correctness and accuracy of the tests performed, results obtained / tabulated, interpretation of test results and recommendations made. The work shall be executed in a professional manner, with fully understanding of the importance of work for a project of this magnitude.

In the event of occurrence of any accidents at / near the site of the work or in connection with execution of the work, a report shall be made immediately to the Owner, giving full details of the accident. He shall also report such accidents to all the competent authorities wherever such reports are required by them as mandated by statutory laws.

All temporary electrical installation shall be supervised by a qualified electrical supervisor of the Contractor.

The Owner reserves the right to order in writing, from time to time, during the progress of the work, removal and re-execution of any work which in the opinion of the Owner, is not in accordance with the specification.

During inclement weather, rains etc., the Contractor shall suspend all works for such time as the Owner may direct and shall protect from damage all works already in progress or completed just then. All such temporary protective measures shall be at Contractor's cost and any damage to works shall be made good by the Contractor at his own expense.

Should the work be suspended by reasons of strikes / riot by Contractor's own employees or any other causes whatsoever save and except the force majeure condition, the Contractor shall take all precautions necessary for the protection of works and make good at his own expense any damage arising from any other than these causes. No compensation, whatsoever, will be given by the Owner.

During the course of Contractor's works, other works either by the Owner or by other Contractors or by the Owner or by other Contractors or by both simultaneously will be in progress within the project area. The Contractor shall make his best effort to work in harmony with others in the best overall interest of the project and towards its speedy completion.

A quality control laboratory shall be set up with all required testing equipments. The quality control laboratory shall be handed over to the Owner and laboratory shall be under the Owner control. However testing of all materials has to be carried out by the Contractor. The Contractor have to re-calibrate the testing equipments brought to site by competent authorities from time to time to maintain the accuracy.

The Contractor should furnish the list of equipments that will be provided in the laboratory.

The Contractor shall be responsible for maintaining cleanliness of the site. The site shall be free of unwanted rubbish or filth which is hazardous and detrimental to health and affect safety of the work place.

All material supplied shall conform to the specification. Entry of unwanted materials shall be prohibited.

Temporary drainage required during monsoon and other seasons to be done by contractor. Any other preparation for continuity of work during monsoon is responsibility of the contractor.

Discarded material shall not be disposed off inside the plot premises.

Quality lab in-charge / supervisor shall have adequate experience to carry out tests and shall be approved by owner.

Safety officer and safety team deployed by contractor shall have adequate experience and shall be approved by the owner.

2.12 Submission of Documents to the Owner after Award of Contract

The Contractor shall commence soil investigation only after obtaining and incorporating the comments given by the Owner on the project-specific specification for soil investigation submitted by Contractor.

After completion of soil investigation, the Contractor shall submit a detailed soil investigation report to the Owner, after vetting by reputed third party institutions, within two months from award of contract, giving all data from tests conducted, conclusions there from, safe allowable bearing pressures, level of ground water, presence of aggressive chemicals to concrete, ground improvement requirement, type of cement to be used, etc., The Contractor shall incorporate all changes suggested by the Owner at no extra cost to the Owner and with no extension of time.

The Contractor shall begin further works like preparation of design criteria only after obtaining approval of the soil investigation report.

Detailed design calculations and drawings shall be commenced by the Contractor only after approval is obtained from the Owner on the basic design criteria for building / structure / areas to be submitted by the Contractor. No later deviation from the approved design criteria shall be permitted unless specifically approved by the Owner in writing, prior to its adoption.

Design calculations and drawings and other documents shall be submitted sequentially after obtaining approval in a phased manner as per approved L2 schedule. The Contractor shall ensure that design calculations / drawings for several structures are not submitted at one time. For this purpose, design / drawing submission schedule furnished during bidding stage and agreed upon by the Owner shall be followed.

Geotechnical investigation report, Ground improvement methodology and Structural design of all buildings and structures shall be vetted by third party institution.

All documents and drawings shall be reviewed by Owner’s Consultant.

The Owner / Owner’s Engineer will review and furnish comments / approval, if any, to the designs and drawings. The Contractor shall resubmit the design documents and drawings within a maximum period of ten days from the date of receipt of comments by the Contractor. Timely submission of designs / drawings to the Owner for review / approval is the sole responsibility of the Contractor and postal or other delays as reasons for late / non-submission shall not be entertained by the Owner.

Should there be a requirement for preparation of separate drawings to show enlarged details to facilitate construction / erection, then such drawings shall also be prepared by the Contractor at no extra cost.

Preparation and review of structural steel fabrication drawings is entirely of the responsibility of the Contractor and will not be approved by the Owner. However, all fabrication drawings shall be submitted by the Contractor for the Owner’s reference and records prior to commencement of

fabrication.

Bar bending schedule for all concrete works shall be prepared by the Contractor and submitted to the Owner for his records.

All architectural features of buildings shall be detailed by the Contractor's qualified architect or architectural sub-contractor. Detailed drawings along with schedule of doors / windows etc floor / wall finishes including color scheme shall be submitted for obtaining approval from the Owner.

Structural design and drawings shall be taken up after in-principle approval of Architectural drawings / equipment layouts.

All construction drawings shall include total quantity of concrete (grade wise), reinforcement (diameter-wise) and structural steel (section wise).

The designs shall clearly spell out the erection scheme for various structures envisaged by the Contractor and resulting additional loadings, if any, shall be duly accounted for. Before taking up actual erection work, detailed erection scheme proposed to be followed by the Contractor shall be submitted for Owner's approval.

Approval / comments conveyed by the Owner neither relieves the Contractor of his contractual obligations and his total responsibility for correctness of dimensions, materials of construction loadings, quantities, design details assembly fits, performance particulars, safety and stability of the structures including foundation / appurtenances and conformity of supplies with the statutory laws as may be applicable, nor does it limit the Owner's right under this contract. No change in the approved designs / drawings shall be permitted without prior written approval of the Owner.

The Owner or his representative has every right to go to Contractor's design office to check the quality control being implemented at their design office to ensure that the documents being prepared are of approved quality. The Contractor shall provide all assistance required by the Owner for carrying out the audit.

Checking for any interference is the sole responsibility of the Contractor.

Specifications issued to sub-contractors must be submitted for approval.

All design calculations and drawings shall be in English and shall be in SI units.

Designs drawings and other documents submitted by the Contractor shall be thoroughly checked and approved by the authorized Contractor's engineers. Any unchecked / unsigned documents will not be reviewed by the Owner. Also design calculations not accompanied by supporting engineering drawings, incomplete or shabbily done design calculations, design calculations without adequate reference or backup data and documents where previous comments have not been incorporated will not be reviewed by the Owner. No claim from the Contractor for extension of time or extra cost on this account shall be entertained by the Owner under any circumstances.

No check will be specifically carried out by the Owner to verify arithmetical / numerical accuracy of the calculations, input data, compatibility of dimensions among various drawings or between drawings and design calculations. These shall remain entirely the Contractor's responsibility.

The Contractor shall submit copies of designs / drawings prepared by him in accordance with the distribution schedule.

All modification suggested by the Owner to meet specification requirements and sound engineering practice shall be incorporated by the Contractor at no extra cost to the Owner. In this respect, the decision of the Owner shall be binding on the Contractor. The Owner will accord his approval only after the Contractor has incorporated in the design and drawings all modifications required by the Owner.

Soft copies (editable working files) of all design calculation and drawings shall be submitted for records after approval of the Owner.

All designs may be done adopting approved software. The complete input (soft copy with editable format) and output data (soft copy) is to be submitted for the Owner's review and approval.

Access to one copy each of all the design software used by Contractor shall be provided for the use of the Owner during the duration of the contract.

Payment will not be made for defective works and other works completed without approved design and drawings.

Final completion report shall be furnished by the Contractor including narrative report with as built drawing in consultation with the Owner. 10 sets of hard copies and 3 sets of editable soft copies of the As-Built drawings shall be submitted.

Rendered 3D walk through model of the entire township shall be submitted during architectural design engineering.

Contractor shall provide methodology for drawing submission, approval and necessary software to be used for the process.

3. EXCLUSIONS AND LIMITS OF SUPPLY

3.1 Power Supply

2 numbers 11 kV Power supply will be made available at 11 kV Unit-1 Switchgear and 11 kV Unit-2 Switchgear at Main power house building for the Township. Supply and laying of 11 kV power & control cables from Main power house building to Town ship is in the Bidder's scope only.

Telephone cables from township shall be terminated at Telephone exchange being proposed at Main receiving substation.

3.2 Storm Water Drainage

Storm water will be sent to a water retention pond (fenced) located outside the township area before overflowing to the Moidhara river. Storm water retention pond is in the scope of the bidder.

3.3 Potable Water

Potable water from Power Plant will be supplied at the common boundary of Township and Power Plant.

3.4 Sewage Treatment

Sewage piping shall end at the common boundary of Township and Power Plant.

From there on, sewage network in Power Plant area and Common Sewage Treatment Plant (located in Power Plant) will be in the scope of Power Plant EPC.

3.5 Roads

All roads in the township boundary limits are in the scope of the bidder. All other roads, that are marked in the layout, outside township area, will be in the scope of the bidder.

Rest all other roads shall be in the scope of Owner.

3.6 Boundary Wall

Township Boundary wall (except the common boundary wall of Township and Power Plant, as shown in the layout) shall be done by Township EPC contractor

3.7 Fire Fighting System

Potable water from Power Plant will be supplied at the common boundary of Township and Power Plant.

Fire fighting system for entire township area will be under township scope of work.

3.8 HVAC System

Design engineering of HVAC works in all the buildings / area of township shall be in township vendor scope of work.

Supply, erection and commissioning excluded for air conditioning. Electrical connection points and fittings for air conditioning systems shall be in the scope of the contractor.

Supply, erection and commissioning of ventilation system included in the scope of the contractor.

3.9 Furnishing

Modular kitchen, cup boards and ward robes in rooms, kitchens, pantries, stores and other required places, shall be in the scope of the contractor. Moveable items like furniture are excluded

3.10 Hospital Equipments

Hospital equipments are excluded from bidder's scope

4. PROVISIONS BY THE OWNER AND CONTRACTOR

Following are the provisions / supplies by the Owner:

- Land within the property line limits as indicated in the plot plan.
- All utilities / services up to the limits of supply and conditions of supply as specified in above section.

Following are the provisions / supplies by the Contractor:

- The Contractor shall arrange construction water.

Construction Power

One no. 11 kV, 3 phase, 50 Hz, feeder will be made available at main plant EPC contractor's construction power sub-station for deriving township construction power supply. Supply and laying of 11 kV power & control cables from main plant EPC contractor's construction power sub-station to Town ship is in the Bidder’s scope only.

5. SITE CONDITIONS

5.1 Project Location

The site for the Maitree-STPP is geographically located between 22° 370'0'' N to 22°34'30''N and 89°32'0''E to 89°34'5''E, approximately 14 km northeast of the Mongla Port and 14 km northwest of the Sundarbans, is infringed by the Passur and Maidhara Rivers to the west and south east respectively.

An area of 50 Acres is allotted for Township from the power plant project area.

Administratively, the site is located in Rampal Upazila of the Bagherat District in the Rajnagar Union

The nearest inland port is Mongla at around 14km direct distance.

Nearest highway is approximately 7 km from site.

Nearest airport is at Jessore.

Nearest railway station is at Khulna.

5.2 Soil Conditions

First soil investigations of the Plant site and adjacent areas have been carried out.

The findings of these initial soil investigations are attached in Part D Annexure, for information only

In general the subsoil conditions can be described as follows:

- Top layer filled sand of approximately 5.5m (+/- 20 cm) height (with unknown silt content)
- Underlying layers of clay
- Underlying fine sand.

The Contractor may conduct soil improvement measures at site. Beside other aspects, consolidation of filling shall be incorporated in soil improvement concept.

5.3 Seismic data

The project area is tectonically inactive with no apparent and geologically significant major faults or folds.

Soil classification as per BNBC-2012

Soil classification	Reference
S2 (Deposits of liquefiable soils, of sensitive clays, or any other soil profile not included in types SA to SE or S1)	Table 2.5.1 Page 79 Chapter 2 - Loads on Buildings and Structures Part 6 - Structural Design

As per BNBC 2012, Clause 2.5.5.1 (Chapter 2 - Loads on Buildings and Structures, Part 6 - Structural Design), site specific seismic study is required to be conducted, because the sub-soil belongs to soil category S2.

Site specific study done for the power plant area is attached in Part D – Annexure. Bidder shall follow recommendations from this report for seismic design and need not carry separate seismic study.

Peak spectral acceleration shall be determined based on this site specific study, but shall be not less than 0.12g, as mentioned in BNBC 2012, Table 2.5.2.

5.4 Meteorological conditions

5.4.1 Temperature

The project site is located in the country's South Central Zone consisting of three dominant seasons:

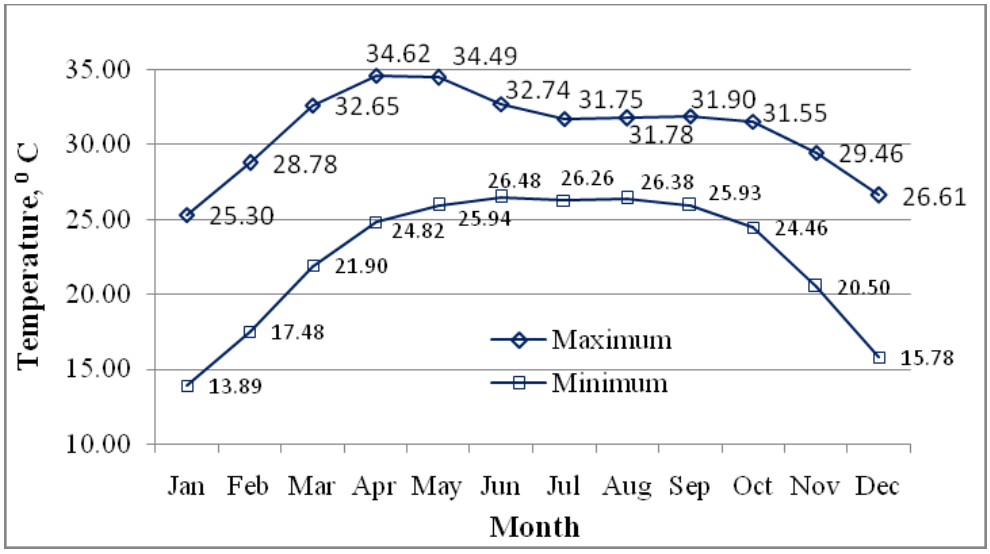
- Summer Season - March to May
- Monsoon Season - June to October
- Winter Season - November to February

During the Monsoon Season occasional cyclonic storms can occur.

The climatic conditions in the area are continuously monitored by the Bangladesh Meteorological Department (BMD) at the Mongla Meteorological Station.

The temperature varies only slightly throughout the year with the highest temperature of 36.9°C and the lowest temperature of 12.2°C recorded in the period from 1989 to 2008.

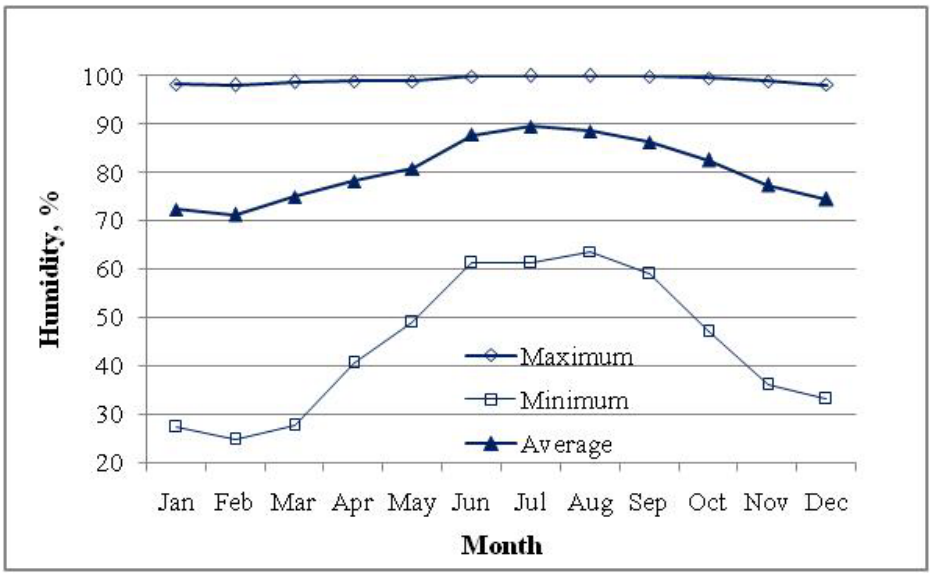
This distribution is depicted in Figure below.



Average monthly temperature between 1989-2008.

5.4.2 Relative Humidity

The relative humidity varies drastically during the Monsoon Season with 80% to 90% and the lowest levels of 20% to 30% during the Summer Season. The humidity profile recorded in the same period as the temperature is visualized in below figure.



Average relative humidity between 1989 -2008 (Source: EIA Report)

Below definitions are to be used as typical data for the different climatically seasons at the site.

Average Site Condition ASC

Ambient Temperature:	27.3 °C
Ambient Humidity	87 %
Ambient Pressure	1007.6 mbar
River Water Temperature:	29.8 °C

Summer Site Condition SSC

Ambient Temperature	36.9 °C
Ambient Humidity	60 %
Ambient Pressure	1007.9 mbar
River Water Temperature:	33 °C

Winter Site Conditions WSC

Ambient Temperature	12.2 °C
Ambient Humidity	100 %
Ambient Pressure	1017.2 mbar
River Water Temperature:	20°C

Reference Site Conditions RSC

Ambient Temperature	31 °C
Ambient Humidity	88 %
Ambient Pressure	1007 mbar
River Water Temperature:	32°C

Reference Site Condition shall apply for the Guarantee Values as well as for the Guarantee Tests/Performance Test. However, Plant must cope with the Site Conditions as specified.

Wet bulb temperature shall be calculated by Bidder/Contractor based on ambient temperature (dry bulb), ambient humidity and ambient pressure for the different cases.

Bidder/Contractor shall determine the wet bulb temperature for all site conditions and not only for reference site condition.

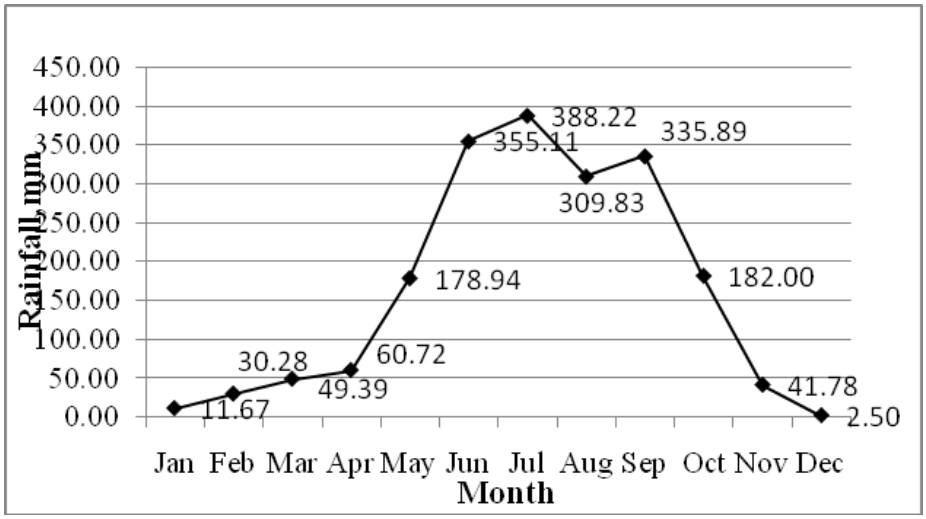
5.4.3 Design Rainfall Intensity

The maximum rainfall occurs during the Monsoon Season by varying between 300 mm and 350mm with almost no rainfall during the Winter Season.

The average evaporation in the project area varies between 3-5 mm/day with its peak of 16mm / day during July.

The average rainfall for the period between 1991 and 2008 is depicted in Figure below for information only.

The storm water drainage system shall be designed for rainfall intensity resulting from 95 mm per hour rainfall event.



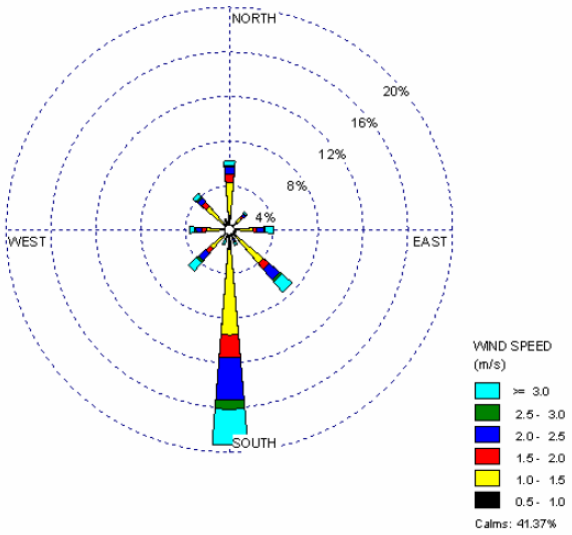
Average rainfall between 1991 - 2008 (Source: EIA Report)

5.4.4 Design Wind Data

The project region is characterized by southerly winds from the Bay of Bengal during the Monsoon Season and northwesterly winds from the Himalayas during the Winter Season. During the Summer Season, the wind blows from south-southwest to north -northeast.

Design Basic Wind speed shall be 73.3 m/s

(as per BNBC-2012, Part-6-Structural Design, Table 2.4.1: Basic Wind Speeds for Selected Locations in Bangladesh, Page 66).
The annual average wind speed amounts to 1.7 meter/second and the wind rose for the entire year is shown in Figure below for information only.



Annual Wind rose for the Khulna Region (Source: EIA Report)

6. SITE WORK REQUIREMENTS

6.1 Access to construction site

Bidder shall make access / construction road from power plant main gate to Township, routing it outside the power plant boundary wall.

Access to site for inspection by Owner and its engineers shall be made available by the Contractor at all times.

6.2 Safety, Health and Environment Program

The Owner requires its employees and Contractors to achieve high standards of Industrial Health and Safety. Safety must form an integral element of the line management control of the site works.

The Owner's safety requirements shall be observed by the Contractor at all times. Contractor shall be responsible for implementing and controlling safety procedures during all phases of the Work.

The Contractor shall be responsible for implementing and controlling safety procedures during all phases of the Work starting from the design phase.

The Contractor shall produce a copy of his Statement of Safety Policy for inspection by Engineer whenever required.

Compliance with the provisions of these Clauses shall not relieve the Contractor of any of his responsibilities under the Contract or of any obligation imposed upon him by Regulation, Order or by-law made by a competent authority having the force of law that shall be applicable to the Project.

The Contractor shall ensure that. prior to delivery to Site, all statutory tests and inspections shall have been carried out on equipment, tools and tackle required on the Site for the purpose of the Works and that any Improvement or Prohibition notices served thereon by the Chief Inspector of Factories shall have been discharged.

The Contractor's safety plan shall give details of the Statutory inspections to be carried out on such equipment, tools and tackle during the currency of the site works, in order to ensure safe operation and control.

Site voltages, maintenance and inspection of all fixed and portable electrical equipment to be used at site must be specified. Compliance with statutory electrical requirements must be executed at all times.

The Contractor's design shall provide lighting to access ways and the work area to enable the works to be carried out without risk to health and safety.

6.3 Cleaning on site

The Contractor has to do area cleaning on daily basis.

7. EQUIPMENT IDENTIFICATION, LABELING

7.1 Plant and Equipment Identification

The Contractor shall propose and apply a common identification system, for the whole township equipment, facilities and systems showing the name and number of each item and its respective drawing number etc. to fully identify the system.

The structure of the designations shall be developed in such a way that the symbols used can be handled by electronic data processing equipment. The identification system must be used by all subcontractors, vendors, etc., and shall be a proven system. Each item shall be separately designed with a reference number, which shall be used consistently on the drawings, in the documents and on the catalogues as well as on the equipment items themselves.

7.2 Labeling

Name plates which are to be firmly fixed on all the equipment, buildings and structures shall be provided. For equipment of small size, these are to be fixed on the piping or structure adjacent to the equipment. The contents of nameplate are to include the designation and principal parameters of the equipment.

The nameplate within the field shall be made of a high temperature - resistant metallic sheets, with designation permanently engraved on them. Indoor installed equipments (e.g., panels, cabinets, switchgear, etc.) shall also be labeled by appropriate name plate. The form, size, base colour and colour of contents of the name plates and prompting plates will be agreed between the Contractor and the Owner. It shall be possible for these to be readily seen by the operator. The designation of warning tags shall be different from that of other tags.

8. TIME SCHEDULE

Overall time schedule for construction broken down for the Township components and all construction works, stating dates for completion of any preparatory work from others which may be necessary, shall be prepared by the Contractor, in line with the time schedule provided elsewhere in the contract document.

The Contractor shall ensure that the final draft of all schedules, lists or data sheets / equipment are produced to a uniform format irrespective of whether the source of the above schedules, lists and data sheets is in the main Contractor or a Sub-contractor of the main Contractor. All documents shall carry a uniform numbering system.

9. PROGRESS REPORTS

During the various stages of the works in the pursuance of the Contract, the Contractor shall at his own cost submit periodic monthly progress reports as may be reasonably required by the Engineer with such materials as charts, networks, photographs, test certificates, etc.

Such progress reports shall be in the form and size as may be required by the Engineer and shall be submitted in at least five (5) copies.

The progress achieved on various fronts like engineering, manufacturing, procurement of sub-vendor items, supply etc, as compared to schedules shall be presented on the progress report.

The reasons for variance, actual progress & corrective measures wherever necessary shall be brought out.

Photographs shall be taken as & when indicated by the Engineer. Photographs shall be adequate in size and number and shall have proper orientation to reveal actual status of works.

10. QUALITY ASSURANCE

This section contains general requirements for inspection of material, parts, equipment and workmanship of the plant during manufacture, assembling to demonstrate compliance with specification, codes and standards to ensure overall reliability and performance.

The Owner and/or authorized Representatives shall, at any time, be allowed free and ready access to the Contractor's premises and those of his suppliers as well as to the site installation and the Contractor has to make the plant items available for the purpose of inspecting the specified equipment components and obtaining information as to the progress of the work. Failure on the part of the Owner, at this or any other time, to discover or reject materials or work which do not meet specified requirements shall not be deemed an acceptance thereof nor a waiver of defects therein.

The approval of the Owner shall not prejudice the right to reject equipment if it does not give complete satisfaction in service.

All materials, components and equipments covered under this specification shall be tested at all stages of procurement, manufacturing, erection, commissioning as per a comprehensive quality assurance programme. The requirements of minimum quality plans to be followed by the Contractor in respect of various equipment are specified in detailed technical specification. The Contractor shall draw his own quality plans in line with these requirements and his standard practices and implement such programme after approval by the Owner.

Manufacturing quality plan shall detail out, for all the components and equipments, various tests/inspection to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Contractor’s quality control organization, the relevant reference document and standards, acceptance norms and inspection documents raised etc. during all stages of material procurement, manufacture, assembly and final testing/performance testing.

The Contractor has primary responsibility for ensuring the quality of items of equipment supplied under the contract and remains accountable when manufacture or erection is subcontracted. It is therefore a requirement of the specification that work is only subcontracted to companies with effective quality control organizations and that the Contractor monitors the performance of these by the attendance at tests of experienced inspectors employed by the Contractor. The Contractor shall, at the appropriate time, prove that his material and / or equipment comply with all the requirements of this Section, such proof being the successful completion of tests and inspections. Routine test and type test certificates shall be submitted for each item of equipment, wherever applicable.

All materials, components and equipment supplied under the contract shall be subject to inspection by the Owner, his representative or his authorized Agency, should they so require during manufacture, erection and after completion. The inspection and tests shall include but shall not be limited to the requirements of this section of the specification. Further requirements to be applied are specified in the detailed specification.

The Contractor along with quality plan, shall also furnish copies of the reference documents/plant standards/acceptance norms/test and inspection procedure etc. referred by him in quality plans. These quality plans and reference documents/standards etc. will be subject to the Owner’s approval and will form apart of the contract. In these approved quality plans, the Owner shall identify customer hold points (CHP), indicating tests/checks which shall be carried out in presence of the Owner’s engineer or authorized representative and beyond which work will not proceed without consent of the Owner’s Engineer/authorized representative in writing.

No materials/equipment shall be dispatched from the manufacturer's works before the same is either accepted subsequent to pre-dispatch final inspection including verification of records of all previous tests/inspections by the Owner's Engineer /authorized representatives, or such pre-dispatch final inspection is waived by the Owner and dispatch is authorized after review of test reports.

The type and extent of inspection of items shall be in accordance with the relevant International standards approved by the Owner, supplemented or amended by the requirements of this section of the specification or as specified elsewhere in the Specification.

The minimum testing requirement for mechanical, electrical and C&I items to be conducted at manufacturer's works are specified under respective sections.

11. CONTRACT DRAWINGS, DOCUMENTS

11.1 Documentation by the Bidder along with the bid

Architectural, Civil and Structural Works

a) Master Drawing / document submission schedule
b) Design Basis Report.
c) Proposed layout for the Township
d) Architectural general arrangement drawings (plans, elevations and perspective views) of all buildings and structures.

Fire Fighting System

a) Technical write-up for fire fighting system.
b) Schedule for all type of fire protection, detection and alarm system for each type for various buildings, equipment and entire township area.
c) Flow diagram for fire water pumping system
d) Schematic diagram for fire detection and alarm system
e) Power consumption list and feeder list.
f) List of all tools, tackles and accessories required for maintenance.
g) List of all recommended spare parts for all equipment.
h) List of all mandatory spares for all the equipment as per technical specification/Codes.

Heating, Ventilation and Air-conditioning System

a) Technical write-up for HVAC system.
b) Sizing calculation for HVAC system.
c) Schedule for all type of HVAC system for each type for various buildings, equipment for entire township area.
d) Flow diagram for HVAC system
e) Schematic duct layout for HVAC system
f) Power consumption list and feeder list.
g) List of all tools, tackles and accessories required for maintenance.
h) List of all recommended spare parts for all equipment.
i) List of all mandatory spares for all the equipment as per technical specification/Codes.

Electrical

a) Technical offer
b) Technical schedules duly filled up and stamped and signed on all the sheets.
c) Single line diagram
d) Technical description & Design basis of Electrical system
e) Catalogues / drawings / leaflets

11.2 Documentation by Contractor after award of work.

Architectural, Civil and Structural Works

a) Final Master Drawing/document submission schedule
b) Topographic survey report
c) Soil Investigation Report

d) Test pile report.
e) Design Basis Report.
f) Layout for the Township – Plan and 3D views along with colour scheme.
g) Roads and drainage network.
h) Sewerage network
i) Architectural drawings (plans, sections, elevations, door, window and finishes schedule) and perspective views.
j) Structural design documents.
k) Foundation and Superstructure drawings for RCC works
l) General Arrangement drawings for Structural Steel works
m) Fabrication drawings for Structural Steel works
n) Bar Bending Schedules for RCC works.
o) Plumbing Drawings

Fire Fighting System

a) Final version of Master Drawing / document submission schedule
b) Technical write-up for fire fighting system.
c) Schedule for all type of fire protection, detection and alarm system for each type for various buildings, equipment and entire township area.
d) P&ID for fire water pumping system
e) Piping and equipment layout for fire water pump house.
f) Foundation drawings with dead load as well as operating load and other data as required.
g) GA drawings of the equipment, dimensional and sectional drawings of all equipment giving details of materials.
h) Piping layout and isometric drawings including pipe support drawings for sprinkler system.
i) Hydraulic calculations for Hydrant system and sprinkler system.
j) Composite layout for hydrant system
k) Schematic diagram for fire detection and alarm system
l) Fire detection and alarm system layout for each area
m) GA and wiring diagrams for PLC panel, MFAP, RAP, local control panels etc.
n) Portable fire extinguisher layout for the entire plant
o) QAP for all manufactured and sub contracted items.
p) Comprehensive quality assurance plan.
q) Instruction manuals for the operation, maintenance, repair, replacement and spare parts ordering.
r) Training manual
s) Test procedures and details of test to be conducted.
t) Type and Routine Test certificates, material test certificates for major components.
u) Technical data sheet, GA drawing for fire fighting equipments.
v) Power consumption list and feeder list.
w) As-built drawings for all equipment/system.
x) Drawings/data to be required / submitted to statutory authorities.
y) List of all tools, tackles and accessories required for maintenance.
z) List of all recommended spare parts for all equipment.

aa) List of all mandatory spares for all the equipment as per technical specification/Codes.

Heating, Ventilation and Air-conditioning System

a) Technical write-up for the HVAC system.
b) Sizing calculation for Air-conditioning system.
c) Sizing calculation for Ventilation system.
d) Schedule for all type of HVAC system for each type for various buildings, equipment for entire township area.
e) P&ID for HVAC system
f) Piping and equipment layout for AC Plant and AHU room.
g) Ducting layout for HVAC system.
h) Foundation drawings with dead load as well as operating load and other data as required.
i) GA drawings of the equipment, dimensional and sectional drawings of all equipment giving details of materials.
j) Cross sectional drawings indicating the assembly of all the major equipment.
k) GA and wiring diagrams for PLC panel and local control panels etc.
l) QAP for all manufactured and sub contracted items.
m) Comprehensive quality assurance plan.
n) Instruction manuals for the operation, maintenance, repair, replacement and spare parts
o) Training manual
p) Test procedures and details of test to be conducted.
q) Type and Routine Test certificates, material test certificates for major components.
r) Owner consumption list and feeder list.
s) As-built drawings for all equipment/system.
t) List of all tools, tackles and accessories required for maintenance.
u) List of all recommended spare parts for all equipment.
v) List of all mandatory spares for all the equipment as per technical specification/Codes.

Electrical

a) Technical data sheet, GTP
b) Design Memorandum
c) Key Single line diagram
d) Equipment Sizing Calculation
e) Sizing calculation for various systems such as earthing, lighting, lightning protection etc.
f) Sizing calculation for various equipment such as transformers, cables, switchboards, capacitors, DG set etc.
g) System study report
h) Relay setting calculation
i) Equipment Layout drawings
j) Illumination Layout drawings
k) Cable routing Layout drawings
l) Earthing Layout drawings
m) Lightning protection Layout drawings
n) Communication Layout drawings
o) Foundation and civil interface drawing
p) Single line drawing of various switchboards

q) General Arrangement drawing of various switchboards
r) Rating and diagram plate
s) Schematic wiring diagrams of various switchboards
t) P & I Diagram for DG Fuel system
u) Bill of materials
v) Interconnection Schedule
w) Quality Plan
x) Test certificates
y) Type test reports
z) Instruction and O&M manual
aa) Equipment Catalogue

12. MANDATORY SPARE PARTS

12.1 Mechanical

Minimum number of mandatory spares are given in this list, however bidder to provide as per codes/standards/local regulations.

FIRE FIGHTING SYSTEM

Bidder to quote for each fire water pumps - motor driven main fire pump / engine driven standby / jockey pump.

Impeller : 1 no. of each type and size

Pump bearings : 1 no. of each type and size

Pump shaft : 1 no. of each type and size

Bearing rings : 2 Set of each type and size

Shaft sleeves: 2 Set of each type and size

Bushings : 2 Set of each type and size

Bearing housing (if provided) : 2 Set of each type and size

Coupling and nuts (with bushes) : 2 Set of each type and size

Fuel injection nozzle : 2 Set of each type and size

Piston ring : 1 Complete set for each type and size

Fuel filters elements and seals : 2 Set of each type and size

Lubricating oil filter elements & seals : 2 Set

Engine joints, gaskets and hoses : 1 Sets

Inlet valve : 1no.

Fire hoses with couplings

Fire hoses with and connections : 4nos

Fire hose with end connection : 4 nos

Branch pipes with nozzles

Nozzles with branch pipes and quick coupling ends: 4 nos

Wet Alarm valve accessories

Clapper assembly complete (consisting of clapper, seat rubber, screws etc.) : 2 Sets.

Vales (Gate / Globe / Butterfly / NRV) accessories

Reduction gear operator (gate / globe / butterfly) : 4 nos. of each type & size

Flap / door with pin (NRV) : 4 nos of each type & size

Disc (butterfly / globe) : 5 nos. of each type & size

Seal rings (all types) : 5 nos of each type & size

Flap ring (NRV) : 4 nos of each type & size

Gaskets : 4 nos of each type & size

Bearing (butterfly valve) : 5 nos of each type & size

Complete valve assembly: 1 no. for each type & size

Y-type strainer

Strainer elements with o-rings and stiffeners : 5 nos of each type & size

Smoke / heat detectors : 10 nos of each type & size

Heat detectors : 5 nos of each type & size

Multi-sensor detectors : 10 nos of each type & size

Indicator assembly for smoke detectors provided in false roof : 20 nos of each type & size

Elevator of each capacity

The following list of spares shall be provided for each elevator.

S.No.	Item description	Unit	Quantity
1)	Car Shoe Liner	Set	4
2)	Counter Weight Shoe Liner	Set	4
3)	Car Shoe	Nos.	2
4)	Counter Weight Shoe	Nos.	1
5)	Lock Contact	Nos.	5
6)	Lock Shorting Base	Nos.	5
7)	Roller	Nos.	5
8)	Break Liner with Rivet	Nos.	1
9)	Control Transformer	Nos.	1

10)	Main Contactor	Nos.	2
11)	Thrust Bearing	Set	2
12)	Landing Gate Shoe Liners	Nos.	5
13)	Car Safety Switch	Nos.	1
14)	Control Relay	Nos.	2
15)	Hall push Button	Nos.	5
16)	Cabin push buttons	Nos.	5
17)	Floor Limit Sensor	Nos.	5

12.2 Electrical

Refer section B3 - Electrical

13. CODES AND STANDARDS

The work must be performed according to the most recent relevant codes, standards, accident prevention regulations and local rules and legal regulations.

All materials and equipment supplied and all work carried out as well as calculation sheets, drawings, quality and class of goods, methods of inspection, specific design features of equipment and parts and acceptances of partial plants shall comply in every respect with the applicable standards, codes and regulations to be chosen from the following:

1.	American Association of State Highway and transportation Officials	AASHTO
2.	American Concrete Institute	ACI
3.	American Institute of Steel Construction	AISC
4.	American Iron & Steel Institute	AISI
5.	American National Standards Institute	ANSI
6.	American Public Health Association	APHA
7.	American Society for Testing and Materials	ASTM
8.	American Society of Civil Engineers	ASCE
9.	American Society of Heating, Refrigeration & Air Conditioning Engineers	ASHRAE
10.	American Society of Mechanical Engineers	ASME
11.	American Water Works Association	AWWA
12.	American Welding Society	AWS
13.	Association Francaise de Normalisation	AFNOR
14.	British Standards Institute	BS
15.	Deutsches Institut für Normung	DIN
16.	European Norm	EN
17.	Fédération Européene de Manutention	FEM
18.	Hydraulic Institute	HI
19.	Illuminated Engineers Society	IES
20.	Institute of Electrical and Electronics Engineers	IEEE
21.	Instrument Society of America	ISA
22.	Insulated Power Cable Engineers Association	IPCEA
23.	International Electrotechnical Commission	IEC
24.	International Standards Organization	ISO
25.	Architectural Institute of Japan	AIJ
26.	Japanese Architectural Standard Specification	JASS
27.	Japanese Electrical Manufacturers Association	JEMA
28.	Japanese Electrotechnical Institute	JEC
29.	Japanese Industrial Standards	JIS
30.	Manufacturers Standardization Society	MSS
31.	National Association of Corrosion Engineers	NACE
32.	National Electrical Code (USA)	NEC
33.	National Electrical Manufacturer's Association (USA)	NEMA
34.	National Electrical Safety Code	NESC
35.	National Fire Protection Association	NFPA
36.	National Structural Code for Building	NSCB
37.	Occupation Safety and Health Administration	OSHA
38.	Portland Cement Association	PCA
39.	Standards of Japanese Electrotechnical Committee	JEC
40.	Steel Structures Painting Council	SSPC
41.	Technische Vereinigung der Grosskraftwerksbetreiber	VGB
42.	Underwriters Laboratory	UL
43.	Uniform Building Code Edition 1994	UBC
44.	Verband Deutscher Elektrotechniker	VDE
45.	Verein Deutscher Ingenieure	VDI
46.	Water Pollution Control Federation	WPCF

Generally, all internationally and nationally recognized standards as above will be applied, except if specific standards called for by:

1. Occupational Safety Board of Bangladesh
2. Department of Inspection for Factories and Establishments , Bangladesh
3. Department of Environment, Bangladesh
4. Bangladesh Power Development Board
5. Bangladesh Energy Regulatory Commission
6. Ministry of Power, Energy and Mineral Resources
7. Bangladesh Fire Service and Civil Defence Ministry
8. All relevant Bangladesh National Statutory Regulations
9. Bangladesh National Building Code
10. Bangladesh Standards
11. Local Authorities.

The Works shall also comply with all requirements of the relevant laws of Bangladesh, including, but not limited to:

1. Environmental Conservation Rules 1997
2. Bangladesh Energy Regulatory Commission Act (BERC), 2003
3. BERC Licensing Regulation 2006
4. BERC Technical Quality Standards
5. Bangladesh National Building Code (BNBC)
6. Bangladesh Khulna Region – Local Government Engineering Department (LGED-2017) Schedule of Rates.
7. Other applicable laws in Bangladesh.

It is the Contractor's responsibility to provide sufficient evidence that any national or other standard the Contractor proposes (other than those mentioned above) will ensure an equivalent or higher standard.

The application of Chinese Standards is allowed if the equivalency to international standards can be demonstrated and the English translation of the Chinese Standards can be furnished. The approval of the application of Chinese Standards by the Owner is required.

Immediately after effective date of the Contract the Contractor shall supply an indexed list of all standards, codes and associated standards referred to, to which the work is to be performed.

Copies of all applied standards (in English) shall be provided to the Owner. The Contractor shall supply preferably two (2) searchable soft copies, else two (2) hardcopies each.

14. STATUTORY REQUIREMENTS

All the applicable statutory rules shall be taken into consideration at the time of design and construction.

Provisions of safety, health and welfare shall be complied with design stage. These shall include provision of railings, fire escape, etc.

Adequate number of fire escapes shall be provided.

15. DEFECTS LIABILITY AND REPAIR

Contractor shall rectify all construction defects for a period of 2 (two) years.

Start date of liability for each building / facility shall be its date of handing over to Owner.

All utility systems (including Mechanical and Electrical) shall be maintained by the contractor (free of charge, including consumables and spares) for a period of two years (from the date of handing over of respective units / buildings / systems).

PART – B : FUNCTIONAL TECHNICAL SPECIFICATION

SECTION – B1

DETAILED TECHNICAL SPECIFICATION - CIVIL

SECTION B1 - DETAILED TECHNICAL SPECIFICATION - CIVIL

DETAILED TECHNICAL SPECIFICATION

SECTION – B1 - CIVIL

SUB SECTION – 1

GENERAL

TABLE OF CONTENTS

1 GENERAL

The Civil, Architectural and Structural Steel work to be performed under this contract consists of design, engineering and providing all labour, materials, consumables, equipment, temporary works, temporary storage sheds, temporary colony for labour and staff, temporary site offices, constructional plants, fuel supply, transportation and all incidental items not shown or specified but reasonably implied or necessary for the completion and proper functioning of the Township, all in strict accordance with the specifications including revisions and amendments thereto as may be required during the execution of work.

This shall include site planning, preparation of master plan, architectural detailing, execution of civil works, erection and commissioning of buildings including plumbing, fitting and fixtures, electrification, interiors, landscaping, water supply, sewage network upto the common boundary wall between Township and Power Plant (sewage treatment will be done in the common STP inside the power plant), necessary assistance for obtaining approval from all appropriate authorities for all works and systems involved.

The scope shall also include setting up by the Contractor a complete testing laboratory in the field to carry out all relevant tests required for the Civil Works.

The work shall be carried out according to the design / drawings (Architectural, Civil and Structural) to be developed by the Contractor and approved by the Owner / Owner's Engineer. For all buildings, facilities, systems, structures, etc., necessary layout and details are to be developed by the Contractor keeping in view the statutory and functional requirements and providing enough space and access for operation, use and maintenance.

Certain minimum requirements are indicated in this specification for guidance purpose only. However, the Contractor's offer shall cover the complete requirements of the Township and facilities and providing enough space and access for operation and maintenance as per the best prevailing practices and to the complete satisfaction of the Owner.

All equipments and materials including cement, reinforcement steel, structural steel etc. shall be arranged / procured by the Contractor.

The Contractor shall make the layout and levels of all structures from the general grid of the plot and the nearest benchmark or other acceptable benchmark of Government department as per the directions of the Owner / Owner's Engineer. The Contractor shall be solely responsible for the correctness of the layout and levels and shall also provide necessary instruments, materials, access to works, etc., to the Owner / Owner's Engineer for general checking of the correctness of the civil works.

Contractor shall obtain approval of Civil / Architectural drawings from concerned authorities before taking up the construction work.

2 TOWNSHIP LAYOUT

The township shall be designed and developed on a land of about 50 acres to accommodate residential units and non-residential facilities. In addition to this area, few facilities will be located outside the Township boundary as described elsewhere in Scope of work.

Multi-storied construction is proposed for most of the buildings due to the following points

- Limited land availability
- Provision of maximum open spaces

- Accommodating all the residential and non-residential buildings requirements.
- Soil conditions (requiring deep higher diameter Pile foundations)
- Arrangement of residential blocks away from the power plant boundary to have less noise.

Detailed site analysis and site assessments to be made prior to zoning and conceptualization of the design.

Zoning of site to consider the following aspects.

- Accessibility and circulation
- Security
- Site geometry
- Topography
- Noise
- Visual connectivity
- Purpose
- External environment.

Township layout drawing provided in this tender is indicative only. Contractor shall improvise this layout during detailed engineering in consultation with Owner.

Internal Access

Vehicular access shall be provided around the Township with a network of roads.

Separate paved pedestrian access around the Township connecting the residential and public areas not conflicting with vehicular movement around the area.

Design should encourage pedestrian access over vehicular access around the area.

Vehicular access to be provided to each dwelling unit.

Spatial organization of built-up units

Grouping of public buildings of similar character is to be considered to emulate modern urban clusters.

Orientation and Alignment of Building Units

Geometric alignment is to be adopted in positioning of building units with reference to each other and of roads.

3 ARCHITECTURAL CONCEPTS

Architectural Design and detailing Aspects of all buildings shall be rendered through professional services of an Architect of reputation having experience in similar kind of works and familiar with vernacular architecture of Bangladesh.

Buildings shall be suitable for installation of Solar Photovoltaic Panels on roof tops for Renewable Energy Purpose.

General Layout shall be designed considering the following points.

a) Layout of the township area shall have definite hierarchy of road network depending upon its usage, aesthetic, visual sensibilities for creating road vistas, focal points, building back drops, building frames.

b) General layout shall be evolved taking over all basis of landform and local climate and due consideration shall be given to adjacent structures, building orientation and wind direction. The resulting built mass shall present a definite image with in distinct vocabulary in the form of landmarks, nodes and skyline.

c) The overall impact of the buildings and facilities shall be one of aesthetically unified architectural composition having a comprehendible scale, blending tonal values with the surroundings and taking full consideration of the climatic conditions and the building.

d) All buildings and structures shall be architecturally treated in such a way so as to be in complete harmony with the surrounding structures and environment. Local architectural characters and materials may be judiciously imbibed.

e) The buildings shall be designed initiating an architectural control, common to all buildings.

f) Overall colour scheme of the buildings shall be designed judiciously and in a comprehensive manner taking into a account the mass and void of buildings, its facade and exposed structural elements.

g) Overall emphasis shall be on developing an eco-friendly architecture, merging with the nature.

4 ARCHITECTURAL DESIGN

a) Natural light shall be used to the maximum extent. For adequate light and ventilation, Bangladesh National Building code recommendations shall be followed.

b) Entrance canopies chajjas (projections, recesses) over openable windows and door openings on exterior facades shall be provided.

c) All the buildings shall be architecturally designed to meet the Bangladesh National Building Code norms and local building bye laws, wherever applicable.

d) Architectural design and detailing aspects of all the buildings shall be rendered through professional services of an Architect. Statutory requirements may be required to be met with, wherever essential. The Architect shall be of International repute having experience in similar kind of works. The Architect shall evolve the design philosophy based on Owner / Engineer guidelines and shall present it in the form of presentation drawings, perspective views, 3-D Models and detail drawings.

e) Architectural components shall be designed for the conditions at the site for a minimum design life of 50 years.

DETAILED TECHNICAL SPECIFICATION

SECTION – B1 - CIVIL

SUB SECTION – 2

DETAILED SCOPE OF WORK

TABLE OF CONTENTS

1 GENERAL

The structures / buildings / areas / facilities described under this section shall be included in the township. The description against each building / system is indicative only and not exhaustive. Although almost all the systems are covered here but any other system (Civil, Structural and Architectural) required for successful completion of the Township shall provided.

The architectural scheme for major residential and non-residential buildings are indicated (with minimum requirements) in tender drawings. Bidders may take these drawings as guidelines to develop their architectural drawings and further detailing.

2 SITE RELATED INVESTIGATIONS

2.1 Topographical / Contour Survey

The Owner has carried out a preliminary survey of the area and drawings indicating the survey detail are enclosed. This should be treated as for reference only. It is the responsibility of the Bidder to verify the various features on his own before submission of bid. The Owner does not take any responsibility for correctness of various features / contour shown on the drawing.

It is the responsibility of the successful Bidder to carryout detail topographical survey of the proposed Township area. The Contractor is not eligible for any extra cost or any extension of time if the results from their detailed survey and actual conditions at site are at variance to any extent.

Site survey shall be carried out to establish the ground levels and to determine any existing structures, roads, etc. The site survey shall be carried out before the commencement of the work and if required during the progress of the work. The site survey shall be carried out at a grid spacing of 10 meters and at every change of level of the existing ground to produce contour drawings of 0.25 meter intervals.

A specialized firm approved by the Owner shall carry out the site survey.

Survey Points (Reference Points and Bench Marks)

The contractor shall construct adequate number of reference points and bench marks for marking the setting out lines and levels.

The reference points shall consist of suitable metal plates set in 400 mm x 400mm x 500 mm precast concrete plinth (grid pillars) and inscribed with the exact level.

All levels of the benchmarks shall be related to the agreed datum.

The proposed numbers, locations, co-ordinates, and levels of the reference points and bench marks shall be plotted on drawings and approved by the Owner prior to the commencement of the work.

Survey points in solid walls shall be stainless steel plates or cast iron, fixed firmly and sufficiently deep in the walls.

Safeguard of Survey Points

The survey points shall not be removed from their position without the permission of the Owner. If any of the survey points are damaged or lost due to any work carried out near their location the Contractor shall be responsible for replacing such survey points.

Surveying During The Progress of Work

The Contractor shall assist the Owner's Consultant at any time when checking survey points, setting out, checking construction items and erection parts. The Contractor shall provide and arrange the following:

- Provision and maintenance of survey instruments and accessories
- Provision of skilled personnel
- Supply of all material required for the survey
- Exposing covered survey points
- Shifting of any machinery used for construction out of the sight lines
- Stopping all drilling, blasting, driving, and any other works causing soil vibrations and stopping during instrument observations
- Removing all obstructive accumulation of water
- Taking all necessary safety precautions
- Furnishing any marking material requested by the Owner in connection with control surveys
- Providing additional survey points.

2.2 Geotechnical Investigation

Preliminary Geotechnical Investigation (2011)

The Geotechnical Investigation, performed by Rana Soil Engineering before filling up of the site, indicates, more or less regular soil formation of grey silt with clay for the upper layer and stiff silt, some clay and fine sand in the lower layer down to approximately 11 meters. This report suggests the application of RCC piles for foundations.

Soil Profile as per Preliminary Geotechnical Investigation

Over all soil profile of the site found to be uniform throughout the area of the plot.

Top soil is found to be of very soft silt with clay for a depth of 14m to 16m. This layer is found to be medium sensitive clay to sensitive clay.

Most of the boreholes record 2.5m to 10.0m thick very loose silty very fine sand between the clay layer and relatively dense fine sand layer. These very fine sand layers have N values less than 5 and in spite of 25% fines,

Underlying soil is of silty sand extending upto the final depth of bore holes (60m).

Post filling Soil Investigation (2014)

A post filling Soil Investigation Survey was also carried out and the report is also annexed with this tender specification.

Information from the soil investigation performed in the year 2014 at this site is provided to the Bidders for information. Bidder may note the presence of thick deposit of soft clay as revealed through borelogs attached. The onus of correct assessment / interpretation and understanding of the existing subsoil condition/data is on the Bidder. The Bidder should note that nothing extra whatsoever on account of variation between soil data collected by Employer and that found by the Bidder during additional soil investigation or during execution of works, shall be payable.

Final Geotechnical Investigation by the Contractor

Once the final layout has been established by the Contractor, he shall carry out a more detailed geotechnical investigation. The scheme of geotechnical investigation shall be prepared by the Contractor and will be subject to the Employer's review and approval

The Contractor has to carryout detailed geo technical investigation at no extra cost to the Owner after the award of contract, through some approved/reputed agency and submit geotechnical investigation report with recommendations for the Owner’s review and approval. The recommendation given in approved final report becomes binding on the Contractor.

The Contractor is not eligible to increase his cost or demand any extension of time if the final report is in variance from preliminary report furnished by the Owner. The Owner is not responsible for any variation of result between preliminary soil investigation report furnished to bidders and final soil investigation to be carried out by the bidder.

Based on the plot plan developed, the Contractor shall identify proposed borehole locations and obtain the approval of the Owner prior to commencing the investigation. The Contractor shall obtain approval for the field and laboratory testing scheme proposed by him from the Owner before commencement of geotechnical investigation works. Bore holes shall be provided and spread judiciously to cover all major buildings. The investigation shall cover sufficient numbers of bore holes in each area to get the longitudinal of the soil profile as required. If required, additional investigations shall be carried out during work progress at the Contractor’s expense in order to obtain additional information.

In-situ Testing

Bore holes shall be located to cover the entire area. All bore holes shall be sunk up to a depth of 40.0 m (maximum) or ‘N ‘ value greater than 100 is obtained for 4 consecutive intervals.

During boring, the level at which ground water is struck shall be carefully noted. Ground water samples shall be collected for chemical analysis. Boring shall be carried out without the use of water or drilling mud up to the depth of ground water table.

In rock strata, core recovery and Rock Quality Designation (RQD) shall be noted carefully for each run, immediately after cores are taken out of barrel.

The diameter of boreholes shall be minimum 150mm in soil and 76 mm in rock.

Borings in Soil

Drilling and sampling shall be performed in accordance with relevant Standards. Disturbed samples shall be taken in all materials at 1.5 meter intervals and at changes of strata and shall be contained in airtight containers. Undisturbed samples shall be taken in cohesive

material or weak cemented granular material where possible at 1.5 meter intervals and at changes of strata. Samples shall be sealed so that no changes in water content or soil structure occur. Cores of cemented material shall be packed in core boxes immediately on removal from the core barrel.

Rock Drilling

During boring operation, once the rock strata is encountered, drilling operation shall be resorted to for determining depth and nature of rock strata.

Rotary core drilling technique with continuous core recovery using double tube core barrel with diamond bit attachment should be adopted for drilling through rock. The casing and core barrel to be used shall be of designation BX or NX.

During the drilling operation for each borehole the Contractor shall record the rate of sinking of drill rods, ground water table elevations if any, nature, type and sequence of rock drilled. The recovered rock cores shall be properly indexed & stored. From the recovered cores, the Contractor shall determine nature of fractures and degree of weathering of the rock for each borehole. The Contractor shall also note and record any appreciable loss of drilling fluid throughout the entire drilling operations for each borehole. The Contractor shall also determine the percentage recovery ratio and rock quality designation from the recovered cores for each stage of core advance and for all the boreholes.

The drilling operation shall be terminated either 3 metres in hard rock or 95% of core recovery whichever is later.

Field tests

Field tests but not limited to the following shall be conducted as per relevant standards:

- Bore holes and standard penetration tests
- Static plate load tests
- Cyclic plate load test
- Cross hole shear velocity test
- Field permeability tests
- Field density tests
- Field Vane shear tests
- Static cone and dynamic cone penetration tests
- Earth Resistivity Tests
- CBR tests
- Seismic refraction tests

Standard Penetration Test (S.P.T.)

The standard penetration test shall be performed in all boreholes at 1.5 meter intervals and at change of soil strata. The blow count shall be recorded. If the blow count exceeds 75 or if the penetration is less than 25mm per 50 blows, the test shall be stopped. Even in highly weathered / disintegrated rock, where core recovery is poor, SPT shall be conducted. The first SPT in any borehole shall be conducted at 1m depth.

Laboratory tests

The laboratory tests shall be conducted on soil, rock & water samples collected during field

investigations in sufficient numbers as approved by the Owner, but shall not be limited to the following. The laboratory tests shall be carried as per relevant standards.

Laboratory tests shall be carried out on disturbed and undisturbed soil samples for

- Grain Size Analysis
- Hydrometer Analysis
- Atterberg Limits (Liquid limit, plastic limit, plasticity index, shrinkage limit, shrinkage ratio).
- Triaxial Shear Tests (UU, CU and CD)
- Natural Moisture Content
- Specific Gravity, Bulk and Dry Unit Weight, Water Content, Soil classification, relative density.
- Consolidation Tests
- Unconfined Compression Test
- Free Swell Index
- Swell Pressure Test
- Chemical Analysis test on soil and water samples to determine the carbonates, Sulphates, chlorides, nitrates, pH, organic matter and any other chemicals harmful to concrete and reinforcement/ steel.
- Modified proctor density
- Relative density
- CBR Test
- Permeability test

Laboratory tests on rock samples shall be carried out for

- Hardness
- Specific Gravity
- Unit Weight
- Uni-axial Compressive Strength (in-situ & saturated)
- Water absorption test.

On completion of all field and laboratory work, the Contractor shall submit a Geotechnical investigation report for the Owner / Owner's Engineer approval. The Geotechnical investigation report shall contain geological information of the region, procedure adopted for investigation, field and laboratory observations / data / records, analysis of results and recommendations on type of foundation for different type of structures envisaged for all areas of work. Recommendations on treatment for soil, foundation, based on subsoil characteristics, soft soils, aggressive chemicals, expansive soils, etc.

Generally, the geotechnical investigation report shall include, but not be limited to, the following:

a) Plot plan showing the locations and reduced levels of all field tests.
b) Geological information of the area.
c) A true cross section of all individual boreholes and trial pits with reduced levels and coordinates, showing the classification and thickness of individual stratum, position of ground water table, results of various in-situ tests conducted and samples collected at different depths and the rock stratum, wherever met with.
d) A set of longitudinal and transverse soil/ rock profiles connecting various boreholes.
e) Detailed bore log Plots of Standard Penetration Tests with depths, ground water level, classification, SPT blow count.
f) Results of all laboratory tests summarised for each Borehole along with a consolidated

table giving the layer wise soil and rock properties. All the relevant charts, tables, graphs, figures, supporting calculations, conditions and photographs of representative rock cores and trial pits shall be furnished.

g) All field test results.
h) All laboratory test results.
i) Earth resistivity of subsoil based on electrical resistance tests including electrode spacing Vs cumulative resistivity curve.
j) Suitability of the sub soil for construction of roads / embankments and their stable slopes for embankment and shallow and deep excavations, values of earth pressures coefficient for active / passive / at rest conditions and modulus of elasticity as a function of depth for the design of underground structures.
k) Suitability of locally available soils at site for filling and back filling purposes.
l) If expansive soil is met with, any special treatment, viz. Soil replacement / lime treatment, etc., required including specifications for materials to be used, construction method, equipments to be deployed, etc. shall be furnished.
m) Protective measures based on chemical nature of soil and ground water with due regard to potential deleterious effects on concrete, steel and other building materials, etc. Remedial measures for sulphate attack, chloride attack and acidity shall be dealt in detail. Susceptibility of soil to termite action and remedial measures for the same.
n) Identification of any other potential geotechnical problems & their remedial measures.
o) Description of measures required for erosion control.
p) Identification of corrective measures required for the improvement of sub-surface conditions such as removal of poor sub soil / material, in-situ densification. If ground improvement is recommended then its detailed specifications, specification for materials to be used, construction method, equipments to be deployed etc. shall be furnished.
q) Recommendations on type of foundations to be adopted for various structures, duly considering the sub soil characteristics, water table, total / differential settlement permissible for structures, minimum depth and width of foundation. Recommended dynamic properties of soil, modulus of subgrade reaction.
r) Allowable safe bearing capacities and settlement values in different strata for shallow foundations indicating relevant design criteria adopted, method of analysis adopted etc.
s) If Pile Foundations are necessary, type of piles recommended with reasons for the same, length, diameter, allowable capacity (lateral, pullout and vertical) of individual and groups of piles, negative skin friction if any and magnitude of estimated negative skin friction, structural design etc.
t) Type of cement to be used for concrete substructures and in stone / brick masonry foundations with reference to the chemical nature of subsoil and ground water.
u) Recommended soil properties such as density, specific gravity, cohesion, angle of internal friction etc. for design.

Geotechnical investigation work shall be got executed by the Contractor through reputed agency after approval of by the Owner / Owner's Engineer:

The detailed Geotechnical Investigation report, Foundation system, founding level to be adopted including the allowable bearing capacities, measures to be adopted as mentioned in the specification shall be submitted to the Owner / Owner's Engineer for approval.

3 SITE DEVELOPMENT WORK

3.1 Site Clearance

The plant and building areas in the site shall be cleared of all trees, shrubs or other

vegetation, rubbish, slush etc and other objectionable matters. If any roots or stumps of trees are met during excavation, they shall also be removed. Where earth fill is intended, the area shall be stripped of all loose / soft patches or top soil containing objectionable matter before filling commences. Any structure or services existing at the site shall be removed / rerouted with the permission of the Owner.

Existing wells, pits, marshy areas etc shall be filled up with earth of approved quality.

The Contractor shall be deemed to have visited and carefully examined the site and surroundings and to have satisfied himself about the nature of the existing structures, underground services, general site conditions, the site for disposal of surplus materials, debris etc and all other items affecting the work. Claims due to ignorance of site conditions shall not be considered after submission of Bid.

3.2 Site Grading

The entire Township area had been filled with dredged material. Due to the consolidation of the underlying soil, the present level of ground may be as shown in topographic survey drawings. The post filling contour survey carried out by the Owner is attached along with this tender specification for Bidder's reference.

The required grade level of the Township area shall be graded by the Contractor considering the contours, cutting and filling.

The material used for general site filling shall be well graded soil, non-expansive with 8 to 15% fines to provide impervious and binding material. These fines are recommended to be in a limited range of plasticity such that the Plasticity Index varies from 4 to 9 and the liquid limit less than 35. The soil shall be compacted atleast to 95% modified proctor density.

In case earth has to be borrowed from outside the plant boundary, the same shall be arranged by the Contractor for the requirement specified above. It is the Contractor's responsibility to identify borrow area and getting statutory clearances involved. Earth from Swamps, marshy as well as logs, expansive type of clays, peats, organic material, material susceptible for combustion, material which shall react with other material already used in work shall not be used as borrow material.

A minimum side slope of 1 vertical : 2 horizontal shall be maintained at all slopes. Slopes shall be provided with proper protection to prevent erosion.

3.3 Boundary Wall

Boundary wall of 3.0 m height above FGL shall be constructed all along the entire Township Boundary wall (except the common boundary wall between Township and Power Plant)

Over the 3.0 m high boundary wall, 0.6m diameter barbed wire concertina shall be provided.

Pile foundation shall be provided for boundary wall. The plinth & superstructure shall be with RCC frame with infill of brick / hollow block masonry.

4 CONSTRUCTION ENABLING WORKS

The Contractor shall provide for at his cost the following buildings and facilities for proper execution and quality control of the job, while meeting the provision stipulated by Factory

Rules regarding staff welfare facilities. All these building shall have brick cladding, Steel sheet roofing over steel roof truss with cement concrete flooring and false ceiling in A/C areas.

All these shall be demolished and the area cleaned before handing over of the Township to the Owner by the Contractor.

4.1 Site office for the Contractor's Use

Basic facilities like toilet for gents and ladies, potable water tanks, soak pit and septic tank for sewage disposal shall also be provided.

An A/C Conference room to accommodate about 50 people shall also be provided in contractor's site office complex.

Covered parking area for parking 10 cars shall also be provided.

4.2 Site Stores Complex

A covered store shall be constructed with brick cladding and colour coated roofing to store at least one month requirement of cement. Cement in bags shall be stored on a raised floor well away from outer walls and insulated from the floor to avoid moisture. Not more than 15 bags shall be stacked in any tier. Each consignment of cement shall be stored separately and consumed in its order of receipt.

Covered storage area may also be provided to store other construction material which shall be affected on exposure to wind, sun and rain.

Reinforcement shall be stacked on top of timber sleepers to avoid contact with ground / water.

Storage yard of suitable area (paved and unpaved) shall be provided with in the site stores complex for storage of other material.

Proper fencing and security arrangement shall be provided for the stores complex.

4.3 Temporary Workshop and Garage

The Contractor shall provide for a temporary workshop and garage to attend to routine maintenance and repair of the construction equipments as well as his fleet of vehicles used for construction activities.

4.4 Structural Fabrication Yard

Depending on the extent of structural fabrication envisaged at site, the Contractor shall establish a full fledged structural fabrication yard with adequate handling facility during and after the fabrication.

4.5 Quality Control Laboratory

A fully equipped quality control laboratory shall be established at site with qualified personnel to conduct acceptance test on all construction material, weldments, concrete cubes etc. This laboratory shall be housed in a covered building with air conditioning as required by the

testing facility.

All testing equipment shall be periodically calibrated to the satisfaction of the Owner. All testing shall be carried out in presence of the Owner.

Testing laboratory shall be equipped with the following minimum apparatus, materials and competent, trained staff required for carrying out field tests.

1. Slump cone apparatus to measure slump.
2. Concrete testing machine with adequate number of moulds to measure compressive strength of concrete.
3. Vicat apparatus to find initial and final setting time of concrete.
4. Sieves with vibrating machine to determine fineness modulus of coarse and fine aggregate.
5. Abrasion & impact testing Equipment for testing coarse aggregate and apparatus to determine Flakiness Index of aggregates.
6. Complete apparatus for the test of air content of concrete by pressure method.
7. Density bottle to determine sand bulkage
8. Hydro meter for testing pH value of water .
9. Thermometer for checking temperature
10. Apparatus for measuring proctor density, water content of compacted soil, determining CBR values.
11. All apparatus for determining dry density and water content of compacted soil determining CBR values.

Any other equipment felt appropriate by the Owner for measurement of plant thickness testing of structural members, welding etc. The moulds for cubes shall be checked frequently.

4.6 Construction Staff Welfare Facilities

The Contractor shall provide adequate facility for his staff inside the township boundary such as Toilets for both gents and ladies, Canteens, drinking water facility, rest places, crèches etc.

Adequate number of mobile toilets shall be provided at various work sites inside the plant boundary.

Necessary approach roads to the construction facility complex and internal roads within the complex as well as proper drainage of the area shall be the Contractor's responsibility.

The Contractor shall also provide for proper disposal of sewage and other wastewater.

The Contractor shall identify sufficient area outside the Township boundary to locate his staff and labour colony. Construction and maintenance of the staff and labour colony to satisfy all statutory requirement is the sole responsibility of the Contractor.

4.7 Fuel Storage Area for the Contractor's Use

The Contractor shall obtain necessary permission from competent authorities and establish and operate a fuel outlet with proper storage, dispensing and adequate fire fighting facility.

5 OUTDOOR CIVIL WORKS

5.1 Fencing, Compound Walls and Gates

Fencing

Fencing along with gates (main gates and wicket gates as applicable) and guard house of suitable size shall be provided around the following areas.

- Gas Cylinder Godown
- Water Tank and Pump House Area
- Electrical Substations
- Storm Water Retention Pond
- Wherever fencing is necessary due to security / safety / statutory requirements.

Compound Wall

1.8 m high compound walls along with gates (main gates and wicket gates as applicable) and guard house of suitable size shall be provided around the following areas.

- Hospital
- Nursery and High School Complex
- Head of Plant Bungalow
- Guest House
- Mosque
- Temple
- Swimming Pool
- Security Force and Army Barracks
- Police Station
- Transport Center.

5.2 Roads

In addition to roads inside the Township boundary, approach road from power plant entrance to Township also to be provided.

All roads inside the township boundary shall be concrete roads.

All roads outside the township boundary shall be bitumen roads.

Single lane roads shall have carriageway of 3.75 m with shoulders of 1.50 m at each side all along (Total width 6.75 m).

Double lane 7.5 m shall have carriageway of with shoulders of 2.25 m at each side all along (Total width 12 m).

Shoulders shall be constructed of interlocking paver blocks.

Access roads to building / facilities from main roads shall generally be single lane roads.

5.3 Storm Water Drainage System

Run off coefficients for paved areas and unpaved areas for design of storm water drainage

system shall be 0.9 and 0.6 respectively.

5.4 Paving

Adequate space around all buildings and facilities shall be paved for pedestrian use.

5.5 Horticulture and Landscaping

The Contractor shall hire professionally qualified landscaping agencies to develop the landscaping and horticulture in the Township area. Special attention shall be given to development in front of Guest House, Head of Plant Bungalow, Hospital, Parks, Executive Club etc.

The scope includes the digging of pits, supply of good earth, installation of watering system, manure, pesticides, plants, tree, shrubs, climbers, pots & plantation of trees, plants, shrubs, climbers in pits, pot with manure mix good earth.

Landscaping shall be carried out after all the underground utilities and drainage systems are in place. The entire work of Landscaping shall be carried out in a manner to have a beautiful appearance after completion of the work. Before the micro grading is started the contractor shall prepare a plan for Landscaping and get it approved by the Owner. The Landscaping plan should be prepared by the Contractor with the help of an expert horticulturist with due considerations for Fauna & Flora grown in the adjacent area and which can sustain in the saline climate.

The area to be landscaped shall be clearly demarcated at site and got approved by the Engineer. The work shall be divided into following sub-items.

Preparing Lawn

For this purpose, within the area where lawn is to be grown, about 0.3 metres of fresh garden soil shall be provided. Fresh garden soil & manure shall be mixed thoroughly, well watered and left overnight. The next morning, the variety of lawn, as per approved plan and as directed by the Engineer, shall be planted. This grass shall be maintained till well established by watering, weeding, clipping, rolling, etc

Preparing Clipped Hedges

Hedges made of shrubs as directed by the Owner shall form borders between footpath and the Lawns. The shrubs shall be planted at spacing not more than 25 cms.

Planting Shrubs

Shrubs with coloured leaves like Crotons, Acalyphia, Oleander and Bouganvillea, Hibiscus etc. which are perennial shall be planted in clusters or over a large area at locations and in the manner as per approved layout. These shrubs shall be planted at spacing of not more than 25 cms.

Installation of Watering System

A watering system consisting of pumps, piping and sprinklers for irrigating all the landscaped areas, parks as well as the green belt shall be provided by the contractor. This watering system shall cover the entire perimeter of the township and the extent of green belt and

landscaping shown in the plot plan.

Before the installation of watering system the contractor shall prepare a plan for watering System for the green belt and submit and get it approved by the Owner. Drip Irrigation and Spray System consisting of complete HDPE pipe with all necessary bends, Tees, Elbows, etc., valves, stop cocks, Spray nozzles, sufficient lengths of Flexible PVC pipes to reach all area of Landscaping shall be included in the watering system. Only after approval of the Engineer, the Contractor shall commence the work. The Owner, however, reserves the right to modify the layout system if he deems necessary although the Owner earlier approved it.

5.6 Central Recreational Park

Central recreational park with benches, walkways, water bodies, fountains, flower gardens and children play area with installed equipments such as slide, swings, see-saw and jungle gym (climbing frame).

5.7 Children Play areas

Children play areas shall be provided with benches, walkways and play equipments such as slide and swings.

5.8 Green Belt

The main objective of the green belt is to provide a buffer between the sources of pollution and the surrounding areas. The green belt helps to capture the fugitive emissions and attenuate the noise apart from improving the aesthetics quality of the region.

For green belt development, recycled water from sewage treatment plant shall be utilized.

The general guidelines for development of greenbelt are:

- Trees growing up to 5 m or more will be planted along the road sides.
- Planting of trees will be undertaken in rows.
- Open areas inside the township will be covered with grass lawns.
- The spacing between the trees will be maintained slightly less than the normal spaces, so that the trees may grow vertically and slightly increase the effective height of the green belt.
- Planting of trees in each row will be in staggered orientation.
- Since the trunks of the tall trees are generally devoid of foliage, it will be useful to have shrubs in front of the trees so as to give coverage to this portion.
- The short trees (<5 m height) will be planted in the first two rows (towards inner side) of the green belt. The tall trees (>5 m height) will be planted in the outer three rows (away from plant side).
- For adsorption of dust and gaseous pollutants the following types of plants have been considered,:
    - Fast growing
    - Thick canopy cover
    - Longer duration of foliage.
    - Adequate height and spread of crown
    - Small leaves trees which can sustain the sea breeze.
    - Preference to perennial and evergreen trees

The choice of plants includes shrubs that grow 1 to 2 m high and trees of 3 to 5m heights. It

will be ensured that the foliage area density in vertical is almost uniform by intermixing the trees and shrubs. Since safety during transport is a major consideration, shrubs in traffic islands and along road dividers will be short enough to be below the eye-level of motorists.

The species identified for greenbelt development will be planted using pitting technique. The pit size will be either 45 cm X 45 cm X 45 cm or 60 cm X 60 cm X 60 cm. Bigger pit size will be preferred. Soil used for filling the pit will be mixed well with decomposed farm yard manure or sewage sludge at the rate of 2.5 kg (on dry weight basis) and 3.6 kg (on dry weight basis) for 45 cm X 45 cm X 45 cm and 60 cm X 60 cm X 60 cm respectively. The filling of soil will be completed at least 5-10 days before actual plantation.

It is proposed to cover an area of 10 m all round the Township. Apart from the bulk plantation around the boundaries, Roadside avenue plantations will also be taken up. The green belt layout is shown in the plot plan.

5.9 Sewage Network

Sewage network shall be provided till the common Sewage Treatment Plant, which will be located inside the Power Plant. Power Plant Plot plan is provided in Annexure D.

6 RESIDENTIAL BUILDINGS

6.1 Executive Residence – Type – A

Residential blocks with Type-A residential units, each with 2000 sq feet plinth area (approximate).

Three bed rooms (two with attached toilets and balconies), One Study Room, Drawing + Dining Hall, One Common Toilet, Kitchen and Work Area.

Servant accommodation shall be provided within the unit itself with separate external entry, one internal entry from Servant quarter to Flat. Servant quarter consisting of one room, small kitchenette and toilet.

Tentative arrangement of the building shall be as given below.

- 2 floors
- 2 Units per floor
- 2 x 2 = 4 Units per block
- 2 Blocks
- Total units = 2 x 2 x 2 = 8 Units
- Stairs – 1 Number for each block

6.2 Executive Residence – Type – B

Residential blocks with Type-B residential units, each with 1500 sq feet plinth area (approximate).

Three bed rooms (two with attached toilets and balconies), Drawing + Dining Hall, One Common Toilet, Kitchen, Work Area and Balcony.

Servant accommodation shall be provided within the unit itself with separate external entry, one internal entry from Servant quarter to Flat. Servant quarter consisting of one room, small kitchenette and toilet.

Tentative arrangement of the building shall be as given below.

- Ground (stilt parking) + 8 floors
- 4 Units per floor
- 8 x 4 = 32 Units per block
- 1 Block
- Total units = 8 x 4 x 1 = 32 Units
- Stairs – 2 Numbers
- Lifts – 2 Nos (8 persons and 13 persons each)

6.3 Executive Residence – Type – C

Residential blocks with Type-C residential units, each with 1250 sq feet plinth area (approximate), with three bed rooms (two bed rooms with attached toilet and balcony), Drawing + Dining Hall, One Common Toilet, Kitchen, Work Area and Balcony.

Tentative arrangement of the building shall be as given below.

- Ground (stilt parking) + 8 floors
- 4 Units per floor
- 8 x 4 = 32 Units per block
- 1 Blocks
- Total units = 8 x 4 x 1 = 32 Units
- Stairs – 2 Numbers
- Lifts – 2 Nos (8 persons and 13 persons each)

6.4 Staff Residence – Type – D

Residential blocks with Type-D residential units, each with 1000 sq feet plinth area (approximate), with two bed rooms (one with attached toilet and balcony), Drawing + Dining Hall, One Common toilet, Kitchen and Work Area.

Tentative arrangement of the building shall be as given below.

- Ground (stilt parking) + 8 floors
- 4 Units per floor
- 8 x 4 = 32 Units per block
- 1 Block
- Total units = 8 x 4 x 1 = 32 Units
- Stairs – 2 Numbers
- Lifts – 2 Nos (8 persons and 13 persons each)

6.5 Head of Plant Bungalow

Bungalow for Head of Plant (Ground + First Floor), 2000 sq feet (approximate), with Three bed rooms (with attached toilets and balcony / sit outs), One Study Room, Drawing + Dining Hall, Common Toilet, Kitchen, Store and Work Area, One car park. Staircase shall be internal, accessible from the Drawing + Dining hall.

Separate servant quarters - 500 sq feet, One bed room, Hall, Common Toilet, Kitchen and Work Area.

6.6 Guest House

This shall be of ground + 3 Stories, accommodating 42 suites / rooms along with VIP lounge, Dining hall and Kitchen facilities.

Tentative arrangement of the building shall be as given below.

Ground floor

- Entrance Lobby cum Reception
- Office and Store Room
- Prayer Room
- Electrical Room
- VIP Lounge
- VIP dining hall
- VIP Suite – 1 No
- Indoor Games Room
- Suites – 2 Nos
- Toilets
- Dining Hall
- Kitchen
- Laundromat and Utility

1st Floor

- Multipurpose Hall
- Dormitory and Toilet for staff members
- TV Lounge
- Utility Room
- 7 suite type rooms, 550 sq. feet each, with Drawing Room, bed room, attached toilets, dressing area and balcony.

2nd Floor and Third Floors

- 16 rooms each, 275 sq feet each, bed room, dressing area, attached toilets, and balcony.

Roof Level

- Gym (part of the roof).

- Roof Top Garden and Party space with pantry.

Total Suites = 3+7 = 10

Total Rooms = 2x16 = 32

Total occupancy = 10 + 32 = 42

Lifts - 2 Nos (8 persons and 13 persons each)

2 Nos of staircases.

Fountain with landscaping around shall be provided in front of the building.

6.7 Studio Apartments

Studio apartments, 550 sq. feet each, with drawing room, bed room, kitchen, toilet, work area and balcony.

Tentative arrangement of the building shall be as given below.

- Ground (stilt parking) + 8 floors
- 8 Units per floor
- 8 x 8 = 64 Units per block
- 1 Block
- Total units = 8 x 8 x 1 = 64 Units
- Stairs – 2 Nos
- Lifts – 2 Nos (8 persons and 13 persons each)

6.8 Field Hostel – Staff

- Ground floor parking
- 420 sq feet rooms including kitchen, Balcony and toilet.

Tentative arrangement of the building shall be as given below.

- Ground (stilt parking) + 8 floors
- 8 Units per floor
- 1 Block
- Total units = 8 x 8 x 1 = 64 Units
- Stairs – 2 Numbers
- Lifts – 2 Nos (8 persons and 13 persons each)

6.9 Trainees Hostel and Training Center

Ground + 2 Stories, 5000 sq feet plinth area.

Tentative arrangement of the building shall be as given below.

Ground floor

- Entrance Lobby
- Workshop
- Store Room
- Electrical Room
- Office Room
- Dining Hall and Toilets
- Kitchen
- Office Room
- Supervisor’s Room

First Floor

- Three training halls, 36 seats each
- One training hall, 20 seats

- Two staff rooms and offices
- Toilets
- Activity Room
- Electrical Room
- Store

Second Floor

- 20 Rooms (double bed with attached toilets and balcony).

2 No of staircases.

7 NON-RESIDENTIAL BUILDINGS

General Requirements for non-residential buildings

1. Suitable provisions shall be provided in doors where ever access control systems are required.
2. Magnetic white boards of suitable size shall be provided in all conference and training rooms.
3. Concealed conduits for installation of overhead projector and audio system shall be provided in all conference and training rooms.

General Requirements for Dining Halls and Kitchens

Toilet and hand wash shall be kept sufficiently away from cooking area.

Toilets (Gents and Ladies) shall be provided for Dining Halls.

Adequate space shall be provided for stores, preparation, cooking, serving and washing facility.

Adequate exhaust fans and ventilation facility shall be given in the cooking area and in dining area. Special arrangement shall be made to lead off the waste water from canteen to the effluent treatment plant.

Main entrance door shall be of aluminium glazed swing type with two leaves opening outside. All windows shall be glazed aluminium. Fly proof mesh shall be provided isolating cooking area from dining area.

Sinks and wash basins shall be of heavy duty stainless steel.

Adequate number of platforms and racks shall be provided in kitchen and stores area.

Kitchen and pantry sinks shall be of Stainless steel.

Platforms in kitchen, pantry and serving area shall be finished with 12 mm thick polished granite stone.

7.1 Gate and Security

Two numbers of Gates and Security buildings shall be provided.

1. Entry to Hospital, Shopping Center, Mosque and Temple area

2. Entry to residential areas.

Security buildings shall have adequate area to house the security staff and toilet facilities. Minimum built up area shall be 300 sq feet each. The Security buildings shall be of RCC construction.

Speed breakers shall be provided both outside and inside the compound with manually operated traffic barriers.

Adequate RCC paved areas shall be provided both inside and outside for parking of waiting vehicles.

Gate area shall contain the following.

1. One main gate, 3.0 m high and 7.5 m wide, with two leaves.
2. Two wicket gates (1.2m wide, 1.5 m high) shall be provided to allow entry and exit of pedestrians and cyclists.

The design entrance area and gates shall be aesthetically pleasing merging with the architecture of the compound wall.

7.2 Car Parks

Covered Car Parks

Covered car park shall be provided for the following buildings.

1. Residence – Type – A – One per each unit
2. Residence – Type – B – One per each unit
3. Residence – Type – C – One per each unit
4. Staff Residence – Type – D – One per each unit
5. Head of Plant Bungalow – 2 cars
6. Guest House – 10 cars
7. Police Station – 5 cars
8. Security Force and Army Barracks – 5 cars

If space is not adequate in stilt areas of the above buildings, additional external shed type car park structure (RCC / structural steel) shall be provided.

Car parking shall be provided in the available stilt areas of the following buildings.

1. Studio Apartments
2. Field Hostel

Crash barriers using MS pipes shall be provided around the building columns.

Open Car Parks

Open parking (with paver tiles) facility shall be provided near the following locations:

Car Park - 1	25 Cars	Common for Hospital and Mosque
Car Park - 2	20 Cars	Common for Shopping center and Temple
Car Park - 3	25 Cars	Common for Community Centre, Swimming Pool and Indoor Sports Complex

Car Park - 4	20 Cars	Outdoor Sports area
Car Park - 5	20 Cars	School Area
Car Park - 6	10 Cars	Trainees Hostel and Training Center

General requirements for Car Parks

Parking areas shall be provided with rigid pavement and shall be provided with antiskid treatment and dividing strips.

Top level of parking area shall be flushed with crown of the connecting roads with a cross slope.

Catch drains shall be provided and connected to the main storm water drains.

7.3 Nursery and High School

Ground + 2 Floor, 15000 sq feet (minimum) in each floor.

Class room area should be 40 ft X 30 ft

Total class rooms required = 18

Tentative arrangement of the building shall be in three wings.

- Wing – 1 – Nursery to Std V
- Wing – 2 – Std VI to Std X
- Wing – 3 – Std XI and XII

In addition to class rooms, the following also shall be provided.

- Office Room
- Head Master Room
- Record room
- Library
- Activity rooms
- Laboratories
- Staff Rooms
- Conference halls

Separate toilet blocks in each floor, Boys and Girls.

Extra toilet blocks (Gents and Ladies) in ground floor for teachers.

Play ground shall have badminton court, basket ball court and football ground with goal post.

7.4 Mosque

Mosque shall be 4500 sq. feet. total containing the following

1. Prayer Hall
2. Minaret.
3. Office.
4. Ablution area and Toilets
5. Residential arrangement for Imam and assistant.

Layout and architectural features shall be prepared considering local Bangladesh practices.

7.5 Hospital

Total capacity shall be 25 beds including a burn ward.

Stair, ramp and 2 nos Lifts (patient lift and 8 person lift) shall be provided.

Layout shall be prepared considering Bangladesh Ministry of Health requirements and any other applicable regulations.

4 Storied construction is envisaged. Structural frame and foundation shall have provision for future vertical expansion upto total of 8 stories.

The following minimum facilities shall be provided.

- Emergency Room
- Waiting Hall
- Consulting Rooms
- Offices
- Document rooms
- Nursing Station
- Pharmacy
- Stores
- Laboratories
- X-Ray Room
- Operation Theatres (Two minor OTs and one Major OT)
- Intensive Care Units
- Prayer Room
- Toilets
- Seminar Room
- Dining Hall
- Kitchen

In general, the patient wards shall have the following configuration, subject to approval during detailed engineering.

- General Wards – 15 beds
- Maternity Ward – 5 beds
- Burn Ward – 3 beds
- Private wards – 2 beds

Piping network for medical gas system shall be provided.

Piping network and disposal system for medical waste shall be provided.

7.6 Shopping Center with Post Office, Bank and Estate Office

2 Storey with two staircases.

Post office (1000 sq feet), Bank (1000 sq feet) and Estate office shall be accommodated in one wing of the shopping complex.

24 nos of shops shall be provided. Rolling shutter shall be provided.

Separate toilet blocks for gents and ladies shall be provided.

Separate Vegetable, Fruit, Fish, Meat stalls - behind Shopping centre. Stalls with elevated floor, rolling shutters and concrete roof.

7.7 Temple

Temple shall have 2200 sq. feet. built-up area and the layout shall meet the local Hindu population's religious practices. Diety Room, Hall, Kitchen, Priest room and Flag Post shall be provided.

7.8 Community Center

Ground floor

- Office
- Mini Hall of 40 seats
- Dining Hall
- Kitchen and store facilities
- Utility room
- Generator room
- Toilets

First floor

- Main hall of 176 seats with stage and two change rooms.

Wiring for stage lighting and public address system shall be provided.

7.9 Executive Club

Club (3500 sq. Ft./ floor)
Ground Floor

- Office Room
- Library & Reading Room
- Seating Lounge
- Restaurant
- Store
- Electrical room

First Floor

- Gymnasium (Ladies / Gents)
- Billiards room
- Carrom & Card room
- Table Tennis Room
- Multi-purpose meeting Hall

7.10 Non - Executive Club

Club (3000 sq. Ft./ floor)
Ground Floor

- Office Room
- Library & Reading Room
- Seating Lounge
- Restaurant

- Store
- Electrical room

First Floor

- Gymnasium (Ladies / Gents)
- Billiards room
- Carrom & Card room
- Table Tennis Room
- Multi-purpose meeting Hall.

7.11 Swimming Pool

Adult Swimming pool (20 m x 10 m x depth from 0.9 m to 1.5 m)
Kids Pool (6 m x 6 m x 0.45 m deep).

Office and Store, Coach room, Changing rooms, Shower rooms, Toilets, Water treatment and filtration plant.

7.12 Indoor Sports Complex

The following shall be provided.

- Badminton Court – 2 numbers
- Office and store
- Toilets.

7.13 Outdoor Sports Area

Football / Cricket Ground cum Athletic Track,
The following shall be provided.

- Volleyball Court
- Basket Ball Court
- Skating rink
- Tennis Court
- Toilets including shower areas.

7.14 Potable Water, Service Water and Fire Water Pump House

Tank and pumping station for potable water, Service Water and fire water.

Separate holding tank and pump house shall be constructed for pumping of recycled water (from sewage treatment plant) for horticulture purposes.

Pump house and the tanks shall be of RCC construction. Suitable monorail shall be provided for erection and maintenance of pumps and motors. Rolling shutter of adequate size shall be provided.

7.15 Main Receiving Substation

Main Receiving Substation shall be of reinforced concrete frame structure with masonry wall and reinforced concrete floors and roofs.

Telephone Exchange shall be accommodated in the building.

7.16 Distribution Substations

Distribution Substations shall be of reinforced concrete frame structure with masonry wall and reinforced concrete floors and roofs.

7.17 Maintenance Store

Reinforced concrete frame structure with masonry wall and reinforced concrete floors and roofs. 10000 sq. feet area containing the following.

1. Workshop
2. Store
3. Tool Room
4. Office
5. Toilet

7.18 Underground Water Tank

Underground Water Tank shall be of RCC construction and shall meet the fire water, service water and potable water system requirements.

7.19 Watch Tower

One new Watch Tower shall be provided at the western corner of Township boundary. This shall be similar in all aspects to existing watch towers around power plant. For details, refer drawings in Annexure D.

8 FACILITIES OUTSIDE TOWNSHIP BOUNDARY

The following facilities shall be located outside the township boundary and shall be in the scope of the contractor.

8.1 Police Station

Police station shall have 2000 sq feet area and minimum provision for the following.

- Detention room
- Examination room
- Inspector's room
- Office room
- Armory
- Toilets

The police station internal arrangements and facilities shall be as per relevant Bangladesh standards.

8.2 Security Force and Army Barracks

Tentative arrangement of the building shall be as given below.

- Ground (Kitchen, Dining, Recreation, Store, etc.) + 2 floors
- 2 dormitories of 8 beds each, in first and second floor
- 4 Blocks
- Total occupants = 2 x 2 x 8 x 4 = 128 occupants
- Stairs – 1 No in each block

Each block shall have armory room sized and located as per relevant security authority requirements.

8.3 Cyclone Shelter

General requirements shall be as per Cyclone Shelter Construction, Maintenance and Management Policy issued by Ministry of Disaster Management and Relief of Bangladesh.

The shelter shall have ramp facilities up to the first floor and staircase till the roof.

Three storied Cyclone Shelter of with each floor having 3000 sq feet.

1. Ground Floor – stilt
2. First Floor – open area for animals, two rooms for disabled and helpless.
3. Second Floor – four rooms and corridor
4. Roof - Open

(Ref. Design – 2 - Cyclone Shelter Construction, Maintenance and Management Policy issued by Ministry of Disaster Management and Relief of Bangladesh.)

Reference may also be taken from cyclone shelters constructed in the vicinity, that is on the approach road to the power plant.

8.4 Storm Water Retention Pond

A retention pond shall be constructed to retain storm water drainage with over flow provision to Moidhara river.

Minimum diameter shall be 50m at the base. Minimum depth shall be 2.5 m below the inlet point. Suitable side slope protection shall be installed. Walking pathway (2.0 m wide) shall be constructed around the pond. Benches shall be provided at 25m intervals along the walkway.

8.5 Gas Cylinder Godown

Single storey concrete building (1000 sq feet) with fixed grills on the sides for ventilation. All around fencing.

Shall be as per relevant Bangladesh standards.

8.6 Transport Center

This shall be located outside the township boundary.

- Booking rooms and shops in ground floor – 500 sq feet
- Drivers retiring room in first floor – 500 sq feet
- 5 Nos Bus parking bay
- Toilets for Ladies and Gents.

9 TYPICAL REQUIREMENTS

9.1 Township Elevations

Township elevations shall be defined as follows:

- Finished Ground level of the township + 5.00 M above MSL
- Buildings plinth level + 5.60 M above MSL
- Final Level of Road + 5.15 M above MSL

- Final level of Landscaping and Paving outside Buildings and Playground + 5.30 M above MSL

9.2 General Requirements

1. All buildings shall have disabled friendly ramps.
2. All buildings shall have concealed wiring.
3. All toilets, pantries and kitchens shall be provided with exhaust fans.
4. All pantries and kitchens shall be provided with 150 L capacity food-grade internal mini water tank for emergency storage, as per item 7.10.01 of Bangladesh Khulna Region – Local Government Engineering Department (LGED-2017) Schedule of Rates.
5. Canopy with metal sheeting shall be provided to all outdoor motors / pumps.
6. Vertical shafts for service pipes and drains shall be covered for better aesthetics.
7. Aviation warning lights shall be provided as per statutory requirements.
8. All buildings shall have separate plumbing to toilets and kitchens for connecting roof top solar water heater system.
9. Exterior surfaces for all buildings shall be applied with weather coat.

Contractor to get approval from Owner for the following (including brand and make) before procurement.

1. Patterns, colour and sizes of flooring and wall tiles
2. Colour of all fixtures.
3. Colour and texture of all finishes
4. Plumbing fixtures.
5. Hardware fixtures.

9.3 Typical Schedule of Finishes and Joinery

Typical schedule of finishes and joinery shall be as per grouping listed below

9.3.1 Schedule of Finishes for Group 1

1. Head of Plant Bungalow
2. Guest House

Floor	Name of space	Floor	Skirting	Wall	Ceiling	Door	Window / Ventilator	Remarks
Ground Floor	Stair	Anti skid tiles with nosing strips (for tread and riser)	1.2 m high, Mirror polished tiles.	Plastered and painted with white plastic paint	Plaster with white plastic paint	Solid wooden door in roof top.	Aluminium sliding window with 6 mm x 25 mm flat bar grill. Fly proof net. Frame: silver colour anodized. Glass: light brown tinted type. Grill with enamel paint.	Stainless steel handrails.
	Lift / Stair lobby	Anti skid tiles	100mm skirting, match with floor.	Plastered and painted with white plastic paint	Plaster with white plastic paint	-	-	Stainless steel handrails.
	Electrical room	Patent stone layer with neat cement finish	Same as flooring	Plastered and painted with white plastic paint	Plaster and white wash	M S grill door	M S louvered window with enamel paint	
	Toilet	Anti skid tiles		Ceramic wall tiles upto bottom of ceiling	Plaster with white plastic paint	Wooden door with lacquer coating (inside)	Aluminium ventilator with 6 mm x 25 mm flat bar grill. Fly proof net.	75 mm high door sill

Floor	Name of space	Floor	Skirting	Wall	Ceiling	Door	Window / Ventilator	Remarks
							Frame: silver colour anodized. Glass: light brown tinted type. Grill with enamel paint.	
	Store	Patent stone layer with neat cement finish	Plastered with neat cement finish	Plastered and painted with white plastic paint	Plaster and white wash	Wooden door	Aluminium sliding window with 6 mm x 25 mm flat bar grill. Fly proof net. Frame: silver colour anodized. Glass: light brown tinted type. Grill with enamel paint.	
	Guard Room / Dormitory	Patent stone layer with neat cement finish	Plastered with neat cement finish	Plastered and painted with white plastic paint	Plaster and white wash	Wooden door	Aluminium sliding window with 6 mm x 25 mm flat bar grill. Fly proof net. Frame: silver colour anodized. Glass: light brown tinted	

Floor	Name of space	Floor	Skirting	Wall	Ceiling	Door	Window / Ventilator	Remarks
							type. Grill with enamel paint.	
Typical floor	Lift / Stair lobby	Anti skid tiles	100mm skirting, match with floor.	Plastic paint on plaster upto ceiling	Plastered and painted with white plastic paint	Solid wooden design door with check viewer, security chain, door knocker, apartment number plate, mortise lock, tower bolt and magnetic door stopper inside room	Aluminium sliding window with 6 mm x 25 mm flat bar grill. Fly proof net. Frame: silver colour anodized. Glass: light brown tinted type. Grill with enamel paint.	
	Stair	Anti skid tiles with nosing strips (for tread and riser)	1.2 m high, Mirror polished tiles.	Plastered and painted with white plastic paint	Plastered & painted with white plastic paint.	Solid wooden door in roof top.	Aluminium sliding window with 6 mm x 25 mm flat bar grill. Fly proof net. Frame: silver colour anodized. Glass: light brown tinted type. Grill with enamel paint.	Stainless steel handrails.
	Drawing Room,	Mirror polished	100 mm high skirting tiles	Plastic paint on plaster	Plastered and painted		Aluminium sliding	

Floor	Name of space	Floor	Skirting	Wall	Ceiling	Door	Window / Ventilator	Remarks
	Recreation Room, Lounges	homogeneous tiles		upto ceiling	with white plastic paint		window with 6 mm x 25 mm flat bar grill. Fly proof net. Frame: silver colour anodized. Glass: light brown tinted type. Grill with enamel paint.	
	Dining	Mirror polished homogeneous tiles	100 mm high skirting tiles	Plastic paint on plaster upto ceiling	Plastered and painted with white plastic paint	Aluminium door. Frame: silver colour anodized Glass: Light brown tinted	Aluminium sliding window with 6 mm x 25 mm flat bar grill. Fly proof net. Frame: silver colour anodized. Glass: light brown tinted type. Grill with enamel paint.	
	Office Room	Mirror polished homogeneous tiles	100 mm high skirting tiles	Plastic paint on plaster upto ceiling	Plastered and painted with white plastic paint	Aluminium door. Frame: silver colour anodized Glass: Light brown tinted	Aluminium sliding window with 6 mm x 25 mm flat bar grill. Fly proof net.	

Floor	Name of space	Floor	Skirting	Wall	Ceiling	Door	Window / Ventilator	Remarks
							Frame: silver colour anodized. Glass: light brown tinted type. Grill with enamel paint.	
	Bed rooms	Homogeneous tiles	100 mm high skirting tiles	Plastic paint on plaster upto ceiling	Plastered and painted with white plastic paint	Door frame of teak, particle board shutter, flush door of wood veneer with mortise lock, tower bolt and magnetic door stopper inside room	Aluminium sliding window with 6 mm x 25 mm flat bar grill. Fly proof net. Frame: silver colour anodized. Glass: light brown tinted type. Grill with enamel paint.	
	Toilet	Anti skid tiles		Ceramic wall tiles upto bottom of ceiling	Plastered and painted with white plastic paint	Wooden door with lacquer coating (inside)	Wooden (Garjan or other approved timber) louvered cat door directly above door with same width upto ceiling painted with	75 mm high door sill

Floor	Name of space	Floor	Skirting	Wall	Ceiling	Door	Window / Ventilator	Remarks
							enamel paint of wall colour and fly proof net inside. 38 mm high door sill	
	Kitchen	Anti skid tiles		Ceramic wall tiles upto bottom of ceiling	Plastered and painted with white plastic paint	Door frame of teak, shutter – particle board flush door of wood veneer with mortise lock, tower bolt and magnetic door stopper inside room	Aluminium sliding window with 6 mm x 25 mm flat bar grill. Fly proof net. Frame: silver colour anodized. Glass: light brown tinted type. Grill with enamel paint.	Kitchen cabinet and hood.
	Balcony	Anti skid tiles	100 mm high skirting tiles	Plastic paint on plaster	Plastered and painted with white plastic paint	Wooden door with lacquer coating (outside)		Stainless steel hand railing.

9.3.2 Schedule of Finishes for Group 2

1. Executive Residence – Type – A
2. Executive Residence – Type – B
3. Executive Residence – Type – C
4. Staff Residence – Type – D
5. Studio Apartments
6. Trainees Hostel and Training Center
7. Gate and Security
8. Hospital
9. Nursery and High School
10. Mosque
11. Shopping Center with Post Office, Bank and Estate Office
12. Temple
13. Community Center
14. Executive Club
15. Non-Executive Club
16. Police Station

Floor	Name of space	Floor	Skirting	Wall	Ceiling	Door	Window / Ventilator	Remarks
Ground Floor	Driveway and parking	Patterned paving block	-	Plaster with plastic paint	Plaster with plastic paint			
	Stair	Anti skid with nosing strips (for tread and riser)	100mm high skirting tiles match with floor tiles	Plaster with plastic paint	Plaster with plastic paint			Stainless steel hand rail

Floor	Name of space	Floor	Skirting	Wall	Ceiling	Door	Window / Ventilator	Remarks
	Lift / Stair lobby	Local best quality homogeneous mirror polish floor tiles	100mm high skirting tiles match with floor tiles	Plaster with plastic paint	Plaster with distemper	Main gate – M.S. sheet with M.S. angle		
	Electrical room	Patent stone with neat cement finish		Plaster with white wash	Plaster with white wash	M.S. grill door		
	Toilet, Ablution hall	Local best quality ceramic floor tiles(anti skid		Local best quality ceramic wall tile up to ceiling	Plaster with distemper	Wooden door with lacquer coating (inside)	Aluminum louvered ventilator	
	Store	Patent stone with neat cement finish		Plaster with white wash	Plaster with white wash	Main gate – M.S. sheet with M.S. angle	Aluminum sliding window with 6mm x 25 mm flat bar grill with glass shutter. Fly proof net.	
	Guard Room	Patent stone with neat cement finish		Plaster with white wash	Plaster with white wash	Door frame of timber shutter-particle board flush door with garjan veneer with enamel paint	Aluminum sliding window with 6mm x 25 mm flat bar grill with glass shutter. Fly proof net.	
Typical floor	Lift / Stair lobby	Local best quality homogeneous mirror polish floor tiles	100mm high skirting tiles match with floor tiles	Plaster with plastic paint	Plaster with distemper	Main gate – M.S. sheet with M.S. angle		

Floor	Name of space	Floor	Skirting	Wall	Ceiling	Door	Window / Ventilator	Remarks
	Stair	Anti skid with nosing strips (for tread and riser)	100mm high skirting tiles match with floor tiles	Plaster with plastic paint	Plaster with plastic paint			Stainless steel hand rail
	Drawing Room, Recreation Room, Lounges	Local best quality homogeneous floor tiles	100mm high skirting tiles match with floor tiles	Plaster with plastic paint	Plaster with plastic paint	Main door-Door frame of timber shutter-solid wooden(teak) decorative door with best quality polish.	Aluminum sliding window with 6mm x 25 mm flat bar grill with glass shutter. Fly proof net.	
	Dining	Local best quality homogeneous floor tiles	100mm high skirting tiles match with floor tiles	Plaster with plastic paint	Plaster with plastic paint	Main door-Door frame of timber shutter-solid wooden(teak) decorative door with best quality polish.	Aluminum sliding window with 6mm x 25 mm flat bar grill with glass shutter. Fly proof net.	
	Restaurant	Local best quality homogeneous floor tiles	2100mm high skirting tiles match with floor tiles	Plaster with plastic paint	Plaster with plastic paint	Main door-Door frame of timber shutter-solid wooden(teak) decorative door with best quality polish.	Aluminum sliding window with 6mm x 25 mm flat bar grill with glass shutter. Fly proof net.	
	Bed rooms	Local best quality homogeneous floor tiles	100mm high skirting tiles match with floor tiles	Plaster with plastic paint	Plaster with plastic paint	Door frame of timber (teak) shutter-particle board	Aluminum sliding window with 6mm x 25	Local best quality homogeneous floor tiles

Floor	Name of space	Floor	Skirting	Wall	Ceiling	Door	Window / Ventilator	Remarks
						flush door of wood veneer with best quality polish	mm flat bar grill with glass shutter. Fly proof net.	
	Study rooms	Mirror polished homogeneous tiles	100 mm high skirting tiles	Plastic paint on plaster upto ceiling	Plastered and painted with white plastic paint	Door frame of teak, particle board shutter, flush door of wood veneer with mortise lock, tower bolt and magnetic door stopper inside room	Aluminium sliding window with 6 mm x 25 mm flat bar grill. Fly proof net. Frame: silver colour anodized. Glass: light brown tinted type. Grill with enamel paint.	
	Toilet	Local best quality ceramic floor tiles(anti skid		Local best quality ceramic wall tile up to ceiling	Plaster with plastic paint	Wooden door with lacquer coating (inside)	Aluminum louvered ventilator	
	Kitchen	Local best quality homogeneous floor tiles	100mm high skirting tiles match with floor tiles	Local best quality ceramic wall tile up to 2100mm height	Plaster with plastic paint	Door frame of timber (teak) shutter- particle board flush door of wood veneer with best quality polish	Aluminum sliding window with 6mm x 25 mm flat bar grill with glass shutter. Fly proof net.	
	Work area	Local best	100mm high	Plaster with	Plaster with			

Floor	Name of space	Floor	Skirting	Wall	Ceiling	Door	Window / Ventilator	Remarks
		quality homogeneous floor tiles	skirting tiles match with floor tiles	plastic paint	plastic paint			
	Balcony	Anti skid tiles	100 mm high skirting tiles	Plastic paint on plaster	Plastered and painted with white plastic paint	Wooden door with lacquer coating (outside)		Stainless steel hand railing.
	Servant rooms	Mirror polished homogeneous tiles	100 mm high skirting tiles	Plastic paint on plaster upto ceiling	Plastered and painted with white plastic paint	Door frame of teak, particle board shutter, flush door of wood veneer with mortise lock, tower bolt and magnetic door stopper inside room	Aluminium sliding window with 6 mm x 25 mm flat bar grill. Fly proof net. Frame: silver colour anodized. Glass: light brown tinted type. Grill with enamel paint.	
	Office Rooms, Telephone Exchange, Prayer rooms, Post Office, Bank, Shops, Sports rooms, Gymnasium, Activity	Mirror polished homogeneous tiles	100 mm high skirting tiles	Plastic paint on plaster upto ceiling	Plastered and painted with white wash and Gypsum false ceiling.	Door frame of teak, particle board shutter, flush door of wood veneer with mortise lock, tower bolt and magnetic door stopper inside room	Aluminium sliding window with 6 mm x 25 mm flat bar grill. Fly proof net. Frame: silver colour anodized. Glass: light brown tinted type.	

Floor	Name of space	Floor	Skirting	Wall	Ceiling	Door	Window / Ventilator	Remarks
	rooms, Conference Hall, Meeting Room, Training Room, Staff Room, Computer Room, Library, Police Station rooms						Grill with enamel paint.	
	Hospital Rooms – Emergency, Waiting Hall, Consulting, Nursing, Pharmacy, Stores, Lab, ICU, Wards, Dining Offices,	Mirror polished homogeneous tiles	100 mm high skirting tiles	Plastic paint on plaster upto ceiling	Plastered and painted with white wash and Gypsum false ceiling.	Door frame of teak, particle board shutter, flush door of wood veneer with mortise lock, tower bolt and magnetic door stopper inside room	Aluminium sliding window with 6 mm x 25 mm flat bar grill. Fly proof net. Frame: silver colour anodized. Glass: light brown tinted type. Grill with enamel paint.	

9.3.3 Schedule of Finishes for Group 3

1. Field Hostel – Staff
2. Security Force and Army Barracks
3. Swimming Pool
4. Indoor Sports Complex
5. Potable Water, Service Water and Fire Water Pump House and Tank
6. Main Receiving Substation
7. Distribution Substations
8. Maintenance Store
9. Watch Tower
10. Cyclone Shelter
11. Gas Cylinder Godown
12. Transport Center

Floor	Name of space	Floor	Skirting	Wall	Ceiling	Door	Window / Ventilator	Remarks
Ground Floor	Driveway and parking,	Rough casting		Plastered and painted with white wash	Plastered and painted with white wash			
	Stair	Anti skid tiles	Cement skirting	Plaster with white wash	Plaster with white wash			Stainless steel handrails.
	Lift / Stair lobby	Anti skid tiles	100mm skirting, match with floor.	Plaster with white wash	Plaster with white wash	Main gate – M.S. sheet with M.S. angle		Stainless steel handrails.

Floor	Name of space	Floor	Skirting	Wall	Ceiling	Door	Window / Ventilator	Remarks
	Electrical room	Patent stone with neat cement finish		Plaster with white wash	Plaster with white wash	M.S. grill door	M.S. louvered window with enamel paint	
	Toilet, Changing rooms, Shower areas	Local best quality floor tiles(anti skid		Local ceramic wall tile up to ceiling	Plaster with white wash	Door frame of timber shutter-particle board flush door with garjan veneer with enamel paint	M.S. louvered ventilator with enamel paint	75 mm high door sill
	Store	Patent stone with neat cement finish		Plaster with white wash	Plaster with white wash	Main gate – M.S. sheet with M.S. angle		
	Equipment Room, Pump room, Sports rooms,	Patent stone with neat cement finish		Plaster with white wash	Plaster with white wash	Door frame of timber shutter-particle board flush door with garjan veneer with enamel paint	Window frame M.S. angle frame / shutter with enamel paint Grill – 5mmX19mm flat bar with enamel paint Fly proof net.	
	Guard Room, Watch Tower	Patent stone with neat cement finish		Plaster with white wash	Plaster with white wash	Door frame of timber shutter-particle board flush door with garjan veneer with enamel paint	Window frame M.S. angle frame / shutter with enamel paint Grill – 5mmX19mm flat bar with enamel paint.	

Floor	Name of space	Floor	Skirting	Wall	Ceiling	Door	Window / Ventilator	Remarks
							Fly proof net.	
Typical floor	Stair lobby / Lift	Anti skid tiles		Plaster with white wash	Plaster with white wash	Main gate – M.S. sheet with M.S. angle		
	Stair	Anti skid tiles	Cement skirting	Plaster with white wash	Plaster with white wash			M.S. stair railing with wooden hand rail
	Drawing Room, Recreation Room	Local best quality floor tiles	100mm high skirting tiles match with floor tiles	Plaster with white wash	Plaster with white wash	Main door-Door frame of timber shutter-solid wooden door with enamel paint	Window frame M.S. angle frame / shutter with enamel paint Grill – 5mmX19mm flat bar with enamel paint. Fly proof net.	
	Dining	Local best quality floor tiles	100mm high skirting tiles match with floor tiles	Plaster with white wash	Plaster with white wash	Main door-Door frame of timber shutter-solid wooden door with enamel paint	Window frame M.S. angle frame / shutter with enamel paint Grill – 5mmX19mm flat bar with enamel paint. Fly proof net.	
	Bed rooms, Dormitories,	Local best quality floor tiles	100mm high skirting tiles match with floor tiles	Plaster with white wash	Plaster with white wash	Door frame of timber shutter-particle board flush door with garjan	Window frame M.S. angle frame / shutter with enamel paint Grill –	

Floor	Name of space	Floor	Skirting	Wall	Ceiling	Door	Window / Ventilator	Remarks
						veneer with enamel paint	5mmX19mm flat bar with enamel paint	
	Cyclone Shelter Rooms,	Local best quality floor tiles	100mm high skirting tiles match with floor tiles	Plaster with white wash	Plaster with white wash	Door frame of timber shutter-particle board flush door with garjan veneer with enamel paint	Window frame M.S. angle frame / shutter with enamel paint Grill – 5mmX19mm flat bar with enamel paint	
	Store Workshop Tool room	Patent stone with neat cement finish		Plaster with white wash	Plaster with white wash	Main gate – M.S. sheet with M.S. angle		
	Toilet	Local best quality floor tiles(anti skid		Local ceramic wall tile up to ceiling	Plaster with white wash	Door frame of timber shutter-particle board flush door with garjan veneer with enamel paint	M.S. louvered ventilator with enamel paint	
	Kitchen	Local best quality floor tiles		Local ceramic wall tile up to 2100mm height	Plaster with white wash/enamel	Door frame of timber shutter-particle board flush door with garjan veneer with enamel paint	Window frame M.S. angle frame / shutter with enamel paint Grill – 5mmX19mm flat bar with enamel paint	

Floor	Name of space	Floor	Skirting	Wall	Ceiling	Door	Window / Ventilator	Remarks
							Fly proof net.	
	Work area	Local best quality floor tiles	100mm high skirting tiles match with floor tiles	Plaster with white wash	Plaster with white wash			
	Balcony	Anti skid tiles	100 mm high skirting tiles	Plastic paint on plaster	Plastered and painted with white wash	Wooden door with lacquer coating (outside)		Stainless steel hand railing.

DETAILED TECHNICAL SPECIFICATION

SECTION – B1 - CIVIL

SUB SECTION – 3.1

CODES AND STANDARDS

TABLE OF CONTENTS

1 GENERAL

The engineering and execution of all the civil works shall be based on the latest editions of the applicable codes and standards as listed in **Section B0.**

If any standard contains a provision, which is inconsistent with a provision in another standard, the more stringent in respect of quality shall apply.

DETAILED TECHNICAL SPECIFICATION

SECTION – B1 - CIVIL

SUB SECTION – 3.2

LOADS AND LOAD COMBINATIONS

TABLE OF CONTENTS

1 GENERAL

All structures shall be designed for the most critical combinations of dead loads, imposed loads, equipment loads, wind loads, seismic loads, temperature loads, loads and forces developed due to differential settlement and any other loading conditions which can occur during the design life of the facility.

All structural components shall be designed to accommodate anticipated concentrated loads which will or may be applied during the life of the structure. Where both concentrated and uniform loads cannot act simultaneously, the structure or component shall be analysed for both conditions of loading and shall be designed for more critical condition.

The applicable loads for the design shall be as listed below :

2 DEAD LOADS

Dead loads consist of the weights of the structure complete with finishes, fixtures, partitions, wall panels partitions, roofing, etc.

The following unit weight of material shall be considered for computation of loads.

Materials		**Unit Weight**
Plain Cement Concrete	-	24 kN/m³
Reinforced Cement Concrete	-	25 kN/m³
Structural Steel	-	78.5 kN/m³
Brick work	-	20 kN/m³
Cement Plaster	-	21 kN/m³
Floor finish	-	24 kN/m³

Gravity weight of soil over burden shall be considered as dead load.

3 IMPOSED LOADS

General

Imposed loads in different areas shall not be less than that specified in BNBC-2012, Table 2.3.1, Chapter-2, Loads on Buildings and Structures, Part-6 – Structural Design.

4 TEMPERATURE LOAD

Temperature loads shall be as per BNBC-2012, Clause 2.6.5, Chapter 2 - Loads on Buildings and Structures, Part 6 – Structural Design.

Suitable expansion joints shall be provided in the longitudinal direction of the structures wherever necessary with provision of twin columns to account for the expansion and

contraction due to changes in temperature of materials of the structure.

The maximum spacing of the expansion joint shall be as per the provisions of relevant standards.

Co-efficient of thermal expansion for concrete and structural steel shall be taken as per relevant standards.

5 WIND LOAD

Site specific parameters for wind loading shall be as per the criteria specified in B0 – General Technical Specification of this document.

Wind loads on structures shall be calculated as per provisions of BNBC.

The wind shall be assumed to blow in any direction and most unfavorable condition shall be considered.

The wind analysis shall consider the wind direction relative to the structure and both external and internal pressures as applied to the windward and leeward sides of the structure.

In design of structures, wind force on all fixtures, staircases, ladders, handrails, etc., shall also be considered.

6 SEISMIC LOAD

Seismic forces shall be considered as per the criteria specified in B0 – General Technical Specification of this document.

All buildings and structures shall be designed for Seismic loads as per the latest edition of BNBC and site specific seismic study, already conducted by Owner.

Response spectrum method shall be used for the seismic analysis using at least five modes of vibration.

7 EARTH PRESSURE LOAD

Earth pressure for all underground structures shall be calculated using coefficients of earth pressure at rest, coefficient of active or passive earth pressure (whichever is applicable).

However, for design of substructure of sumps and under ground tanks, earth pressure at rest shall be considered.

In addition to earth pressure and ground water pressure etc., a minimum surcharge load of 20kN/sqm shall also be considered for the design of all underground structures including basement, channels, sumps, cable & pipe trenches etc., to take into account the vehicular traffic in the vicinity of the structure.

When a portion or whole of the adjacent soil is below free water surface, computations shall be based on submerged weight of soil plus full hydrostatic pressure.

8 HYDROSTATIC PRESSURE LOAD

Ground water level for calculation shall be considered at finished grade level.

Buoyancy load also be considered.

9 LOAD COMBINATIONS

Building / Structures

The individual members of the frame shall be designed for worst combination of forces such as bending moment, axial force, shear force and torsion. Different load combinations and permissible stresses for different load combinations shall be taken as per relevant codes.

Wind and seismic forces shall not be considered to act simultaneously.

Wind or Seismic loads acting in the transverse and longitudinal direction shall be considered independently as separate load cases.

Underground Structures

Based on the data on subsoil and underground water, adequate precautions shall be taken for design of foundation and underground structure.

All under ground structures such as sumps, pits, trenches etc. shall be designed considering soil, water and surcharge pressures.

Following loading conditions shall be considered in addition to the loading from super structure for the design of sumps, tanks, reservoirs, trenches and other underground structures.

a) Only liquid pressure from inside and no earth pressure & ground water pressure and surcharge pressure from outside (applicable only to structures which are liable to be filled up with water or any other liquid).

b) Earth pressure, surcharge pressure and ground water pressure from outside and empty inside.

c) Base slab of the sumps (with more than one compartment) shall be designed for the condition of different combinations of pump sumps being empty during maintenance stages with maximum ground water table.

d) Design shall also be checked against buoyancy due to ground water during construction and operation stage. Minimum factor of safety against buoyancy shall be ensured considering empty condition ignoring superimposed loads.

Walls of tanks with top slab shall be designed as propped cantilever slab between top and bottom slabs (where L/h > 2.5) or as a two way slab with three sides fixed and top side propped (where L/h <2.5).

The structures shall also be checked for stability and factor of safety shall not be less than those specified under applicable standards against overturning and sliding. Proper considerations in design shall be taken to prevent any possibility of floatation due to upward thrust caused by underground water. Factor of safety against uplift shall be at least 1.2. Special care shall also be taken to prevent floatation during construction period.

10 INCREASE IN STRESSES

Concrete Structures

The increase in allowable stresses in concrete shall be as per relevant standards.

Steel Structures

Increase in allowable stresses in steel structures shall be as per relevant standards.

Soil Bearing Pressures

Increase in allowable stresses in Allowable bearing capacity of soil / pile capacity shall be as per relevant standards.

DETAILED TECHNICAL SPECIFICATION

SECTION – B1 - CIVIL

SUB SECTION – 3.3

GENERAL REQUIREMENTS

TABLE OF CONTENTS

1 PLINTH LEVEL

Plinth levels of all buildings and pump houses shall be minimum 600 mm above the formation level or FGL.

2 PLINTH PROTECTION

Plinth protection in 100 mm thick PCC shall be provided with 1000 mm wide or the distance between the brick wall to the garland drain. It shall be laid over prepared subgrade and base formed with broken brick bats or rubble to a thickness of 150 mm. Grade of concrete shall as specified in section related to Reinforced Concrete Works.

3 ANTI TERMITE TREATMENT

Anti termite treatment shall be given to all vulnerable areas susceptible to termite attack and shall include column pits, wall trenches, foundations, filling below the floors etc., as per relevant Standards.

4 DAMP PROOFING (DPC)

Damp Proof Course shall be as per item 5.03.08 of Bangladesh Khulna Region – Local Government Engineering Department (LGED-2017) Schedule of Rates.

Two layers of hot bitumen coating conforming to BS 6398 or equivalent international code shall be applied one before & one after the DPC.

The masonry surface shall be leveled, flushed up and prepared as directed to receive the damp-proof course. In masonry walls of buildings, it shall normally be placed above the external ground level. It shall be laid for the full width of the wall. The top surface shall be kept rough or ribbed for proper adhesion of mortar for brickwork coming over it. All exposed surfaces of the damp proof course shall be finished fair and smooth. It shall be cured for at least seven days. After the surface has partially set, it shall be cleaned with brushes and finally with a piece of cloth lightly soaked in kerosene oil.

5 BRICK / STONE MASONRY AND PARAPET WALL

All masonry works shall be designed in accordance with relevant codes as applicable.

All brick work shall be as per the following items of Bangladesh Khulna Region – Local Government Engineering Department (LGED-2017) Schedule of Rates.

1. Brickwork in foundation – 5.04.02
2. Brickwork in superstructure – 5.04.03
3. Brickwork in exterior walls – 5.04.04
4. Exposed brickwork – 5.04.05

All ground floor masonry walls for buildings shall be raised on plinth beams.

All walls shall be non-load bearing walls. All external and internal walls shall be of at least one brick thick except for internal partition walls, which may be half brick thick. Half brick & one brick thick walls shall be provided with RCC bands (transoms and mullions) wherever necessary to curtail the unsupported length / width / height of the wall.

Salient points to be considered for masonry work:

a) Compressive strength of brick for all external walls and for non-load bearing brick work shall be as relevant standards.

b) DPC shall be provided at plinth level before starting masonry work.

c) Transoms shall be provided at lintel / door height. The spacing of mullions shall not exceed 3000 mm center to center.

Cut lintels shall be avoided.

Parapet Wall

All upstands and parapet walls on roof shall be of RCC / brick masonry. Minimum height of parapet walls shall be 1000 mm and one brick thickness or 125 mm for RCC, with aesthetics of architectural design as approved by the Owner.

Masonry Construction

Bricks are to be whole, uniform texture, sound, well burnt, free from cracks, square and well shaped, uniform in size, uniform red cherry or copper colour and shall emit a clear ringing sound when struck. Slight distortion or rounded edges are permitted provided no difficulty arises during laying of uniform course. Water absorption after 24 hours immersion shall not exceed 20% by weight. Dimensional tolerance shall not exceed 8%. Representative samples shall be submitted and approved samples shall be retained by the owner for future comparison.

Whole of the brickwork shall be carried out by the Contractor in a uniform manner. All the bricks shall be kept under water till they are completely soaked and shall be used for the works on their becoming skin dry. The Contractor shall set out and build all brickwork to the dimension, thickness and heights shown on the drawings. The Contractor shall build all brickwork in English bond and half brick walls in stretcher bond. Brickbats shall not be used except where required for bond.

The Contractor shall lay bricks in full mortar beds with shoved joints. The joints are not to exceed 10 mm in thickness and are to be full of mortar, close, well finished and neatly struck. The vertical joints in any course shall not be nearer than quarter of a brick length from those in the course below. All joints shall be of same width except for small variations to maintain bond. The brickwork shall be laid plumb and trim to line and level. No portion of brickwork shall be raised more than 1 metre above another at one time. If the mortar in any course has begun to set, the joints shall be raked out before another course is laid. The top course of brickwork in reinforced concrete framed structure shall be wedged against reinforced concrete surface and joint well filled with mortar. The Contractor shall flush up thoroughly with mortar all joints as the work proceeds. Where brickwork is to receive plaster, the joints shall be raked to a depth of 10 mm to provide proper bond. All half brick walls shall be reinforced with 2 nos. 8 dia bars at every fourth course.

The brickwork as it progresses shall be thoroughly watered on its faces and top. New work shall be properly bonded with the old work. The surface of unfinished work shall be cleaned and thoroughly wetted before joining new work to it. Any work in which the mortar perishes shall be dismantled and rebuilt by the Contractor.

The Contractor shall carry out work in as clean a manner as possible and shall remove excess material and mortar droppings daily. Where brick walls are to receive plaster, excess materials and mortar droppings shall be removed and the surface shall be brushed clean. During cleaning operations, adjacent work shall be protected. Any damage resulting from improper protection shall be made good by the Contractor at his own cost.

The brick masonry works shall be cured for a period of fourteen (14) days after laying.

Encasing of structural steel shall be done by building masonry work around flanges, webs etc., and filling the gap between steel and masonry. Encased members shall be wrapped with chicken wire mesh when shown on drawings or instructed by the Owner. The minimum lap in chicken wire mesh shall be 50 mm. Other steel embedments shall be generally embedded in mortar and masonry unit shall be cut as required.

6 SUNSHADES

Doors and windows on external walls of buildings shall be provided with RCC sunshade over the openings with 300 mm projection on either side of the opening.

Projection of sunshade from the wall shall be as below

Window openings	-	600 mm
Entrance doors / rolling shutters of all buildings	-	1200 mm wide for upto 3.0 m high openings
	-	1500 mm wide for more than 3.0 m upto 6.0 m high openings
Normal Buildings door openings	-	750 mm wide

Parapet, Sunshades over window and door heads, architectural facias, projections, etc., shall be provided with drip course in cement sand mortar 1:3.

7 DOORS, WINDOWS & VENTILATORS

7.1 Unless specified all doors, windows and ventilators of air conditioned areas, entrance lobby of all buildings and windows/ventilators provided on the outer face of all buildings shall have, powder coated aluminium framework with glazing.

For all air conditioned areas, double glazed wall panels with aluminium frame shall be provided between air-conditioned and non air-conditioned areas.

Single glazed panels with aluminium frame work shall be provided as partition between two air-conditioned areas wherever clear view is necessary.

Hollow extruded section of minimum 3 mm wall thickness and minimum 38 mm deep shall be used for all aluminium doors, windows and ventilators.

Aluminium windows in ground floors shall have suitable aluminium grills.

All windows shall have fly proof net.

7.2 Flush Steel Doors

Steel doors and pressed frames shall be made of 18g steel sheets.

No joints shall be permitted in the steel sheets.

All steel doors shall consist of double plate flush door shutters. The door shutter shall be 45 mm thick with two outer sheets of 18 G rigidly connected with continuous vertical 20 G stiffeners at the rate of 150 mm centre to centre. Side, top and bottom edges of shutters shall be reinforced by continuous pressed steel channel with minimum 18 G. The door shall be sound deadened by filling the inside void with mineral wool. Doors shall be complete with all hardware and fixtures like door closer, tower bolts, handles, stoppers, aldrops, etc. Both doors and frames shall be factory galvanized, primed and field painted.

All doors shall be fitted with necessary best quality hardware and fixtures conforming to relevant specifications and shall be capable of withstanding repeated use.

Three steel butt hinges of 100 mm length shall be provided for each door leaf. Steel frames shall be fixed to the masonry by steel sleeve anchor bolts M12 mm passing through holes of 25 mm diameter in the frame. Steel frames shall be fixed to the steel structure by screws.

The clearance of doors shall be 2.5 mm at jambs and heads.

Steel frames shall be provided with door closer fitted with rubber cushions.

External doors shall have an external weather stop.

All fire exit doors shall be provided with panic latch system with horizontal bar action parallel to the door face moving in the direction of the door travel to provide immediate exit in the event of fire or emergency whilst providing security against unauthorised entry.

The thickness of the normal steel door shall be 45 mm for both single and double doors.

All the above specified details shall be applied for normal steel doors, fire resistant steel doors and fire proof steel doors.

The contractor shall provide the Owner with following documents for the steel doors:

- Detailed shop and construction drawings as well as the door schedules and samples of hardware. Detailed structural analysis of the proposed supplies.
- Test certificates proving conformity of the physical properties stipulated in this specification and relevant standards

7.3 Fire Resisting And Fire Proof Doors

Fireproof doors with panic devices shall be provided at all fire exit points. Minimum requirement shall be for two hours. Type of doors shall be double cover-plated type with mineral wool insulation.

7.4 Rolling Shutter (Hand Operated, Mechanical Gear Operated and Electrically Operated) and Grills

Rolling shutters shall be fabricated from 18 gauge steel and machine rolled with 75 mm rolling centres with effective bridge depth of 12 mm lath sections, interlocked with each other and ends locked with malleable cast iron clips. They shall be designed to withstand a wind load of 200 Kg/m2 without excessive deflection.

The guides shall be either rolled or pressed deep channel sections 75 mm and 25 mm wide fitted with necessary fitting and fixtures.

The suspension shaft shall be formed from heavy duty tubes and of sufficient diameter so as to resist deflection due to weight of the rolling shutter. The deflection shall not exceed 5mm / metre width. The shaft shall be provided with CI pulleys and helical springs for counter balancing the weight of the shutter adequately.

The springs shall be approved high tensile flat springs. These shall be fitted inside the fabricated housing at either ends, which counter-balance the shutter curtain.

The ball bearings shall be double row self-aligning ball bearings fitted inside CI housing fixed on side brackets holding the suspension shaft at either end. The roller assembly shall be designed so as to be capable of producing sufficient torque to ensure easy operation of the rolling shutter in any position. The spring tension shall be adjustable by means of suitable adjustment holes drilled on the rims of the pulley.

The hood cover shall be made of 20 gauge sheets with necessary stiffeners and framework to prevent sag. The bottom lock plate shall be made of 5 mm thick M.S. plate and 95 mm wide, reinforced with angle/T iron of suitable section with 6 mm dia M.S. rivets interlocked with last stride of curtain.

The locking arrangement shall consist of sliding bolts at both ends of the bottom plate fitted to engage with suitable receiving pockets at the bottom of guide channels.

Unless otherwise specified, for overall area of rolling shutters up to 9 sq.m, pull and push type hand-operated shutters shall be used. For area between 9 and 12 sq.m, pull and push type shutters shall be provided with ball bearings. For area larger than 12 sq.m mechanical gear type or electrically operated shutters shall be supplied.

Rolling grills shall be constructed out of 6 mm dia. rods at 35 mm on centres running horizontally flexible connected with vertical links spaced not more than 200 mm centres. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6 mm dia. rods.

7.5 Steel Windows and Ventilators

All steel work shall be as per the following items of Bangladesh Khulna Region – Local Government Engineering Department (LGED-2017) Schedule of Rates.

1. Steel glazed window shutters (1/3 glazed + 2/3 panelling) – 5.08.12.01
2. Combined Steel window (frame and grill welded together) – 5.08.12.02

All welds shall be dressed flush on all exposed and contact surfaces.

All windows shall be outside glazed fixed with putty or metal glazing beads.

7.6 Aluminium Doors, Windows, Glass Walls and Louvers

Aluminium doors, windows and glass walls as well as aluminium frames shall be powder coated.

All hardware shall be of concealed construction in the aluminium frame.

All doors shall be provided with door closer, door stops.

Aluminium alloys shall be of uniform quality, free from defects impairing strength and durability with regularity of surfaces and accuracy of right angles. Aluminium windows at high levels shall be fitted with mechanical devices of type approved by the Owner to allow for opening of such windows from the ground level.

Marble sills of 30 mm thickness shall be installed under the windows.

Door and window elements shall be fixed to the structure by means of separate rectangular hollow galvanized steel or aluminium frame.

Joints of door and window frames to the walls shall be covered with aluminium angle on each side and they shall be sealed with permanent elastic material in accordance with the manufacturer's instructions. For air-conditioned rooms, the aluminium windows shall have double glazing.

7.7 Wooden Doors

All wood work shall be as per the following items of Bangladesh Khulna Region – Local Government Engineering Department (LGED-2017) Schedule of Rates.

1. Door frames – 5.07.01
2. Door shutters (solid) – 5.08.01
3. Door shutters (flush) – 5.08.02
4. Door shutters (panel) – 5.08.03 and 5.08.04
5. Door shutters (grooved panel) – 5.08.05
6. Particle board shutters (solid) – 5.08.06
7. Door shutters (fixed louver) – 5.08.07
8. Door shutters (glazed louver) – 5.08.09

All doors shall be of solid core with minimum thickness of 44mm. The core shall consist of fully glued laminated board / block board of reverse straight grain timber strips each of which shall be continuous through the height of the door except for 150 mm rails top and bottom. The core shall be planed true overall to receive plywood facing.

All doors shall have 150 mm 1st class hardwood rails for the full thickness and width of core as well as around all openings to cover the end grains of the laminated boards. The plywood facing on both sides shall be well matched teak or commercial 3 ply veneering with vertical grains or cross bands having minimum thickness of 6 mm as per requirement. Hardwood lipping of the same timber as the face veneer shall be provided at all edges of the door as well as to the opening for glazing.

All doors shall be covered by natural veneer. Door frames shall be minimum 75 mm thick and 125 mm wide. They shall be fixed to the RCC / masonry frames around the door by screws / hold fasts (MS strip lugs) and shall be provided with adequate rubber sealing. The

minimum number of fixtures shall be five screws or three holdfasts on each side of the frame. Holes for screws shall be drilled with a rotary drill and filled with wooden plugs, raw plugs or hold fasteners. Clearance of doors shall be 3 mm at jambs and heads. All hardware shall be heavy duty of non-corroding materials (stainless steel / anodized aluminium / oxidised copper / brass). Each door leaf shall be furnished with the following:

- Hinges preferably 140 mm high pivoted with ball bearings
- 1 Heavy door lock with profile cylinder for master-key system
- Stainless door level handles of 125 mm
- Stainless door handle plates or roses
- 1 Door stop sealed with PVC or rubber strips to reduce impact sound

7.8 Wooden Windows and Ventilators

All wood work shall be as per the following items of Bangladesh Khulna Region – Local Government Engineering Department (LGED-2017) Schedule of Rates.

1. Ventilator shutters (glazed louver) – 5.08.08
2. Window shutters (glazed) – 5.08.10
3. Window shutters – 5.08.11

8 GLAZING

Double glazing shall consist of two 6 mm thick clear toughened safety glass, hermetically sealed and separated by 12 mm thick gap for thermal insulation.

For single glazed aluminium partitions and doors, Float glass of minimum 6 mm thickness shall be used.

Ground glass / frosted glass of minimum 4 mm thickness shall be used for all windows / ventilators in toilets.

Wired glass

Wired glass shall be polished on both sides and shall be transparent. It shall be square pattern wired. The wired glass will be used for doors and windows etc. and also used in fire resistant doors of up to 30 minutes resistance.

Putty for glazing to wood shall be linseed oil putty.

Outer glazing shall be rain-proof. For metal and aluminium frames, structural U-channel gaskets of synthetic rubber (neoprene) shall be use as sealing strips.

9 VERTICAL HEAD ROOM

All accessible areas shall be provided with minimum clear headroom as follows, unless otherwise specified:

Doors, Walkways, Platforms, Stairs etc.	-	2100 mm
Residential rooms without false ceiling	-	3000 mm
Non Residential rooms without false ceiling	-	4000 mm

False ceiling areas – residences	-	2400 mm
False ceiling areas – public buildings	-	3000 mm

10 RCC STAIRS

Normally for all RCC staircases,

Minimum clear width of stairs	-	1500 mm for residential buildings
	-	2500 mm for public buildings
Minimum width of tread	-	300 mm
Maximum height of riser	-	150 mm
Maximum no. of risers in one flight	-	15

11 STEEL LADDERS

Ladders shall be provided to platforms, walkways and areas which do not require frequent access.

Ladders shall have minimum clear width of 450 mm with 20 mm diameter MS rungs at a maximum spacing of 300 mm. The steel ladders shall be made of side rails of 65 mm width and 12 mm thickness flats and 20 mm diameter rungs welded to the side rails. The side rails shall be bent at the top of the ladder and fixed on the roof / floor of the structure to allow for climbing down.

Ladders shall be provided with safety cage of minimum 750 mm diameter clear when the top of ladder is more than 4.5 m above the lower landing level. However safety cages shall start at 2.5 m above the lower landing level. The cage shall consist of 50mm width and 6 mm thickness steel bar hoops bent to the specified radius and spaced uniformly and horizontally on a maximum of 1000 mm with 5 equally spaced vertical steel bars fixed on the inside face of hoops.

Ladders and safety cages shall be galivanized.

12 HAND RAILS

All wooden hand rails work shall be as per the following items of Bangladesh Khulna Region – Local Government Engineering Department (LGED-2017) Schedule of Rates - Solid Wooden Handrails – 5.07.05

Handrails shall be provided at appropriate places to ensure safety e.g. walkways, etc.

Handrail shall be a two-rail system with elevations of each rail from floor level shall be as listed below.

- the top rail at 1000 mm
- the bottom rail at 500 mm

All handrails shall be of stainless steel of Grade 316.

Handrail post spacing shall be limited to 1500 mm as far as possible but can be proportioned to the length of the protected horizontal opening and shall not exceed 1850 mm in such a case.

All handrails on floor level (instead of kerbs) shall be provided with kick plates of minimum thickness of 8 mm & projecting 100 mm above the floor surface.

13 FLOOR DRAINAGE

For all buildings and areas, suitable arrangement for draining out water collected from leakage, floor washing, fire fighting etc. shall be provided on each floor.

Garland drains shall be provided around all buildings to receive the drainage water from roof and floor and lead them to the township storm water drainage system.

14 ROOF DRAINAGE

Roof drainage system shall be provided for quick and efficient draining of rain water from roof. For efficient drainage of rain water, roof shall be given a gradient of a minimum of 1 in 100. Gradient may be provided using screed concrete. The average thickness of such screed concrete may be restricted to about 75 mm.

Roof drainage system shall consist of roof drain heads, rainwater down comers and fixtures. System shall be designed to handle design for the specific site. Roof drains shall conduct water to storm drains around the building.

The rain water down comer pipes shall be HDPE pipes of minimum 150mm diameter.

15 SUMPS

In case of underground structures, sumps with pumping arrangement shall be provided at suitable location to collect and pump out any incidental water collection.

16 WATER PROOFING OF UNDERGROUND STRUCTURES

All underground structures like water retaining structures, other deep underground structures, etc., shall have plasticizer cum waterproofing cement additives. In addition, limits on permeability shall also be met with. Also provision shall be made on the inner surface of walls and base slab, so that water proofing grouting can be injected later in case of leakage after hydro test. Construction joints of underground structures, where water tightness is required, shall be provided with waterstops. Hydro test for water tightness shall be done at full height as directed by the owner.

The concrete surface of structures in contact with soil shall be provided with water proofing treatment using minimum two coats of bituminous painting of grade 85/25 at 1.7 kg/sqm minimum.

17 TOILETS AND BATHROOMS

Attached toilets in residential buildings shall have 1 No WC, 1 No Wash basin, 1 No Mirror, 1 No Towel rail, 1 No Liquid soap holder cum dispenser. WC shall be of western type with toilet paper roll holder and all fittings including flushing valve of appropriate capacity and

type.

Toilet fittings shall be of chromium plated brass (fancy type).

Eastern type WC shall be with all fittings including flushing system of appropriate capacity and type.

Western type WC shall be with toilet paper roll holder and bibcock and all fittings including, flushing system of appropriate capacity

Push shower shall be provided for all water closets.

Urinal shall be with all fittings with quarter turn tap flushing system

Wash basin (oval shape) shall be fixed on concrete platform finished and under fixed with 20mm thick polished granite stone.

25mm dia Stainless steel towel rail shall be with all fittings – one set each for WCs and Wash basins

Liquid soap holder cum dispenser shall be provided – one each for all wash basins

Janitor room shall be provided.

Provision for installation of water cooler with recessed floor and stainless steel grating for draining of spillage water, including provision for potable water supply connection.

Photo-voltaic control fittings and electric operated hand dryer shall be provided for all wash basins of public buildings.

Wall to wall Bathroom mirror (6 mm thick float glass) with high square edges including all fittings shall be provided near all wash basins of public buildings.

Number of exhaust fans shall be decided as per ventilation requirements to maintain hygienic conditions.

All sanitary appliances and fittings shall be inspected and tested. All defects and deficiencies detected shall be promptly rectified by the Contractor to the satisfaction of Owner.

18 WATER SUPPLY & SANITATION

All material for plumbing and sanitary installation shall be suitable for their intended purpose and appropriately matched to each other. All material and structural components shall be standardised and shall meet the respective quality and dimensional requirements. The Contractor shall submit samples, description, catalogues and/or drawings showing all technical details, type, manufacturer etc. of the offered materials for Owner's approval.

All plumbing and sanitary works shall be executed by a licensed or authorized plumbing supervisor or a licensed or authorized plumber and shall be in accordance with relevant codes.

Any damage caused to floors, walls etc. during execution of the sanitary and plumbing works shall be made good by the Contractor to the satisfaction of the Owner.

All sanitary fittings shall be procured from approved vendors and shall conform to the requirements of the relevant Codes.

Glazed earthenware fittings shall be of reputed make, white colour and one piece construction. All metallic fixtures like taps, stop cocks, soap holders etc. shall be of Chromium Plated (CP) brass of approved make. All wall fittings shall be fixed with wooden cleats and CP brass screws and washers.

Roof water tank of adequate capacity depending on the number of users and 8 hours requirement shall be provided for each building and pump house. The tank shall be complete with all fittings including float valve, stop cock etc.

Installation

All execution will be done on the basis of approved drawings / instructions given by the Owner. Fittings shall be located and oriented to allow easy reach such that operation, maintenance, repairs and replacements of pipes, fittings and fixtures are conveniently possible.

Sanitary Appliances

All sanitary appliances shall be fixed in position rigidly on floor and walls as indicated in the drawings or as directed by the Owner. All appliances shall be from the approved manufacturer and of approved colour.

Eastern Water Closet - Squatting type

Squatting type water closet shall be fitted on trap and shall be jointed with gasket yarn and cement mortar. Rim of the pan shall be levelled properly and set flush with the finished floor. Valve type flushing system shall be provided.

European Water Closet - Pedestal type

Pedestal type water closet shall be rigidly fixed on the finished floor by means of 75mm long brass screws with suitable plugs. Valve type flushing system shall be provided.

Urinals

Standing type urinals with suitable partitions shall be firmly fitted on finished wall by means of 50mm long brass screws and suitable plugs. Height of the lip from the standing point shall be as shown in the drawings.

Wash basin

Wash basin shall be fitted in position true to level on a pair of cast iron brackets fixed to the wall with brass screws and plugs. The basin shall be fitted with 15mm dia approved quality CP pillar tap and 32 mm dia waste fittings.

Sink

Stainless steel sink shall be levelled properly and fitted in position on a pair of cast iron cantilever brackets firmly embedded in the wall in cement mortar (1:4). The sink shall be

fitted with chromium plated brass waste fittings of standard size. The type of waste pipes and their connections shall be as directed by the Owner.

DETAILED TECHNICAL SPECIFICATION

SECTION – B1 - CIVIL

SUB SECTION – 3.4

FINISHES

TABLE OF CONTENTS

1 FLOORING

The nominal total thickness of floor finish shall be 50 mm including under bed and topping. The flooring shall be laid on already matured concrete base. The under bed for floors shall consist of cement concrete screed with stone chips 12.5 mm down graded as coarse aggregates. The under bed shall be provided with appropriate slope towards catch pit for floor drainage.

All tiles and marble stone work shall be as per the following items of Bangladesh Khulna Region – Local Government Engineering Department (LGED-2017) Schedule of Rates.

1. Mosaic Terrazo tiles – 5.15.01
2. Glazed Wall tiles – 5.15.02
3. GP (Homogeneous) glazed floor tiles – 5.15.03
4. GP (Homogeneous) unglazed floor tiles – 5.15.04
5. GP mirror polished floor tiles – 5.15.05
6. Stair Steps – 5.15.06
7. Marble Stone Flooring (Italian or equivalent) – 5.15.10
8. Marble Stone Flooring (Indian or equivalent) – 5.15.11
9. Black Granite floor tiles – 5.15.12
10. Black Granite wall tiles – 5.15.13

2 SKIRTING / DADO

Skirting Tiles shall be as per item 5.15.07 of Bangladesh Khulna Region – Local Government Engineering Department (LGED-2017) Schedule of Rates.

100 mm skirting matching with floor finish shall be provided in all areas where dado is to be provided.

Staircase wall shall be given dado to a height of 1200 mm.

3 PLASTERING

All brickwork shall be provided with plastering on both faces and internal and external painting.

For sand cement plaster, sand and cement in the specified proportion shall be mixed dry on a watertight platform and minimum water added to achieve working consistency.

External face of all walls shall be provided with 20 mm thick cement mortar plastering with an under layer 12 mm thick in CM 1:5 and top 8 mm thick layer in CM 1:3 (Sand faced) with approved water proofing compound.

For internal walls 18 mm thick plaster in CM 1:4 shall be provided on the uneven (rough) side of the wall and 12 mm thick plaster in CM 1:4 on the even (plain) side of the wall.

Ceiling plastering of 6 mm thick with CM 1:3 shall be provided for all buildings.

Plastering for sunshades shall be 12mm at top and 6 mm at soffit with CM 1:4.

Internal plastering on walls shall be done to cover surfaces from skirting level to bottom of roof/floor slab in all areas including areas where false ceiling is provided.

The under coat shall be scratched or roughed before it is fully hardened to a mechanical key.

All drips, grooves, mouldings and cornices as shown on drawing or instructed by the owner shall be done with special care to maintain true lines, levels and profiles.

After the plastering work is completed, all debris shall be removed and the area left clean.

Neat cement finish:

After achieving a true plastered surface with the help of wooden straight edge, the entire area shall be uniformly treated with paste of neat cement at the rate of 1 kg/sq.m and rubbed smooth with a trowel (Aldeck smooth finish).

Curing:

All plastered surface after laying shall be watered, for a minimum period of seven days, by an approved method, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall commence, as soon as the plaster has hardened sufficiently and not susceptible to damage. Each individual coat of plaster shall be kept damp continuously, for at least two days, and then dried thoroughly, before applying the next coat.

Plaster-of-Paris Punning

Inside surfaces of walls shall be provided plaster of paris punning over the plastered surfaces.

The thickness of punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation. Before bulk work is taken up, a sample of punning shall be done on roughly 1 sq.m area and approval of Owner taken. The work shall then be completed as per approved sample.

4 PAINTING

All white washing, painting, distempering, polishing and varnishing works shall be as per the following items of Bangladesh Khulna Region – Local Government Engineering Department (LGED-2017) Schedule of Rates.

1. White washing – 5.16.01
2. Cement Paint – 5.16.03
3. Distempering – 5.16.04
4. Plastic emulsion painting – 5.16.05
5. Acrylic emulsion painting – 5.16.06
6. Chlorinated rubber painting – 5.16.07
7. Exterior weather coat – 5.16.09

Following general instruction for painting shall be followed.

a) All paints shall be of best brand and make.

b) A minimum of two finishing coats of paint over a primer shall be provided to give a smooth uniform finish for the painted surface.

c) All painting on masonry or concrete surfaces shall preferably be applied by rollers.

d) Thinner shall not be used with textured paint (Matt etc) finish.

Preparation of Surfaces

All surfaces to be painted shall be smooth, even and free from dirt or rubbish and shall be dry and protected from dampness. In general, all surfaces shall be free of any material which will adversely affect the adhesion or appearance of paint.

Plaster surface	All defective plaster shall be cut out and trimmed. All holes in internal plaster faces shall be made good with approved material. All dirt and powdery substrate shall be removed by wiping with slightly damp cloth. Concrete surface All laitance shall be removed by wire brush. All holes, defects shall be filled and repaired by epoxy grouts.
New metal surface	All dust and / or mill scale etc. shall be removed with a wire brush or chipping hammer or grinding if necessary. The surface of the metal work shall then be primed with an approved metal primer before application of the undercoat.
Wood surface	All iron mongery shall be removed prior to the preparation of surfaces and shall be re-fixed upon completion of painting. All knots and resinous parts in wood surfaces shall be treated by two coats of shellac varnish. All cracks and holes shall be treated by one coat of primer and filled with approved filler.

Application of Paints

Before applying the paint, all prepared surfaces shall be dry and clean. All priming paints shall be applied by brush except for etch primer which may be applied by brush or spray. Paints shall be applied as evenly as possible to provide a smooth coating of uniform thickness. Damaged areas of priming coats or undercoats shall be made good before further coats of paints are applied. The various coats of paint shall be distinguishable from each other by their shade. The Contractor shall inform the owner in good time before starting to apply the next coat so that the owner shall have the opportunity of approving the previous coat. Painting systems shall not be carried out at temperature above 45° C. Trial coats shall be prepared at the request of the owner. The Contractor shall, upon completion, remove all paint where it has been spilled, splashed or spattered on surfaces including sanitary fixtures, glass and hardware. It shall be removed without marring the surface finish of the item being cleaned.

5 ROOF WATER PROOFING

Screed concrete 1:2:4 (1 part cement, 2 part sand, 4 parts of aggregate by volume) having minimum 25mm thickness at the lowest point of the slope shall be laid over R.C.C. Over the finished surface PU based water proofing treatment shall be applied. This treatment shall include one coat of polyurethane or any other equivalent material based primer with an application rate of minimum 6 sq.m per litre and two successive liquid coatings of high solids

content urethane pre-polymers or equivalent material based finish coats as per relevant ASTM standards to form an elastomeric membrane with overall dry film thickness of 1.5 mm. Top of the elastomeric membrane shall be finished with 25mm thick PCC (1:2:4) cast in panels of maximum 1.2 x 1.2m size and reinforced with 0.56mm dia galvanized chicken wire mesh and sealing of joints using sealing compound. However, chequered concrete tile flooring 22 mm (min.) thick of approved colour and shade shall be provided for path way of 1 meter width for access of personnel and handling of equipment and for the entire area of the roof where equipment like AC / Ventilation units, cooling towers, etc. are provided. Equipment shall be installed on raised pedestal of minimum 30 cm height from the finished roof to facilitate maintenance of roof treatment in future.

Haunched portions shall be treated properly.

The slopes and surface level shall be such as to allow quick draining of water without leaving any pool anywhere.

The water tightness of the roof shall be tested by ponding the roof with 300mm height of water for 7 days and checking for any signs of leakage.

The Contractor shall furnish a performance guarantee of all the waterproofing treatment for a minimum period of five (5) years.

Rain water down take pipe shall be HDPE. It is recommended that the minimum diameter of the pipe shall be kept as 150 mm.

6 FALSE CEILING AND UNDER DECK INSULATION

All false ceiling work shall be as per the following items of Bangladesh Khulna Region – Local Government Engineering Department (LGED-2017) Schedule of Rates.

1. Gypsum / veneered board – 5.17.02
2. Perforated Gypsum board – 5.17.05

DETAILED TECHNICAL SPECIFICATION

SECTION – B1 - CIVIL

SUB SECTION – 3.5

EARTHWORKS

TABLE OF CONTENTS

EARTHWORKS

1 GENERAL

This section applies to all earthwork required for the construction of buildings, structures, pavements, road works, landscaping and burying service lines in the ground.

The Contractor shall satisfy himself as to the ground conditions on the site including the nature of the strata to be excavated, obstructions, possibilities of flooding and such like and shall allow for all provisions necessary to carry out the work in the most suitable manner.

Furthermore, this division applies to excavation works in connection with pavement, roadwork and landscaping.

Generally, all buildings and structures must be founded on bearing strata which means that all excavation work for foundations shall meet the requirements of structural analysis based on the results obtained from the soil investigation and of the available information and instruction given in writing by the Owner.

Furthermore, this division applies to excavation works in connection with pavement, roadwork and landscaping as far as earth and rockwork is concerned and deals with the handling and disposal of the materials to be re-used or taken to soil dumps on or off site.

Excavation shall be done to the required dimensions and shall be finished according to the specified lines and slops, in a way acceptable to the Owner. All necessary precautions shall be taken to cause the minimum possible alteration or disturbance to the material lying under and adjacent to the excavation final lines.

2 FILL MATERIALS

The fill materials used are to be examined and approved. Excavated materials can be used if they fulfill the requirements as specified in Tender Documents. Material approval is required on site.

Source for fill material shall be determined by Contractor. All works related to transport and handling of filling material is in the scope of Bidder/Contractor.

Select fill:

Select fill shall have the following properties:

Well graded, non-cohesive and nearly silt free (silt content not greater than 5%; up to 10% tolerated, except below footings of structures), soils free of organic matter (limit 2%). Decomposing or compressible materials shall not be used.

The material shall be of such nature and character that it can be compacted to the specified densities. It shall be free of highly plastic clays, of all materials subject to decay, decomposition or dissolution and of cinders or other materials which will corrode piping or other metal.

The intention is to use select fill below structures, roads, parking areas etc.

Ordinary fill:

Ordinary fill shall have the following properties:

- For other properties see under 'Select fill'.
- Natural inorganic soils: Organic matter less than 3%.

The intention is to use ordinary fill for non-built areas.

Special fill:

Special fill material shall be gravel or crushed rock.
The intention is to use special fill e.g. as sub-base material for tanks, roads and switchyard areas.

Rip-rap / Rockfill

Rip-rap must be of a size suitable for the place where it is to be used, as determined by the speed of the current, wave height and depth of water. Rip-rap shall be of deformable and yielding construction, using round stones if the intention is to safeguard the underlying ground against scour. If the rock infill is to be used as a foundation for structural components, the aim should be to secure effective bedding of angular stones under water. The stones must be weather and waterproof.

3 EXCAVATION

The works shall be excavated either by hand or by use of excavating plant and tools acceptable to the Owner. Excavation by hand may be required close to existing installations and/or underground services, but subject to special instruction of the Owner. The contractor shall carry out all kind of earth and rockwork for the following particular works as defined hereafter (where applicable):-

a) Clearing and grubbing
b) Excavation of top soil
c) Open cut excavation
d) Backfilling
e) Safety precaution during earthwork
f) Mining or underground excavation (if required)
g) Grading
h) Replacement of material
i) Trench excavation for service lines
j) Embankments
k) Archaeological findings

The excavation for the foundations can be done by machines, if the underground is not disturbed by this procedure. In every case, the last 20 cm above the foundation level are to be excavated by hand.

Safety precaution

The contractor shall be responsible for all necessary safety measures. Proper strutting, sheeting and bracing, including re-arrangement of the installations when necessary, stabilization and protection of slopes, methods of excavation to reduce risks of slides etc shall be to the Contractor’s debit. The additional moving of soil resulting from such damages will not be paid for.

Over excavation

If somewhere, and for any reason, excavation is executed beyond the established lines and without the Employer's previous approval, the Contractor shall at his own expenses backfill with approved material (including required compaction) or with lean concrete.

4 STOCKPILES AND DISPOSAL

Excavated material from the Works selected by the Employer for re-use shall be placed immediately in its final position, if possible, or otherwise may be stockpiled or deposited on Site as directed by the Employer.

Contractor shall remove the excess earth and deposit the excess earth at a location outside the plant boundary duly and in accordance with the local and environmental regulations and subject to BIFPCL approval.

5 PREPARATION OF FOUNDATIONS

All surfaces on which or against which concrete is to be poured shall be carefully cleaned and roughened and shall be free of any detrimental impurities, organic matter or unsuitable material to the Employer's satisfaction.

The surface shall be free of oil, stagnant or running water, mud, loose rock, residue and impurities or any other improper material.

Immediately after excavation, all such surfaces shall be moistened and treated as directed by the Employer and then protected by means of a lean concrete layer, 5 cm in thickness. No concrete is to be poured until formation is inspected and approved by the Employer.

6 BACKFILLING

Foundations and structures shall be backfilled with approved material compacted in layers by suitable equipment until optimum stability has been obtained to the satisfaction of the Employer. Compacting shall be carried out by means of pneumatic or mechanical rollers or other compactors of a type previously approved by the Employer.

Density requirements shall be as follows:

• under buildings and structure foundations and slabs • under roadways and parking areas • under transformers and other major foundations	85% relative density (ASTM D-4253 and D-4254) for free draining soils containing less than 15% by weight finer than 75 micron sieve non plastic material or 98% of the maximum density as determined by ASTM D-1557 for soils containing more than 15% material passing the 75 micron sieve.
• embankment	80% relative density (ASTM D-4253 and D-4254) for free draining soils containing less than 15% by weight finer than 75 micron sieve non plastic

material or 95% of the maximum density as determined by ASTM D-1557 for soils containing more than 15% material passing the 75 micron sieve.

The thickness of fill layers, number of passes and type of equipment to be used shall be proposed to the Employer after compaction tests have been made.

Backfilling of foundation work shall be carried out only after foundations have been inspected by the Employer.

7 SOIL REPLACEMENT

The material to be used for replacement of soil shall not contain soluble or swelling components such as clays, or organic matters. Sand gravel mixtures of favorable grain size distribution shall be used in exchange.

Prior to the commencement of work, samples shall be taken from the anticipated borrow area and tested in respect of Proctor density, optimum moisture content, grain size distribution and content of soluble matters.

The fill material shall be placed in horizontal layers of no more than 25 cm in compacted thickness. The fill moisture content shall be controlled and adjusted in order to achieve a maximum of compaction.

The fill material shall be compacted by vibratory roller (min. weight 20 t).

8 BLASTING

The Contractor shall obtain license from the district authorities for undertaking blasting work as well as for obtaining and storing the explosives as per Explosives Rules 1940, corrected up-to-date.

Explosives used for blasting shall be stored in clean, dry, well ventilated magazines to be built for the purpose. Fuses and detonators shall be stored in separate magazines. Detonators and explosives shall be transported separately to the blast site. Explosive shall be kept dry and away from the direct rays of the sun, naked lights, steam pipes or heated metal and other sources of heat. Only the quantity of explosive required for a particular amount of firing to be done shall be brought to the site of work. All surplus explosives left after filling the holes shall be removed at least 400 metres from the firing point.

A wooden tamping rod shall be used to push the cartridge into the shot hole. Metal rod or hammer shall not be permitted on the site of the works. The charges shall be pressed firmly into place and not rammed or pounded. The explosive shall be fired by means of an electric detonator placed inside the cartridge and connected to the firing cable. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current and to keep the lead wires short circuited until ready to fire.

Holes for charging explosives shall be drilled with pneumatic drills, the drilling pattern being so planned that rock pieces after blasting will be suitable for handling. The locations and depths of the holes shall be chosen so that the bed rock below the design level is not shattered and voids, fissures and cracks below this level are not formed. The rock pieces so blasted shall be neatly stacked at allotted places. Before any blasting is carried out, it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of

minimum 300 metres radius from the firing point, or as required by statutory regulations at least 45 minutes before the firing time by sounding a warning siren.

The area shall be encircled by red flags. All the operations shall be carried out by competent and experienced licensed supervisors. The number of shots fired at a time shall not exceed the permissible limits. Cases of the misfired unexploded charges shall be exploded by drilling a fresh hole alongside the misfired hole (but not nearer than 600 mm from it and by exploding a new charge. The workmen shall not return to the site of firing until at least half an hour after firing. When blasting is conducted in the neighborhood of roads, structures, buildings or any place which requires controlled blasting, only shallow shot holes shall be drilled. These holes shall be filled with a light charge of explosive and the blast controlled by placing steel plates with gunny bags filled with sand or earth over the holes and covering them with wire net fixed to the ground, so as to ensure that the blasted materials do not scatter.

Adequate safety precautions as per building bye-laws, safety code, statutory regulations etc., shall be taken during blasting operations.

Drilling pattern, charge of explosive for blasting and controlled blasting may be obtained by engaging Government authorized explosive consultant.

9 DUST CONTROL

The contractor shall use all means necessary to control dust on roads, construction areas and borrow pits. Surfaces shall be regularly watered to prevent dust becoming a nuisance for the public and interfering with the proper execution of the works.

10 DEWATERING DURING CONSTRUCTION

Prior to the decision for the method and technique to be applied, a comprehensive knowledge of the soil and ground water conditions have to be obtained from the results of the soil investigation and/or information given in writing by the Owner. All costs for ground water control for keeping the construction pits dry shall be included in the relevant excavation items of the lump sum except otherwise indicated.

The scope of supply includes the installation of all equipment, plants, pipes, machinery, etc and its removal after completion including operation & maintenance of the equipment during the construction period.

Where ever necessary, cofferdams, sheet piles, pump sumps, equipment and channels, troughs, inlet gutters, pipes and any other works required for the water control and discharge shall be part of the scope of supply. The dewatering system shall be designed and installed in such a way that alteration and extensions can be made at any time throughout the operating time, if necessary. Reserve units shall be kept ready for service when failure of any of the installed units occurs. The contractor has to consider the possibility of a temporary failure of any pump, diesel engine and/or the electric power service and shall install emergency power units with sufficient capacity to feed the necessary power to the installed unit at the moment of failure. The contractor shall submit to the Owner, the detailed method of the envisaged pumping system for dewatering, the pump capacity and the standby reserve units. The Contractor shall adjust the system if required by the Owner.

The Contractor must ensure that any dewatering works will not cause any interference to his own work and to those of other contractors working elsewhere on site or at structures under

construction. Any damage occurring during the above mentioned period shall then be made good by the contractor at his own expense.

During the foundation works, the excavated areas, foundation levels, and pits are to be kept free of water down to at least 0.50 m below the foundation level.

All equipment, instruments, machineries, tools, pipelines, etc required for execution of the water control shall be in good repair and shall be kept in good working condition throughout the operation period.

11 FOUNDING SOIL

This clause describes all foundation works which are to be performed so as to ensure the bearing of all loads without detriment for and damage to the structures. The contractor has to choose up-to-date methods and equipment to ensure this in accordance with relevant internationally recognized standards.

The soil conditions met during the foundation works especially in the foundation level are to be checked, recorded and compared with previous known or investigated results. If essential differences occur, which could be detrimental to the structures, the contractor has to inform the Owner and to propose further measures. Foundation works in such areas are to be continued only after approval of such measures by the Owner.

If there is any doubt about the soil quality or if discrepancies appear with regard to the previous decisions or investigations stated by the Owner, then additional measures are to be taken after consulting the Owner (e.g. additional excavation and lean concrete fill).

Immediately prior to concreting any footing, the contractor has to verify the specified soil conditions below the foundation level by a sounding.

For soil improvement works i.e. execution of special foundations (except replacement method) only specialised contractors (or sub-contractors) are acceptable subject to providing proof of experience in successful execution of such works in the form of a detailed description and references. Together with the description and the references a detailed execution programme including quality control measures relating to the actual site conditions is to be transferred to the Owner for approval.

12 PIPE BED PREPARATION

Pipe beds shall be constructed to guarantee the uniform transmission of loads. The bearing section for supported profiles shall cover at least an arc of 90°. Pipes shall be bedded in an earth foundation of uniform density and carefully shaped by means of a template supported at the desired grade, to fit the lower part of the pipe exterior.

Where rock in either ledge or boulder formation is encountered, it shall be removed below grade and replaced with suitable materials in such a manner as to provide a compacted earth cushion having a thickness under the pipe of not less than one quarter of outside pipe diameter with a minimum allowable thickness of 200 mm if not otherwise specified.

Where a firm foundation is not possible at the grade established due to soft, spongy or other unstable soil, all such unstable soil under the pipe and for a width of at least one diameter on each side of the pipe shall be removed and replaced with suitable selected materials as approved by the Owner, properly compacted to provide adequate support for the pipe.

DETAILED TECHNICAL SPECIFICATION

SECTION – B1 - CIVIL

SUB SECTION – 3.6

FOUNDATIONS

TABLE OF CONTENTS

FOUNDATIONS

1 GENERAL

All foundations, water retaining structures, trenches, pits, etc., shall be designed as per relevant Codes in general.

2 FOUNDATIONS AND UNDERGROUND STRUCTURES

Foundation design shall be based on approved geotechnical investigation report. The Contractor shall submit a detailed design for the foundation to the Employer for approval. The bid price for the contract shall be lump sum and shall remain firm irrespective of the type of foundation.

The Contractor shall make his own assessment for the type of foundations envisaged based on his site visit and data collected from site during the site visit.

A study of soil liquefaction potential shall be performed using parameters from the geotechnical investigation performed by the Contractor and subject to the Employer's review and approval.

Special measures have to be taken if the results of soil and laboratory tests prove chemical aggressive conditions.

The soil conditions met during the foundation works are to be checked by the Contractor's soil engineer, recorded and compared with previous results. If essential differences occur, the Contractor has to inform the Employer and to propose further measures.

Immediately prior to concreting, the Contractor has to verify the specified soil conditions below the foundation level by a sounding.

From the detailed study of the sub-surface ground conditions, the type of foundations required for each location shall be determined to suit the loads imposed.

The foundation / soil improvement could include any of the following:

- shallow foundations on improved ground
- sand piles
- bored cast-in-place concrete piles
- driven piles, single piece without joint
- vacuum consolidation.

The Contractor may propose any other type of foundation and ground improvement as required provided the proposal is based on proven engineering and acceptable standards and codes of practice. As a part of the design of the works and after fully detailed ground investigations, the Contractor shall submit for the Employer’s approval a comprehensive foundation plan for the works proposing the type of foundation for each part of the works.

Dewatering

During the foundation works the excavated areas, foundation levels and pits are to be kept free of water down to at least 1.0 m below the foundation level.

Waterproofing

All underground structures shall be of water tight concrete in accordance with approved standards and shall be protected against water action and rising damp in accordance.

All foundations, footings and slabs in contact with ground shall receive a bituminous coating.

Pit wall stability

The excavated pit sides, walls or slopes have to be stable and established with respect to safety regulations.

Settlement and expansion joints

Joints are to be arranged in such a way that stresses and strains caused by settlements, temperature, differential settlement, etc. do not adversely affect the structures. The settlement joints shall run through the complete structure down to foundation level, the expansion joints however shall stop on the top level of foundations.

The joint width shall be at least 25 mm or as per applicable standards.

Settlements of all relevant structures shall be measured, recorded and shown in diagrams according to relevant standards.

Foundations at different depths

Foundations at different levels should be based beyond a load spread angle of 30° (against the horizontal).

Safety against uplift

For all parts of the structures extending into the ground water, safety against uplift has to be guaranteed during all execution stages.

Soil replacement

If unsuitable soils are encountered below the foundation level or basement floor, they are to be replaced by suitable layer-wise compacted material down to the bearing soil.

3 PILE FOUNDATIONS

These specifications cover the requirements for the materials, the installation and the realization of bored cast-in-place concrete piles with grouting at the base, if required, and driven piles.

The piling works and design shall be in accordance with relevant standards.

Two types of piles foundation can be proposed and quoted by the Contractor: driven piles or cast-in-place bored piles.

The net vertical pile capacity computed from the soil investigation report is used to determine

the maximum test load in case of piles testing.

Bored cast-in-place piles

The piles are drilled up to the depth indicated by the pile drawing submitted by the Contractor and approved by the Employer. For each pile, the Contractor draws up the geo-technical profile of the drilling with description of the strata and samples taken for each stratum as mentioned in the piling record item of these specifications. A representative sample from each stratum will be kept in tight packing until the end of the works.

A suitable type of drilling equipment shall be provided in order to penetrate obstacles (e.g. boulders) which may be met during the execution of the piles.

Generally drilling operations shall be carried out in such a way as to avoid any disturbance of the surrounding soil.

Based on the initial bore log data, temporary casing length shall be 16m below NGL. However, in some cases, it may be required to be terminated in such soil strata where there is a refusal of vibro hammer which will result in lateral deflection of temporary casing.

The bottom of the casing shall always be kept sufficiently below the excavated borehole bottom, in order to prevent inflow or loosening of the adjacent soil.

When drilling below the groundwater table inside the casing shall always be maintained above the natural groundwater level by at least 1.5 m, i.e. water has to be added accordingly.

Just before reinforcing and start of concreting the pile foot is to be cleaned out so that no disturbed, loose or weak soil remains below the pile tip.

Driven piles

The weight of the falling mass must always be adequate to take down the piles at the depth defined at the project.

In case of damages to the adjacent piles, for example observation of concrete raising in the neighboring piles, the Contractor must alter the driving sequence.

The pile driving is carried out following a sequence in order to avoid, as much as possible, an increasing of the driving resistance for the last piles.

Each pile has to be driven continuously until the specified depth has been reached.

The Contractor immediately informs the Employer in case any unexpected change in driving characteristics occurs and proposes methods to solve the problem. A detailed record of the driving resistance over the full length of the nearest available pile will be taken if required by the Employer.

The Contractor gives adequate notice and provides all facilities to enable the Employer to check driving resistances; a set of blows recordings is taken only in the presence of the Employer unless otherwise approved.

The final set of blows has to be recorded for each pile either as the penetration in millimeters per 10 blows or as the number of blows required to produce a penetration of 25 mm (see item on piling record of these specifications).

Staking out-tolerances

The landmarks to be used for the implementation of the piles must be effective, solid and well protected.

The method of location of the piles is a duty of the Contractor. The setting out has to be carried out from the main grid lines of the respective structures.

The maximum allowed deviation of the piles center from the theoretical location shown on the setting out drawing is 50 mm in any direction. The maximum permitted deviation of the completed pile from the vertical is 20 mm per meter (2.0%).

Cut-off

The piles are to be concreted up to a minimum of 60 cm above the cut-off level. The cut-off must eliminate all polluted or poor characteristics concrete at the top of the pile and should be carried 10 cm into sound concrete.

The concreting of the raft may start only after the cut-off of the pile and after obtaining a satisfactory resistance of the pile concrete.

The cut-off must be carefully performed according to a method approved by the Employer. The concrete in the head of the pile shall be carefully broken away from the reinforcement, which shall then be cleaned and bent as shown on the drawings or as directed. The concrete surface at the cut-off level shall be horizontal, plane and free from all loose aggregate.

Piling Records

For each pile, a piling record book giving the main checked values during execution shall be drawn up and updated by the Contractor with all the work hazards and incidents. That record book shall be submitted daily to the approval of the Engineer as the execution proceeds.

This record book shall include for each pile details on:

- location, reference number (corresponding to the number fixed on the drawing), type and diameter of the pile;
- length of the temporary casing;
- date and hour of start and end of each operation drilling, reinforcement setting, concreting;
- level from which the pile is bored or driven (platform level);
- level at the pile base;
- top level of the concreted pile before the cut-off operation;
- used materials (driving or drilling tools, concreting equipment);
- cleaning results of the bottom of the hole before putting down the reinforcement cage and before concreting;
- nature and description of the encountered soils;
- poured concrete volume and theoretical volume (measured concrete curves);
- behavior, workability, fluidity of concrete, results of the compression tests;
- water level within the hole before concreting;
- for driven piles, the refusals corresponding to the three last sets of blows (10 hammer blows) shall be noted for each pile; for one pile from each 20 piles, a driving diagram shall be drown up;

- type of boring-chisel, lengths of piles where chisel has been used.

Records shall be submitted in duplicate to the Engineer every following working day until 9 a.m.

The Contractor shall submit to the approval of the Employer/Engineer a proposal of piling record sheets including all the details mentioned above.

Pile tests

The Contractor shall carry out pile tests on a minimum of 0.5% of total no. of working piles of each type. The piles to be tested shall be to the approval of the Employer.

The tests shall include as minimum:

- compression load test at piles
- lateral load test at pedestal piles.

In addition, at least one Test Pile for each of the main structures shall be tested and approved before the commencement of the working piles for that structure.

The maximum test load shall be 2.5 times the working load for Test Piles and 1.5 times the working load for tests on working piles.

The loading materials and equipment, the measurement devices and procedures shall all be to the approval of the Employer. All tests shall be carried out only under the supervision of an experienced and qualified supervisor familiar with the test equipment and test procedure. All personnel operating the test equipment will have been trained in that field. The number of increments of load shall be a maximum of 25% of the design load,, with a decreasing of load down to zero after each increment.

In the case of a test failing to meet the set criteria, the Contractor shall propose for the approval of the Employer his plan for the necessary changes in the pile design without any cost implication to the Employer.

4 SETTLEMENTS

Settlements have to be calculated according to BS EN 1997-1 or equivalent.

The following requirements for settlements shall be applied:

- Max. settlement 25 mm,
- Max. Differential settlement 1/500 rad.

DETAILED TECHNICAL SPECIFICATION

SECTION – B1 - CIVIL

SUB SECTION – 3.7

CONCRETE WORKS

TABLE OF CONTENTS

CONCRETE WORKS

1 GENERAL

All structures, building foundations, water retaining structures, trenches, pits, etc., shall be designed as per relevant standards..

2 DESIGN METHODOLOGY

General RC Structures

All designs of RCC structures shall be carried out by as per relevant standards.

Liquid Retaining Structures

In case of leakage in the liquid retaining structures injection grouting method shall be applied to repair the structure.

All liquid retaining structures shall be designed assuming liquid up to the full height of wall irrespective of provision of any over flow arrangement.

Approved water proofing compound shall be used for addition in concrete to all liquid retaining structures.

In all liquid retaining structures, PVC water bar shall be provided at each construction / expansion joint. The sequence of construction shall also be specified on drawings showing construction joints.

Design shall also be checked against buoyancy due to ground water during construction and operation stage. Minimum factor of safety against buoyancy shall be ensured empty condition ignoring super imposed loads.

3 STABILITY OF STRUCTURES

Design shall be checked against buoyancy due to the ground water during construction and maintenance stages for structures like under ground tanks, pits trenches, basements, etc. Minimum factor of safety against buoyancy shall be ensured considering empty condition inside and ignoring the superimposed loading. For purpose of calculating downward load due to any overburden, only the mass located vertically above the projected area shall be taken in to consideration.

All building and sub-structures including pump houses shall be checked for sliding and overturning stability during both construction and operating conditions for various combination of loads. Factor of safety for these cases shall be taken

- Factor of safety against overturning shall be 1.5 minimum.
- Factor of safety against sliding shall be 1.5 minimum.
- Factor of safety against uplift due to hydrostatic forces shall be 1.2 and due to any other loads shall be 1.5.

Stability of the structure shall also be investigated for loading conditions during construction, repair or other temporary measures. Lower factor of safety may be used for such loading conditions as per relevant codes.

In case where dead load provides the restoring force, only 0.90 times characteristic dead load shall be considered. Imposed loads shall not be considered as restoring force.

4 EXPANSION / CONSTRUCTION JOINTS

Expansion and construction joints shall be provided wherever required. Maximum spacing between Expansion joints in Concrete structures shall be 45m.

All expansion and construction joints of the water retaining structures and underground structures in RCC shall be made watertight using PVC ribbed waterstops with central bulb. However, kicker type (externally placed) PVC waterstops may be used for the base slabs and in other areas where it is required to facilitate concreting.

A screed layer not less than 100 mm thick of cast in situ concrete shall be provided below all water retaining structures. A sliding layer of craft paper or bitumen paper shall be provided over the screed layer to destroy the bond between screed and base slab.

5 MINIMUM THICKNESS OF STRUCTURAL ELEMENTS

The following minimum thickness shall be followed :

Suspended floor slab / roof slab / walkways / canopy slabs etc.	-	125 mm
Ground floor slab (non — suspended)	-	150 mm
Water Retaining Slab / Walls	-	200 mm
Cable / Pipe Trenches / Underground pit	-	125 mm
All footings (including raft foundations)	-	300 mm
Tapered footings	-	200 mm (Min. at edges)
Parapets	-	125 mm
Sunshades	-	75 mm at edge
Precast louvers / fins	-	50 mm
Precast trench cover slabs / floor slabs / louvers	-	75 mm
Paving	-	100 mm
Pile cap	-	500 mm
Basement walls and base slab	-	200 mm

Underground reservoir

- Below ground water table - 200 mm
- Above ground water table - 150 mm

6 CONCRETE MIX

The type of cement to be used shall be as per Geotechnical Investigation report and shall satisfy the requirements of the applicable international and local Standards or equivalent.

Ordinary Portland Cement (OPC) or fly ash based Portland Pozzolona cement shall be used.

For aggressive/saline soil approved cement shall be used.

Mix design shall be as per applicable design standard.

The following minimum grades of concrete shall generally be used for the type of structures noted against each grade.

Mass concrete filling	C 8/10
PCC below pile cap / foundations and all vibratory foundations	C 12/15
PCC below Paving incl. plinth protection	C 12/15
RCC in grade slabs and paving	C 20/25
RCC for roads	C 30/37
RCC for superstructure works	C 30/37
RCC in foundation and water retaining structures	C 30/37
Precast RCC trench covers	C 40/50
Encasement of Base plate / Steel columns	C 20/25
Drain / cable trench	C 25/30

Intermixing of different grades of concrete in the same structure shall not be allowed in a particular structural element.

The Cement content and water cement ratios shall be as per the concrete mix design report subject to a minimum cement and maximum water cement ratio as per relevant standards.

For water retaining structures the minimum water cement ratio shall be 0.45

Unless specified 20mm and downgraded aggregates shall be used for all structural concrete works. However 40mm and downgraded aggregates may also be used under special conditions for foundation. Sound and durable crushed stone aggregates shall be used. All aggregates shall be tested for alkali aggregate reaction. Materials, which contain high percentage of reactive silica, shall not be used. In exceptional cases of high percentage of

reactive silica content, aggregate may be allowed where low alkali cement shall be used.

7 REINFORCEMENTS

High strength deformed steel shall be used for all RCC structures. The grade of reinforcing steel shall be as per BS 4449 Grade B500B or equivalent.

Reinforcement shall be selected based on aggressive condition, especially for below ground structures.

All reinforcement shall be of TMT bars and shall be used for all RC structures unless specified elsewhere.

Inter mixing of different grade of reinforcing bars in the same structure shall not be allowed in a particular structural element.

Minimum percentage of reinforcement shall be as per relevant applicable standards.

Two layers of reinforcement (on both inner and outer faces) shall be provided for RCC wall sections having thickness 150 mm or more, even if not required from design consideration.

Reinforcement or dowel bars for future connection of the structural works shall be protected by cement paint, if they are to be left exposed for a long time

8 GROUTING

Non-shrink flowable grout shall be used for under pinning work below base plate of columns. Non-shrink cum plasticizer admixture shall be added in the grout.

Crushing strength of the grout shall generally be one grade higher than the base concrete.

Surfaces to be grouted shall be thoroughly roughened and cleaned of all foreign matter and laitance.

Anchor bolts, anchor bolt holes and the bottom of equipment and column base plates shall be cleaned of all oil, grease, dirt and loose material. The use of hot, strong caustic solution for this purpose will be permitted. Prior to grouting, the hardened concrete surfaces to be grouted shall be saturated with water. Water in anchor bolt holes shall be removed before grouting is started.

Forms around base plates shall be reasonably tight to prevent leakage of the grout. Adequate clearance shall be provided between forms and base plate to permit grout to be worked properly into place.

Grouting, once started, shall be done quickly and continuously to prevent segregation, bleeding and breakdown of initial set. Grout shall be worked from one side of one end to the other to prevent entrapment of air. To distribute the grout and to ensure more complete contact between base plate and foundation and to help release entrapped air link chains can be used to work the grout into place.

Grouting through holes in base plates shall be by pressure grouting.

Forms and shims used to obtain adequate clearance shall not be removed and the anchor

bolts shall not be tightened for at least three days after placing the grout. After the removal of forms and shims, area occupied by shims shall be filled and the area between the base and edge of the foundation shall be finished smooth to allow drainage away from the base.

9 MINIMUM COVER TO REINFORCEMENT

The minimum cover to the main reinforcement for all the structures, unless otherwise specified, shall be as follows :

		Bottom (mm)	Sides (mm)	Top (mm)
A.	**Substructure Work**			
1.	Foundation / Pile Cap	75	60	60
2.	Columns / Pedestals / Grade Beams / Tie Beam	60	60	60
3.	Trenches, Pits, Walls, Duct Bank, etc	60	60	60
4.	Equipment foundation	60	60	60
5.	Grade slab	40	60	40
B.	**Superstructure Work**			
1.	Columns	-	40	-
2.	Beams	40	40	40
3.	Slabs / Walls	40	-	25
4.	Lintel, Projections above windows / doors, RCC bands in Walls, etc	40	40	40
5.	Pre cast concrete	40	40	40

10 CORROSION PROTECTION OF CONCRETE STRUCTURES

Admixture

Corrosion Inhibiting Admixture shall be used in concrete. Dosage as per manufacturer specifications shall be compatible with the type of cement used.

11 CONSTRUCTION REQUIREMENTS

11.1 Materials

The materials described below shall be specified and used.

11.1.1 Storage of Materials

All materials shall be stored and handled in a manner that will prevent contamination and / or deterioration. Deteriorated and / or contaminated material shall not be used for the concrete and shall be removed from the site at the expense of the contractor.

11.2 Aggregates

Fine aggregates shall be clean natural sand.

Coarse aggregates shall be crushed rock.

Materials used as aggregate shall be obtained from a source known to produce aggregate

satisfactory for concrete and shall be chemically inert, strong, hard, durable, of limited porosity and free from adhering coats, clay lumps or organic impurities that may impair the strength or durability of the concrete. Aggregate shall comply with and be tested in accordance with the requirements of applicable standards.

Each size of aggregate shall be separately stored in a manner that will prevent contamination, intermixing and/or segregation. The equipment and methods of handling aggregates shall be such as to prevent deterioration and contamination of the stockpiles.

11.3 Binding wire

Binding wire for general use shall be 1.6 mm dia annealed wire.

11.4 Waterstops

Waterstops shall be PVC or equivalent and shall be used. Type and manufacturer shall be submitted to the Owner's approval. The minimum thickness and width of PVC waterstops shall be 6 mm and 225 mm respectively. For base slab, kicker waterstops shall be used.

All intersection pieces shall be prefabricated by the manufacturer and only welding of butt-joints in running lengths will be allowed to be carried out on the site.

The site welding of butt-joints shall be executed by using the manufacturer's purpose-made electrically heated jig and work shall be done by a competent and trained personnel only. The manufacturer's instructions shall be carefully observed.

The wings of the waterstops shall be formed with corrugations or bulbs to achieve a good bond. Moreover, the waterstops shall conform to the following requirements:-

a) The tensile strength not less than 10 N/sq.mm when tested.
b) The ultimate elongation shall not be less than 22% when tested.
c) The tear resistance shall not be less than 2 N/ sq.mm when tested.
d) The material shall not crack when tested.
e) Under accelerated elongation, the tensile strength shall not be less than 8 N/ sq.mm and the ultimate elongation shall not be less than 200%.

The waterstops shall be installed so that they are securely held in position during the placing of concrete which shall be fully and properly compacted around the waterstops to prevent voids or porous areas. Adequate clearance between the reinforcement and all the waterstops shall be kept to permit proper compaction of concrete.

No holes or nailing shall be made through any waterstop for fixing purposes. Jointing by lapping two pieces of waterstops shall not be permitted. The free edges of waterstops shall at all times be protected from direct sunlight.

11.5 Concrete Additives

If necessary, concrete additives could be used to improve consistency, workability, quality and strength of the concrete. Waterproof concrete and mortar shall be used where necessary.

Waterproofing shall be achieved by an approved brand of additive, which shall be used in accordance with the manufacturer's instructions.

Plasticizer/ superplasticizer cum water proofing additives of approved make shall conform to BS 934 or equivalent international standard.

Accelerating and retarding additives shall only be used in case of necessity and after obtaining the written approval of the BIFPCL.

11.6 Water

Clean water of potable quality shall be used in all concrete mixes.

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel.

Ph value of water shall not be less than 6.

The concrete supplier shall provide chemical and physical test data for each source of water to be used prior to use.

When water is transported in tank trucks, each unit shall be accompanied by a chemical test report indicating compliance with the above requirements. All water to be analysed by an independent laboratory before any work commences and at intervals as direct by the Owner.

The contractor shall make his own arrangement for water for construction and other purposes.

11.7 Formwork Requirements

Plywood formwork shall be used for all water retaining structures and for all over ground concrete works. For other areas steel / plywood formwork shall be used.

No metal part of any device for maintaining formwork in the correct location shall remain permanently within the specified concrete cover to the reinforcement.

In watertight construction, methods of fixing formwork, which result in holes through the concrete section when the formwork is removed, shall not be used. All wall ties shall have water baffles and wall kickers shall be cast monolithically with the base slab.

Approval for the size, type and position of any holes, insert or fixing required by Contractor shall be obtained before work proceeds. Unless otherwise specified or approved all holes shall be formed and all inserts cast in at the time of pouring No part of the concrete works shall be drilled or cut away without approval.

Formwork panels shall be stiff enough to prevent damage to the concrete surface caused by excessive movements of the panel during vibration of the concrete.

Damaged and used formwork shall not be re used without repairing.

All joints in form work and joints between the form works shall be sufficiently tight to prevent loss of liquid from the concrete through these joints.

The part of the ties shall be capable of being removed, so that no part remaining embedded

in the concrete shall be nearer the surface of the concrete than the specified thickness of cover to the reinforcement. Holes left after the removal of ties shall be filled with concrete or mortar of approved composition.

Formwork props shall be positioned between permanent supports so that all members are supported at not more than 3 meters centre in both directions.

The props shall be in the form of space frames, composite or single members with sufficient stiffness or bracing so that props shall neither sway nor buckle under loads which they are designed to carry.

The formwork or the false work shall not be removed from a structural component until Contractor ensure that the concrete has attained sufficient strength.

The concrete is to be regarded as sufficiently hardened when the component has attained such strength that it can resist all loads acting at the time of removal of the formwork.

Particular care shall be taken with components which have to carry virtually the full design load directly upon removal of the false work (e.g. in the case of roofs, or floor slabs which have to support loading from floors above them which have not yet hardened).

Props shall remain in position for as long a period a possible, particularly for structural components, which are subjected to a major proportion of their design loading as soon as the formwork has been removed.

No superimposed load shall be allowed on any part of the concrete work prior to the removal of the forms and props.

11.8 Construction, expansion and contraction joints

11.8.1 Construction joints

The number of construction joints should be kept as low as possible consistent with reasonable precautions against shrinkage. Concreting should be carried out continuously up to construction joints.

Where it is necessary to introduce construction joints, careful consideration should be given to their exact location, which should be indicated on the drawings. Alternatively, the location of joints should be subject to agreement between the Owner and the Contractor before any work commences.

Construction joints should be at right angles to the general direction of the member and should take due account of shear and other stresses.

Concrete should not be allowed to run to a feather edge and vertical joints should be formed against a stop board.

The top surface of a layer of concrete should be level and reasonably flat unless design considerations make this undesirable. Joint lines should be so arranged that they coincide with features of the finished work.

If a kicker (i.e. a starter stub) is used it should be at least 70 mm high and carefully constructed. The kicker must be incorporated with the previous concrete.

Where possible, the formwork should be designed to facilitate the preparation of the joint surface, as the optimum time for treatment is usually two to four hours after placing.

The maximum horizontal length of wall to be poured in one operation in any one direction is 7.5 metres. A period of 7 days to be allowed between adjacent pours except where waterstops are provided when this can be reduced with Owner's approval. Alternatively a gap of 600 mm wide shall be left between adjacent pours and filled after 7 days from the date of formation subject to Owner's approval.

Immediately prior to recommencement of concreting on a joint, the surface of the concrete against which new concrete will be cast should be free from laitance and should be roughened to the extent that the largest aggregate is exposed but not disturbed. Care should be taken that the joint surface is clean immediately before the fresh concrete is placed against it.

Particular care should be taken in the placing of the new concrete close to the joint. This concrete should be particularly well compacted and if possible a vibrator should be used.

Where the Owner considers that special preparation is necessary, i.e. for an in-situ structural connection, preparation should be carried out preferably when the concrete has set but not hardened, by spraying with a fine spray of water or brushing with a stiff brush, which is sufficient to remove the outer mortar skin and expose the larger aggregate. Where this treatment is impracticable, sand blasting or a needle gun should be used to remove the surface skin and laitance. Hacking of hardened surfaces should be avoided.

A record shall be kept on site of the time and date of placing the concrete in each section of the work.

11.8.2 Expansion and contraction joints

The expansion joints, contraction joints and other permanent structure joints shall be provided in positions as shown in the drawings. Joints shall be straight and vertical, except where other specified, and concrete surfaces on both sides of the joint shall be flush. Where necessary, waterstops of a type approved by the Owner shall be embedded in the concrete. The waterstop should be made of high quality material which must obtain its resilience through the service live of the structure for the double function of movement and sealing.

The surface of waterstops should be carefully rounded to ensure tightness of the joint even under heavy water pressure. To ensure a good tightness with or without movement of the joints the waterstop should be provided with anchor parts. The cross-section of the waterstops should be determined in accordance with the presumed maximum water pressure and joint movements. The complete works of fixed and welded connections must be carried out strictly in accordance with the manufacturer's instructions.

All joints between structural steel and concrete parts shall be sealed by a suitable permanent flexible compound.

11.9 Waterproofing and protection of underground concrete structures

Water aggressive to concrete should be kept away from the fresh concrete. Concrete which is exposed for a prolonged period to "very severe" chemical attack must be protected against direct access of the aggressive substances. The protection, which is to be laid as protection

to all concrete surfaces in contact with the ground, shall consist of an approved waterproofing membrane. The membrane shall adhere to all concrete surfaces, including undersides of structures and other surfaces where concrete is cast in contact with the membrane. Such membranes shall be PVC sheets of minimum 0.35 mm thickness. The waterproof membranes shall be installed in strict accordance with manufacturer's instructions.

The membranes shall extend 15 cm above ground level.

When setting forms and reinforcing steel caution shall be exercised to avoid damage to the impervious membrane. The surface of the impervious membrane extending outside the forms shall be protected during subsequent operations. Any puncture or damaged areas shall be cleaned and patched according to manufacturer's instructions.

11.10 Curing

Concrete shall be protected from loss of moisture for not less than 7 days after the concrete is placed. Trowelled surfaces, except those that receive a separate finish or coating, shall be cured with a membrane curing compound. Float finished surfaces, except those that receive a separate finish, may be cured with either a membrane curing compound or with water. Only water curing shall be used if the surface receives a separate finish.

11.10.1 Water curing

Water saturation of concrete surfaces shall begin as quickly as possible after initial set of the concrete. Water curing shall begin within 12 hours in dry weather and within 24 hours in damp weather. The rate of water application shall be regulated to provide complete surface coverage with a minimum of runoff. The application of water may be interrupted for surface rubbing. The concrete surface shall not be permitted to dry. After the rubbing has been completed, rubbed surfaces shall be covered with burlap and kept saturated for the remainder of the curing period.

11.10.2 Membrane curing

Membrane curing compound shall be applied within 30 minutes after final finishing of the surface or as soon as possible after finishing without causing damage to the surface. Membrane curing compound shall be spray applied at a coverage of not more than 7.4 square meters per liter. Membrane curing shall not be used on surfaces that shall be covered at a later date with mortar, concrete, damp—proofing, tile, or any coating. Membrane curing shall not be used on cast-in-place concrete bases for field erected tanks.

11.11 Floor Sealer

All concrete floors shall be given two coats of clear floor sealer in addition to that applied as membrane curing compound. The first coat shall be applied at the end of the curing period before any traffic is permitted on the floor. The second coat shall be applied after the floor has been cleaned in preparation for the final inspection. Floor sealer shall be applied in strict accordance with the manufacturer's recommendations.

11.12 Repairing of Damaged or Defective Concrete

Concrete which has completed its final setting shall be inspected by the Owner and any cracks, honeycomb areas, segregations, etc shall be marked. No repairs shall be carried out

until direction by the Owner.

Surface defects in formed concrete shall be repaired to the satisfaction of the Construction Manager within 24 hours. Concrete that is porous, honeycombed, or otherwise defective to a depth in excess of 25 mm shall be cut out and removed to sound concrete. Edges shall be square cut to avoid feathering. Cut surfaces shall be coated with epoxy bonding compound before the concrete is placed.

Defective concrete shall be replaced within 48 hours after the forms have been removed. Concrete repair work shall not interfere with the curing of surrounding concrete. Mortar and concrete used in repair work shall be adequately cured and shall be finished to match adjacent surfaces.

12 ALLOWABLE DEFLECTIONS

The following deflection criteria for concrete structures shall L/500 or 20 mm (whichever is less)

DETAILED TECHNICAL SPECIFICATION

SECTION – B1 - CIVIL

SUB SECTION – 3.8

STRUCTURAL STEEL WORKS

TABLE OF CONTENTS

STRUCTURAL STEEL WORKS

1 GENERAL

Design of structural steel work shall include generally but not be limited to the steel constructions listed below :

a. Steel building structure and open structures. This shall include beams, columns, bracings, supporting structure for floors, roof slabs, cladding etc.

b. Platforms and walkways

c. Ladders, staircases, handrails etc

Wherever possible, without compromising system requirements, prefabricated structural steel construction shall be adopted.

2 MATERIALS

2.1 Structural steel

All ferrous materials, their dimensions, forms, weights, tolerances, chemical and mechanical properties, shall be the best of their kind, complying with relevant international Standards.

All structural steel material shall be grade E250/E350 (Grade A) for Rolled sections & plates up to 20mm thickness, E250/E350 (Grade BR) for plates above 20mm as per IS 2062.

The structural steelwork and testing shall comply with the relevant clauses of BS 4, BS EN 10162, BS 4360 and BS 6323, BS EN 10025-1:2004, BS EN 10130:2006 or equivalent standards.

2.2 Grating

All gratings shall be pressure locked type (preferably Electro-forged) manufactured in accordance with applicable Standard. All removable grating shall be bolted or clipped to supports. Sizes of grating shall be such as to allow easy handling. Grating units at all penetrations shall be made up in split section All gratings shall be arranged such that bars in either direction are in line. All gratings and accessories shall be hot dip galvanized.

It may be of rectangular pattern of parallel bearing bars of 40 mm depth and 5 mm thickness and cross bars of 25 mm depth and 3 mm thickness. Bearing bars shall be at 30 / 40 mm c/c with cross bars at 100 mm c/c.

2.3 Chequered Plates

Removable chequered plates shall be provided with two lifting holes and the size of plates shall be such as to allow easy handling. All edges of plates shall be smooth and straight with 3 mm clearance between plates. All chequered plates shall rest flat on their supports without rocking. All chequered plates shall be hot dip galvanized.

2.4 Galvanizing

Hot dip galvanized coatings on iron and steel articles shall be carried out in accordance with relevant standards. The coating shall be smooth, continuous and free from flux stains.

Small areas of galvanized coating damaged by welding, cutting, or during transport shall be repaired by applying at least two coats of zinc-rich paint. All structural steel works, which are not galvanized, shall be painted.

The minimum average coating weight of galvanizing shall be 610 gm / sq.m.

3 DESIGN METHODOLOGY

The design of steel structures shall be done in accordance with the provisions of relevant codes as applicable to specific structures.

Basic consideration for structural framing shall be stability, rigidity, building uses, ease of fabrication / erection and overall economy. Additional bracings/moment connections shall be used to assure stability of structures. Structure shall be designed such that the surfaces of all parts shall be accessible for inspection, cleaning, painting and maintenance.

For design which requires the use of the minimum column load (such as, uplift on anchor bolts, column axial tension, etc.) the following criteria shall be used in determining minimum load.

- Use 90% of the column dead load.
- No live load is used.
- Uplift forces from vertical bracing are included where applicable.
- Wind uplift on the roof is included where applicable.

Base plates shall be placed on foundation pedestal with grouting. All anchor bolts for fastening steel columns on foundation shall be embedded in foundation during concreting itself.

4 MINIMUM THICKNESS

The minimum thickness of various components of a structure and hot rolled sections shall be as follows. The minimum thickness of rolled shapes shall mean flange thickness regardless of web thickness. Structural steel members exposed to marked corrosive environment shall be increased suitably in thickness or suitably protected otherwise as per good practice and sound engineering judgment in each instance.

a.	Trusses, purlins, girts and bracing	:	6 mm
b.	Columns and beams	:	8 mm
c.	Gussets	:	8 mm
d.	Stiffeners	:	8 mm
e.	Base plates	:	10 mm & above
f.	Chequered plates	:	6 mm o/p & above

g. Grating flats : 5 mm

Minimum thickness of structural members, other than gratings and chequered plate, directly exposed to weather and inaccessible for painting and maintenance shall be 8 mm.

5 MINIMUM SIZES

Width of steel rolled section connected to other member shall be at least 50 mm.

The depth of beams for platform of all structures shall not be less than 125 mm.

6 LIMITING SLENDERNESS RATIOS

The slenderness ratio of main members in tension, compression or bending shall be in accordance with relevant standards.

7 LIMITING DEPTH TO SPAN RATIOS

The following limiting ratios of depth to span shall be considered as general guide.

a.	Truss	-	1/10
b.	Rolled beams and girders for ordinary floors and rafters	-	1/24
c.	Supporting floor beams for vibrating machinery / equipments	-	1/15
d.	Roof purlins and girts	-	1/45
e.	Gable columns	-	1/30

8 JOINTS / CONNECTIONS IN STEEL STRUCTURES

Steel structures shall be detailed and connection and joints provided as per the provisions of relevant standards and as per following requirements.

a. Connection of vertical bracings with connection members and diagonals of truss members shall be designed for full tensile capacity of the bracings unless actual loads are indicated on the drawings.

b. Size of fillet weld for flange to web connection for built up section shall be as follows:

   i) For box section weld size shall be designed for 60% of full shear capacity or actual shear whichever is more. Where fillet weld is not possible, full penetration butt weld shall be provided.

   ii) All welds shall be continuous unless otherwise specifically approved. The minimum size of the fillet weld shall be 6mm.

c. Shear connections shall be designed for 75% of section strength for rolled sections and 80% of section strength for built up section or rolled section with cover plates. However, if load is more than above, the connection shall be designed for actual load.

d. Moment connections between beam and column shall be designed for 100% of moment capacity of the beam section. This can achieved either by direct butt welding of the top flange of beam with column flange or by providing top moment plate with suitable notch for additional weld length.

e. Welding shall be used for shop fabrication and joints. All butt welds shall be full penetration butt welds.

f. Connection of base plate and associated stiffeners with the columns, minimum weld size (double fillet) shall not be less than 0.6 times the thickness of stiffeners

g. Splicing: All splicing work shall be of full strength. Field splicing shall be done with web and flange cover plates for full strength. Shop splicing for all sections other than rolled shall be carried out by full penetration butt welds with no cover plates. Splicing for all rolled sections shall be carried out using web and flange cover plate.

h. For site connections, high strength friction grip (HSFG) type bolts shall be used, except in few cases for shear connections of lighter members or removable beam connections where bolted joints using permanent mild steel bolts may be adopted e.g. purlins, side girts etc. High strength friction grip bolts shall be of property class 6.6 or 8.8. High strength bolts shall be installed as bearing type joint except where loads are reversible.

i. A minimum of two bolts per connection shall be used.

j. All bolted connections shall have bolts of minimum 16 mm dia. The connections of stairs and hand railing shall be made with 20 mm diameter threaded fasteners. Erection bolts shall be black bolts of minimum 12 mm dia.

k. All bolts and nuts have property class compatible to each other. For bolts carrying dynamic or fluctuating loads and those in direct tension shall be provided with an additional double coil helical spring washer. The threaded portion of the bolt shall project through the nut at least by one thread.

l. Where a steel beam or member is to be connected on RCC structure, it shall be connected using an insert plate and preferably through shear connection.

m The work point of the bracing connection shall be the centre of column and beam to which it connects, where practical. The connections of gusset plates to column and girders shall be made to include provisions for eccentricity in connection. Double angle bracings (back to back or star) can be used. The double angle back-to-back with gusset plates in between shall not be used in dust-laden areas. Where double angles are not adequate, beam sections with web in the plane of bracing are used.

n. Horizontal bracings shall be angle / tee section connected to the bottom portion of the top flange of framing beams. Field welding of bracing at the underside of beam as required to meet slenderness requirement of bracing member shall be indicated on the drawings. Horizontal bracing shall be arranged to avoid framing into the beams at columns locations.

o. Minimum size of fillet weld shall be 6 mm. Main structural elements shall be welded continuously. Intermittent weld shall be used only on secondary members, which are not exposed to weather or other corrosive influence. Overhead welding shall not be

permitted.

p. Efficiency of site welds to be considered shall be as follows:

i)	Fillet weld above 25 m from ground	50%
ii)	Others	80%

Shop connections shall be all welded and field connections shall generally be bolted unless otherwise if specifically indicated by owner. Field bolts, wherever provided shall be high tensile of 20 mm dia or of higher diameter and of property class 8.8 (minimum) for all major connections. All bolts, nuts and washers shall be procured from the manufacturers as approved by Owner. The bolted joints shall be designed for friction type connection and the HT bolts shall be tightened to develop the required pretension during their installation. However, the nominal connections in the field like purlins, stairs, wall beams shall be carried out by using MS black bolts not less than 16 mm dia (minimum property class 4.6) unless specified otherwise. All removable type connections shall be with bearing type HT bolts of grade 8.8 (minimum).

Welding shall be in accordance with the recommendation of relevant standards.

Built-up members will be fabricated using submerged arc welding procedure. All electrodes, flux, bare wire etc shall be procured by the contractor only from manufacturers approved by owner. All butt-welds in beams, girders & columns will be of full penetration. All butt-welds will be radiographically or ultrasonically tested as per and standard practice.

The combination of wire and flux for submerged arc welding shall be as follows:

Filler wire shall be of classification AWS-A-5.17-EH14 and flux shall be of agglomerated type of classification AWS-A-5.17F7 A2-EH14.

Low hydrogen electrodes as approved by the Owner shall invariably be used in the following cases:-

a) For welding of all important joints such as butt-joints in columns (flange or web), butt-joints in main frame beams (flange or web) etc.
b) For welding steel members having thickness more than 20 mm.

In case of fillet weld between two components, the thickness of the thinner part shall be considered.

Minimum preheat & interpass temperature for welding over 40 mm to 63 mm (thickness of the thicker part at the point of welding) shall be 66°C and for over 63 mm, it shall be 110°C. However, higher preheat & interpass temperature may be required due to joint restraint etc and shall be followed as per approved welding procedure.

9 FABRICATION AND ERECTION

Contractor shall prepare detailed fabrication drawings and erection scheme based on the design drawings approved by Owner. Fabrication drawings are not to be submitted to Owner for approval as the responsibility for correct detailing rests exclusively on the Contractor. However these drawings shall be furnished to Owner for their reference to effect payment

and information.

Erection of fabricated steel components shall be as per erection drawings prepared by Contractor and approved by his Owner

At the stages of fabrication, structural steel members shall be identified by a suitable marking scheme. Cutting, holing, assembly, welding and bolting shall be carried out in accordance with appropriate Standards.

The structural steel shall be pre-assembled in the workshop to such an extent as to ensure proper site erection.

Levelling of base plates shall be carried out by levelling screws or shims subject to the Owner's approval. The structural steel erector shall verify the positions of the anchor bolts of the base plates before the concreting of the foundations. The base plates shall be set at a minimum of 35mm above the concrete foundations in order to allow for the grouting. The deviation for plumbing of columns shall not exceed 1 to 1000 of the total height of the column. The position in plan of the column base shall not deviate more than 10 mm along either of the setting out axes. The positioning in plan of the column base shall be carried out by non-shrink grout subject to the Owner's approval.

Unless otherwise specified the erection of the steel structures shall comply with relevant standards.

Steel packing plates shall be provided where necessary to ensure that the total remaining gap between the connected parts does not exceed 2 mm.

All non-matching holes or holes required for new connections shall be formed by drilling and in no case will burning of holes be permitted.

All bolts shall project through the corresponding nuts and check nuts, but such projection shall not exceed three threads. Where connections have to be made by high strength friction bolts, the mating surfaces must be clean from any oil, grease, and any type of paint or primer. All fixing bolts, screws, nuts, clips, and washers shall have approved anticorrosive finishes. Any temporary bracing or temporary restraint shall be left in position until such time as erection is sufficiently advanced so as to allow for its safe removal.

10 PAINTING

All steel structures shall receive two primer coats and two finish coats of painting.

First coat of primer shall be given in shop after fabrication, before dispatch to erection site after surface preparation as described below. The second coat of primer shall be applied after erection and final alignment of the erected structures. Two finish coats shall also be applied after erection.

Steel surface which is to painted shall be cleaned of dust and grease and the heavier layers of rust shall be removed by chipping prior to actual surface preparation. The surface shall be abrasive blasted to Sa-2½ finish as per SIS05-5900. Primer paint shall be zinc silicate of approved make.

Finish paint shall be 2 coats of **High built epoxy finish** of approved brand. Dry film thickness of each finish coat shall be 80 microns. The undercoat and finish coat shall be of

different tint to distinguish the same from finish paint. The total dry film thickness shall be 80 microns. All paints shall be of approved brand and shade as per the OWNER's requirement.

Joints to be site welded shall have no paint applied within 100 mm of welding zone. Similarly where Friction grip fasteners are to be used no painting shall be provided. On completion of the joint the surfaces shall receive the paint as specified.

Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly. Surfaces inaccessible after erection including top surfaces of floor beams supporting gratings or chequered plate shall receive one additional coat of finish paint over and above number of coats specified before erection. Portion of steel member embedded / to be encased in concrete shall not be painted.

11 DELIVERY, STORAGE AND HANDLING

All structural steel works shall be protected from damage during handling, transporting, unloading, and storage. Particular attention shall be given to stiffen free ends and to prevent any permanent distortion. All bolts, nuts, washers, and small articles shall be suitably packed and identified. All structural steel shall be stored on thick timbers to prevent any dirt or accumulation of water under the steel.

Safety

The safety precautions to be applied during the erection of the steel structures shall be in accordance with appropriate standards.

Inspection at Site

After erection of the structures, the Contractor shall carry out inspections and checks in the presence of owner in order to demonstrate completeness of the works and correctness of the assembly. The Contractor, subject to owner's approval shall propose the inspections and checks to be carried out. In order to facilitate inspections as well as future maintenance, the structures shall be provided with steps, ladders, handrails, and other facilities in approved positions. The Contractor shall provide for the owner's use all equipment and instruments for inspection.

DETAILED TECHNICAL SPECIFICATION

SECTION – B1 - CIVIL

SUB SECTION – 3.9

OUTDOOR CIVIL WORKS

TABLE OF CONTENTS

OUTDOOR CIVIL WORKS

1 GENERAL

All drainage lines for storm water, sewage, and waste drainage etc. shall preferably be laid in service aisles close to the road. Separate network shall be provided for lines of storm water, sewage, and waste drainage.

2 ROADS & PAVEMENTS

Roads and pavements shall be designed and constructed in accordance with the provisions of relevant standards.

All buildings and facilities / components shall be approached by access road, which shall either be single or double lane road depending upon the functional requirement and as directed by the Owner.

The construction of rigid pavement including box cutting, edging, sub grade, WBM / dry lean concrete sub base, cement concrete pavement, wearing course, shoulder works, etc. and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work in accordance with relevant codes and standards in respect of design, construction, workmanship, quality and properties of materials, method of testing, tolerance etc.

Sub-base shall be of granular material i.e. laterite, moorum, natural sand, gravel, crushed stone (grading-1) or combination thereof laid over well compacted sub grade. Granular base shall be of water bound macadam course (WBM) construction. Thickness of sub-base/base shall be designed as per relevant standards.

A separation membrane shall be used between concrete pavement slab and the sub base. Membrane shall be impermeable plastic sheeting of 125 microns thick laid flat without creases

The joints, dowel bars, tie bars, joint filler, sealing compound, tolerances, curing, etc, shall be as per relevant standards.

The geometric design of roads shall be done in accordance with relevant standards. Road widths, curves and parking areas shall have adequate space for maneuvering of vehicles. The ruling gradient for roads in longitudinal direction shall not exceed 1 in 30. Normally the roads shall have much flatter gradient.

All double lane roads shall have a minimum turning radius of 20 meters and all single lane roads shall have a minimum turning radius of 10 meter. However, for minor roads this shall be reduced suitably as per layout requirements and site conditions. Road width and turning radii shall also to be checked for to take largest vehicles and equipment which can reasonably be expected.

All service and utility lines crossing under roads shall be taken through concrete pipes / ducts and designed for imposed loadings. Number of such crossings shall however be kept to a minimum.

Turning area shall be provided at blind ends.

All roads shall be surfaced with gravel during the construction period. Occasional applications of a dust palliative material shall be used to minimize the dust problem during the dry seasons.

Signs shall be provided for vehicle management and shall meet standards. All signs shall be dual worded in both English and Bangla.

California Bearing Ratio (CBR) method shall be followed for the design of roads. CBR test shall be carried out in remoulded soil samples under soak condition.

RCC pipes of 150 mm diameter shall be provided below each road at every 50 m and 600 mm diameter at every 300 m and also at all turnings for maintenance purpose.

Minimum width of RCC culverts shall be 1000 mm.

No underground service piping except for drainage and sewage system shall run directly below the road (including up to 1.0m from the edge of road) along its longitudinal direction.

Surface drainage of roads shall be provided by giving proper longitudinal slopes and cross falls.

Pre-cast Concrete Kerb stones

The pre-cast concrete kerb stones shall be provided at both sides of the road. The size of the kerb stones shall be 380 mm height, 200 mm width at bottom and 150 mm at top and 600 mm length.

Foot Path

Shoulder provided on either side of the road and shall be of interlocking paver blocks placed over murrum construction of 150 mm compacted thicknesses. The shoulder shall be laid with slope of 1 in 30.

The sub-grade and sub-base of the foot path shall comply with the requirement for the sub-grade and sub-base of the roads. After the top layer/WBM course for the road width is laid and compacted, the existing surface at the shoulders of the road must be scarified. Fresh quantity of approved earth, which may be extracted from the surplus earth obtained by box cutting, shall be spread in layers for building up the berms. The layer of earth must be compacted by at least three passes of 8 - 10 tonne rollers. The edges must be well compacted by suitable means to prevent edge slips and the work shall be properly trimmed and dressed. The foot path shall be paved Pre-cast concrete blocks 400 mm x 400 mm x 80 mm or Cast in situ concrete as directed by the owner.

RCC Paving in Parking Areas

150 mm thick RCC paving, laid to a slope of towards the nearest drain, with minimum 8mm dia reinforcement at 200 mm c/c both ways in top and bottom, shall be provided in parking areas. The under bed shall consist of well compacted ground supporting dry rubble soling of compacted thickness 230 mm with interstices properly filled with grits, followed by a layer of PCC, 50 mm thick.

Interlocking Paving Blocks

Interlocking paving blocks shall be minimum 80 mm thick. Pattern and quality of the interlocking blocks shall be subject to the owner's approval. Laying of interlocking paving blocks shall be carried out as follows:

The sub-grade and sub-base shall be prepared as specified above for the subgrade and sub-base of roads. Layer of carefully screeded sand shall be placed of about 100 mm thickness well graded to line and levels as required. The interlocking blocks shall be laid on the sand screed in a herring bone pattern, with all edges fitted to the required shape. After a sufficient area of blocks has been laid the surface shall be vibrated with adequate vibrator. Then the whole surface shall be covered with fine sand and brushed into the open joints.

3 FENCING

Fencing shall be provided in areas as listed in Detailed Section related to Scope of Work.

Fencing shall comprise of 2.4 m high PVC coated galvanized chain link fence of minimum 8 gauge (excluding PVC coating) with mesh size 75 mm.. 3 lines of 12 gauge high tensile spring steel wire shall be provided for the entire length of fencing.

Top of toe wall shall be 200 mm above formation level. Toe wall shall be generally of RCC construction and shall extend 150 mm below the formation level and the fencing mesh shall be embedded inside toe wall by minimum 75 mm.

Fencing post shall be fabricated out of galvanized 65 x 65 x 6 MS angle section and shall be spaced at a maximum spacing of 2.5 m with struts made up of galvanized MS angle at every tenth fencing post in addition to those at expansion joints and bends.

Expansion joint shall be provided at every 60 m.

All straining posts i.e., end posts shall be 65 x 65 x 6 MS angles. All corner posts will have two stay posts..

Suitable concrete foundations for the angle iron posts and stays shall be provided based on the prevailing soil conditions

Steel entry gates shall be provided for all fenced areas. Gates shall be formed out of tubular section.

If warranted, removable type of fencing shall be provided at suitable location to permit entry and exit of equipment.

4 GATES

Gate shall be fabricated out of rectangular hollow sections.

The gate frame shall be fixed to tubular post or RCC post.

DETAILED TECHNICAL SPECIFICATION

SECTION – B1 - CIVIL

SUB SECTION – 3.10

WATER SUPPLY SYSTEM

TABLE OF CONTENTS

1 GENERAL

This section applies to potable and service water system for the entire Township.

The source of water supply for the entire town ship shall be from the power plant.

The total potable, service and fire water requirement for the various occupancies within the Township area is about **640 m^3/day** based on the requirement of Bangladesh National Building Code (BNBC).

The water storage tank shall be ground level water tank with **one and half day** water requirements and made of concrete tank with necessary coating inside to satisfy the requirements of the appropriate standards.

The tank shall be covered with concrete floor slab with outside water level gauge and automatic float control.

Water supply to all individual building shall be through with overhead tanks. For multistory buildings water stored in a sump within the building premises and from there water shall be pumped to the overhead tanks. From the overhead tanks of each building, water shall be supplied by gravity system.

Pumping of water to all individual building / blocks shall be done thrice a day.

All internal plumbing works for water supply system shall be done as per the requirement of Bangladesh National Building Code (BNBC).

All pipelines shall be of material fit for drinking water requirements and shall be installed to ensure protection against extreme weather conditions.

2 SCOPE OF WORKS

This technical Specification establishes the minimum requirements for the equipment to be incorporated into hot and cold water services plumbing pipe work.

Provision of all labour, materials and the performance of all operations necessary for the supply and installation of pipe work and fittings of the cold water services plumbing pipe work as specified herein.

3 QUALITY ASSURANCE

The Contractor shall ensure that the water supply systems are fully compatible with all trades, particularly those of the, Mechanical and Electrical services, for successful installation and operation.

The Contractor shall only propose the use of materials produced by Companies which have been regularly engaged in the manufacture of plumbing pipe work systems and whose products have proved satisfactory in similar service for not less than 10 years.

Firms proposed for the installation of the plumbing pipe work systems shall have been regularly engaged for at least 5 years in the installation of plants of a similar type, quality and scope as is required for this Project.

4 APPLICABLE CODES AND STANDARDS

The plumbing pipe work shall comply fully with the latest relevant British and Standards in all respects.

The following are the most commonly used and relevant British Standards associated with water supply systems. However the Contractor shall ensure that all applicable British Standards are complied with, whether listed here or not.

DIN 1988	Codes of practice for drinking water installations (all Parts)
BS: 3505	Specification for uPVC pressure pipes.
BS: 3974	Pipe supports.
(Part 1 & 2)	
BS: 4118	Glossary of sanitation terms.
BS 843	Thermal-storage electric water heaters. In conjunction with BS 3456, Sections 2.21, 2.7 and 3.9 and 3999 Part 2.
BS 1010	Specification for drains off taps and stop valves for water services.
BS 2779	Pipe threads. for tubes and fittings where pressure-tight joints are not made on the threads
BS 3284	Polythene pipe (type 100) for cold water services. In conjunction with BS 21 and 5556.
BS 3505	CPVC pressure pipes for cold potable water. In conjunction with BS 21 and CP 312.
BS 3605	Seamless and welded austenitic stainless steel pipes and tubes for pressure purposes. In conjunction with BS 3600.
BS 3955	Electrical controls for household and similar general purposes
BS 4346	Joints and fittings for use with uPVC pressure pipes. In conjunction with BS 3505, 3506, 4576, 4660, 5481 and 6209.
BS 4368	Compression coupling for tubes. In conjunction with BS 1706, 2051, 2779, 2871, 3601, 3602, 3605, 3643, 4368 and Din 2353.
BS 5114	Performance requirements for joints and compression fittings for use with polyethylene pipes. In conjunction with BS 1972, 1973,2494 and 3284.
BS 5433	Underground stop valves for water services. In conjunction with BS 21,61,864, 1972, 3284, 3885 and 5728 Part 1 and 2.
BS 6281	Devices without moving parts for the prevention of contamination of water by backflow. In conjunction with BS 864, 2779, 2872, 4504, 5412 and 5413.

BS 1387	Galvanized steel medium and heavy duty.
BS 6675	Servicing valves (copper alloy) for water services. In conjunction with BS 864, 1400, 2871, 2872 and 2874.
BS 6700	Design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages.
BS: 6283	Safety devices for use in hot water systems. In conjunction with BS 864, 2056, 2779, 2872, 2874, 3075, 3457, 4504, 5412 and 5413.
BS 5572:	Sanitary pipework.
BS 1387:	Specification for screwed and socketed steel tubes and tubular and for plain end steel tubes suitable for welding or for screwing to BS 21 Pipe Threads. 8mm - 150 mm dia.
BS 3505:	uPVC pressure pipes for cold potable water. In conjunction with BS 21 and CP 312.
BS 3974:	Pipe supports.

(Part 1 & 2)

In addition to the above standards the works shall be in accordance with all local by-laws, local municipality requirements and the manufacturer's recommendations.

5 PIPE WORK AND FITTINGS

PIPES

HDPE Pipe work for domestic water distribution network throughout the site.

CPVC pipe work from main water HDPE pipes to manifolds.

XLPE Pipes with oxygen barrier and matching fitting for Domestic cold water from water manifolds to Sanitary Fixtures.

The contractor is free to use galvanized steel or copper pipes inside the buildings provided that the pipes used are conform to international acceptable codes on pipe work for potable water and that the pipes are continuously marked as such and with the applicable code by the manufacturer.

PIPE SUPPORTS

Pipe shall not be visible in offices meeting room and other occupied rooms excluded from this rule are plant rooms and other technical room where all services and plant are surface mounted. Pipes shall normally be installed in shafts an inside suspended ceilings or recessed under plaster.

All supports, hangers and brackets shall be of an approved manufacture as herein and indicated on the drawings.

All steel products used for support systems if not manufactured from malleable cast iron or

stainless steel shall be either galvanized or painted with two coats of red oxide paint.

All drop rods shall be galvanized and sized to suit the bracket type and system weight but in no case shall be less than 6 mm diameter.

All materials used for support systems shall be compatible with the material they are supporting. Generally steel pipe work shall be supported by cast iron and steel clips and UPVC and CPVC pipe work by brass or PVC clips.

Where brackets are exposed to view they shall be of a chrome plated finish.

Fixings to concrete and masonry shall be of the expanding bolt or wedge anchor type selected in accordance with the manufacturer's recommendations and suitable for the imposed loads. Where fixings are to be made close to the outside edge of concrete or masonry structures resin banded fixings shall be used to reduce the risk of fracture.

Brackets for fixing to woodwork or light weight partitioned walls shall be of the screw on pattern.

Purpose made girder clamps shall be used where any system is supported from steelwork and only with the approval of the Engineer.

PRODUCT HANDLING

Pipes delivered and handled on site shall be closed on both sides with appropriate plastic caps to avoid fouling of the pipes by dirt or debris.

All products shall be handled and stored as recommended by the manufacturer to prevent damage and deterioration. The Contractor shall supply and handling equipment such as lifting beams, reinforced canvas slings, protective padding, struts, cradles, etc., required to handle the products without damaging hardware or linings and coatings.

Products shall be protected against damage and the ambient conditions both during transport, site storage and immediately up to the time products are installed. Precautions shall be taken to protect the product from mechanical damage and the effect of sunlight heat, until the backfilling operations have been completed. All site storage areas shall be shaded.

INSTALLATION OF PIPEWORK

Pipe work from main HDPE line to the border of the buildings where running below ground level shall be HDPE class 16 bar. Pipes inside shaft to distribution cabinets shall be CPVC class 16 bar. Pipes from water distribution boxes to fixtures shall be XLPE pipes.

Joints in buried pipe work shall be kept to the absolute minimum. Marker tapes shall be laid 150 mm above the pipe work. If valves are required, they are to be in a valve chamber with the surface box lettered to indicated what service is below them.

The underground pipe work shall be laid in 200 mm of sand or stone free bedding material and wherever possible in straight lines to uniform gradients. The clearance between the pipe work and footings of the buildings is not to be less than 200 mm. If less, the pipes shall be installed in a flexible sleeve.

All pipe work shall run vertically or at an inclination of 1° to the horizontal to enable the whole system to be drained off either through the system or through a valve discharging externally

with an air gap to prevent contamination by backflow. When the pipe work is drained down, air is to be allowed into the system to prevent failure or damage to the hot water cylinder. A manual air inlet value shall be fitted to the high point in the system to achieve this.

All pipe work shall be erected to present a neat and orderly appearance, arranged parallel to or at right-angles to the structural members of the buildings, giving maximum headroom and shall not obstruct windows or doorways. Pipes shall bend round piers, projections and into recesses forming part of the structural works whether so indicated on the drawings or not. Pipe work shall be erected such that there is a minimum clearance of 75 mm to the finished floor level and at least 25 mm to the finished wall faces.

All fittings shall, as far as practicable, be the same size as the tubes and pipes connected to them. Bushed outlets shall only be accepted if the required outlet size of a fitting is not of standard manufacturer. Eccentric bushings and square tees shall be used where concentric bushing and pitcher tees might cause air to be trapped in the system. Elsewhere square tees shall be confined to dead-leg branches of domestic hot water supply systems and on cold-water branches to fitting or ranges of fittings.

Bends shall be used, where practicable, in preference to elbows. Square elbows shall not be permitted.

Sets or springs in tubes of 50 mm size and above shall be fire-made and tubes shall remain circular after setting.

Eccentric reducing sockets shall be used where changes of bore are made in runs of nominally horizontal pipe work to facilitate air venting and draining.

Tubes shall be reamed after cutting and shall be free from burrs, rust scale and other defects and shall be thoroughly cleaned before erection. Open ends left during the progress of work shall be temporally closed with purpose-made metal or plastic plugs or caps, or blank metal or plastic flanges.

Pipe work of 75 mm size and larger subject to expansion and contraction and hung from supports shall be suspended on swivel hangers unless otherwise agreed.

Piping that is insulated shall be secured by clips that allow sufficient space behind the back of the pipe for the pipe insulation to be properly installed.

All pipe work shall be installed so that the vertical distance between the discharge point and overflow level of the receiving appliance shall not be less than 25 mm for taps and/or fittings up to and including 20 mm and 70 mm for those over 20 mm to prevent contamination as result of backflow of water.

A 15 mm diameter washout pipe, discharging outside the building shall be provided at ground floor level to drain the system. The top of the outlet is to be in excess of 70 mm from the ground or receiver.

PIPE SUPPORTS

All systems shall be adequately supported in such a manner as to permit free movement due to expansion, contraction, vibration or other changes in the system. Supports shall be arranged as near as possible to joints and changes in direction.

Vertical rising pipes and ducts particularly in shafts shall be adequately supported at the base to withstand the total weight of the riser. Under no circumstances shall branches from

vertical rising pipes be the means of support for the vertical pipe work.

Pipe work shall be independently supported, double stacking of pipes from the same support shall not be permitted.

Adjustable mild steel hangers on steel pipe work systems shall be used with swivel joints at the pipe rings and spherical washers at the top of the hanger rods. Pipe rings shall be malleable cast iron or fabricated steel made in halves and secured by bolts or screws. Malleable iron hinged pipe rings may also be used but caliper hooks shall not be permitted. Pipe work 65 mm diameter and over shall not be supported using malleable iron brackets. All pipe brackets over 50 mm diameter shall be submitted to the Engineer and approved by the Engineer prior to manufacture.

Where rollers and chairs are required, these shall be pre-formed and where used singularly they shall have restraining "U" straps or bolts formed over the diameter of the pipe and bolted to the base support of the chair. The "U" straps or bolts shall be fitted to allow movement of the pipe without binding. Continuously threaded "U" bolts shall not be permitted.

The spacing of supports shall be determined in accordance with the following table. Where one support carries more than one pipe of different diameters the spacing shall be determined by the requirement of the smallest diameter.

Maximum spacing of fixings for internal piping

Type of piping	**Nominal size of pipe mm**	**Spacing on horizontal run m**	**Spacing on vertical run m**
Steel complying with BS 1387	15	1.800	2.400
	20	2.400	3.000
	25	2.400	3.000
	32	2.700	3.600
	40	3.000	3.600
	50	3.000	4.500
	80	3.600	4.500
	100	3.900	4.500
	150	4.500	5.400
Copper complying with BS 2871	15	1.800	2.400
	20	2.400	3.000

	25	2.400	3.000
	32	2.700	3.600
	40	3.000	3.600
	50	3.000	4.500
	80	3.600	4.500
	100	3.900	4.500
	150	4.500	5.400
Unplasticized PVC Complying with BS 3505	12	0.530	1.060
	15	0.610	1.220
	20	0.685	0.370
	25	0.760	1.520
	32	0.840	1.680
	40	0.910	1.830
	50	1.065	2.130
	80	1.370	2.740
	110	1.520	3.050
	160	1.830	3.660
Chlorinated PVC	12	0.600	1.200
	15	0.800	1.600
	22	0.88	1.600
	28	0.900	1.800
	32	1.000	2.000

Figures for UPVC are for normal ambient temperatures below 20°C. For temperatures above

20°C the pipe manufacturer should be consulted. Figures For CPVC are Based on average temperature of 80°C.

STORAGE

All pipe work shall be stored on purpose made pipe racks of welded construction and of sufficient strength to support the entire weight of the materials without any noticeable deformation. The racks shall be such that all pipe work is clear of the ground.

Pipe work fittings shall be stored within a well-lit container made compartmented racks or shelves. The fittings shall be separated by means of their type and size and laid out in an orderly manner for ease of identification.

SYSTEM TESTING

The Contractor shall ensure that all pipe work is watertight to the satisfaction of the Engineer and shall supply all pressure gauges, meters, hoses, pumps and other temporary supports, equipment and manpower necessary for carrying out pressure tests.

The Contractor shall, during testing, check the satisfactory operation of each valve installed under the Contract.

Before filling or pressure testing is started the Contractor shall re-check pipes and valves for cleanliness and shall re-check the operation of valves. The open ends of the pipes shall normally be stopped off by blank flanges or capped ends additionally secured where necessary by temporary struts and wedges.

Potable water system shall be tested with water to 1.5 times the normal system working pressure or 6 bar whichever is greater while uncovered but adequately anchored. The testing shall be carried out in sections if necessary. If a section should fail the test, the Contractor shall trace and repair all leaks and defects and retest the section before any further pipes or section of adjacent pipe work are laid.

The system shall be filled with potable water and all air expelled. After the system has been completely filled, the pressure shall be steadily and gradually increased until the test pressure has been reached. if any loss is recorded, repairs shall be made and the test re-run.

Written records of every test clearly identifying the tested system together with time of test and name of testing Engineer in tabulated format shall be submitted for review by the Engineer upon completion of the test.

FLUSHING AND DISINFECTION

Potable water pipelines shall be flushed with potable water after completion of pressure testing and before introducing disinfection.

Liquid chlorine, calcium-hypochlorite shall be used for disinfection. Where chlorine is used, it shall be introduced only in conjunction with proper equipment and under the supervision of qualified personnel familiar with the physiological, chemical and physical properties of liquid chlorine and who are suitably trained and equipped for dealing with any emergency which may arise from it's use.

Potable water from a suitable source shall be injected with flow control at a constant and measured rate. The water shall receive a dosage of chlorine fed at a measured rate to

ensure chlorine concentration in the water entering the pipe is maintained at a minimum of 50 mg/1. The chlorine residual shall be measured at regular intervals to ensure that the required chlorine concentration is maintained.

During the application of chlorine, valves shall be manipulated to prevent the treatment dosage from flowing back into the line supplying the water. Chlorine application shall continue until the entire pipeline is filled with chlorine solution.

After 24 hours retention, the chlorinated water shall be flushed out with potable water, until the chlorine concentration in the water leaving the pipeline does not exceed 21 mg/1. Chlorine residual determination shall be made to ascertain that the heavily chlorinated water has been removed from the pipeline.

Flushing water shall be discharged only to sites or into conduits. Discharges which cause damage, create nuisance or health hazard, or interfere with the work of others shall not be permitted.

6 PLUMBING FIXTURES

SCOPE OF WORKS

This technical Specification establishes the quality of materials and workmanship to be used in the supply and installation of plumbing fixtures.

Provision of all labor, materials and the performance of all operations necessary for the supply and installation of plumbing fixtures as specified herein.

The Contractor shall be responsible for the co-ordinations of the work of all other trades inside sanitary rooms.

QUALITY ASSURANCE

Manufacturers: Companies which have been regularly engaged in the manufacture of plumbing fixtures and fittings whose products have been in satisfactory use in similar service for not less than 10 years.

Installer: Firms regularly engaged in plumbing work of similar type, quality and scope as is required for this project for at least 5 years.

APPLICABLE CODES AND STANDARDS

The following are the most commonly used British Standards associated with plumbing fixtures. However the contractor shall ensure that all applicable British Standards are complied with, whether listed here or not.

BS 1010 part 2	Draw-off taps and stop valves for water services. In conjunction with BS 21, 61, 864, 1224, 1806, 2779, 2879, 3457, 3885 and 4518
BS 1125	W.C. flushing cisterns In conjunction with BS 1212, 2456, 3402, 4781, 5503, 5504 and 6700

BS 1188	Ceramic wash basins pedestals
BS 1189	Baths made from porcelain enamelled cast iron
BS 1206	Fireclay sinks
BS 1224	Electroplated chromium coatings
BS 1254	W.C. seats (plastics) In conjunction with BS 771 and 1322
BS 1329	Metal hand rinse basins In conjunction with BS 1010, 1344, 3380, 3831 and 6731
BS 3380	Water (excluding skeleton sink wastes) and bath Overflows In conjunction with BS 864, 2779, 3643 and 5572
BS 3402	Quality of vitreous China sanitary appliances
BS 3456	Section 2.9 Household and similar electrical appliances 2.21, 2.22, 2.34, 2.35, 3.6, 3.8, 3.9, 102.5, 102.7, 102.11, 102.24, 102.31
BS 3457	Water tap and stop valve seat washers
BS 5388	Spray taps In conjunction with BS 1010, 5412 and 5413
BS 5412	Draw-off taps with metal and plastic bodies In conjunction with BS 864, 2779, 2871 and 3506
BS 5503	W.C. pans with horizontal outlets
BS 5504	parts 2 & 3 Wall hung W.C. pan
BS 5506	pts.1,2 & 3 Wash basins
BS 5572	Sanitary pipework
BS 5627	Plastic connection for use with horizontal vitreous china W.C. pans In conjunction with BS 65, 416, 437, 1387, 2598, 2871, 3868, 4514, 4660, 5503 and 5504
BS 5779	Spray mixing taps In conjunction with BS 1010, 1415, 5412, 5413 and CP 342

7 General specification plumbing

All plumbing fixtures and fittings selected shall be appropriate to the type of function of the specific buildings and shall be from a single and approved manufacturer.

They shall be chosen for the required standard of hygiene, ease of use and cleaning.

They shall be of the best quality and the installation shall be of an economical, water-saving type.

Flow speed in pipe systems shall not exceed 1.5 m/s.

Quality of fixtures

Plumbing fixtures shall be made from high quality vitreous china, porcelain, enamelled steel of latest design and type for their intended use.

All plumbing fixtures shall be provided with traps, wastes, vents and water connections.

Quality of fittings

All fittings shall be made from cast brass. Set crews, escutcheons, taps, traps, exposed piping, etc. shall be made from brass with a final chrome plating with polished finish.

All faucets to which hoses can be connected shall be provided with vacuum breakers.

Installation

All installation work shall be in accordance with the recommendation of the manufacturer of the plumbing fixture concerned.

Each plumbing fixture shall be installed complete with all necessary fittings for operational and maintenance requirements. All fit exposed to view (i.e. not concealed in chase, void, duct or buried in building structure) shall be heavily chrome plated unless otherwise indicated in the specification or on the drawings.

Each water connection to each plumbing fixture shall have a stop valve. The stop valves shall be the same size as the connection and shall be of the wall fixing angle pattern, complete with a chromium plated flexible connection tail for connection to the fixture.

All disabled water closets shall be provided with stainless steel nylon coated

600 mm long 3 nos. grabbers. Mixing faucets shall be of the lever type.

Storage

All plumbing fixtures shall be stored in their original containers in a secure enclosed store. Vitreous china ware shall be stored out of direct sunlight. Fittings (Taps, Showers etc.) shall be stored in boxes or wrappings to prevent the ingress of dust to machined surfaces. All storage areas shall be dry and shall have adequate artificial lighting to allow for inspection of the equipment by the engineer.

DETAILED TECHNICAL SPECIFICATION

SECTION – B1 - CIVIL

SUB SECTION – 3.11

STORM WATER DRAINAGE SYSTEM

TABLE OF CONTENTS

1 GENERAL

Storm water drainage shall be provided for all buildings, roads, paved areas, landscaping etc. and the entire area within the Township area. The storm water drainage system shall be designed for rainfall intensity resulting from 95 mm per hour rainfall event. Run off coefficients for paved areas and unpaved areas for design of storm water drainage system shall be 0.9 and 0.6 respectively.

The storm water runoff from the entire township area shall be disposed into water retention pond (fenced) located outside the township area and necessary overflow arrangement shall be provided to Maidhara river.

The invert level of end drain shall be decided in such a way that the water can easily be discharged above the Maximum water level of water retention pond located outside the township area to which the storm water is to be led.

2 STORM WATER DRAINAGE SYSTEM

All storm water drainage shall preferably be through open storm water drains with perforated precast cover slabs on both sides of the roads and shall be designed to drain the appropriate catchment area including road surface, open and covered area etc. In case of road along boundary wall, storm water drain may be provided on one side.

In general, drainage systems shall be designed in accordance with BS 6367 or equivalent, the Bangladesh National Building Code 2012 and all relevant Local Authority requirements.

Rainfall Runoff

Rainfall runoff shall be determined in accordance with the relevant Bangladesh Standards by considering the maximum rainfall intensity of 95 mm/hr for a one hour rainfall with 50 year return period.

Sizing of Storm Water Drains and pipes shall be determined by using Manning`s formula, using the following Roughness coefficient **N** for the various types of material:

Type	Roughness efficient N
Concrete pipe	0.014
Plastic pipe	0.013
Vitrified clay pipe	0.013
Smooth concrete channels	0.014

For design of storm water drain network, the Minimum velocity of 0.80 m/s shall be maintain for self-cleaning.

For the entire township, a complete storm water drainage system is required. A substantially maintenance-free and, above all, an operationally safe installation must be guaranteed.

Storm water shall be drained by gravity. If this is not possible, necessary pumping stations with sand traps are to be provided. For each pumping station the pumps are to be provided with stand-by pump of 100% capacity.

Rainwater run-off from township area shall be directed through drains, channels and culverts into a retention pond.

3 QUALITY AND STANDARDS

Materials and components which the Contractor shall supply and install and which therefore shall be incorporated in the work or structure shall be of selected qualities which are subject to approval.

Materials and structural parts shall be standardized and shall be adequate for the purpose required. They shall comply with the specifications and standards acceptable to the Owner.

DETAILED TECHNICAL SPECIFICATION

SECTION – B1 - CIVIL

SUB SECTION – 3.12

SEWAGE NETWORK

TABLE OF CONTENTS

1 GENERAL

Sewerage system shall be fully functional and fit for the purpose of collection of sewage from the entire area of the Township. The sewage from bathrooms, toilets, kitchens, washrooms, common services and other buildings shall discharge into the common sewage treatment plant where it shall be treated to have effluents that can be reused for irrigation (gardening), and road cleaning or wetting. The sewage generation from the each building / blocks is considered as 80% of water supply and total sewage generation from the township is worked out about 510 m^3/day.

For township area sewage collection, a network of sewage manholes shall be provided to convey the sewage to the sewage treatment plant. The treated sewage from the sewage treatment plant shall conform to the requirement of appropriate standards

2 SEWERAGE SYSTEM

Salient points to be considered for sewerage system,

- For sewerage system heavy duty uPVC pipes shall be used.
- Pipes connecting toilet facilities to manholes shall be minimum 100 mm.
- Pipes connecting various manholes shall be minimum 150 mm.

The sewer shall be designed to discharge the peak simultaneous load weight flowing half full with a minimum self-cleansing velocity of 0.75 m per second. However, flatter gradient may be used if required but the minimum velocity shall not be less than 0.6 m per second. Again, it is undesirable to employ gradients giving a velocity of flow greater than 2.5 m per second.

The maximum spacing of manholes for a given pipe size should be as follows:

Pipe Diameter (mm)	Spacing of Manhole (m)
a) Up to 300	45
b) 301 to 500	75
c) 501 to 900	90

d) Beyond 900 Spacing shall depend upon local condition and shall begotten approved by the Authority

Suitable manholes shall be provided to piped sewage lines at some interval as mentioned above, at junctions and at change of gradient, alignment & diameter of pipe and shall be of masonry or RCC construction. Minimum size of manholes shall be 1.0 m x 1.0 m. All manholes shall be designed considering maintenance, inspection and cleaning of pipes. Easy accessibility and safety shall also be given due consideration.

The sewage pipelines shall follow the shortest possible route, making allowance for the other pipelines and building works.

All sewers shall be uPVC pipes with spigot and socket joints incorporating a rubber ring.

All sanitary fixtures and kitchen equipment shall be drained by means of the building

wastewater drainage system to the main sewer outside the building.

The vertical down pipes shall be mounted inside the building in shafts where applicable. The down pipes shall connect to the underground pipes at the lowest level of the building, which can either be the basement or the ground floor. Pipes that are recessed in wall shall be insulated with at least 9 mm tear resistant insulation to avoid structure borne noise transmission.

Connections to the sanitary fixtures and soil and vent pipes in buildings shall be of uPVC (unplasticised PVC) pipes and fittings with bell and spigot connections. Connection pipes shall be installed recessed inside installation walls, under plaster or in shafts.

All down pipes shall be vented over the roof in accordance with international accepted codes and standard. Where vent pipes pass through the roof slab special fittings for waterproofing shall be used. The up-stand pipe shall protrude at least 1 m above the roof and shall be covered with a vent-hood.

On every down pipe a clean out with rectangular or round cover shall be provided before it connects to the underground pipes.

All underground sewage and drain water drain pipes and pipes underneath the base slabs of the buildings shall be uPVC underground drain pipes.

Where underground drainpipes pass through the base slab a waterproofing collar shall be provided which shall be fitted to the pipe and cast into the concrete.

Pipes shall be laid in a gravel bed at the required gradient.

3 EXECUTION OF SEWERAGE SYSTEM

General

For pipe laying and backfilling the requirements of the pipe manufacturer; BS 6031 “Earthworks”; DIN 4033, 'Sewage channels pipe lines made from prefabricated pipes, code of practice for the construction', BS 5911 'Concrete cylindrical pipes and fittings'; BS 4625', Pre-stressed concrete pressure pipes (including fittings)' as well as ASTM D 3839-79 "Practice for underground installation of flexible reinforced thermosetting resin pipe and reinforced plastic mortar pipe" are valid.

A complete detailed program shall be submitted for approval by the Owner, containing: structural stability analysis using an up-to-date calculation method description of the bedding, filling, compacting and testing procedure. The design of the pipes shall be based on the max. combination of loadings (external and internal) and shall be applied systematically for the whole pipeline. This program is to be approved the Owner prior to execution of the works.

Independently of any groundwater lowering measures which may be necessary, the bottom of the trench shall be kept free of water to permit satisfactory excavation, placing and compaction. If necessary, drainage pipe shall be laid; it may be necessary to widen the trench for this purpose. Buoyancy effects on the pipes are strictly to be avoided during the construction period. Appropriate precautions (e.g. filters) shall be taken to prevent earth from entering the drain pipe. Mechanical filter stability is to be ensured for all adjacent layers.

The Contractor shall provide sufficient supervising personnel who shall be present at all times during execution of the works described in this section and who shall be thoroughly trained

and experienced in placing pipes.

Preparation of the trench bottom

The dimensions and shape of the trench bottom shall be designed to suit the required working space and type of pipe bedding. Trench bottom material must not be loosened. It must be protected against digging up, washing and scouring. Any cohesive bottom soil which becomes loosened must be removed down to the depth of disturbance before pipes are laid and must be replaced by non-cohesive soil or a special approved pipe bedding. Non-cohesive soil shall be compacted by layer-wise tamping or vibrating.

Bedding of pipes

The pipes may be bedded on:

Type A existing soil

Type B a bed of placed sand or gravel sand

Type C concrete support

Type D concrete enclosure

Type E special forms of construction

In detail these five possibilities shall be designed and executed as follows:

Type A, bedding on existing soil

Assuming that the soil encountered at the pipeline bottom is suitable, is workable by hand, has a minimum bearing capacity of 15 N/cm2 and has at least medium to stiff consistency or medium density, then the following instructions must be observed:

- the bedding in the natural soil has to be performed so that it corresponds to the surface of the pipe. In the cross-sectional area this applies for a supported segment of the circumference of the pipe corresponding at least to a bearing angle of 90° (related to the center line of the pipe and in accordance with the design and calculation).
- the natural density of the subsoil shall not be disturbed (loosened).
- the bedding must be executed in such a way that the pipe is completely and uniformly supported throughout its length.

Where the trench bottom is of sand, the bearing surface shall be contoured from the undisturbed soil to suit the shape of the outside of the pipe before the pipe is laid, so as to ensure that when laid the pipe is firmly supported over its entire length.

For pipes of cast iron, plastics and steel of all nominal bores and or pipes of concrete, reinforced concrete, stoneware and reinforced concrete pressure pipes up to and including nominal bore DN 600, a firm support can be obtained by placing the pipe on the carefully leveled bottom of the trench, provided that material is packed and condensed beneath the pipe to ensure uniform load-bearing support. If these requirements cannot be satisfied the following methods of bedding shall be executed.

Type B, bedding on a sand of gravel layer

If the soil encountered is not suitable as an immediate pipe bedding a layer of "select fill" has to be placed under the pipe. This layer has to satisfy the following conditions:

The sand or fine gravel used must be well graded. In the case of natural material the maximum particle size is 30 mm. In the case of crushed stone material the maximum particle size is 15 mm.

The thickness of the bedding below the lowest point of the pipe must be at least 10 cm + 1/10 of the pipe nominal bore.

After placing, the bedding must be compacted by suitable equipment (as select fill in the clause 6.7 'Earth and Rockwork' so that the pipe rests firmly on the bedding over the entire prescribed bearing angle (90°).

Type C, concrete support

If the material of the trench bottom is unsuitable for forming a sand or fine gravel bedding, if the bottom is steeply inclined or if there is a risk of sand being washed out by drainage effects or if local loads require it, the pipes shall be fully bedded on concrete.

The minimum thickness of concrete bedding shall be 5 cm + 1/10 of the pipe nominal bore, with a minimum value of 10 cm. The excavation must be correspondingly deeper. The minimum concrete quality for bedding is B10.

The surface of the concrete bedding shall be shaped to suit the outside of the pipe so that when laid the pipe rests firmly over the prescribed bearing angle. Bedding concrete can be placed after aligning of the pipe. If it is placed before the pipe is installed, the pipes must be laid in a fresh layer of mortar.

Type D, concrete enclosure

In order to increase the load-bearing capacity of pipes, a full concrete enclosure may be provided. In designing the cover (statical calculation), it is important to consider whether the concrete shall be cast against the undisturbed soil or, for example, against sheet piling; the later extraction of sheet piling has an adverse effect upon the relieving action of the horizontal earth pressure.

The minimum concrete quality for pipe enclosure is B15. Construction joints should be bridged by short reinforcing bars.

It may be advantageous to subdivide the concrete enclosure by suitably spaced concrete joints at the pipe connections.

Type E, special forms of construction

Concrete saddles (e.g. prefabricated pipe supports) should in general not be used as support for buried pipes. If this type of support is unavoidable, its suitability must be demonstrated by calculation. Where the ground is not stable or large settlements are to be expected, special precautions must be taken. For example the pipes should be supported by piles or laid on reinforced concrete beams consisting at least of B15. The suitability of such methods is to be proved by the Contractor by calculation. Suitable precautions must be taken at transitions between types of ground possessing different settlement properties. For pipes laid beneath embankments, provision shall be made for sustaining any longitudinal tensile stresses and

bending stresses which may occur.

Penetration of pipes through buildings and structures

The penetration of pipes through buildings, shafts, thrust blocks and other structures or the transition from the pipes to any structure must be designed in such a way that differential settlements do not occur or cannot cause leakages or damage. Such penetrations or transitions shall be designed to be flexible if not otherwise approved by the Owner.

Supporting and anchoring

Pipelines laid in groundwater shall be secured against uplift by anchoring or additional loads, if their dead-weight is not sufficient. If branches, bends, transition pieces, closures and the like are incorporated in pressure pipelines in such a way that they do not transmit longitudinal force, they shall be so secured that these forces are resisted.

Thrust blocks and other fixing structures are to be arranged in such a way that the ends of the reinforced/pre-stressed concrete or other pipelines shall not be subjected to all forces and displacement.

Bend structures are to be calculated as gravity structures. The pipeline forces have to be transmitted by bottom friction from this gravity structure into the ground. Horizontal active and passive earth pressure may not be taken into consideration.

Temporary storage of pipes before laying

The method of storing pipes shall be such that they are not covered by excavated material and do not unduly load the walls of the trench. Pipes shall be protected from damages.

Pipe laying

Lifting equipment shall be designated to permit uniform, accurate raising and lowering. Assembling of the pipes shall be carried out centrally along the pipe axis, using levers, gripping tackles, winches or jacks. Each individual pipe length shall be accurately located to line and gradient.

Pipe surfaces which come into contact with seals must be clean. During assembly and sealing the pipes must be protected from dirt. Ends or branches of pipes, to which connections shall not be made until later, shall be closed and sealed.

Leak test

The pipes shall be tested for leakage before being back-filled. The regulations of the manufacturer or referred to in this specification shall be used as the basis for the test.

- Embedding and back filling of pipes
- Until final acceptance and fill, the Contractor shall protect pipes, trench and inspection pits from damage and obstructions.

Embedding of pipes and back filling shall not be commenced until pipe joints and supports are capable of being loaded by overburden and other forces which occur during back filling. Embedding and back filling shall be done in accordance with clause "Earth and Rockwork" above. This especially applies to the suitability of fill materials, compaction requirements and quality assurance (internal control and independent spot check). The number of independent spot checks is limited to one check per 3 km trench length, at least three checks, being

performed. The number of tests can be increased by the Owner if the results are doubtful. The costs for this are to be included in the lump sum price.

For embedding of the pipes cohesion-less material according to clause “Earth and Rockwork” “Select fill” above shall be used. The maximum particle size is limited to 30 mm for embedding. Bedding material is deposited on both sides of the pipe up to a height of 30 cm above the pipe crown in layers and shall be compacted as requested for 'select fill'.

Under-packing and compaction shall be carried out with the greatest possible care; only hand tamping using flat tampers or light mechanical compaction equipment shall be employed. Under-packing shall be carried out simultaneously from both sides, in order to prevent displacement of the pipe. Any external protection (coating) provided on the pipeline shall not be damaged.

Back filling and placing of fill over pipes must be carried out in layers, materials used and compaction to be chosen in conformity with the drawings or to correspond to the subsequent use of the areas above the pipeline. The thickness of the layers and the compaction equipment shall be such that the stability of the pipeline is not prejudiced. In addition, the compaction equipment shall be selected to suit the ground conditions and trench supports. The fill material and fill procedure shall be as defined for “select fill” if not explicitly specified otherwise.

The use of heavy tamping and vibrating appliances where the pipe cover is less than 1m is not permitted. Exceptional loading during the construction stage, for example by heavy construction equipment or vehicles passing over the fill above the pipe, and unacceptably high levels of fill, must be avoided.

The removal of timbering, and especially the relaxation of the struts must be carried out in the same stage as back filling; it must be executed step-by-step, so that the portion of the excavation from which stiff supports have been removed is immediately back filled and compacted. Falling-in of material and subsidence affect the proper development of the surcharge above the pipes and are to be avoided.

When removing the trench lining, care should be taken that the compaction of the back filled material ensures that it is packed closely against the undisturbed ground of the trench wall.

Flexible pipes, as e.g. glass fiber reinforced plastic pipes, shall be designed taking into account soil mechanical and foundation aspects. All relevant checks and calculations have to be made following at least two different internationally recognized design methods/standards. One of these shall be:

For flexible pipes only bedding type B is permitted. The uppermost layer of the pipe bed shall consist of 3 to 5 cm sand with grains not larger than 20 mm. The pipe bedding and pipe zone shall be compacted to at least 90% of modified proctor density (or 80% relative density if proctor density cannot be determined).

For lifting of pipes only nylon ropes shall be taken.

4 STRUCTURES OF SEWERAGE SYSTEMS

Shafts and manholes

Manholes shall be provided at each inlet to the drainage system at each change in gradient or direction, and at some frequent intervals. The diameter of manhole should be chosen as a function of the pipe cross-section. RCC manholes may be used. The construction of

prefabricated shafts or manholes shall meet the requirements set out in BS 5911, Part 2.

Cast in-situ concrete shafts shall meet the requirements set out in clause "Concrete Works" specified herein.

Manholes on foul water, oily water and chemically contaminated water drains shall be rendered internally on all faces using anti-corrosive resin mastic. The mastic used shall be highly resistant to acids, alkalis and solvents. All manholes shall have step irons to BS 1247.

Manhole covers and frames shall be heavy duty GRP, except where flush with paved surfaces, where they shall be ductile iron to BS 497 and be of sufficient strength for the duty to which they shall be subjected.

At the end of each main run of foul water sewer, flushing shafts equipped with automatic drain flushers of 50 l/s rating (total flushing quantity 4000 liters) shall be provided. Basin shall have a thermo-insulated lining.

Drainage Systems Inside Buildings

Pipe work

All piping shall be cut accurately and be worked into place without springing or forcing. Overhead piping shall be located in the most inconspicuous locations, wherever possible.

Pipes shall not be buried, concealed or insulated until they have been inspected, tested and approved.

Pipes shall not be jointed inside walls or slabs where pipes pass through walls, floors, or ceiling.

All pipes, fittings, etc. shall be free from corrosion, scale or obstruction. When being worked on, open ends shall be effectively blanked off by means of caps, plugs or flanges. The use of wooden plugs, rags or waste shall not be permitted.

Only couplings, fittings, plugs and connectors fixing accessories as recommended by the pipe manufacturer shall be used.

Pipe work of different diameters shall be connected by means of eccentric reducing coupler. When pipe work is to be jointed, all burrs and deformities shall be removed so that the full internal diameter of the pipe is unobstructed. It must be ensured, that cut ends are square and any burrs removed.

Metal sleeves shall be provided for each pipe passing through a wall or floor. The sleeves shall terminate flush with the floor or wall finish and the space between the pipe and the sleeve shall be adequately caulked with ceramic glass rope to reduce noise, fire and smoke transmission. Where necessary, the sleeve shall be of an approved fire resistant pattern. Sleeves shall not be used a as supports and in all cases pipes shall be clear of the sleeves.

Pipes shall be run in such manner that they are not fixed hard on to walls, or tight brackets (other than fixed points) and laid with a gradient as specified. Pipe work shall follow lines of walls whether horizontally or vertically.

All pipes and fittings must be internally finished in such a manner that they shall not promote incrustation, deposits and clogging.

All fittings shall have good flow characteristics. Changes of direction in buried sewers and main sewer shall always be executed by means of 15°, 30°, 45°, 67° and 87° bends

Branches shall have only an angle of 45° maximum.

A pipeline shall not feed into another pipeline of lesser diameter.

Damage to coatings or redcoat shall be made good as recommended by pipe manufacturer.

Manufacturer's recommendations regarding installation, jointing procedures, fixing, cutting techniques, cutting tools and fixing tools. of pipe work shall be strictly adhered to.

Supports and fixing

All supports shall be made of sectional galvanized steel.

Clips, brackets, rod and hangers shall be of hot dipped galvanized steel when used on cast iron pipes and plastic pipes.

All clips and brackets shall be equipped with 8mm sectional rubber liners (Shore-Hardness A40 + 5°).

Pipe work supports shall be installed in such a manner as to allow free movement due to expansion and contraction. Supports shall be arranged adjacent to joints, changes of direction and branches. Each support shall carry the overall weight of pipe work and water with which it is filled. The intervals between pipe supports shall not exceed the following :

Horizontal and vertical cast iron pipes, shall not have more than 2.0 m spacing. Spacing on either side of joints shall not exceed 0.75 m.

Single pipes hung from floor slabs shall be supported by threaded rod hangers fixed to metal safety dowels.

All hanger rods shall have double nuts and bevelled washers to allow the hanger rod to swing.

Multiple pipe runs along walls shall be supported by purpose made frames of galvanized sectional steel securely fixed to the wall, floor and ceiling as necessary.

All pipes shall be individually supported. Pipes shall not be hung from other pipes.

Fixed points or pipe supports shall not be located where pipes pass through walls and floors, or where pipes are connected to plant and equipment.

Vertical rising pipes shall be supported at the base or at anchor points to withstand the total weight of the riser. Brackets for fixing risers shall not be used as a means of support for the riser.

The types of dowels shall be suitable for the mounting surface (e.g. concrete, brickwork) and the maximum load which has to be carried. Holes for dowels must be drilled not hammered or chiseled. Only officially approved metal dowels may be used. The installation of the dowels shall conform to the certificate of approval.

Prior to drilling holes for dowels at the bottom of slabs and beams the consent of the structural engineer must be obtained first.

Drawings of all types of supports and anchors shall be submitted for approval by the

Contractor

Expansion and contraction

Pipe work subject to thermal movement (plastic pipes) shall be supported by swivelling rods.

Expansion of pipe works shall be allowed for by the provision of expansion joints or expansion sleeves. All branch pipes shall be free to allow for thermal movement and shall not be used as anchor points. Anchor points shall be provided so that expansion of contraction is taken up in the joints or expansion sleeves. All anchor points shall be designed to resist maximum thrusts developed within the piping system. Approval of the type of expansion must be given by the Contractor.

All pipes passing through walls, floors, false ceilings, etc. shall be sleeved. Sleeves shall be of metal and shall allow not less than 25mm clearance around the pipe. Pipes passing through sleeves entering plant rooms or passing from one fire compartment to another, shall be packed with mineral wool and split plates shall be provided in visible positions where pipes pass through walls, floors or ceilings. Where pipes pass through wet areas, sleeves shall be provided with puddle flanges (water stops).

Flexible connections shall be installed on all pump connections to minimise transmission of noise and vibration. Flexible connections shall have flanged ends which shall be secured between bolted mild steel flanges to ensure proper and adequate location.

Pipeline identification

All sewage and ventilation pipes shall be identified by letters and banding of heat and vapour resistant, pre-coloured plastic adhesive bracket taping.

Pipe work shall be identified by black PVC direction arrows on 150mm white bands.

5 SOIL, WASTE WATER, VENT PIPE INSTALLATION

The design of soil, waste water and vent installations shall be to the single stack system.

Every sanitary appliance should be fitted with a trap with sufficient seals and the arrangement of ventilating lines and connections shall be in such manner that corrects functioning and discharging in the pipe systems shall be possible.

Down pipes and main collector pipes shall be installed as cast iron socket-less pipes according to DIN 19522 / DIN EN 877.

Connection pipes inside installation walls shall be installed as polypropylene pipes with bells and spigots.

- Defects
- All leaks and defects shall be located and made good. Retest to satisfaction of the Owner or Owner.

Pipe material

HT-pipes, Polypropylene Pipes (Plant)

HT-pipes & polypropylene Pipes with bell and spigot shall be used for connections between fixtures and down pipes. These pipes shall only be used inside buildings (no UV resistance),

within installation walls, where they are not exposed to fire. Pipes and fittings for waste water and sewage shall conform to DIN 19 560 / EN 1451, with formed bell and spigot, round section rubber sealing rings, cutting to measure of pipes at connections, including all pipe fittings, connections and joints. The pipes shall be hot water resistant.

A test certificate shall be submitted for all pipes, fittings and joints.

The unit price shall include all fittings, sealing, connectors, etc. fixing and supporting material.

PART – B: FUNCTIONAL TECHNICAL SPECIFICATION

SECTION – B2

DETAILED TECHNICAL SPECIFICATION - MECHANICAL

Table of Contents

PART – B : FUNCTIONAL TECHNICAL SPECIFICATION

SECTION – B2

DETAILED TECHNICAL SPECIFICATION – MECHANICAL

1.0.0 FIRE FIGHTING SYSTEM

1.1.0 General

This specification includes, the design, manufacture, supply erection, testing and commissioning of complete fire fighting system.

The proposed fire fighting system shall be in accordance with the BNBC and NFPA recommendations additionally the approval of local authorities must be obtained.

1.2.0 Scope of Work

Scope of supply and services shall include the design, manufacture, construction, factory testing, shop painting, packing for transport delivery unloading, stacking, erection, testing and commissioning F.O.B. of fire protection system and associated equipment including but not limited to final coat of the painting shall also be done at site.

Bidder shall consider minimum of following items. However to comply with safety and NFPA requirement any additional item which bidder may feel necessary shall also be considered in scope of supply.

All equipment and/or accessories not specifically mentioned in this Specification, but which are necessary for a safe, reliable and proper operation of the whole plant as well as service or maintenance of the systems, shall be deemed to be included in the package. The bidder shall provide and execute such works as a part of the Contract and shall not be entitled to any extra payment on the account.

Providing of all necessary documents for review and approval by the Client before beginning some performance of work or preliminary tests for provisional acceptance such as but not limited to calculations, determination of dimensions, drawings of construction details, certificates, equipment samples, installation and stock plans, switch and control diagrams, airflow diagrams, equipment selecting sheets, equipment schedule, motor lists, measuring point and instrument lists, measuring tables, test records, cable, wiring and terminal lists, technical data sheets of all parts of the plants and characteristics curves, working, operating and servicing manuals, lubrication schedules, spare part lists, etc.

Fire Water Pumping System

- One (1) no. of Horizontal split casing type centrifugal pump, electric motor driven, complete with non-return valve, coupling, motor, mounting frame and all accessories for fire water ring main network. The pump capacity is decided as per BNBC/NFPA recommendations.
- One (1) no. of Horizontal split casing type centrifugal pump, diesel engine driven complete with non-return valve, connecting shaft, gear box, coupling, mounting frame, fuel tank, muffler, cooling system and all accessories for fire water ring main network. The pump capacity is decided as per BNBC/NFPA recommendations.
- One (1) no Pressure maintenance pump (jockey pump), electrically driven, complete with non-return valve, coupling, motor, mounting frame and all accessories, for fire water ring main network.

- One (1) lot of pump controller for each pump, complete with all accessories for the above mentioned pumps (pump controllers instruments and accessories (as per NFPA 20) including support channels for each fire pump).
- One (1) lot of above ground piping duly painted and complete with all fittings and supports inside the pump house.
- Five (5) nos. of Horizontal split casing type centrifugal pump, electric motor driven, complete with non-return valve, coupling, motor, mounting frame and all accessories for Down comers with fire pump shall be provided at terrace tank level in high raised building. The pump capacity is decided as per BNBC/NFPA recommendations.
- Test line including with flow measuring meter shall be provided back to fire water tank.
- Terrace tank and fire water booster pump for down comer (if required) shall be provided for each high raised building as per BNBC recommendation.
- One (1) lot of isolation gate valves, check valves, globe valves, butterfly valves, strainers, relief valves, re-circulation valves, instrument root valves, vent valves and drain valves etc. as required for the completeness of the system (minimum instruments shall be considered as per attached flow diagram).
- All controllers/ local control panels and instruments required for completion of fire water pumping system.
- All level indicators, level switches, level transmitters along with necessary alarms, annunciations and controls required for fire water tank and, fuel oil tank of diesel engine driven pump shall be provided.

Hydrant System for Entire Township Area

- One (1) lot of rising stem gate valves with road way box.
- One (1) lot of rising stem gate valves and blind flanges for future ring main extension.
- One (1) lot of 3-way barrel type fire hydrants for outdoors complete with all accessories.
- One (1) lot of hose cabinets each complete with 2 fire hoses of 2 ½” each 30 m to 45 m long hoses with BS336 type couplings, fog nozzles, universal spanner wrench, 2 branch pipes 2 ½” with adjustable jet/spray nozzle, hydrant wrench and wrench for roadway box gate valve.
- One (1) lot of underground and above ground isolation valves.
- One (1) lot of indoor Hose outlets in a metal cabinet each complete with pressure restricting hose valve, swinging hose reel with 25m long of 1 ½” diameter flat hose with jet/spray nozzle. 2 ½” each15 m long fire hose, hose reel with supporting bracket, adjustable fog nozzle, wrench etc.
- One (1) lot of vent valves, drain valves, relief valves etc.
- One (1) lot of above ground galvanised piping (within building) complete with fittings, flexible couplings and supports.
- One (1) lot of all hangers/supports required for above ground piping, valves, hose reels, hose cabinets etc.
- One (1) lot of down comer for each high raised building (as per BNBC recommendation) including with check and gate valves in terrace level tank.
- One (1) lot of Water Monitors (where applicable) complete with isolation gate valves.
- One (1) lot of manifold with an inlet gate valve (supervised), strainer, fire brigade connection (2Nos. x 2 ½” Dia.) with non-return valve and a drain valve shall be provided for each riser system.

Portable and Mobile Extinguishers for Entire Township Area

- One (1) lot of Dry Chemical Powder type fire extinguishers.
- One (1) lot of CO2 type fire extinguishers.
- One (1) lot of foam type fire extinguishers.
- One (1) lot of fixed automatic foam or gaseous or dry chemical fire extinguishing system for Fuel station.

Fire Detection and Alarm System

- One (1) no Master Fire alarm and control panel shall be provided in the fire water pump house and shall be interfaced with substation control room of township by fibre optic cable. (routing to be ensured) The panel shall be a microprocessor based addressable analog panel with built-in hot-redundant processor and shall consist of master CPU, addressable loop modules, monitoring modules, system supervisory control modules, releasing modules, loop isolators, auxiliary output control modules, power supplies, battery and battery chargers, etc.
- One (1) lot of Local Supervisory Fire Alarm Panels
- One (1) no. fire alarm repeater (annunciation) panel located in guardhouse/ gatehouse/security building with necessary display unit.
- One (1) lot of Multi-sensor detectors.
- One (1) lot of input modules and one (1) lot of output modules.
- One (1) lot of spot type heat detectors.
- One (1) lot of Indoor & outdoor manual pull stations.
- One (1) lot of Response Indicators.
- One (1) lot of Siren with accessories.
- One (1) lot of exit signs & warning signs.
- One (1) lot of all erection hardware.
- One (1) lot of Hooters and other necessary accessories.
- One (1) lot of complete power cabling, addressable loop cabling, network cabling, control and signal cabling complete with double compression glands, lugs, ferrules, markers etc.
- All necessary electrical equipment like switchgears, motors, power and control cables, control panels with alarm, interlocks, necessary DC systems, push button stations, cable trays and accessories, cabling, glands lugs, earthing and lightning protection shall be provided.
- All necessary equipment and provisions in the main fire alarm panel for expansion of fire alarm system for the future (minimum 10% spares in each loop).
- Motor controllers (as per NFPA 20) including support channels for each fire pump.

Common Equipment and Services

- All general services as required such as transport, erection, commissioning, trial operation, testing, training on site, supervision of operation and maintenance during guarantee period, etc as stipulated in the technical specification.
- All control, measuring and monitoring equipment, to an extent at least in accordance with the corresponding description of of sections in the specification, as well as additional instrumentation necessary for matching to specific designs of equipment and units.
- All necessary pipe work, expansion joints, valves, automatic actuators, supports, fastenings, etc.
- All necessary base frames, base plates, anchor bolts, supports, covers, etc.
- All necessary insulation as required in the system requirement shall be provided.
- All necessary painting, corrosion protection and preservation measures as required in the relevant section of the technical specification.
- Complete detailed labeling of all installation as required in the relevant section of the technical specification.
- Acoustic enclosure (if required) for diesel engines of hydrant pumps shall also be provided by the Contractor to limit the noise level .
- Documentation according in the relevant section of the technical specification.
- Spare parts as stipulated in the relevant section of the technical specification.
- Pressure transmitter shall be provided at discharge of each pump and Pressure transmitter in common header
- One (1) number Monorail Electric Hoist for main fire water pump house shall take care of erection / maintenance requirement of pumps and their associated auxiliaries. The capacity of the crane shall be minimum 5 tonnes and not less than 25% above the weight of the heaviest item envisaged to be lifted during erection and maintenance.

- All consumables such as lubricants, chemicals for first fill for the complete commissioning, trial operation
- The Contractor shall furnish a complete new set of all special tools and tackles of reputed make and model which are required for erection, ease in maintenance to have minimum down time, testing and calibration of all the equipments and systems to be provided by the Contractor under this specification
- All standard equipment and accessories normally included in the supply schedule but not separately listed.
- Complete electrical system including drive motors suitable for area specified, Motor Control Centre, control panel, local push button stations, transformers rectifier set, power & control cables, cabling complete with supports, cable trays, glands, lugs, earthing and lightning protection system for the successful operation of the plant. The electrical system shall conform to the requirements specified in the relevant section of the technical specification.

1.3.0 System Description

The entire fire protection & detection system shall be designed and installed as per the regulations of Bangladesh National Building Code (BNBC), Part 4, Fire Protection.

The fire fighting system shall be provided for the township as described herein. The various types of Fire fighting Systems are envisaged and the areas covered for the proposed facilities are as follows:

Sl. No.	Building / Area Description	Category	Recommended Fire protection system
1)	Executive Residence Type-A (Ground + 1 Floors)	Group A Residential Buildings 5.3.2) Flats and Apartments (A3).(a)	Up to 20m height fire detection and fixed fire fighting arrangement shall not be required. Fire extinguishers shall be provided.
2)	Executive Residence Type-B (Ground (stilt parking) + 8 Floors)	Group A Residential Buildings 5.3.2) Flats and Apartments (A3).(b)	No protection required within the dwelling units of Flats and Apartments buildings having more than 20m heights. Manual alarm system and fixed hydrant system shall be provided in the landings of fire stairs or in the left lobby. Fire extinguishers shall be provided.
3)	Executive Residence Type-C (Ground (stilt parking) + 8 Floors)	Group A Residential Buildings 5.3.2) Flats and Apartments (A3).(b)	No protection required within the dwelling units of Flats and Apartments buildings having more than 20m heights. Manual alarm system and fixed hydrant system shall be provided in the landings of fire stairs or in the left lobby. Fire extinguishers shall be provided.
4)	Staff Residence Type-D (Ground (stilt parking) + 8 Floors)	Group A Residential Buildings 5.3.2) Flats and Apartments (A3).(b)	No protection required within the dwelling units of Flats and Apartments buildings having more than 20m heights. Manual alarm system and fixed

Sl. No.	Building / Area Description	Category	Recommended Fire protection system
			hydrant system shall be provided in the landings of fire stairs or in the left lobby. Fire extinguishers shall be provided.
5)	Head of Plant Bungalow (Ground + 1 Floor)	Group A Residential Buildings 5.3.2) Flats and Apartments (A3).(a)	Up to 20m height fire detection and fixed fire fighting arrangement shall not be required. Fire extinguishers shall be provided.
6)	Guest House (Ground (stilt parking) + 3 Floors)	Group A : Occupancy A4: Boarding house 5.3.3) (A4).(c)	The floor area of 3 story building having more than 300m2 per floor and upto 20m height having central corridor with rooms on both sides, manual fire alarm system shall be provided along with portable fire extinguishers. Instead of double loaded corridor a single loaded corridor having 3m width shall not require any detection and fixed fire fighting arrangements. Fire extinguishers shall be provided
7)	Studio Apartments (Ground (stilt parking) + 8 Floors)	Group A Residential Buildings 5.3.2) Flats and Apartments (A3).(b)	No protection required within the dwelling units of Flats and Apartments buildings having more than 20m heights. Manual alarm system and fixed hydrant system shall be provided in the landings of fire stairs or in the left lobby. Fire extinguishers shall be provided.
8)	Field Hostel – Staff (Ground (stilt parking) + 8 Floors)	Group A Residential Buildings 5.3.3) (A4).(d)	More than 20m height Mess, Boarding House and Hostels manually operated electric fire alarm system shall be provided along with Hydrant system. Fire extinguishers shall be provided
9)	Trainees Hostel & Trainee Center (Ground + 2 stories)	Group A Residential Buildings 5.3.3)(A4).(b)	Buildings having 3 story and having floor area less than 300m2 shall not require fire detection and fixed fire fighting arrangements. Fire extinguishers shall be provided
10)	Security force and Army barracks (Ground + 2 Floors)	Group A Residential Buildings 5.3.2) Flats and Apartments (A3).(a)	Up to 20m height fire detection and fixed firefighting arrangement shall not be required. Fire extinguishers shall be provided.
11)	Nursery and High School (Ground + 2 Floors)	Occupancy B : Educational Buildings Not Exceeding 20m in height.	Manually operated fire alarm system, portable fire extinguishers and outdoor hydrant will be provided.
12)	Mosque	Occupancy I :	Automatic fire alarm system will be

Sl. No.	Building / Area Description	Category	Recommended Fire protection system
		Assembly Occupancy I3: Large Assembly without Fixed Seats	provided. Portable firefighting appliances will be installed.
13)	Hospital Building	Occupancy D : Health Care Facilities Buildings Not Exceeding 20m in height.	Manually operated electric fire alarm system or automatic fire alarm system will be installed in the duty room, so that the duty personnel receive the fire warning well in advance. Portable firefighting extinguishers will be installed.
14)	Shopping center, Post office, Bank and Estate office	Occupancy F : Mercantile Building Not Exceeding 20m in height.	Manually operated fire alarm system, portable fire extinguishers and outdoor hydrant will be provided.
15)	Temple	Occupancy I : Assembly Occupancy I3: Large Assembly without Fixed Seats	Automatic fire alarm system will be provided. Portable firefighting appliances will be installed.
16)	Community Center (Ground + 1 Floor)	Occupancy I : Assembly Occupancy I3: Large Assembly without Fixed Seats	Automatic fire alarm system will be provided. Portable firefighting appliances will be installed.
17)	Executive Club (Ground + 1 Floor)	Occupancy I : Assembly Occupancy I3: Large Assembly without Fixed Seats	Automatic fire alarm system will be provided. Portable firefighting appliances will be installed.
18)	Non-Executive Club (Ground + 1 Floor)	Occupancy I : Assembly Occupancy I3: Large Assembly without Fixed Seats	Automatic fire alarm system will be provided. Portable firefighting appliances will be installed.
19)	Indoor Sports Complex	Occupancy I : Assembly Occupancy I5: Sports Facilities	Manually operated electric fire alarm system will be provided. Portable firefighting appliances will be installed.
20)	Potable Water, Service Water and Fire Water Pump House	Occupancy G : Industrial	Manually operated electric fire alarm system will be provided. Portable firefighting appliances will be installed.
21)	Main Receiving Substation	Occupancy G : Industrial	Manually operated electric fire alarm system will be provided. Portable firefighting appliances will be installed.
22)	Distribution substations	Occupancy G : Industrial	Manually operated electric fire alarm system will be provided. Portable firefighting appliances will be installed.
23)	Maintenance store	Occupancy H : Storage	Manually operated electric fire alarm system will be provided. Portable

Sl. No.	Building / Area Description	Category	Recommended Fire protection system
			firefighting appliances will be installed.
24)	Police Station	Occupancy E : Business	Portable firefighting appliances will be installed.
25)	Gas Cylinder Godown	Occupancy H : Storage	Manually operated electric fire alarm system will be provided. Portable firefighting appliances will be installed.
26)	Gate and Security	Occupancy E : Business	Portable firefighting appliances will be installed.
27)	Entire township area		Entire township area will be protected by the fire water network system. The System shall consist of fire water pumping, piping including with outdoor hydrants and indoor hydrants (landing valves) Hose box for Multi-storey buildings.

Fire Water Storage Tank / Service Water Storage Tank

The source of water for the fire fighting system will be two full-capacity of service water / fire water storage tanks located in the Township area. The tanks will supply fire water to a fire water pumping system. Both the tanks will be connected to a common suction header of fire water pumps so that any fire pump can be fed by either service water / fire water storage tank, and at least two pumps will always be available for any single piping break or valve closure. Inlet water to the service water / fire water storage tanks will be provided by the plant water system.

The fire water required for hydrant system shall be from the reserve storage provided in the fire water storage tank of the township. To the risk in accordance with the requirements of BNBC/NFPA Standards and in accordance with any local requirements or regulations. The tank capacity shall be sized in accordance with relevant BNBC/NFPA design guidelines.

Fire Water Demand

The fire water demand shall be calculated based on the worst case scenario as per NFPA. A safety factor of approximately 15% shall be added. The fire fighting pumps and distribution system shall be designed and installed accordingly.

Fire Fighting Pumps

The capacity of main fire fighting pumps shall be calculated based on a single largest /major fire (worst case) at the most probable location.

- One (1) no electric driven main pump
- One (1) no diesel engine driven main pump
- One (1) no electric driven main Pressure Maintenance Pump
- Five (5) nos electric driven main pump at terrace level

The diesel engine driven pump will be 100% stand-by, for the case of mains supply failure. The Pressure Maintenance Pump will be fed by the Emergency Diesel Generator in case no normal AC supply is available. The Pressure Maintenance electric pump will have the function to maintain the water circuit pressurized compensating possible water leakage in the fire water ring main network piping.

The main fire pumps will be of horizontal, split case, single stage and centrifugal type with single entry and will be complete with mating flanges, air releases, drain connection and base plate with sufficient capacity to supply Exposure Protection System at the design requirements. The pumps will be directly coupled to the electric motors and mounted on a common, pre-fabricated steel base plate. The electric motors will be totally enclosed fan cooled motors which motors which shall be equipped with sleeve bearings.

Motor drive for fire pumps will conform to the requirements of NFPA No.20. The locked rotor current will not exceed the values listed in the NFPA No.20. Continuous drive motor rating shall be at least 10% (ten percent) above the maximum load demand of the pump in the entire operating range.

Motor will be furnished with complete across-the line starter controllers and control panels, designed and constructed in accordance with NFPA No.20 and shall be UL-listed or FM-approved or equivalent. Emergency fire pump diesel engine drive will be in accordance with NFPA No.20, NFPA No.37, UL and will conform to the “Standard Practices for Low and Medium Speed Stationary Diesel and Gas Engines” of the Diesel Engine Manufacturer’s Association (DEMA).

The diesel engine will be a self contained unit complete with automatic starting mechanism, storage batteries, closed circuit cooling system, governor, tachometer, oil pressure gauge, temperature gauge, instrument and control cubicle/panel as well as with a fuel oil day tank (tank capacity shall be provided as per NFPA recommendation) including all pipe work and measurement equipment (e.g. level measurement and flow indication). The diesel engine will be capable of operation continuously on full load. The diesel engine shall be provided with a complete fuel system. Flexible fuel hoses connected to the engine shall be flame resistant.

A complete exhaust system including silencer and sufficient pipe work to discharge exhaust gases outside the pump house will be provided for the engine, flexible or corrugated connections will be used between the engine and the exhaust pipe work.

Diesel engine will be steel base mounted, pressure lubricated and shall include mufflers, filters, strainers, silencers, alarms for high coolant temperature and low lubricating oil pressure, and other necessary accessories as may be required, including battery racks and cables. The diesel engine shall be provided with a local control panel

The steel base will be extended to accommodate the pump will be of the drip lip type. Engine starting will be by an electric starting device taking current from storage batteries.

Two (2) 100% starting and control batteries with rack and accessories will be provided. Each battery (sealed maintenance free battery) will be sized for starting the diesel engine and for furnishing all control power by itself.

Battery charging equipment will be designed for single phase AC power supply and will have an isolation transformer to ensure that the battery is completely isolated from the AC power system.

All fire fighting pumps including main, diesel and Pressure Maintenance pumps to maintain the desired pressure will be fully automatic and complete instrumentation, control panel and alarm annunciator for this purpose will be provided.

The Pressure Maintenance Pump will be of a horizontal type with sufficient capacity to supply one hose pipe at the operational conditions without bringing the main water fire pumps into operation and to overcome the leakage in the system.

The pressure maintenance pump will be provided with a local controller. The pump will automatically stop and start based on high and low system pressure, respectively. The local

controller will be independent of other controllers and will be designed in accordance with applicable code requirements.

Each fire water pump will be capable of being started manually at the controller, and automatically based on low system pressure. Once started, each fire water pump will be manually shut down at the local controller. Each fire pump controller will contain a time delay rely to allow the pump to be sequentially started upon a sudden loss of pressure.

Vibration and noise level measurement shall also be taken at full load and at overload run test and shall be below the specified value. Vibration level of electric motor driven pumps, their motors and diesel engine driven pumps shall be 75 micron and noise level less than 85 dB. Vibration and noise level for diesel engines shall be 15 - 20mm/sec (rms) and 85 dB at 1.5 m above floor and 1.0M from the equipments. Suitable acoustic enclosures shall be provided to limit the specified noise level for diesel engines.

Each fire pump controller will be in accordance with NFPA-20 and other applicable codes, including the following additional features;

- Annunciation and operator interfaces required by NFPA-20. Where codes require use of pre-approved pump/controller sets, each controller will be specifically listed or approved for use with its respective fire pump.
- Provisions for periodic testing the standby start function. A solenoid valve will be provided to relieve the pressure in the sensing line to the standby start pressure switch for the engine driven fire pump.
- Battery powered pressure recorder which will provide verification that the fire pump operated normally during the required periodic automatic test runs.
- Each pump controller will have visible and audible alarms.

Fire Hydrant and Hose Reel System

The fire water distribution system shall feed water based fire extinguishing systems such as external/internal hydrants, hose reel systems for entire township area. The fire water ring main network system shall be formed inside and outside the high raised buildings like Residential Buildings, Security Force accommodation, Support Staff accommodation, Non-Residential Buildings and other buildings/complexes. The system shall consist of a network of underground/above ground piping around the buildings/areas to be protected. Sectional isolating valves shall permit continuity of supply via another route, if any part of the system is inoperable. The fire mains will be provided with sectionalising valves in accordance with NFPA-24 guidelines.

The hydrant and hose reel system shall consist of external and internal hydrants, hose cabinets, fire escape route first aid hose reels and portable fire extinguishers. The fire water supply shall be provided by a tee-off from the fire water ring main distribution system.

Each wet riser pipe system of a building shall consist of a Landing Valve of 63 mm (2 ½”) at each landing floor of staircases. Each Landing Valve shall be provided with a hose cabinet comprising of a pair of 15 m long hoses, hose couplings, branch pipe and spray jet nozzle.

Down comers and landing valves shall be provided including the fire water pump with check valve and gate valves in the terrace tank for high raised buildings as per BNBC recommendation.

For first aid fire protection by fire protection personnel, swinging hose reel (1”) shall be provided in the fire escape staircase of Hotels, Hospitals and Commercial buildings. The hose reels shall consist of a 30-meter length of 25 mm diameter double braided rubber, non-collapsible hose mounted on reel drums, which shall be of the swinging arm type. Each hose reel shall be permanently connected to the water supply and provided with a normally closed

isolating valve which shall be located approximately 900 mm above the floor level. The hose shall be provided with jet nozzles.

External hydrants shall be located all around the periphery of the buildings. Each outdoor Pillar-type hydrants shall have with 2 hose connections of (2 ½") outlet and 1 hose connection of 4 inch with an instantaneous coupling with cap and chain and gate valves shall be located along the fire water main and should protect all sides of a structures or buildings. The hydrant shall be wet type connected directly to the fire water main. Each hydrant shall be provided with a hose cabinet comprising of a pair of hoses, hose couplings, branch pipe and spray jet nozzle.

A minimum of one water monitor shall be provided for fuel station and shall be provided for multi-storey buildings with an elevation of 20 meters or higher area.

Two-way Fire Brigade connection will be provided for each riser system with the fire brigade connection housed in a cabinet with glass doors and located external to the building.

Wet Riser

Wet risers shall be provided as per BNBC recommendation. The fire protection system wet riser pipe is vertical rising mains not less than 150m nominal diameter with landing valves on each floor/landing permanently charged with water from a pressurized fire water pumping system.

Down comer

The fire protection system down comer pipe sizes shall be not less than 150m nominal diameter with landing valves on each floor/landing for high raised buildings as per BNBC recommendation.

Portable fire extinguishers

Portable fire extinguishers will be provided throughout the site, with larger capacity units sited at increased risk areas. Extinguishers will be manufactured in accordance with NFPA standards/BNBC recommendation and operated by means of a lever operated valve provided with a safety pin, which will allow controlled partial discharge.

The extinguishing medium selected will be selected based on hazards encountered in the immediate area. Fire Extinguishers with suitable capacity, rating and medium such as CO2, foam, Dry Chemical Powder (DCP) and with standard accessories and in adequate numbers as per NFPA-10 covering all the buildings in the township premises shall be provided.

Where extinguishers are provided externally or other areas where they may be subjected to whether they will be hung inside protective cabinets.

Piping

- Fire fighting water supply pipes will be of Carbon Steel conforming to ASTM A53, Grade B.
- Belowground pipe shall be properly covered with corrosion protective tape of minimum thickness of 4mm in one layer or 2mm in two layers or coal tar type tape in accordance with AWWA C203.
- The sizing of the ring main network pipes will be carried out by the fire fighting contractor based on the hydraulic analysis to meet the pressure and flow in accordance with NFPA requirement. The design pressure for the ring main system shall be the maximum pressure in the system. The maximum pressure in the system is the shut-off pressure of the fire water pumping system if surge pressures are not considered.

- The surge analysis for the network shall be carried out the fire fighting contractor and necessary surge alleviation provisions shall be provided by him in the fire water pumping system in order not to allow the maximum surge pressure exceed the design pressure.
- RCC encasing/hume pipe sleeves will be provided as BS for road crossings area.
- Pipes will be hydro-tested at 1.5 times the pump shut-off head or twice the design head, whichever is higher.
- The fire water ring main shall be predominantly underground piping buried along side roads. The depth of cover for buried pipes shall be such that the top of the pipe is buried not less than 0.3m below the frost line. The depth of cover shall be not less than 1.0m to prevent mechanical damage. Wherever the mains need to cross cable/ pipe tunnels & trenches, the mains shall be locally routed below such tunnels
- All above ground piping shall be adequately supported (pedestal/sleepers) at regular intervals.

Fire Detection & Alarm System

The fire detection and alarm system will consist of :

- Independent Fire Detection Systems
- Local Supervisory Fire Alarm Panels
- Master Fire Alarm and Control Panel

Independent Fire Detection Systems

The independent fire detection systems will operate as protected premises systems, monitoring selected areas and equipment for a fire condition. Fire alarm or trouble conditions will be reported via the fire alarm and control panels. The areas and the type of independent fire detection systems provided are given below:

Area / Equipment	Type of Detection System
Electrical rooms : Each Switchgear / Motor Control Center rooms (MCC rooms)	Multi-sensor detectors
Each Elevator Equipment Room	Multi-sensor detectors
Each Elevator Landing area	Multi-sensor detectors
Prayer hall, Club, Multi-purpose meeting hall, Community center, Hospital buildings, Mosque, Temple	Multi-sensor Detector
Conference Rooms and Offices	Multi-sensor detectors
Each Battery Room	Heat detector
Entire Building, Gas Cylinder Godown and all other area	Manual operated break glass

Independent fire detection systems will alarm locally and in the substation control room of township. After a smoke or spot type heat detector has actuated and the ambient conditions return to normal, the given detector will automatically reset and be ready for any further fire conditions. After a linear heat detector has actuated and the ambient conditions return to normal, the linear heat detector will not automatically reset and will require minor splicing repair to restore to normal.

Multi-sensor detectors

Multi-sensor detectors will be a combination of smoke and heat detection sensors. Multi-sensor detectors shall take alarm decision based on the existence of both smoke and heat. These sensors shall not cause fire alarm activation if only smoke or only heat is present.

Multi-sensor detectors shall have floating sensitivity, becoming more sensitive as temperature rises and less sensitive as temperature falls.

Each detector will be provided with an indicating lamp glowing steadily to indicate that it has operated which shall otherwise flash intermittently to indicate the healthy condition of the detector and sensing circuits. The Multi-sensor detectors shall continually monitor any changes in sensitivity due to the environmental effects of dirt, smoke, temperature, etc. This information will be stored in the processor and transferred to the loop controller. The Analog detectors will be suitable for mounting on any other detector mounting base.

When the detectors are mounted below the false floor or in inaccessible position, response indicator for each of the detectors and test switch will be mounted on a separate box which will be suitable for mounting on the wall. If the detectors are mounted above the false ceiling, response indicators with test switch will be mounted directly below the detector (on the false roof).

Response Indicator

Response indicator 'LED' shall be provided for all the detectors located in the concealed spaces such as above false ceiling, below false floor etc. These shall indicate the status of the detector. All the response indicators shall be monitored by the fire alarm panel for location.

Electronic Hooters

The electronic hooters shall be compact, high output operating on piezo-electric principle. The unit shall have strobe with minimal 12,000 peak candlepower. The solid-state design shall be reliable in operation and long endurance with no contact resistance or electrical noise concerns. All mounting accessories shall be supplied.

Fire Sirens

The sirens will be capable of being heard distinctly throughout the plant area and will comprise twin sounders having a suitable range. The sirens will be suitable for installation outdoors and will be complete with rain shades and all other mounting accessories. The sirens will be motor operated type with AC motors of three phase design. The starters required for switching the sirens ON / OFF will be supplied with them. Siren will be mounted on duct support near chimney (capacity 3 km range) to operate in case of any alarm other than fault registered in the composite panel. The control of the sirens will be performed automatically by the fire alarm system, but manual operation from the central control room must also be possible.

Master Fire Alarm and Control Panel and Related Equipment

One Master Fire Alarm and Control Panel shall be located in the Main electrical substation Control Room and will be equipped with a recording alarm signals. The Master Fire Alarm and Control Panel will monitor all local supervisory fire alarm panels, all fire pump control cum annunciation panel and all addressable initiating devices such as Multi-sensor detectors, heat detectors and manual call points/pull stations.

The panel will be a microprocessor based addressable analog panel and will consist of master CPU, addressable loop modules, monitoring modules, system supervisory control modules, releasing modules, loop isolators, auxiliary output control modules, power supplies, battery and battery chargers, etc.

The panel will provide the following functions:

- Visual indication of each specific fire alarm will be provided on the Master Fire Alarm and Control Panel.
- Audible indication of each specific fire alarm will also be provided by a dedicated notification appliance in the Main substation Control Room.
- Annunciator acknowledge capability will be provided on the Master Fire Alarm and Control Panel to allow silencing fire alarms and trouble signals where allowed by code.
- Visual indication of each fire alarm or trouble condition on the Master Fire Alarm and Control Panel will be displayed until the initiating device, system, or trouble condition has been restored to normal.

1.4.0 Design Criteria

Fire fighting system	Design Criteria
Fire Water Flow Rate / Fire Water Ring Main Network.	***Design code:*** NFPA 850, NFPA 14 & 24 ***Criteria :*** Water supplies : The fire water supply shall be based on providing a 2 –hr storage for both item a) and b) below: a)Largest fire water demand of the fixed fire suppression system provided b)The hose stream demand of not less than 500 gpm. Minimum pressure : To provide required water flow rate at the minimum residual pressure of 6.9 bar at the outlet of the hydraulically remote 2-1/2 inch hose connection and 4.5 bar at the outlet of the hydraulically most remote 1-1/2 inch hose stream. Hydrant spacing : 75 m between two hydrants
Fire Water Storage	Design code: NFPA 850 Criteria : Two fire water storage tanks each having a capacity of 2 hours of maximum fire water pumping capacity.
Fire Water Pump Capacity	Design code: NFPA 20 Criteria : Capacity of one 100% electrical motor driven fire water pump according to worst case scenarios. Capacity of one 100% diesel engine driven fire water pump according to worst case scenarios.
Pressure Maintenance Pump Capacity	Design code: NFPA 20 Criteria : Capacity of one 100% pressure maintenance fire water pump shall be designed to make-up the allowable leakage in the fire water ring main network, which maintains the system pressure.
Portable Fire Extinguishers	In Accordance with NFPA 10

1.5.0 Control Philosophy

The hydrant lines shall be kept under pressure by water. Operation of all the fire pumps shall be automatic. To cater to minor leakages and to maintain header pressure, Pressure Maintenance Pump shall be automatically operated. Sudden drop of pressure below set point, due to opening of any hydrant valve shall be sensed by pressure switches located in the fire water main, which shall provide the starting signal to the fire pumps. In case the drop in pressure is drastic than the main pumps will be automatically operated. The stand by pump to the main pump will be automatically operated in case of the main pumps fails to start automatically. The automatic starting of the pumps will be effected by pressure switches set at different set point which will carry out the sequential operation of the pumps. Stopping of the pumps shall be manual only.

1.6.0 Codes and Standards

Code No.	Description
NFPA 10	Standard for Portable Fire Extinguishers
NFPA 14	Standard for the installation of Standpipe, Private Hydrant and Hose systems
NFPA 20	Standard for the Installation of Stationary Pumps for Fire Protection
NFPA 22	Standard for Water Tanks for Private Fire Protection
NFPA 24	Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA 72	National Fire Alarm Code
NFPA 850	Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations
BNBC	Bangladesh National Building Code, Part4, Fire Protection.

2.0.0 HEATING, VENTILATION AND AIR-CONDITIONING SYSTEM

2.1.0 General

This specification includes, the design of complete optimize HVAC system. The proposed HVAC system shall be in accordance with the ASHRAE and CARRIER hand book recommendations.

2.2.0 Scope of Work

Scope of supply and services shall include the design & engineering of Air conditioning system and ventilation system and associated equipment. Supply of Equipment for Air conditioning system out of scope. The supply of Ventilation system by Bidder.

All air conditioning and ventilating systems shall be fully automatic in operation and shall include all cooling, air heating and air humidification, dehumidification as necessary for maintaining internal conditions within the bands of temperature and humidity specified hereafter.

All equipment and/or accessories not specifically mentioned in this Specification, but which are necessary for a safe, reliable and proper operation of the whole plant as well as service or maintenance of the systems, shall be deemed to be included in BOQ

Providing of all necessary documents for review and approval by the Client before beginning some performance of work or preliminary tests for provisional acceptance such as but not limited to calculations, determination of dimensions, drawings of construction details, certificates, equipment samples, installation and stock plans, switch and control diagrams, airflow diagrams, equipment selecting sheets, equipment schedule, motor lists, measuring point and instrument lists, measuring tables, test records, cable, wiring and terminal lists, technical data sheets of all parts of the plants and characteristics curves, working, operating and servicing manuals, lubrication schedules, spare part lists, etc.

The Bidder shall submit system description, calculations, detailed construction drawings, equipments and materials list for Client approval.

All building material U-values shall be calculated and be part of calculation submittal.

Cooling-load calculation shall only be done on a software preferably “CARRIER E-20-II” Block Load or a new version of this. The design data inputs for the Software shall be preferably based on “ASHRAE Fundamentals Handbook Volume”.

Air-conditioning System:

Air-cooled DX type Air-conditioning Units

Each Air-cooled DX type Air-conditioning Units shall comprise of the following:

- Air cooled chiller units comprising of Screw/scroll compressor (Semi-hermetic type) suitable for the refrigerant R407C/R410A/R-134a other equally acceptable Ozone friendly refrigerant with drive package, Fin and fan type air cooled condenser, Refrigerant pipes and fittings for interconnecting the equipment.
- Each air handling units (AHU) shall comprise of fan section, Cooling coil, strip heater, filter and air mixing chamber and recirculation fans
- Galvanized sheet metal ductwork for supply and return air including diffusers/grille.
- Duct thermal and acoustic insulation for supply air ducts
- Air outlets and inlets with volume control device

- Silencer for supply and return air ducts
- Fire dampers when necessary on fire zone penetrations
- Electrical steam humidifier (100 per cent capacity) including control
- Automatic control for temperature and humidity.
- Necessary drain piping up to the nearest floor drains for each AHU with thermal insulation.
- 1 x 100% of fresh air fan with filter units and sand trap louvers shall be located in the AHU room for the fresh air circulation.
- Local control panel and local push button station.

Air Cooled Package Type Air conditioning System
Each Packaged Air cooled air-conditioning system shall comprise of the following:

Evaporator unit section which in turn is composed of the following:
- Centrifugal blowers
- DX cooling coils
- Electrical air heater or Heat Pump
- Humidifiers (If Required)
- Set of Panel filter (90%)

Refrigerant condensing unit section with
- Semi-hermetically sealed reciprocating / or any type of compressors
- Condenser fin tube cooling coil
- Condenser cooling air fans

Common supply air and return air Ducting complete with
- Ceiling mounted supply air diffusers
- Ceiling mounted return air grilles or through return air slots provided around the periphery of the false ceilings.
- Supply & Return Volume Dampers
- Solenoid operated Fire dampers in supply air ducting
- Solenoid operated Fire dampers in return air ducting
- Silencer for supply and return air ducts.
- Automatic control for temperature and humidity.
- Duct thermal and acoustic insulation for supply air ducts
- Local push button station

Split type Air-Conditioning System
The major components of split type air–conditioner system are:

Indoor unit comprising of:
- DX -Cooling coil
- Blower
- Coarse filter

Outdoor unit comprising of:
- Compressor
- Condenser.

Ventilation System

- Wall mounted axial flow fans – Supply air fans with pre-filters
- Wall mounted axial flow fans – Exhaust air fans
- Gravity dampers
- Fresh air through intake louvers.

- Wall mounted propeller type exhaust fans.

Common Equipment and Services:

- All general services as required such as trial operation, testing, training on site, supervision of operation and maintenance during guarantee period, etc as stipulated in the technical specification.
- All control, measuring and monitoring equipment, to an extent at least in accordance with the corresponding description of sections in the specification, as well as additional instrumentation necessary for matching to specific designs of equipment and units
- All necessary details of pipe work, expansion joints, valves, automatic actuators, supports, fastenings, etc.
- All necessary details of base frames, base plates, anchor bolts, supports, covers, etc.
- All necessary insulation as required in the system requirement.
- All necessary painting, corrosion protection and preservation measures as required in the relevant section of the technical specification.
- Each equipment shall be provided with suitable lifting arrangement, e.g. lifting lugs, eye bolts, etc to facilitate maintenance.
- Spare parts as stipulated in the relevant section of the technical specification.
- All consumables such as lubricants, chemicals, etc. for the complete commissioning, trial operation and a period
- The Contractor shall furnish a complete new set of all special tools and tackles of reputed make and model which are required for erection, ease in maintenance to have minimum down time, testing and calibration of all the equipments and systems to be provided by the Contractor under this specification
- Complete electrical system including drive motors suitable for area specified, Motor Control Centre, control panel, local push button stations, transformers rectifier set, power & control cables, cabling complete with supports, cable trays, glands, lugs, earthing and lightning protection system for the successful operation of the plant. The electrical system shall conform to the requirements specified in the relevant section of the technical specification.

2.3.0 System Description

The HVAC system involves the followings:

- Air-conditioning system
- Ventilation system

Air-conditioning System
The areas to be air-conditioned and the type of air-conditioning system and equipment provided are:

Conditioned Area	Type of Air-conditioning system
Community centre building - Recreation Halls, Dining hall, Office and Meeting Halls.	Air cooled DX Type Air-conditioning System
Executive Club, Office Room, Library & Reading room, Seating lounge, Restaurant, store. gymnasium, Billiards room, Carrom & card room, table tennis room, Multi purpose meeting hall, Non-Executive Club Office Room, Library & Reading room, Seating lounge, Restaurant, store. gymnasium, Billiards room, Carrom & card room, table tennis room, Multi purpose meeting hall	Air cooled DX Type Air-conditioning System
Swimming pool area- Office	Split type air conditioning Unit
Hospital - Emergency room, Waiting hall, Consulting rooms, Offices, Record rooms, Pharmacy, Stores, Laboratories, Radiography, Operation Theatres, Intensive care units, Physiotherapy, Prayer room, General wards, Double wards, Single wards, Burn ward, Seminar room and Dining hall	Air cooled DX Type Air-conditioning System
Training Centre & Trainees Hostel building - Office room, Dining Hall and Training Hall. Office room, Prayer room and Dining Hall.	Split type air conditioning Unit
Shopping Center, Post office, Bank and Estate office.	Air cooled Package unit
Head of Plant Bungalow - Bed Room.	Split type air conditioning Unit.
Guest house - Bed rooms, Entrance lobby, Main Dining Hall, Lounge and VIP Dining Hall, Prayer Room, VIP Suite, VIP Lounge, Reception Office, Indoor games room, Multi-purpose Hall, TV Lounge, Suite type rooms	Split type air conditioning Unit.
Mosque - Residential Imam & Moazzin, Prayer Hall and Office.	Split type air conditioning Unit.
- Office room, Prayer room and Dining Hall.	Split type air conditioning Unit.
Field Hostels - Bed rooms and Living room.	Split type air conditioning Unit.
Nursery and High School - Office room, Head Master Room, Library, Laboratories, Computer rooms and Conference hall. Activity room, Staff room	Split type air conditioning Unit.

Note:
Any other area/room requiring air-conditioning and not specifically mentioned above shall be included.
Bidder may suggest standby also as per proposed area.

In office and meeting room areas shall be air conditioned to provide comfort conditions for the occupants. Each individual room/area or unit shall be complete with dedicated controls which can be adjusted by the room users.

Air-cooled DX type Air-conditioning Units

Air cooled DX air-conditioner units shall be preferably 2 x 100% (One Working + One standby). Each air cooled DX air conditioner units shall consist of semi-hermetic compressor & its drive motor, condenser coil with fans, filters and accessories, Refrigerant pipes and fittings for interconnecting the equipment. The access panels and the main unit casing shall be attached to a sturdy chassis. The unit shall have multi steps of cooling through unloaders and/or by having multiple compressors.

Cooled and dehumidified air from the AHU shall be circulated by means of supply air ducting and diffusers which are routed in between the false ceiling and ceiling. The warm air from the conditioned area is sucked through return air grill located in the above false ceiling. The space between ceiling and false ceiling shall act as a return air path. The warm air shall be cooled by the refrigerant in the cooling coil and supplied to the conditioned area. A dedicated room shall be provided for the DX units and AHU's.

Air Cooled Package Type Air conditioning System

Air cooled package type air conditioning units shall be 2 x 100% (One Working + One standby). Each air cooled package type air conditioning units shall consist of semi-hermetic compressor & its drive motor, condenser and evaporator coil with fans, filters and accessories, Refrigerant pipes and fittings for interconnecting the equipment.

Cooled and dehumidified air from the Package unit will be circulated by means of supply air ducting and diffusers which are routed in between the false ceiling and ceiling. The warm air from the conditioned area is sucked through return air grill located in the false ceiling through return air duct. The warm air will be cooled by the refrigerant in the cooling coil and supplied to the conditioned area.

Supply air duct will be provided with filters, electric duct heaters, humidifiers and motor operated fire damper. Both supply and return air ducts will be insulated and provided with fire dampers

As per manufacturer's practice, the PAC units shall be provided with necessary protection and interlock such as lube oil pressure low, low suction pressure, high discharge pressure, and motor protection system.

Split type Air-Conditioning System

Outdoor unit consisting of hermetic / semi-hermetic rotary/scroll compressor, on anti-vibration mounts, axial flow fan air cooled condenser of seamless copper with aluminium fins, design & construction. Casing of galvanized sheet metal will be weather proofed or stored enameled against corrosion.

Indoor unit consisting of direct expansion cooling and dehumidifying coil 3 speed forward curved Double inlet double width (DIDW) centrifugal motor unit, insulated drain pan, coarse filter panel, casing of aesthetically designed Acrylonitrile butadiene styrene (ABS) moulded plastic construction for direct mounting unit or galvanized sheet steel casing weather proofed or stoved enameled against corrosion in case of ductable type.

Refrigeration circuit with R-410A/R134a/R407C or other equally acceptable Ozone friendly refrigerant filling, refrigerant drier, thermostatic expansion valves unit control panel barrier all control interlocks and power supply.

Ventilation System (In the scope of Bidder)

Ventilation system is considered for the following areas where, buildings or rooms in which waste heat occurs and has to be removed. Buildings or rooms in which hazardous/ toxic / acidic fumes/ vapours are present and has to be removed.

The type of ventilation system provided for various areas is based on the inside condition to be maintained, the heat loads, operational and maintenance ease.

Fresh air is supplied through a wall mounted fan unit comprising of axial fan, complete with supports and hardware. The air from the room shall be exhausted through wall mounted gravity dampers in order to provide pressurization preventing infiltration of external dust. The dry bulb temperature shall be maintained maximum 3 to 5°C above design ambient summer temperature during summer considering all heat gain from equipment.

The areas to be ventilated and the type of ventilation system and equipment provided are:

Ventilated Area	Type of Ventilation system	Type of Ventilation equipment
Switchgear rooms	Wall mounted supply fans with pre filters	**Supply :** 1x100% Wall mounted supply fans with pre filters. **Exhaust :** Gravity dampers.
Elevator machine room	Wall mounted supply fans with pre filters	**Supply :** 1x100% Wall mounted supply fans with pre filters. **Exhaust :** Gravity dampers.
Kitchen	Fresh air through intake louvers	**Supply :** Fresh air through intake louvers. **Exhaust :** 1x100% Wall mounted Axial flow exhaust fans.
Workshop & stores	Fresh air through intake louvers	**Supply :** Fresh air through intake louvers. **Exhaust :** 1x100% Wall mounted Axial flow exhaust fans.

Ventilated Area	Type of Ventilation system	Type of Ventilation equipment
Fire water pump house	Fresh air through intake louvers	**Supply :** Fresh air through intake louvers. **Exhaust :** 1x100% Wall mounted Axial flow exhaust fans.
Toilets in all buildings	Through door undercuts/door louvers	**Supply :** Fresh air through door undercuts/door louvers. **Exhaust :** 1x100% Wall mounted propeller type exhaust fans.

2.4.0 Design Criteria

Air conditioning system

The refrigeration capacity of the air-conditioning equipment shall be derived considering the following:

- Solar heat load (sensible and latent)
- Equipment & lighting loads
- Human occupancy load
- Fresh air load

The design parameters to be considered for arriving at the air conditioning cooling loads are:

Outdoor Design Condition:

The design inside temperature for air-conditioned areas is as per General Technical specification clause no.5.4.2.

Indoor Design Conditions:

The design inside temperature for air-conditioned areas is as per General Technical specification clause no.5.4.2.

Air-conditioning System:

Seasons	DBT°C	RH%
Indoor design condition	24.0°C ± 1.0°C	50+5%
Fresh air	1.5 AC/hr or 35 m3/hr/person whichever is higher.	
Lighting loads	20 W/Sq.m of floor area as per general practice.	
Electric duct heater	Shall be provided as per winter load requirement.	
Humidifier		

If number of occupancy is not separately specified, the same for general/ office area shall be minimum one person per 10 Sq. M and for conference room (Minimum).

All the equipments of Air Conditioning system shall be designed for continuous duty.

The air distribution system shall be sized to have a constant frictional drop along its length and velocity through ducts shall not exceed 7.6 m/sec.

For fans, compressors and blowers continuous Motor rating (at 50 deg.C ambient) shall be atleast ten percent (10%) above the maximum load demand of the Fan, compressors, blower at the design duty point.

Noise level within the air conditional space shall be restricted to 35-45 NC level with suitable acoustic attenuation/ duct silencers/ acoustic insulation, etc.

Wherever, belt drives are used the belts shall be sized for 150% of the rated power and there shall be minimum of two belts per drive.

Note :

1. Data has to be established by the EPC contractor during detailed engineering and shall be approved by the Client/Client's Engineer.
2. Data is a general industrial practice and is subject to change during detailed engineering based on actual equipment supplier's data.

Ventilation system

Dry Pressurised Ventilation

The ventilation system fan capacity is derived considering the following:

- Solar heat load (sensible and latent)
- Equipment loads
- Allowable temperature rise

These design parameters to be considered for arriving at the ventilation system capacity:

System parameter	Design Criteria	Reference
a) Outdoor Design Condition	Design maximum dry bulb Temperature 36.9°C	
b) Indoor Design condition	Maximum room temperature of 3 to 5°C above ambient	

Note :
General assumption based on similar equipment for past projects and is subject to change during detailed engineering based on vendor data.

General Supply/Exhaust Ventilation

The general exhaust ventilation system fan capacity is designed considering Minimum recommended air change rate.

Room	Basis of Airflow rate: Air changes per hour
Switch gear room	30
Workshop and Stores	15
Kitchen	15

Room	Basis of Airflow rate: Air changes per hour
Toilets in all buildings	15
Elevator machine room	15

2.5.0 Control Philosophy

Air conditioning system
Each AC plant shall be provided with one PLC based simplex control panel housing all interlock relay, Control cards, auxiliary contacts, annunciation facia, start / stop push button. This control system shall also include control and annunciation for Ventilation system.

One collective fault signal from PLC system shall be hardwired to main control panel for annunciation in the main substation control room.

Dry Bulb Temperature Control
The dry bulb temperature of control room shall be maintained within the specified tolerance by automatic unloading device of the refrigerant. A temperature sensor transmitter placed in the control room RA path shall load/unload the compressor in stages.

Relative humidity control
The RH of control Room shall be maintained within the specified tolerance by steam humidification and reheat control. Reheat control is achieved by the strip heatersin the supply air duct. A Humidity sensor transmitter placed in the Return Air path of control room shall provide the ON/OFF signal to the heater in steps with increase in Return Air (RA) Relative humidity above set point. Similarly the humidity sensor transmitter shall also provide the ON/OFF signal to the immersion heaters of pan humidifiers with decrease in RA Relative Humidity below set point.

Fire Safety Interlock
The AHU fan motor shall be interlocked with fire detection system such that the AHU fans motor will trip closing the smoke damper at the SA ducting, with the sensing of fire/smoke in the conditioned space.

Filter dirty condition interlock - High differential pressure switch
A high differential pressure switch provided across the panel filters will rise an alarm in the control panel on sensing a clogged condition of the filter.

High supply air temperature Interlock
A High temperature switch provided in the supply air ducting shall rise an alarm in the units control panel and trip the electric air heater and humidifier.

Fire damper interlock
Fire damper provided in the supply & return air ducting and shall close on fire signal from the fire alarm system.

The AC Plant shall be operated from local control panel only. For the equipment, which are located away from LCP, local start/stop push button will be provided near to the drive for testing / maintenance only, the stop push button shall be lockable. Required Test/Service selector switch for the same shall be provided in LCP.

The following are the signals envisaged from air-conditioning system local control panel to main control panel located at main sub-station control room (Exact details shall be furnished later) if required.

- AHU fan tripped on O/L (As required)
- Compressor tripped
- Condenser fan motor tripped.

Ventilation system

The local start/stop push button station shall be provided for the supply/exhaust fans.

2.6.0 Codes and Standards

ASH RAE 30	Methods of testing liquid chilling package
ARI 430	Central station air handling units
ARI 410	Forced circulation air cooling and air heating coils
ANSI-B31.5	Refrigeration piping
AMCA - 210	Test code for Air Moving device
AMCA - 300	Test code for sound rating of Air Moving device
ARI 520	Standard for Positive Displacement Refrigerant Compressor, Compressor Units, and Condensing Units.
ARI 850	Standard for Commercial and Industrial Air Filter Equipment.
AMCA 99	Fan – Standards handbook
UL 499	Underwriters laboratories–Standard for safety for Electric heaters
UL 705	Underwriters laboratories–Standard for safety for Roof Ventilators
TEMA	Standards for Tubular Exchangers Manufactures Association
SMACNA Std	Sheet metal ductwork
UL 555	Underwriters laboratories – Standard for safety for fire dampers
AHRI	Air-conditioning, Heating and Refrigeration Institute
ASTM	American Society for Testing & Materials

3.0.0 ELEVATORS

3.1.0 Intent of Specification

This section covers the technical requirements of Elevator for various buildings in the township.

3.2.0 Codes and Standards

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest edition (including amendments) of the National standards, OSHA, IEC publications and other codes except where modified and /or supplemented by this specification.

3.3.0 Technical Requirements

3.3.1 Elevator shall be provided in high raise residential building, non residential building and hospital. Elevators of persons capacity 8 and 13 shall be provided as per the quantity detailed in Civil section of this specification. For hospital, patient elevator shall also be provided

3.3.2 The Elevator shall be complete with all fittings and accessories including the following:

- Hoisting machine including motor
- Over speed governor
- Brakes
- Limit switches.
- Guide rails, guide bracket and wall inserts
- Machinery support structure / beams
- Steel beams of raft for machine and pulleys
- Safety grips
- Buffers and any associated steelworks,
- Steel wire ropes
- Enclosed vestibule with framing
- Hoist way entrances, doors and door tracks
- Car enclosure with door and door hangers
- Car frame and platform construction
- Supporting steel works for horizontal sliding doors and frames for hinged doors
- Pit screen to counter weight
- All steel embedment for fixing landing doors and equipment.
- Steel ladder for access to pit
- Car operating panel with controls, indications and protections
- Landing call station with call registering push buttons and call registered indication
- Load plate
- Intercom for three way communication
- Controller panel
- VVFD for main motor
- VVFD for door motor
- UPS with battery
- Disconnecting switch
- Power and control cables
- Galvanized steel conduits, cable glands/ lugs and terminations
- Earthing system
- Lighting for hoist well
- Light, fan and telephone for car
- Emergency stop switch on top of car

- Emergency stop switch in the pit
- Car and counterweight buffer switch
- Auto rescue device
- Erection material
- Touch up paint
- First charge of lubricants and consumables
- Startup and commissioning spare parts
- Special tools and tackles required for maintenance of equipment

3.3.3 All the equipment and its components shall be designed for ambient temperature of 50ºC. The Elevator shall be suitable for operation at 415 V+10% to -10% of the supply voltage, 50 Hz +3% to -5% of the supply frequency and combined voltage and frequency variation of 10%.

3.3.4 All statutory approvals from commencement to commissioning of Elevator shall be obtained by the Contractor from the 'Office of the Chief Inspector of Elevator and Escalators and / or other authorities. However, the Owner shall provide all necessary assistance for providing documents, drawings and certificates pertaining to other contractors, if required. Necessary fees in connection with the approval of installation of Elevator shall paid by Owner.

3.3.5 Comprehensive maintenance during Defects Liability Period inclusive of periodic servicing, prompt attention to Owner's complaint, prompt rectification of all malfunctions and equipment failures, replacement of defective equipment / parts, replacement of light fittings, lubrication including lubricants, maintaining correct alignment and leveling of cars and ensuring smooth running, starts and stops etc. all complete to Owner's satisfaction shall be done.

3.3.6 **Traction machine**

The machine shall be worm geared traction type with motor (steel worm, bronze gears, steel sheave shaft & Ferro molybdenum sheave), electro-mechanical type of brake and driving sheave mounted in proper alignment on a single heavy cast iron base or steel bedplate.

The worm shaft shall be fitted with roller bearings to take end thrust. The sheave shaft shall also be fitted with roller bearings to ensure proper alignment. All shafts shall be provided with well-designed keys.

Rotating parts shall be statically and dynamically balanced.

The drive sheave shall be designed with machined V-grooves to ensure adequate traction with minimum wear on rope. All sheaves including deflector sheaves, where used, shall conform to applicable codes and standards. Adequate and dust – proof lubrication shall be provided for all bearings and worm gears.

The brake shall be suitably curved and provided with fire proof friction lining. The operation of brake shall be smooth, gradual and with minimum noise. The brake shall be designed to be of adequate size and strength to stop and hold the car at rest with rated load. The brake shall be capable of operation automatically by various safety devices, current failure and by the normal stopping of the car. The brake shall be released electrically. It shall also be possible to release the brake manually so as to move the Elevator car in short stops. Suitable Brake release tools shall be supplied and stored in the machine rooms.

For manual operation of Elevator, up & down direction of the movement of the car shall be clearly marked on the motor or traction machine. A warning plate in bold signal red colour to switch off the mains supply before releasing the brake and operating the wheel shall be prominently displayed.

3.3.7 Hoist motor

The motor shall be suitable for 415 Volts +10% to –10%, 50 Hz. + 5%, 3 Phase A.C. Supply. The motor must be designed for arduous Elevator duty, rapid reversals and constantly repeated starts & stops as defined in the relevant codes of practice. All windings must be heavily insulated, adequately impregnated for tropical climate and mechanically strengthened and must be specifically designed to have a high starting torque and low starting current characteristics. The motor shall be designed in such a way as to withstand occasional overloading above its rated capacity and shall have overload protection. The motor shall have good speed regulation under different conditions of load and shall be designed to give a noiseless and vibration-free operation. Insulation shall be class F.

3.3.8 Motor control and drive

The Elevator motor shall be controlled by a variable voltage variable frequency (V.V.V.F.) micro-processor control system which shall control and monitor every aspect of Elevator operation at all stages of the car motion cycle on real time basis.

The A.C. V.V.V.F. drive system shall control A.C. voltage and frequency concurrently with the hoist motor to regulate the Elevator's actual performance to match closely the ideal speed pattern, obtain maximum efficiency of operation and provide a very smooth ride.

Frequency shall range fully between zero and rated value.

The Controller shall be provided with a self diagnostic programme to keep downtime to a minimum possible.

The controller shall intelligently adjust door times in response to car calls, hall calls and "Door Open" button operation.

An Inspector's changeover test switch and set of test buttons shall be provided in the controller. Operation of the Inspector's changeover switch shall make both the car and landing buttons inoperative and permit the Elevator to be operated in either direction from machine room for test purposes by pressing corresponding test buttons in the controller. It shall not, however, interfere with the emergency stop switches inside the car or on the top of the car.

3.3.9 Guides and fastenings

i. Guide-rails for car and counterweight shall consist of machined mild steel Tee sections, erected plumb, and securely fastened to the Elevator well framing by heavy steel brackets, suitably spaced, to limit deflection of guide rails to 3 mm under normal working conditions.

ii. The guide-rails shall be of suitable section with ends tongued and grooved, forming matched joint and shall be connected with steel fish plates.

iii. Guide-rails shall cover the full height of the hoistway and pit , such that It shall be not be possible for any of the car or counter weights shoes to run off the guides.

iv. Guides shall be designed to withstand the action of safety gear when stopping a counter weight or fully loaded car.

v. The max. deviation from true plumb and alignment of guide rails shall be 2 mm.

vi. All support framing shall be rigid and shall be designed to restrict displacement of the point of support of brackets to 3 mm under normal working conditions.

vii. The whole guide rail installation, including expansion joints, shall be designed for a smooth ride.

viii. The guide-rails shall be protected during storage and installation with a rust inhibiting coating which shall be cleaned off on completion of installation.

ix. Guide-shoes shall be adjustable type & mounted so as to provide continuous contact with guide rails under all conditions.

x. Guide shoes shall be provided at top and bottom of each side of car and counterweight and shall be designed for quiet operation.

xi. Additional guide shoes shall be provided on each side of buffer frame in case of oil buffers.

xii. Each Elevator shall be equipped with roller guides for up and down travel. There shall not be any metal-to-metal contact between Car and rail. Roller shall be mounted on ball bearings to provide quiet operation and excellent ride quality. (It is not required in case the design varies however the ride quality shall not be compromised for any other design).

3.3.10 Safety

Elevator shall be provided with safety devices as follows :-

a) Against overload

b) Safety gear on car so that in the event of rope breaking or loosening, the car shall be brought to rest immediately by means of grips on the guides.

c) The overspeeding car shall be automatically brought to a gradual stop on guide rails and power supply to the hoist motor shall be switched off.

d) Overspeed centrifugal governor operating the safety gear in case of overspeeding of car in the down direction.

e) Car gate lock so that in the event of car gate being opened when passengers are in the car, the Elevator shall be brought to rest.

f) Overtravel limit switches at top and bottom limits of travel to disconnect the power supply and apply brakes to stop the car within a defined safe distance in case of overtravel in either direction

g) Ultimate terminal switches to stop the car automatically within top & bottom clearances independently of normal overtravel limit switches but with buffers operative.

h) Protective guards to counterweights in pit, rope sheaves and wherever required.

i) Toe guard apron to the car platform.

j) Terminal buffers.

k) Terminal switches shall stop the car automatically at terminal floors within the top and bottom permissible over travel

l) Electro-mechanical door lock

m) Motor operated / electromechanical brake

n) Counter-weight guards

o) Overload alarm through load cell

p) Alarm bell at the top of car and in the machine room

q) Emergency door lock release operating key

r) “Slackening of rope” iidentification

3.3.11 **Car**

a) The internal clear dimensions of the cabin shall not be less than those specified in codes and standards. The car shall be so mounted on the frame that vibration and noise transmitted to the passengers inside is minimised.

b) The car frame shall consist of mild steel channel/structural steel top and bottom securely riveted or bolted and substantially reinforced and braced so as to relieve the car enclosure of all strains when the safety device comes into action due to overspeed or when the capacity loaded car is run on the buffer springs at normal speed.

c) The safety device mounted on the bottom members of the frame operated by a centrifugal speed governor shall be arranged to bring the car to a gradual stop on the guide rails in the event of excessive descending speed; and provision shall be made to shut off the power supply to the motor.

d) Substantial spring buffers (2 Nos.) shall be furnished and installed in the pit under the car and counterweight. These buffers shall be mounted on RCC Pedestals in the pit. The car buffer spring must be of correct design to sustain the car with capacity load without damage should the car terminal limits become inoperative. The car buffers must be located symmetricaly with reference to centre of car.

e) The Elevator shall be suitably counter-balanced for smooth and economical operation. Cast iron weights shall be contained in a structural steel frame properly guided with suitable guide shoes (minimum 4 Nos). It shall be equal to the total weight of Elevator plus approx. 50% of the contract load. Substantial expanded metal counter-weight screen guard shall be furnished and installed at the bottom of hoist way, as required by Elevator Inspector.

f) Hoisting and Governor Ropes: Bright steel wire ropes with fibre cores suitable for Elevator duty as per Codes and standards shall be used for hoisting ropes. Not less than 3 independent suspension ropes shall be provided and designed to share load equally by means of adjustable shackle rods with equalizer springs at each end of hoisting ropes.

g) Each rope shall have adequate section to provide a minimum factor of safety of 4 based on the max. force on the rope. Governor ropes shall be similar to hoisting ropes. Their ends shall be securely attached to the car and to the safety gear. The governor ropes shall be tensioned by a weight loaded device in the pit.

h) The cabin floor, roof and walls shall be free of distortion and undue deflection as per codes and standards.

i) D.C. brakes shall be spring-applied and electrically released. They shall be designed to provide smooth stops under variable loads.

j) Provision shall be made for vertical and horizontal fine adjustment of doors as per the specifications given in technical data sheet.

k) The door operators shall be VVVF inverter controlled heavy duty A. C. motor, allowing variable opening and closing speeds, and full synchronization of car and landing doors.

l) The traveling cables shall be multi-core with high conductivity stranded conductors specifically designed for Elevator duty. The cables shall be provided with retaining straps and individual cable clamps.

m) A self-contained, non-maintained emergency light with a trickle boost charger shall be provided.

n) An Intercom system shall be provided between the car, main landing, machine room.

o) Manual cranking facility shall be provided in the machine room to facilitate evacuation of passengers in case of power failure. The manual mode shall be in addition to automatic car failure operation specified elsewhere.

p) A stop switch in the machine room / top of car shall be provided for use by maintenance crew to cancel all car and landing calls for a particular Elevator.

q) On operation of the maintenance switch located on top of the car by the maintenance crew, the car shall travel at slow speed not exceeding 0.85 m / sec by continuous operation of a button

r) Electrical interlocks shall be provided to ensure that the car does not operate unless all doors are closed and unless the car reaches a landing zone.

s) An overload indicator with buzzer shall be provided in the cabin to indicate to the passengers that the car shall not start as it is overloaded.

t) All the Passengers Elevator shall be suitable for use by disabled persons capacity. The following additional facilities shall be provided in this Elevator:

   i. Full length handrails shall be provided on the rear and side wall panels.
   ii. The door closing time shall be set for min. 5 seconds and the door closing speed shall not exceed 0.25 m/sec.
   iii. The “door open” and “door closed” announcements shall be audibly made in the car.
   iv. Braile signs / buttons.

u) Main and secondary car operating panels, buttons and switches shall be located on one of the two front wall panels next to the car door.

v) All buttons and switches shall be clearly legible with fade-proof text and figures, and shall be easily accessible, (especially for disabled persons capacity in the Elevator designated for them).

3.3.12 Electric wiring

Necessary insulated wiring to connect all parts of the equipment shall be furnished and installed. Insulated wiring shall be flame retardant and moisture resistant and shall be run in G.S. conduits. All cables shall be flame – retardant with copper conductors.

Trailing cables shall be PVC sheathed copper conductor multi-core ribbon type designed for Elevator service and shall be flame retardant and moisture resistant. They shall be flexible and shall be suitably suspended to relieve strains on individual conductors. All copper conductors shall be of appropriate gauge copper to avoid excessive voltage drop. All wires, cables, conduits, metal boxes, fittings and earthing shall comply with statutory requirements and specifications.

The controller unit comprising of the MCCB, 25KA, adjustable overload and phase reversal and phase failure protection, all the circuit elements, transformer, rectifier for D.C. control supply, inverter power pack, terminal blocks etc. shall be enclosed in an insect vermin proof, sheet steel floor or wall mounted cabinet with hinged doors at front or at both front and rear. Proper warning boards and danger plates shall be provided on both sides of the controller casing. Sheet steel used for controller cabinet shall not be less than 14 gauge and shall be properly braced, where necessary. Suitable gland plate shall be provided for cable entry. The battery for the charger unit shall be suitably placed in the machine room. Degree of protection of Enclosure shall be IP54. Enclosure shall have provision of earthing studs.

All sheet steel work shall be painted with two coats of synthetic enamel paint of suitable shade both inside and outside over two coats of zinc primer.

3.3.13 Features required for VVVF elevator

(a) **Group / Independent / Attendant Operation:** It shall be possible to group specified cars in a group wherever required with dynamic disposition of cars as required by the traffic pattern. A smart car dispatching system with ring communication shall be provided for optimum passenger comfort and Elevator performance under all traffic conditions. Any defective car shall be automatically eliminated from the group. Each car shall be provided with a keyswitch for independent operation housed in a service cabinet. In this mode, the Elevator shall respond only to car calls. Hall calls shall not be registered. It should be possible for an attendant to operate any car.

(b) **Fireman's Switch:** A fireman's toggle switch shall be provided in a break glass for the specified Elevator at ground floor to enable firemen to bring the Elevator non-stop to ground floor from any location and to cancel hall calls until the car is operated on attendant control.

(c) **Emergency Power Operation:** In case of power failure, standby power equipment shall enable Elevator to reach a pre-determined floor, in a pre-determined sequence, and then permit operation of one or more Elevator on emergency power. A trickling battery shall be provided to supply power to light fixtures, fan, alarm and intercom.

(d) **Profile Generator:** A profile generator or similar device shall be provided to use the car at an optimum speed level and to improve levelling accuracy.

(e) **Predictive Car Selection:** Once a hall call is registered, a dynamic car algorithm shall transfer the call to an optimally selected car to provide the maximum traffic efficiency.

(f) **Home Landing Facility:** A car shall return to a pre-determined landing after the last call is answered.

(g) **Door Safety:** Multi-beam infrared / ultrasonic electronics curtains shall be provided to scan the doorway and reverse the door closing in case of any obstruction.

(h) **Double Door Operation:** If both up and down calls are registered at a hall which is the last registering hall in the direction of the car, the Elevator shall travel to that hall and open / close the doors. After this, the car shall reverse its travel and shall open / close the doors again unless no car calls are registered at that floor.

(i) **Nudging Door Operation:** When the doors remain open for more than a predetermined period, a buzzer shall sound and the door shall close automatically. The door sensing device shall be rendered inoperative but the Door Open button and the safety shoe shall remain operative

(j) **Selective floor Service:** Programming for selective floors services shall be software driven.

(k) **Manual Cranking & Slow speed Travel:** A manual cranking facility shall be provided. Slow speed operation shall be possible from machine room and car top.

(l) **Auto Fan Off:** In case no calls are registered for a pre-set time, the cabin fan shall be automatically switched off.

(m) **Automatic Rescue Device :** In case of mains power failure and Elevator control system failure, the Elevator's own rechargeable and maintenance free battery power shall move the car to the nearest floor and the door shall open automatically for automatic rescue of passengers. A battery run-down indicator shall be provided.

3.3.14 **Elevator operation**

a) Microprocessor based simplex selective- collective operation with/without automatic operation by means of one button in the car for each landing level served and by up-and-down buttons at the landings, wherein all stops registered by the momentary actuation of car made as defined under non-selective automatic operation but wherein the stops registered by the momentary actuation of the landing buttons are made in the order in which the landings are reached in each direction of travel (irrespective of the sequence in which the buttons have been actuated.

b) With this type of operative all' up' landing calls are answered when the car is traveling in the up direction and all 'down' landing calls are answered when the car is traveling in the down direction except in the case of the uppermost or lowermost calls which are answered as soon as they are reached in-respective of the direction of travel of the car.

c) A by-pass button (non-stop button) shall also be provided inside the car to enable the attendant position. The operation of the cars shall be identical with that described for automatic operations except that closing of doors and starting of cars shall be initiated by the car buttons only and landing by-pass shall be effective.

d) The control circuit shall be designed to the type of Elevator specified for safety operation. It shall not be possible to start the car unless all the car and landing doors are fully closed and landing doors locked. The circuit shall have an independent fuse protection for fault and over loads and be arranged so that earth fault or an open circuit shall not create unsafe condition. The circuit shall be so arranged that for the stoppage of the car at specified landing or for actuation of a contactor by emergency switches or operation of safety gears the system shall not depend upon the completion or maintenance of an electrical circuit to cut off power supply and apply the brakes.

e) Door open and close push button shall be provided in the car. It shall be possible to stop or reverse the door closing through the door open button in the Elevator car. Door close button shall allow the door to be closed for a call. The following buttons shall also be provided in the car operating panel in addition to standard buttons.
   - Emergency Stop
   - Attendant Transfer Switch/Key
   - Alarm

f) When the car door panel is touched by a person or object while the car door is closing, the car and Hoist way doors shall return to their open position. The doors shall remain open until expiration of a pre-determined interval and then close automatically.

g) Elevator shall have means to cut off power from the motor, whenever an excessive descending speed is reached, and apply the normal brake prior to the application of the safety brake.

h) Overload of the Elevator shall be sensed by improvised sensing devices such as strain gauge, load cell and shall be precise and accurate. The Elevator car and landing door shall not close on overload condition and shall remain open till the over load cease to exist. Audiovisual alarm for overload shall be provided inside the car.

i) Elevator shall be provided with a self-leveling feature that shall automatically bring the car to floor landings. This self-leveling shall, within its zone, be entirely automatic and independent of the operating device and shall be self-correcting for over-travel or under-travel and rope stretch.

j) Elevator shall have auto recorded audio annunciation system which shall annunciate for arrival of each landing, improper closing of doors and any other required for the Elevator.

k) Elevator shall be equipped with an automatic stopping device, arranged to bring the car to a stop at the terminal landings independently of the regular operating device in the car. Final limit switches shall be provided in the hoist way, operated by the car and arranged to stop the car and prevent normal operation should it travel beyond the zone of the normal stopping device.

3.4.0 Painting

All exposed metal work furnished in these specifications, except as otherwise specified, shall be given one shop coat of anti-corrosive primer after approved surface treatment of metal surfaces and two coats of approved enamel paint of approved shade. After installation of Elevator, a final Touch-up coat of paint shall be applied.

3.5.0 Works Tests

The following tests shall be carried out at Works. Owner shall be given notice of the time and procedure of the tests before they are carried out, and shall be given facilities for observing the tests at Works.

a. High voltage works tests of equipment which is not already tested in accordance with appropriate codes.
b. Buffer test.

3.6.0 Tests on Completion

The following tests shall be carried out to the satisfaction of the Owner.

3.6.1 Insulation resistance and earth test for all electrical apparatus.

3.6.2 Continuous operation of the Elevator under full load conditions and simulated starts and stops (150 nos. per hour each) for one hour at the end of which time the service temperature of the motor and the operating coils shall be tested.

3.6.3 The car shall be loaded until the weight on the rope is twice the combined weight of the car and the specified load. The load must be carried on for about 30 minutes, without any sign of weakness, temporary set or permanent elongation of the suspension rope strands.

3.6.4 The following items shall be tested :

a. Leveling accuracy at each landing in conditions of fully loaded and empty car.
b. No load current and voltage readings both on 'Up' and 'Down' Circuits.
c. Full load current and voltage readings both on 'Up' and 'Down' Circuits.
d. One and quarter load current and voltage readings both on 'Up and 'Down' Circuits.
e. Stalling current and voltage and time taken to operate overload.
f. Overload protection.
g. Gate sequence relays, if provided and installed.
h. Car and landing door interlocks.
i. Collective control and priority sequences, if installed.
j. Safety gear mechanism for car and counterweight with fully loaded car and also with only 68 kg load.
k. Speeds on Up and Down travel with full load, half load and empty car.
l. Door contacts.
m. Final terminal stopping device.
n. Normal terminal stopping device.
o. Car and counterweight buffers with contract load and contract speed.
p. Operation of controllers.
q. Manual operation of Elevator at mid-way travel.
r. Emergency operation.

3.6.5 Tests on completion shall also be performed to the satisfaction of Inspector of Elevator and a certificate shall be obtained from the 'Elevator Inspector ' by the contractor.

3.6.6 The following parameters shall be achieved in the installation :

*	Levelling Accuracy	$\pm$ 3 mm for 1.5 m/s speed $\pm$ 4 mm for 0.75 m/s speed
*	Jerk level	0.9 – 1.5 m/s^3
*	Noise level in car	58 dB
*	Noise level at 1 M in machine room	60 dB
*	Acceleration rate	0.6 – 1.0 m/s^2 (adjustable)
*	Max. car vibration	20 milli gals.

3.7.0 Drawings, Data and Manual

The bid shall be submitted with the following:

- Technical data sheet.
- Drawing & catalogue

The following documents shall be submitted by the successful Bidder after the award of contract.

- Single line diagram
- Schematic diagram
- Technical data sheet
- General Arrangement drawing
- Quality Plan
- Test certificates
- O&M manual

3.8.0 BOQ

No.	Elevators	Unit	Qty
1)	8 persons capacity Passenger Elevator	Lot	1
2)	13 persons capacity Passenger Elevator	Lot	1
3)	Patient elevator for hospital	Lot	1

3.9.0 Technical Parameters:

Sl. No.	Item Description	Data
1.	Application	Passenger Elevator
2.	Type	Floor Elevator system with car.
3.	Type of operation	With/without attendant
4.	Minimum carrying capacity	8 Persons capacity and 13 persons capacity. (For Hospital, patient lift shall be provided)
5.	Speed	1 metre /second
6.	Position of machine room	Over the Elevator well
7.	Car enclosure (Interior)	Decorative and architectural
8.	Car flooring	Granite finish
9.	Car door	Centre opening, automatic horizontal sliding type. Stainless steel construction.
10.	Levelling accuracy	± 12 mm
11.	Hoist way door opening	Pressed steel frames and hollow metal doors – with weather gasketing
12.	Drive	Variable Voltage, Variable Frequency (VVVF) Drive.
13.	Control system	Directional collective control. Fully automatic microprocessor based control
14.	Safety device for door operation	Infra-red light curtain required
15.	Type of construction of car operating panel	Box type with stainless steel face plate
16.	Type of construction of car position indicator	Box type with stainless steel face plate
17.	Type of display of car position indicator	7 segment led display
18.	Type and mode of operation of over speed governor device	Centrifugal action
19.	Type and location of safety gear	Friction type, safety gear located at bottom of car frame

Sl. No.	Item Description	Data
20.	Power supply	415 V , 3 phase, 4 wire, 50 Hz supply
21.	Type of motor	AC, squirrel cage induction motor
22.	Duty of motor	Elevator duty suitable for inverter application
23.	Type of enclosure of motor	IP 55
24.	Class of insulation of motor	Class F, temperature rise limited to class B limits

PART – B : FUNCTIONAL TECHNICAL SPECIFICATION

SECTION – B3

DETAILED TECHNICAL SPECIFICATION - ELECTRICAL

Table of Contents

PART – B

SECTION B3

DETAILED TECHNICAL SPECIFICATION FOR ELECTRICAL

SECTION – B3.1 : GENERAL

1.0.0 INTENT OF SPECIFICATION

This specification covers the requirements for supply and installation of electrical equipment for efficient and trouble-free operation of electrical system of the proposed Township.

It is not the intent to specify completely herein all the details of design, manufacture, supply & installation. However, the equipment shall conform in all respects to high standards of design engineering and workmanship and shall be capable of performing in continuous commercial operation up to agreed guarantee.

The general terms and conditions, instruction to Bidders and other attachments referred to elsewhere be hereby made part of the technical specification. Bidder's offer shall conform to all the requirements stipulated in the specification.

Deviations, if any, shall be brought out very clearly in the deviation sheet enclosed with the specification only. Otherwise it shall be construed that the Bidder's offer is in line with what has been stated /asked for in this specification.

2.0.0 SCOPE OF WORK

2.1.0 The scope of work shall include electrification of (Internal electrification and external electrification) various buildings, structures and facilities including the following as detailed in the civil section of this specification.

I. Residential Buildings

a. Executive Residence – Type – A
b. Executive Residence – Type – B
c. Executive Residence – Type – C
d. Staff Residence – Type – D
e. Head of Plant Bungalow
f. Guest House
g. Studio Apartments
h. Field Hostel – Staff
i. Trainees Hostel and Training Center

II. Non - Residential Buildings

a) Gate and Security
b) Car Parks
c) Nursery and High School
d) Mosque
e) Hospital
f) Shopping Center with Post Office, Bank and Estate Office
g) Temple
h) Community Center
i) Executive Club

j) Non - Executive Club
k) Swimming Pool
l) Indoor Sports Complex
m) Outdoor Sports Area
n) Potable Water, Service Water and Fire Water Pump House
o) Main Receiving Substation
p) Distribution Substations
q) Maintenance Store
r) Underground Water Tank
s) Watch Tower

III. Facilities Outside Township Boundary

a) Police Station
b) Cyclone Shelter
c) Storm Water Retention Pond
d) Gas Cylinder Godown
e) Transport Center
f) Security Force and Army Barracks

2.2.0 The scope of work shall include design, engineering, manufacture, assembly and testing at works, packing, dispatch and transportation to site (including transit insurance), erection, testing and commissioning of the complete electrical system. Major equipment and systems are listed below and are further detailed in subsequent sections of this specification.

a) 11 kV indoor switchgear
b) 11 kV incoming cable from power plant to township
c) 11 kV Ring main units
d) 11/0.433 kV Distribution transformers
e) 415 V Power control centres
f) 415 V Power factor improvement capacitor banks
g) 415 V Motor control centres
h) 415 V Main Distribution Boards / Floor Distribution Boards / Distribution Boards / Essential Distribution Boards / Sub-distribution boards
i) 415 V lighting panels & receptacle panels
j) 415 V bus trunking & overhead busbar system
k) 415 V Rising mains
l) 415 V Diesel generator sets
m) Motors (associated with bidder supplied equipments)
n) Local push button station for motors
o) 11 kV Power cables
p) 1100 V grade Power & Control cables
q) Cables for telephone, television and data communication
r) 110 V DC Battery with Charger & DCDB
s) 48 V DC Battery with Charger & DCDB
t) Digital EPABX sub system
u) 230 V Uninterrupted Power Supply system (UPS)
v) Cabling system complete with cable trays, supports, conduits, glands, lugs etc.
w) Cabling for telephone, television and data
x) Fire stop cable penetration system
y) Earthing system including buried earth mat and above ground earthing.
z) Lightning protection system
aa) Illumination system (internal and external) for the complete facilities inside and outside the township boundary listed in the specification including lighting panels, poles, Masts, lighting fixtures, aviation obstruction lights, wires, switch boxes, receptacles, conduits & accessories.

bb) Ceiling fans, wall mounted fans, exhaust fans, switches, fan regulators, socket outlets, call bell
cc) Circuit wiring & Point wiring
dd) Main distribution frame, junction box, Telephone cables including fiber optic cables etc. for telephone system.
ee) Telephones of Analog type, digital type, IP Phone, ISDN phone, PC with soft phone, and Video conference device,
ff) Master antenna television system along with cables & Accessories
gg) Supporting structures for all equipment with foundation bolts
hh) Safety items like Rubber mats, First aid box, Danger plate, shock treatment chart, Sand buckets etc.
ii) Construction power supply
jj) Erection hardware
kk) Complete detailed design of electrical system.
ll) All interfacing engineering with other packages such as pumps, ventilation, firefighting, piping etc.
mm) All required interfacing engineering with Civil works.
nn) Deriving 11kV power supply from main plant EPC contractor's construction power sub-station for township construction power supply
oo) System study

Detailed Bill of Quantity is listed in Annexure-B.

2.3.0 The scope of supply shall also include the following:

- Consumables
- Spare parts required for successful commissioning. Bidder shall submit the list.
- Mandatory spares for operation & maintenance (O&M)
- Special tools and tackles

2.4.0 Equipment / items not specifically mentioned in the specification but which are required for the successful operation and maintenance of the system in all respects, consistent with the best engineering practices are deemed to be included in the scope of supply.

2.4.1 All sundry fittings, assemblies, accessories, hardware items, foundation bolts, termination lugs for electrical connections as required, and all other sundry items which are useful and necessary for proper assembly and efficient working of the various components of the work shall be deemed to have been included in the tender, whether such items are specifically mentioned in the tender documents or not.

2.4.2 O&M spares and special tools & tackles being purchased by the Owner in this contract shall not be used during the commissioning of the equipment.

2.4.3 The Contractor shall obtain and pay for all permits, licenses, and statutory approvals from local authorities for completion of work. Original copies of these approvals shall be delivered to the Owner

2.4.7 Detailed specifications for the above mentioned equipment are covered in the subsequent sections of this specification.

2.4.8 **Terminal points**

- Two nos. 11 kV, 3 phase, 50 Hz, incoming supply at 11 kV Switchgear located at power plant at a distance of about 1 kM from township.

- Telephone & data cable at Telephone exchange of township located at main receiving substation.

- One no. 11 kV, 3 phase, 50 Hz, feeder at main plant EPC contractor's construction power sub-station for township construction power supply.

2.4.9 **Exclusions**

- Telephone exchange

3.0.0 GENERAL REQUIREMENTS

3.1.0 All drawings, schedules and annexures appended to this specification shall form part of the specification.

3.2.0 All the equipment and accessories covered under this specification shall be designed, manufactured and tested in accordance with the latest revision of the standards mentioned under respective section. They shall also conform to the requirements of latest editions / amendments of the following:

- Bangladesh Electricity Act & Electricity Rules
- Bangladesh national building code
- Bangladesh national standards
- Regulations laid down by the office of the Chief Electrical Inspector to Government
- Factory Act

3.3.0 All materials and equipment furnished for permanent installation shall be new, unused, and undamaged. Asbestos containing materials are not allowed.

3.4.0 They shall be of such design, size and materials as to satisfactorily function under the rated conditions of operation and to withstand the environmental conditions at site.

3.5.0 Similar parts of all switches, lamp holders, distribution boards, switch gears, ceiling roses, brackets, pendants, fans and all other fittings of the same type shall be interchangeable in each installation.

3.6.0 In case of any discrepancy among other technical sections and / or the drawings enclosed, the most stringent one shall prevail.

3.7.0 The successful bidder is referred as ‘Contractor’ or ‘Vendor’ in the specification.

3.8.0 Suitable and lockable storage accommodation, watch and ward of the stores and their safe custody shall be the responsibility of the Contractor till the final taking over of the installation by the Owner.

3.9.0 Contractor shall take due care to ensure safety of electrical installation during execution of work.

3.10.0 All tools and tackles required for handling of equipment and materials at site of work as well as for their assembly and erection and also necessary test instruments shall be the responsibility of the contractor.

3.11.0 The work shall be carried out in accordance with the drawings enclosed with the tender documents and also in accordance with modification thereto from time to time as approved by the Owner.

3.12.0 Good workmanship is an essential requirement to be complied with. The entire work of manufacture/ fabrication, assembly and installation shall conform to sound engineering practice.

3.13.0 The contractor shall be a licensed electrical contractor of appropriate class suitable for execution of the electrical work. He shall engage suitably skilled/ licensed workmen of various categories for execution of work supervised by supervisors / Engineer of appropriate qualification and experience to ensure proper execution of work.

3.14.0 All tests prescribed in the Specifications, to be done before, during and after installation, shall be carried out, and the test results shall be submitted to the Owner in prescribed Performa, forming part of the Completion Certificate. After the work is completed, it shall be ensured that the installation is tested and commissioned.

3.15.0 System study shall be carried out using authenticated validated software of latest version. The system study shall include the following for the power distribution system:

- Load flow study
- Short circuit study during steady state and transient condition.
- Voltage drop study during steady state and transient condition.
- Relay setting coordination study.

4.0.0 VENDOR LIST

4.1.0 The equipment supplied shall be of proven design, incorporating the latest generation technology, best engineering practice and of reputed make.

4.2.0 Makes of all electrical equipment and accessories are subject to prior approval by the Owner. Similar equipment and components shall be of same make. Equipment of same type and rating shall be interchangeable. For various items, bidder shall furnish a list of makes proposed by him for Owner's approval.

5.0.0 QUALITY ASSURANCE and INSPECTION

5.1.0 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, tested, and commissioned at all the stages, as per approved Quality Plan.

5.2.0 The Contractor shall adopt suitable quality assurance program to ensure that the equipment and services under the scope of Contract, whether manufactured or performed within the Contractor's works or at his sub-Contractor's premises or at the Owner's site or at any other place of work are in accordance with the specification. Such program shall be outlined by the Contractor and shall be finally accepted by the Owner / authorized representative after discussion. The quality assurance (QA) program shall be generally in line with ISO standards.

5.3.0 Manufacturing Quality Plan (MQP) shall detail out for all the components and equipment, various tests and inspections to be carried out as per the requirements of this specification and standards mentioned therein, quality practices and procedures followed by Contractor's and sub-Contractor's quality control organization, the relevant reference documents, acceptance norms etc. during all stages of manufacturing including raw material procurement, in-process manufacturing, assembly and final testing and performance testing. The quality plans shall be submitted to Owner for approval for all the equipment listed under scope of work.

5.4.0 Field Quality Plan (FQP) shall detail out the quality practices, procedures etc. to be followed by the Contractor's 'site quality control organization', during various stages of site activities starting from receipt of materials and equipment at site, storage at site, internal transport, erection, testing and commissioning for all the equipment.

5.5.0 The Contractor shall carry out all tests and inspections required to establish that the items and equipment conform to the requirements of the specification and relevant codes and

standards specified in the specification, and also as per the approved quality plans. Tests shall be performed in the presence of Owner's representative, if so desired by the Owner. For all spares and replacement items, the quality requirements for the supply of main equipment shall be applicable.

5.6.0 Quality audit / surveillance / approval of the test results and inspection and acceptance of material shall not, however, prejudice the right of the Owner to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service. Also they shall not limit the liabilities and responsibilities of the Contractor in ensuring complete conformance of the materials and equipment supplied to relevant specification, standards, data sheet, drawing etc.

5.7.0 The Contractor whose equipment are offered should have designed, manufactured, tested and supplied the same for the specified system voltage and which are in satisfactory operation for at least five (5) years as on date of bid opening. Type test certificates for test conducted within last ten (10) years, earlier on similar rating shall be furnished.

5.8.0 Equipment offered shall be of type tested and proven type. In case type test reports are not found to be meeting the specification requirements, Contractor shall conduct, all such type tests according to the relevant standards at his cost and the Owner shall not absorb such cost.

5.9.0 Tests shall be carried out for all the equipment as per applicable standards as stated in the various sections of this specification. Copies of certified reports of all tests carried out at the works shall be furnished. The equipment shall be dispatched from works, only after receipt of Owner's written approval of the test reports.

5.10.0 The charges for carrying out all routine/acceptance/functional tests shall be deemed to be included in the Bid price.

6.0.0 GUARANTEE

6.1.0 Manufacturers' guarantees for all bought out items/equipment shall be made available to the Owner and shall be valid for the entire liability period. If such guarantees are not issued by any Manufacturer, the Contractor shall guarantee the bought out items for the entire defects liability period along with guarantee for his equipment / system.

6.2.0 The Contractor, shall guarantee for a period of 24 (Twenty four) months from the date of handing over each unit against defective performance of all equipment under Contractor's scope of supply. Contractor shall rectify defects for a period of 2 years after handing over each unit.

6.3.0 Contractor shall replace consumables and spares for all the facilities included in the scope of work for a period of 2 year after handing over each unit.

6.4.0 Efficiency of the transformers shall be about 98.5% at 0.8 PF at full load.

6.5.0 The loss figures quoted by the bidders shall be taken in to account for Bid evaluation at the rates as indicated below. For fraction of kW, the loading shall be pro-rata.

No load loss	Rs.2,98,800 per kW
Load loss	Rs 2,00,800 per kW

6.6.0 During testing, if the losses exceed the guaranteed value, penalty shall be applied for at the rates indicated above.

7.0.0 PACKING & DELIVERY

The Contractor shall arrange transportation of all equipment from the point of manufacture to the Site. The arrangements shall include, but not be limited to, hiring adequate capacity of Wagon, determination of routes, determination of required permits, payment of required taxes and duties, and notification to the Owner.

8.0.0 TENDER DRAWINGS

All drawings, schedules and annexure appended to this specification shall form part of the specification. These drawings are meant to give a general idea to the Contractor. No information / data shown / not shown in these drawings shall be construed to relieve the Contractor of his responsibility to carry out the work as per this specification. The drawings are listed in **Annexure-A**.

9.0.0 DRAWINGS, DATA AND MANUAL

9.1.0 The bid shall be submitted with the following:

- Technical offer
- Technical schedules duly filled up and stamped and signed on all the sheets.
- Single line diagram
- Technical description & Design basis of Electrical system
- Catalogues/drawings leaflets

9.2.0 The following documents shall be submitted by the successful Bidder after the award of contract. Drawing / documents distribution schedule shall be firmed-up during finalization of contract

- Technical data sheet, GTP
- Design Memorandum
- Key Single line diagram
- Equipment Sizing Calculation
- Sizing calculation for various systems such as earthing, lighting, lightning protection etc.
- Sizing calculation for various equipment such as transformers, cables, switchboards, capacitors, DG set etc.
- System study report
- Relay setting calculation
- Equipment Layout drawings
- Illumination Layout drawings
- Cable routing Layout drawings
- Earthing Layout drawings
- Lightning protection Layout drawings
- Communication Layout drawings
- Foundation and civil interface drawing
- Single line drawing of various switchboards
- General Arrangement drawing of various switchboards
- Rating and diagram plate
- Schematic wiring diagrams of various switchboards
- P & I Diagram for DG Fuel system
- Bill of materials
- Interconnection Schedule
- Quality Plan
- Test certificates
- Type test reports

- Instruction and O&M manual
- Equipment Catalogue

ANNEXURE–A: LIST OF DRAWINGS

Sl.No.	Document no.	Revision	Document title
1)	1114129-E-202	A	Main Single line diagram for Township
2)	1114129-E-203	A	Single line diagram for 11 kV switchgear
3)	1114129-E-204	A	Single line diagram for 11kV RMU and 415V PCC
4)	1114129-E-301	A	Control Schemes for 11 kV switchgear
5)	1114129-E-302	A	Schematic diagram for DC system
6)	1114129-E-303	A	Schematic diagram for UPS system
7)	1114129-E-401	A	Equipment layout at MRSS
8)	1114129-E-403	A	Equipment layout at Distribution Substation-Type-1
9)	1114129-E-402	A	Equipment layout at Distribution Substation-Type-2
10)	1114129-E-406	A	Equipment layout at Distribution Substation-Type-3
11)	1114129-E-404	A	Power distribution layout for Substations
12)	1114129-E-405	A	Telephone system location layout
13)	1114129-E-501	A	Typical details of cable trays & accessories
14)	1114129-E-502	A	Typical details for bolted type cable tray support system
15)	1114129-E-503	A	Typical details for cabling installation
16)	1114129-E-504	A	Typical details for earthing installation
17)	1114129-E-505	A	Typical details for lightning protection installation
18)	1114129-E-506	A	Typical installation details for illumination system

ANNEXURE- B: BILL OF QUANTITY

Sl. No.	Description	Unit	Quantity
	Design, Engineering, supply, inspection, installation, testing and commissioning of following equipment		
1)	11/0.433 KV, cast resin dry type transformer in sheet steel enclosure	Lot	1
	11 kV Switchboards		
2)	11 kV, 1250A, 40 kA for 1 sec rated switchgear	Lot	1
3)	11 kV Ring Main Unit with three nos, isolator and 1 no. VCB	Lot	1
	LT Switchboards		
4)	415 V Power control centre of required rating	Lot	1
5)	415 V Motor control centre for fire water system & Potable water system	Lot	1
6)	415 V Motor control centre for HVAC	Lot	1
7)	415 V Main distribution board	Lot	1
8)	415 V Floor distribution board	Lot	1
9)	415 V distribution board	Lot	1
10)	415 V sub distribution board	Lot	1
11)	415 V Branch distribution board	Lot	1
12)	415 V Essential distribution board	Lot	1
13)	415 V Lighting panels	Lot	1
14)	415 V Receptacle panels	Lot	1
15)	**415 V Bus trunking system**	Lot	1
16)	**415 V Rising Main**	Lot	1
17)	**415 V Power factor improvement capacitor banks** of required rating	Lot	1
18)	415 V DG set of required rating complete with acoustic enclosure	Lot	1
19)	Local Push button station	Lot	1
	Power & control Cables		
20)	11/11 kV unearthed grade, XLPE insulated armoured Copper cables of required sizes	Lot	1

Sl. No.	Description	Unit	Quantity
21)	1100 V grade XLPE insulated armoured Copper power cables of required sizes	Lot	1
22)	1100 V grade PVC/ XLPE insulated armoured copper control cables of required sizes	Lot	1
23)	Data cables	Lot	1
	DC System		
24)	110V, Sealed maintenance free battery of required rating	Lot	1
25)	110 V Float cum Boost charger of required rating	Lot	1
	Cable trays, Supports & Accessories		
26)	Galvanised steel cable trays of required sizes complete with fittings and accessories	Lot	1
27)	Bolted type galvanized steel cable tray support system	Lot	1
28)	Double compression type brass cable glands of various sizes	Lot	1
29)	Cable joints & terminations	Lot	1
30)	Copper lugs of various sizes	Lot	1
31)	Ferrules of various sizes	Lot	1
32)	Cable clamps of various types & sizes	Lot	1
33)	Fire stop cable penetration system	Lot	1
	Telecommunication and television system		
34)	Digital EPABX sub system	Set	1
35)	48V Sealed maintenance free battery of required rating	Set	1
36)	48 V Float cum Boost charger of required rating	Set	1
37)	Main distribution frame	lot	1
38)	Telephone tag box	lot	1
39)	Junction box	lot	1
40)	Telephones of Analog type, digital type, IP Phone, ISDN phone, PC with soft phone, Video conference device,	lot	1
41)	Power cables	lot	1
42)	Telephone cables for outdoor application including Fiber optic cables	lot	1
43)	Telephone cables for indoor application	lot	1
44)	Cable troughs, Conduits, cable glands, lugs and Cabling Accessories	lot	1
45)	Network and data cables	lot	1

Sl. No.	Description	Unit	Quantity
46)	Master Antenna Television system and cables & accessories	lot	1
	Illumination		
47)	Circuit and point wiring	Lot	1
48)	Lighting fixtures	Lot	1
49)	Switchboxes	Lot	1
50)	Receptacles	Lot	1
51)	Junction boxes	Lot	1
52)	Lighting mast (Winch operated)	Lot	1
53)	Lighting poles	Lot	1
54)	Conduits, fittings & accessories	Lot	1
55)	Ceiling Fans	Lot	1
56)	Wall mounted Fans	Lot	1
57)	Exhaust Fans	Lot	1
58)	Modular Switch	Lot	1
59)	Modular Fan regulator	Lot	1
60)	Power Socket outlet	Lot	1
61)	Telephone Socket outlet	Lot	1
62)	TV socket outlet	Lot	1
63)	Call Bell	Lot	1
64)	Wires	Lot	1
65)	Aviation obstruction lights for high rise buildings	Lot	1
	Earthing system		
66)	Copper Earthing conductor of various sizes	Lot	1
67)	Earth electrodes/Earth pit of various sizes	Lot	1
68)	PVC insulated copper earth cables of various sizes	Lot	1
69)	Earth bus/ earth bar, Clamps & connectors	Lot	1
	Lightning protection system		
70)	Vertical air terminations	Lot	1

Sl. No.	Description	Unit	Quantity
71)	Horizontal air terminations	Lot	1
72)	Down conductors	Lot	1
73)	Test links	Lot	1
74)	Earthing conductors	Lot	1
75)	Earth electrodes/ Earth pit	Lot	1
76)	**UPS system for Hospital complete with Battery and UPS DB**	Set	1
77)	**Safety items such as shock treatment charts, danger boards, caution boards, rubber mats, first aid box, sand buckets etc**	Lot	1
78)	**Erection hardwares**	Lot	1
79)	**Commissioning spares**	Lot	1
80)	**Maintenance spares**	Lot	1
81)	**Special tools & tackles**	Lot	1
82)	**Design & engineering of electrical system for the complete township**	Lot	1
83)	**Construction power supply**	Lot	1

ANNEXURE-C : MANDATORY SPARES

Sl.No	Description	Unit	Quantity
1.	**Dry type Transformer of each rating**		
a)	HV Bushings with metal parts for each rating	Nos.	3
b)	Winding Temperature Indicator with all accessories	Nos.	2
c)	Limit Switches	Nos.	2
d)	Temperature scanner	Nos.	2
2.	**HT Switchgear**		
a)	Circuit Breaker Components (for each voltage rating & current rating)		
	i. Complete poles of the each breaker size & rating	Nos.	3
	ii. Spring charging motor	Nos.	3
	iii. Primary disconnect (power) complete set of each type	Nos.	3
	iv. Aux. Contact set	Set	3
	v. Limit switches	Nos.	3
	vi. Charging spring of each type	Nos.	3
	vii. Closing coil of each type	Nos.	3
	viii. Tripping coil of each type	Nos.	3
b)	Meters of each type	Nos.	2
c)	Protection Relays of each type	Nos.	2
d)	MCB of each type & rating	Nos.	5
e)	HT HRC fuses of each rating	Nos.	3
f)	Bus bar supporting insulator	Nos.	5
g)	CT, PT of type and ratio of each type	Nos.	3
h)	Lockout relays of each type	Nos.	2
3.	**LV Switchgear**		
a)	LT circuit breaker of each type & rating	Nos.	1
b)	CTs of each type and rating	Nos.	5
c)	Meters of each type and rating	Nos.	5

Sl.No	Description	Unit	Quantity
d)	Selector switch of each type and rating	Nos.	5
e)	Protection Relays of each type	Nos.	5
f)	MCCB / MPCB / MCB of each type and rating	Nos.	5
g)	Bus bar supporting insulator	Nos.	10
h)	Lockout replay of each type	Nos.	5
i)	Auxiliary contacts of each colour and rating	Nos.	5
j)	Indication lamps of each colour and rating	Nos.	10
4.	**For Battery of each type and rating**		
a)	Inter cell connectors with insulated cover	Nos.	10
b)	Inter row connectors with insulated cover	Nos.	10
c)	Cable clamps with hardware	Set	5
5.	**For battery charger**		
a)	Contactors	Set	2
b)	Thyristor for each type and rating	Nos.	2
c)	Blocking Diode for each type and rating	Nos.	2
d)	Relay for each type and rating	Nos.	2
e)	MCCB for each type and rating	Nos.	2
f)	Filter capacitors for each type and rating	Nos.	2
g)	Output fuses & links for each type and rating	Nos.	2
h)	Pulse transformer	Nos.	1
i)	SCR controller cards of each type	Nos.	1
j)	Rectifier protection fuses for each type and rating	Nos.	2
6.	**DG Set of each capacity**		
a)	Maintenance spares for Diesel engine (List to be provided)	Set	2
7.	**Telephone tag box**	No.	5
8.	**Illumination system**		
a)	Each type and rating of MCBs	Nos.	25
b)	Each type and rating of lamp	Nos.	25

Sl.No	Description	Unit	Quantity
c)	Each type and rating of receptacles	Nos.	25
d)	Lighting Switches	Nos.	50
e)	Photo voltaic sensor	Nos.	10
9.	**UPS system**		
a)	HRC Fuses of each type and rating	Nos.	5
b)	Semiconductor fuses of each rating	Nos.	5
c)	Electronic cards/modules of each type	Nos.	1
d)	Thyristors /Power transistors / power diodes of each rating	Nos.	5
e)	Filter capacitors & Chokes of each rating	Nos.	2
f)	Static transfer switch	Nos.	1
g)	Inter cell connectors with insulated cover	Nos.	5
h)	Inter row connectors with insulated cover	Nos.	5
10.	**LT Motors of each type and rating**		
i)	Bearing	Set	1
j)	Motors of each type & rating	Nos.	1 of each rating and type

ANNEXURE-D : SPECIAL TOOLS & TACKLES

Sl.No.	Description	Unit	Quantity
1.	**Special tools for HT Switchgear**		
a)	Earthing trucks for bus earthing of each voltage rating	Nos.	1
b)	Earthing trucks for cable earthing of each voltage rating	Nos.	1
c)	Breaker Trolleys of each type	Nos.	1
d)	Spanner sets	Nos.	1
2.	**Special tools for LT Switchgear**		
a)	Breaker Trolleys	Nos.	2
b)	Spanner sets	Nos.	2
3.	**Telephone system**		
	Dial testers for DC pulsing and telephone instruments	Nos.	2
	Krone tools	Set	1
	Long nose pliers	Nos.	2
4.	**Portable Aluminium Ladders of various sizes for lamp replacement**	**Nos.**	**4**
5.	**Mini truck mounted with adjustable hydraulic lift for the maintenance of street lights**	**No.**	**1**
6.	**Tools kit box (List of items to be provided).**	Set	1

SECTION – B3.2 : DESIGN REQUIREMENTS

1.0.0 INTENT OF SPECIFICATION

This section covers the design requirement for the electrical system of the Township.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the applicable IEC publications.

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 Normal Power supply is envisaged for the following buildings and structures.

I. Residential Buildings

a. Executive Residence – Type – A
b. Executive Residence – Type – B
c. Executive Residence – Type – C
d. Staff Residence – Type – D
e. Head of Plant Bungalow
f. Guest House
g. Studio Apartments
h. Field Hostel – Staff
i. Trainees Hostel and Training Center

II. Non - Residential Buildings

a) Gate and Security
b) Car Parks
c) Nursery and High School
d) Mosque
e) Hospital
f) Shopping Center with Post Office, Bank and Estate Office
g) Temple
h) Community Center
i) Executive Club
j) Non - Executive Club
k) Swimming Pool
l) Indoor Sports Complex
m) Outdoor Sports Area
n) Potable Water, Service Water and Fire Water Pump House
o) Main Receiving Substation
p) Distribution Substations
q) Maintenance Store
r) Underground Water Tank
s) Watch Tower

III. Facilities Outside Township Boundary

a) Police Station
b) Cyclone Shelter
c) Storm Water Retention Pond
d) Gas Cylinder Godown
e) Transport Center

f) Security Force and Army Barracks

3.2.0 Essential Power supply

Essential power supply using Diesel generator set as back-up shall be provided for the following services.

a) All the Elevators
b) Lighting & Ventilation for Guest House, HoP bungalow
c) Lighting & Ventilation for Shopping Centre
d) Hospital
e) Lighting for Substation
f) Required lighting on primary roads
g) Water supply pumps
h) Fire fighting system

3.3.0 Power feeding arrangement

3.3.1 Total power requirement for the township is estimated to be about 2000 kVA and the Power supply is proposed to be drawn from the Power plant through redundant feeders. Incoming power supply voltage level is proposed as 11 kV. 11 kV supply shall be stepped down to 415 V at township substations for further distribution.

3.3.2 For residential and commercial services, the nominal voltage shall be 240 volts AC single phase and 415 volts AC 3 phase. All the devices and appliances shall be rated for the same.

3.3.3 In the power plant, 11 kV power supply (earthed system) is envisaged through 11 kV indoor switchgear.

3.3.4 Two numbers redundant power supply feeders, each rated for 2 MVA, shall be provided to feed the township. 11/11 kV grade XLPE insulated armoured Copper cable shall be provided for the same.

3.3.5 Main Receiving Substation (MRSS) shall be considered in the township to receive 11 kV power supply from the power plant. The township area shall be divided into various sectors based on the load demand, each with one distribution substation to cater the power requirements in that sector. About 5 distribution substations are envisaged as shown in the Main single line diagram and these distribution substations are fed from 11 kV switchgear located at MRSS.

3.3.6 One substation shall be accommodated in the MRSS and the other 5 distribution substations shall be located in distributed manner in the township considering the load density. Substation room shall be provided in each locality.

3.3.7 The MRSS shall comprise the following equipment:

- 11 kV VCB, indoor switchgear with two incomers, one bus coupler, Bus VT and required no. of outgoing feeders for distribution substations
- 11/0.433 kV dry type distribution transformer
- 415V Power Control Centre and Distribution boards
- Battery and battery chargers for control supply
- Power factor improvement capacitor banks
- DG Set
- One telephone exchange room consisting Digital EPABX sub system, telephone Main Distribution Frame (MDF), 48V DC battery and charger system

3.3.8 Each distribution substation shall be indoor type and shall comprise the following:

- 11 kV ring main unit with three load break isolators and one VCB breaker (where specified)
- 11/0.433 kV dry type distribution transformer
- 415 V Power Control Centre and Distribution boards
- Power factor improvement capacitor banks

- DG Set (where specified)
- Telephone Main Distribution Frame (MDF) (where specified)

3.3.9 11 kV VCB, indoor switchgear in MRSS shall receive power from power plant. The 11 kV distribution from MRSS to various distribution substations shall be through ring main arrangement to ensure that power supply is not affected in case of failure of one incoming source. Two numbers 11kV ring mains shall be formed with 11/11kV XLPE insulated Copper armoured cable.

3.3.10 415 V Power Control Centre shall feed power distribution boards of respective building. Power distribution board shall feed floor distribution boards and sub-distribution boards of individual dwelling units.

3.3.11 A separate Motor Control Centre shall be provided to feed fire water pumps, and shall be located in fire water pump house.

3.3.12 The power distribution arrangement is shown in the enclosed Main single line diagram.

3.4.0 SYSTEM DESIGN

3.4.1 Design ambient air temperature shall be considered as 50°C for sizing the electrical equipment.

Voltage levels envisaged in the township are as follows:

Sl. No.	System/Equipment	Nominal voltage	Permissible voltage variation	Permissible frequency variation	Combined voltage & frequency variation
a)	Main Distribution	11 kV	±10%	±5%	10%
b)	Consumer supply	415 V	±10%	±5%	10%
c)	Appliances	240 V	±10%	±5%	10%
d)	AC Control supply	110 V	±10%	±5%	10%
e)	DC supply	110V, 48V	-15% to +10%		
f)	UPS supply	230 V	-1% to +1%		

3.4.2 The three phase symmetrical short circuit ratings of the switchboards at different voltage levels are as follows:

Sl.No.	Voltage level	Symmetrical breaking capacity / duration	Making capacity
a)	11 kV	40 kA/ 1 second	100 kAp
b)	415 V	25 kA/ 1.0 second	52.5 kAp

3.4.3 Neutral Grounding System

- Neutral of the 11kV system shall be resistance grounded.
- Neutral of the LV winding (415V) of Service Transformers shall be solidly grounded.

- Neutral of the 415 V DG sets shall be solidly grounded.
- 110 V DC systems shall be ungrounded.
- 48 V DC systems shall be ungrounded.
-

3.4.4 Design Margin

10% Design margin shall be considered in sizing of various electrical equipment.

3.4.5 Average power demand for various types of residential units shall be considered as follows

S.No.	Type of quarter	Unit power in kW
1	Executive Residence Type A	10
2	Executive Residence Type B	8
3	Executive Residence Type C	7
4	Staff Residence Type D	5
5	Head of Plant Bungalow with servant quarters	26
6	Studio Apartments	2

3.4.6 Controls of Electrical

a) 11 kV breaker and 415 V feeders from the substations and DG sets shall be controlled from respective switchgear locally.

b) For motors, Local Push Button (LPB) station shall have Start & stop push buttons.

3.4.7 Layout Aspects

c) Separate electrical room shall be provided to accommodate 11 kV indoor Switchgear, 415V Switchgear, capacitor bank, dry type LV transformer, Battery, Battery Charger, DG Set etc. Cable trench shall be provided below the panels.

d) Minimum clearance of 1000 mm shall be provided on rear of panel for single front boards. For double front boards, clearance from wall/column shall be 1500 mm. For installations with two rows of boards facing each other, minimum clearance of 2000 mm shall be maintained between fronts of boards. Clearance between adjacent panels in a row shall be < 200 mm or $\geq$ 800 mm. However actual clearance shall be firmed up during detailed engineering stage.

3.5.0 PLANNING OF ELECTRICAL INSTALLATION

3.5.1 The contractor should take the responsibility of detailed designing and planning to meet the requirement of various functional needs, efficiency, economy, energy conservation, aesthetics, appropriate technology, safety and avoidance of possible fire hazards. Some of the guiding factors are:

a) Adverse conditions like humidity, high/low ambient temperature, pollution, heat, dust, flame etc. that are likely to affect the installation.

b) Possible presence of inflammable or explosive vapour, gas, liquid.

c) The degree of mechanical and electrical protection necessary.

d) The need of Essential power supply.

e) Flexibility for future modification or extension.

f) Energy conservation measures.

g) Need of building management system for efficiency and energy cost saving.

h) Safety aspects including provision of built in safety measures.

i) Specific measures for avoidance of possible fire hazards.

j) Use of appropriate technology.

k) Quality control based on appropriate design and use of quality materials and equipment.

l) Aesthetics and co-ordination with Architectural and Structural requirement.

m) Taking into account future growth of load.

n) Need to provide related space/ conduits/ channels/ cables/ wire for services like: Communication cables, computer cabling, fire alarm cabling, UPS cabling, Security system cables etc.

o) Reducing operation and maintenance cost with appropriate use of automation, sensors, remote control, microprocessor control for controlling various electrical and mechanical activities.

p) Providing an efficient power distribution system to meet the various power requirements of equipment like Computers, ACs, Pumps, Elevator, Ventilation Plant, AC Plant etc.

3.5.2 Coordination and collaboration is needed amongst Owner/Civil/Structural Engineer/Architect/ Horticulture. Based on the specific requirement and projected use of the building, conceptual coordinated detailed planning for the entire building shall be finalized. The electrical portion has to fit into such integrated concept of the building.

3.5.3 Diesel Generator Set

Provision should be made for standby power supply, in buildings, where interruption of electrical power supply would cause significant discomfort, result in interruption of activities, cause hazard to life and property and cause panic.

The capacity of standby generating set shall be chosen on the basis of essential light load, essential air conditioning load, essential equipment load and essential services load, essential Elevators, water pumps and other loads required as essential load.

The generating set should preferably be housed in the substation building or should be placed adjacent to the substation room to enable transfer of electrical load (Change over) with negligible voltage drop as well as to avoid transfer of vibration and noise to the main building. The generator room should have significant amount of ventilation. Appropriate type and number of fire fighting equipment must be installed inside the generator room. The generator engine exhaust should be appropriately taken out of the building and should preferably be taken out through any other side except South. The generator Oil tank should be place away from the control panel side.

A standby generator is to be connected at the supply input point through a Changeover Switch of appropriate rating. The Changeover Switch shall be of such a type so that when moved to the mains position, there is no chance that the generator shall be connected and vice versa. The Changeover Switch may automatic type with magnetic contactors.

3.5.4 Power Factor Management

Low power factor results in higher current resulting in higher voltage drop and system losses. In order to have control over these parameters, unity power factor to be maintained. Automatic Power Factor Correction Capacitor Banks shall be provided to maintain power factor automatically at desired level.

3.5.5 Allied Services

In the buildings, besides electric wiring, cabling for the following services shall be provided:

- Telephone /Communication
- Cable TV
- Computer/ networking

(a) Each specialized service shall be executed without mixing up with other services.

(b) Wiring of each service shall be taken in its own pipe/ channel/cable shaft.

(c) Cable duct/shaft with access at each elevation shall be provided as an integral part of the building structure, to provide facility for maintenance of systems provided at higher level.

3.5.6 Master Antenna Television (MATV) System

Master antenna television system shall be provided for various residential buildings enabling the individual user to receive television and radio signals without having personalized antennas. The system with master antenna, filters, distribution amplifiers, attenuators, splitters, tap offs, cables, conduits, distribution up to individual dwelling units complete with all accessories shall be considered. Necessary head end room for installing the equipment shall also be considered.

SECTION – B3.3: 11 kV SWITCHGEAR

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of 11 kV Switchgear for efficient and trouble-free operation of electrical system of the Township.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the applicable IEC Standards, except where modified and /or supplemented by this specification.

3.0.0 DESIGN REQUIREMENTS

3.1.0 11 kV switchgear shall be provided at main receiving substation to receive incoming power supply from Power plant and distribute to various distribution substations. It shall comprise the following:

a) Incomer breaker feeder-1
b) Incomer breaker feeder-2
c) Buscoupler breaker feeder
d) Six numbers outgoing feeders
e) One number spare feeder
f) Two numbers Bus VT

3.2.0 Design ambient air temperature shall be considered as 50°C for sizing the electrical equipment and relative humidity of 95% maximum.

3.3.0 Ambient temperature prevailing inside the switchgear while carrying rated current, when the outside air ambient temperature is 50º Celsius shall be considered as Design ambient temperature for sizing the equipment/device/bus rating. Temperature rise shall be as per applicable IEC standards.

3.4.0 A design margin of not less than 10% shall be considered for sizing various devices.

3.5.0 Switchboards shall be mounted on ISMC channels embedded in concrete.

3.6.0 11 kV Switchboards shall have Vacuum circuit breakers for incomer, bus coupler and outgoing feeders.

3.7.0 Control supply voltage shall be 110 V DC and busbars shall run throughout the length of Switchboard. Each panel shall receive DC supply from the bus.

3.8.0 230V AC supply shall be considered to derive 230V Space heater supply for each panel. For each panel space heater, cubicle lamp & socket, rated for 230V AC supply shall be provided.

3.9.0 Each breaker module shall be provided with multifunction numerical relays for protection. Relays shall have built in protection, control & metering and communication modules shall be suitable for 61850 protocols.

3.10.0 Hardware and software for communication of relays for parameterization and down load / analysis of fault data from relays shall be supplied complete with set of cables, accessories and licensed software.

4.0.0 TECHNICAL REQUIREMENTS

4.1.0 Switchgear Construction

4.1.1 The switchgear shall have a single front, single tier, fully compartmentalized, metal clad construction complying with clause No. 3.102.1 of IEC-62271 part 200, comprising of a row of free standing floor mounted panels. Each circuit shall have a separate vertical panel with distinct compartments for circuit breaker truck, cable termination, main busbars and auxiliary control devices. The adjacent panels shall be completely separated by steel sheets except in busbar compartments where insulated barriers shall be provided to segregate adjacent panels.

4.1.2 The circuit breakers and bus VTs shall be mounted on withdrawable truck which shall roll out horizontally from service position to isolated position.

4.1.3 The trucks shall have distinct Service, Test and Isolated positions. It shall be possible to close the breaker compartment door in Isolated position also, so that the switchgear retains its specified degree of protection.

4.1.4 The VT/ relay compartments shall have degree of protection not less than IP:52. However, remaining compartments can have a degree of protection of IP: 4X.

4.1.5 Enclosure shall be constructed with rolled steel sections and cold rolled steel sheets of at least 2.0 mm thickness, Gland plates shall be 2.5 mm thick made out of hot rolled or cold rolled steel sheets and for non magnetic material it shall be 3.0 mm.

4.1.6 Total height of the switchgear panels shall not exceed 2500 mm. The height of switches, push buttons and other hand operated devices shall not exceed 1800 mm and shall not be less than 700 mm.

4.1.7 Safety shutters complying with IEC-62271 part 200 shall be provided to cover up the fixed high voltage contacts on busbar and cable sides when the truck is moved to TEST and ISOLATED position. The shutters shall move automatically, through a linkage with the movement of the truck.

4.1.8 The switchgears shall have the facility of extension on both sides.

4.1.9 Bus and Bus Taps

- The main buses and connections shall be of high conductivity Copper sized for specified current ratings with maximum temperature limited to 90°C. The busbars shall be designed for specified short circuit rating.
- Busbar insulators shall be epoxy cast resin type designed to withstand stresses due to maximum short circuit current.
- Busbars and connection shall be fully insulated for working voltage with adequate phase/ground clearances. Insulating sleeves for busbars and cast-resin / transparent polymer (fire retardant) shrouds for joints shall be provided. Busbars shall be colour coded for easy identification and so located that the sequence R-Y-B shall be from left to right, top to bottom or front to rear, when viewed from front of the switchgear assembly.
- The busbar chamber shall be provided with inter panel barrier with epoxy case seal-off bushings which the buses shall pass through so as to prevent fire from one panel to another.

4.1.10 The circuit breakers shall be of Vacuum type. They shall comprise of three separate, identical single pole interrupting units, operated through a common shaft by a sturdy operating mechanism. Surge arrestor shall be provided for all motor and dry type transformer feeders.

4.1.11 Circuit breaker shall be restrike free, stored energy operated and trip free type. Motor wound closing spring charging shall only be acceptable. An anti-pumping relay shall be provided for each breaker, even if it has built-in mechanical anti-pumping features.

4.1.12 Plug and socket isolating Contacts for main power circuit shall be silver plated, of self aligning type, of robust design and capable of withstanding the specified short circuit currents.

4.1.13 For motor wound mechanism, spring charging shall take place automatically after each breaker closing operation. One open-close-open operation of the circuit breaker shall be possible after failure of power supply to the motor.

4.1.14 The closing coil and spring charging motor shall operate satisfactorily at all values of control supply voltage between 80 and 110 percent of the rated voltage. The shunt trip coil shall operate satisfactorily at all values of control supply voltage between 70 and 110 percent of the rated voltage.

4.1.15 For breakers spring charging motor shall be provided with MCB for over current protection. Motor windings shall be provided with class B insulation or better.

4.1.16 Mechanical / Electrical interlocks shall be provided to prevent mal-operation.

4.2.0 Current Transformer

4.2.1 The CTs shall be mounted on the switchgear stationary parts. The CTs shall be of cast resin, bar / wound primary type and of Class B or better insulation. CT secondary current shall be 1A.

4.2.2 Accuracy class of the Current Transformer shall be :-

- Class 5P20 for other relaying
- Class 0.5 for Energy metering (For incomer feeders)
- Class 0.5 for metering (For Outgoing transformer feeders)

4.2.3 Core balance CT and associated relay combination shall be such as to ensure a pick up sensitivity of 10 A primary ground fault current for all the outgoing feeders.

4.3.0 Voltage Transformer

4.3.1 Voltage Transformer shall be cast-resin, draw-out type. Over voltage factor shall be considered for resistance grounded system as follows:

- 120% for continuous duty
- 190% for 8 hrs.

4.3.2 Accuracy class of the Voltage Transformer shall be :-

- Class 3P for protection
- Class 0.5 for metering

4.3.3 High voltage windings of voltage transformer shall be protected by current limiting fuses. The voltage transformer and fuses shall be completely disconnected and visibly grounded in fully draw-out position. Low voltage side MCB's shall be provided.

4.4.0 Relays

4.4.1 Protection relays shall be provided for each feeder which shall include the following:

a) For Outgoing feeders
   - Numerical protection relay having Short circuit protection (50) on all the three phases, IDMT Over current protection (51) on all the three phases and residually connected earth fault protection (51N & 50N).
   - Back up earth fault protection (51N) connected to transformer neutral CT (For transformer feeders)
   - Auxiliary relays for trip signals from transformer CT (For transformer feeders)

b) For incoming feeder & Bus coupler

- Numerical protection relay having Short circuit protection (50) on all the three phases, IDMT Over current protection (51) on all the three phases, residually connected earth fault protection (51N & 50N)

c) Bus PT shall have the following protections.
- 3 phase Under voltage relay

4.5.0 Control and Interlocks

4.5.1 The circuit-breaker shall have three distinct positions as follows:

- ‘Service’ both power and control contacts connected. 'Test' Power contacts isolated, control contacts connected. 'Isolated' Both power and control contacts isolated.

4.5.2 Circuit breaker control switches shall be 3-position spring return to `neutral' from both close and trip positions. They shall have `Pistol Grip' handle. The contacts shall be of silver plated, air break type. The continuous current and breaking capacity of the contacts shall be adequate for the duty involved.

4.5.3 ‘Red’, ‘Green’ and ‘Amber’ indication lamps shall be provided on the panel to indicate breaker ‘Close’, ‘Open’ and ‘Auto-Trip’ position. In addition to above, mechanical indicator shall be provided which shall be clearly visible to the operator standing in front of the panel.

4.5.4 Indication lamps to show the circuit-breaker 'Service' and 'Test' positions shall be provided. Further additional indication lamps shall be provided as per scheme requirement.

4.5.5 Indication lamps shall be of the panel mounting, clustered LED type. The lamps shall have escutcheon plates marked with its function, wherever necessary. Lamps shall have translucent lamp-covers as warranted by the application.

4.6.0 Meters

4.6.1 The following meters shall be provided:

- Incomers : 0.5S class static energy meter and Multi Function Meter (V, I, kW, kVA, kVAR, kWH, PF)
- Outgoing feeders : Multi Function Meter (A, kW, kVA)
- Bus VT: Digital Voltmeter measuring all three phases

4.7.0 Secondary wiring

4.7.1 The Switchgear shall be fully wired at the factory to ensure proper functioning of control, protection, transfer and inter locking schemes. MCB shall be provided to permit individual circuit isolation from bus wires without disturbing other circuits. MCB’s shall be provided with auxiliary contacts for Close/open/trip conditions of the MCB.

4.7.2 Wiring shall be done with flexible, 1100V grade, PVC insulated switchboard wires with stranded copper conductors of 2.5mm² for current circuits and 1.5 mm² for voltage circuits. Each wire shall be identified, at both ends, with permanent markers bearing wire numbers as per Bidder’s wiring Diagrams.

4.8.0 Terminal Blocks

Terminal blocks shall be 600V grade box-clamp type with marking strips. CT shorting links, Drop link type terminals shall be provided for C.T secondary leads. Not more than two wires shall be connected to any terminal. Spare terminals equal in number to 20% active terminals shall be furnished.

4.9.0 Name plates

Name plates of approved design shall be furnished at each cubicle and at each instruments & device mounted on or inside the cubicle. Name plate shall be provided at both front and rear of cubicle. The material shall be lamicoid or approved equal, 3 mm thick with white letter on black back ground. The material shall be held by self-tapping screws. Caution notice on suitable metal plate shall be affixed at the back of each vertical panel.

4.10.0 Surge arrestor

The surge arrestors shall be provided for all motor/ dry type transformer feeders to limit switching over voltages to 2.2 PU. The Surge arrestors shall be metal oxide, gapped or gap less type generally in accordance with IEC 60099- 1 and suitable for indoor duty. These shall be mounted within the switchgear cubicle between line and earth, preferably in the cable compartment.

4.11.0 Earthing and Earthing Devices

4.11.1 Copper earthing bus shall be provided at the bottom and shall extend through out the length of each switchgear. It shall be bolted to the framework of each panel and each breaker earthing contact bar.

4.11.2 All metallic cases of relays, instruments and other panel mounted equipment shall be connected to earth by independent stranded copper wires of suitable size.

4.11.3 VT and CT secondary neutral point earthing shall be at one place only on the terminal block. Such earthing shall be made through links so that earthing of one secondary circuit may be removed without disturbing the earthing of other circuits.

4.11.4 Separate earthing trucks shall be provided for maintenance work. These trucks shall be suitable for earthing the switchgear busbars as well as outgoing/ incoming cables or bus ducts. The trucks shall have a voltage transformer and an interlock to prevent earthing of any live connection. The earthing trucks shall in addition have a visual and audible annunciation to warn the operator against earthing of live connections.

4.11.5 Interlocks shall be provided to prevent insertion of the breaker truck to Service position if earthing switch is in closed position.

5.0.0 PAINTING

Painting shall be carried out by approved process. After preparation of the under surface the equipment shall be painted with epoxy based paint by powder coating. The final thickness of paint film on steel shall not be less than 85 microns. Final shade shall be RAL9002.

6.0.0 DRAWINGS, DATA AND MANUAL

6.1.0 The bid shall be submitted with the following:

- Technical data sheet
- Drawing & catalogue

6.2.0 The following documents shall be submitted by the successful Bidder after the award of contract.

- DG sizing calculation
- Technical data sheet
- Single line diagram

- Schematic diagram
- Equipment Layout drawings
- Earthing Layout drawings
- General Arrangement drawing for various items
- Quality Plan
- Test certificates
- O&M manual

7.0.0 TECHNICAL PARAMETERS

Sl.No.	Description	Unit	Data
1.0	**Switchgear**		
a)	Type		Metal clad, Indoor
b)	Applicable standard		IEC 62271-200
c)	Rated Voltage (normal / max)	kV	11 /12, 3 phase, 50 HZ
d)	Short circuit withstand current rating for 1 Sec. duration	kA rms	40
e)	Peak withstand current rating	kAp	100
f)	Internal arc withstand rating for 0.5 Sec. duration	kA rms	40
g)	Impulse withstand voltage	kVp	75
h)	One minute power frequency with stand voltage	kV rms	28
i)	Degree of protection for breaker, cable, busbar compartment		IP4X
j)	Degree of protection for relay & meter compartment		IP52
2.0	**Circuit breaker**		
a)	Type		VCB
b)	No. of poles		3
c)	Rated operating duty		O-3min-CO-3min-CO
d)	Rated short circuit breaking current	kA rms	40
e)	Rated short circuit making current	kAp	100
f)	Control supply voltage		
	i. Closing coil, Spring charging motor	V	110 V DC (80-110%)
	ii. Tripping coil	V	110 V DC (70-110%)
3.0	**Busbar**		
a)	Short-time current for 1 sec.	kA rms	40
b)	Material		Copper

Sl.No.	Description	Unit	Data
c)	Temperature rise of over design ambient of 50°C • Bus bars • Silver plated joints		 40 °C 55°C
d)	Dynamic withstand current rating	kAp	100

SECTION – B3.4: RING MAIN UNITS

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of 11 kV Ring Main units (RMU) for efficient and trouble-free operation of electrical system of the Township.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the applicable IEC Standards, except where modified and /or supplemented by this specification.

3.0.0 DESIGN REQUIREMENTS

3.1.0 11 kV RMU shall be provided at various distribution substations, where specified.

3.2.0 Design ambient air temperature shall be considered as 50°C for sizing the electrical equipment and relative humidity of 95% maximum.

3.3.0 The Ring main unit shall be installed at 11 KV junction points to have continuous supply by isolating faulty sections. The RMU shall be extensible and consists of the combinations of load break switches and Circuit Breaker for a nominal voltage of 12 KV using SF6 gas as insulating and vacuum as arc quenching medium.11 KV ring isolator controls incoming and outgoing feeder cables of the 11 KV distribution system and VCB. Vacuum circuit breaker shall be used to control and isolate the 11 KV/433 V distribution transformer through 11KV grade cable.

3.4.0 Ring main unit suitable shall consist of the following:

a. Three numbers of 11kV, **630 Amps**, continuously rated fault making, load breaking switches. These units shall be triple pole, SF6 Insulated, quick break type with spring charge stored energy mechanism for operation. It shall have arrangement for terminating up to 300 mm^2 XLPE incoming and outgoing feeder cables.

b. One Tee-Off unit with 11kV, Vacuum Circuit Breaker (for controlling transformer), load breaking and fault breaking type fitted with three 200 Amps continuously rated SF6 insulated busbar along with CT with combination for protection of transformer. It shall have arrangement for terminating cables.

3.5.0 The switchgear and component thereof shall be capable of withstanding the mechanical and thermal stresses of short circuit without any damage or deterioration of the materials.

3.6.0 The equipment should be totally enclosed, metal clad, vermin and dust proof suitable for tropical climate use as detailed above. The gas tank of the RMU Unit should be of 2mm stainless steel, welded to the highest quality and should be tested for specified Internal Arc withstand rating.

3.7.0 The complete gas tank should be Partial discharge tested for a noise level less than 5 pc, to ensure proper insulation level.

3.8.0 All connection including band joints for busbars etc. shall be of ample cross section to cater the rated load current continuously and shall be suitable for the specified short time rating.

4.0.0 TECHNICAL REQUIREMENTS

4.1.0 The equipment shall be compact, totally enclosed in as self contained self supporting, gas tight compartment, mounted on base frame or channels. The assembly shall be equipped with common power busbars, load break switches and vacuum circuit breaker as specified in specific requirement as above. All medium voltage parts should be totally enclosed in an SF6 environment.

4.2.0 The isolator shall be SF6 insulated, triple pole, spring assisted hand operated type with quick break contacts. The isolator shall be contained in sealed SF6 enclosure made of stainless steel. SF6 gas pressure gauge shall be provided for pressure indication purpose.

a) The operating positions “ON”, “OFF”, and “EARTH” shall be clearly marked with suitable arrangement to padlock in any position. An in-built arrangement shall be provided by which the isolator operation shall be prevented from “ON” position to “EARTH” position or vice versa in a single operation. Preferably there shall be two separate, non-interchangeable handles, so as to have the above mentioned safety.

b) A facility for Cable testing with clear identification mark and with interlocked cover shall be provided. The interlocks shall be so arranged that, the cable test terminals shall be accessible only in the “EARTH” position of the isolator, and after opening the cable box.

c) Off load isolator shall have three positions i.e. ON, OFF & EARTH.

d) Isolators shall be operated manually.

4.3.0 Vacuum Circuit Breaker

a) The circuit breaker unit shall consist of VCB (for controlling transformer), load breaking and fault breaking type fitted with three continuously rated busbars and arrangement for cable to the primary side of the transformer.

b) The circuit breaker shall be suitable for manual closing and opening.

c) The operating mechanism shall be direct hand operated, trip free with a mechanically operated indicator, positively coupled to the operating mechanism to indicate whether the breaker is in the closed or in the open position.

4.4.0 Voltage Indication: Arrangement shall be provided to check whether the cable connecting to the isolator is live or not.

4.5.0 There should be fault passage indicator for incoming and outgoing isolators. In case of fault current passing through that isolator, the flag must indicate that the fault current has passed through it. There shall be provision of resetting the indication by providing a timer having adjustable time setting 1/2/4/8 hrs.

4.6.0 The indications for ON/OFF/EARTH of the Isolator & Breaker Switches should be visible from outside even with the enclosure.

4.7.0 The tee-off unit shall be provided with accessories for tripping such as CT operated series trip coils for over current and earth fault protection.

4.8.0 Breaker shall be provided with a shunt trip coil suitable for 240 VAC supply.

4.9.0 Current Transformer: The Ratio of the CTs shall be suitable for controlling transformer as specified in enquiry. The VA burden of the CTs shall be sufficient to supply the energy required by the relay for normal operation and tripping of the circuit breaker.

4.10.0 The protection system should be provided with the provision of suitable self-powered relays having scheme for both over current & earth fault. It must provide immediate protection and can detect faults instructing the circuit breaker to trip in less than 40 ms.

a) The protection system shall be a self-powered relay which requires no external power source or batteries**.**

b) Relay shall be suitable to trip the breaker through shunt trip coil without any external power

c) It must have improved operation and control with the Relay settings clearly displayed on the front of the panel. Manual reset flag shows separate tripped on fault for either phase or earth fault conditions.

d) It should have the provision for the trip test on circuit breaker. The 'trip inhibit' facility allows the Relay to be tested without tripping the circuit breaker. Secondary injection can also be carried out using conventional test equipment.

4.11.0 The free standing metal housing shall be designed to withstand internal pressure and external mechanical loads without distortion. Where required the SF6 gas insulated switchgear housing shall have an over pressure relief device vented to the rear-bottom side of the equipment. An operating mimic diagram shall be provided on the front side of RMU. Each unit shall be provided with lifting facility of proven design for easy handling.

4.12.0 Isolator/Breaker ON-OFF, Earth, (230VAC space heater, thermostat controlled) with heater ON/OFF indication & `SF6 gas pressure low' indication etc. shall be provided.

4.13.0 Local control of switch / isolator shall be possible.

4.14.0 SF6 Insulation: Switchgear housing shall be completely gas tight.

4.15.0 A manometer should be provided to indicate the healthy state of SF6 gas pressure inside the tank. SF6 gas pressure inside the tank shall not be more than 1.3 bar at 20 Deg Centigrade.

5.0.0 OPERATION AND INTERLOCKING

5.1.0 All operations shall be from front of the equipment via spring assisted mechanism. The Ring Main Unit and VCB should be provided with a series trip coil for tripping. It shall be possible to operate the switches and circuit breaker manually and spring assisted mechanism shall ensure speed of operation of switches.

5.2.0 Operation handle shall be considered as part of the unit and should be provided with each RMU.

5.3.0 Load break switches and earthing switches shall be fully interlocked to ensure that operation is carried out in correct sequence. Movement of operating handle against interlock shall not by any means originate, store or activate the energy mechanisms. Padlocking facility shall be provided for operation of load switch and earthing switch. Safety of operation shall be ensured by interlocks.

5.4.0 Simultaneously closing of the main switch and earth switch: This interlock shall be integral part of the operating mechanism. Also separate operating shafts shall be provided for operation of earthing switch and main switch for the same purpose.

5.5.0 The fully interlocked cable test facilities shall be provided underneath the units, so that access to the test terminals is achieved only be removal of the cable cover.

5.6.0 The SF6 insulated isolators and VCB breaker operating mechanisms shall be totally enclosed and self lubricating type. The manually operated handle shall be mounted in front of the isolators and so designed that the operation is complete by one movement without any undue stain on the operator.

5.7.0 All mechanical interlock shall be robust so as not to give way during normal operation.

5.8.0 The secondary wiring supplied for the equipment shall consist of non-deteriorating fire proof superior grade stranded copper PVC wires suitably colored and fitted with numbered ferrules at both ends. The cross section of the wires shall be 4 mm^2 for CT and 2.5 sqmm for others. Following color codes shall be used for wiring.

C.T : Red, Yellow, Blue, Black,
D.C. Circuit: Grey
Earth: Green,

A.C Circuit: Black

5.9.0 Wiring shall be terminated with ring type ferrules with ferrule numbers marked at both ends of wiring. CT wiring shall be marked with additional distinct Red tags on both ends. All secondary wiring shall be terminated by using reputed make terminal blocks.

6.0.0 MISCELLANEOUS

6.1.0 It shall be easily possible to test the cables including the Tee-off (in case of RMU) by a simple earthing arrangement. In case of breaker, the earthing shall be preferably accomplished through the circuit breaker and the tripping arrangements made inoperative if required.

6.2.0 Equipment earthing of copper strips of adequate size shall be provided.

6.3.0 A set of earthing and a set of three phase test bushings shall form an integral part of RMU and shall be all enclosed within an interlocked cover to prevent incorrect operation. The access of the test bushing shall be fully interlocked.

6.4.0 A mechanical 'ON/OFF' indicator shall be provided on SF6 insulated isolators and VCB breaker to indicate whether switch is ON and OFF.

6.5.0 SF6 insulated switches shall be fitted with correct sequence device having "ON/OFF" and re-set and test position and shall have provision for padlocking operating handle.

6.6.0 The isolators and SF6/VCB shall be provided with suitable and identical cable boxes for connection of 11 KV, 3 Core, XLPE cables of size up to 300 mm2 approaching vertical from below. The cable boxes shall be so located at convenient height to facilitate easy cable jointing work.

6.7.0 The access for the isolator cable box and for the VCB cable box shall be from front side only and distance of bottom level of wiping gland from ground shall be maintained at 310mm (minimum).

6.8.0 The cable boxes shall be with detachable front cover for ease of termination & shall be interlocked with switch position (i.e. when isolator is in Earth/OFF position).

6.9.0 The design of the cable box shall be such that any type of jointing methods such as heat shrinkable/push on type/cold shrinkable type termination's can be adopted.

6.10.0 Earthing: All ring main units shall have a special earth bar/bolt.

6.11.0 All foundation bolts, nuts and washers necessary for installation shall be supplied by the manufacturer.

6.12.0 Removable eye bolts shall be provided to facilitate the handling of the RMU/tee-off unit/SF6 isolators.

6.13.0 Labels: All RMUs shall be clearly labeled as required indicating where necessary their purpose and "ON" and "OFF" lettered on brass, ivory, enamel iron or other suitable materials.

7.0.0 PAINTING

Painting shall be carried out by approved process. After preparation of the under surface the equipment shall be painted with epoxy based paint by powder coating. The final thickness of paint film on steel shall not be less than 85 microns. Final shade shall be RAL9002.

8.0.0 TESTING & INSPECTION

7.1.0 Equipment offered shall be of type tested and proven type. Type test certificates for test conducted earlier on similar rating shall be furnished. For the various bought out item test certificates from equipment manufacturer shall be furnished. Routine tests shall be carried out for all the equipment as per applicable standards.

7.2.0 All tests shall be conducted as per relevant IEC standards and shall be performed in the presence of Owner / Owner's representative, if so desired by the Owner / Owner. The bidder shall give at least 15 days advance notice of the date when the tests shall be carried out.

7.3.0 Copies of certified reports of all tests carried out at the works shall be furnished. The equipment shall be dispatched from works, only after receipt of Owner / Owner's written approval of the test reports.

7.4.0 Switchgear and all its components should have been type tested and proven type. Type test certificates shall be furnished for Owner's review. Switchgear and its components shall be subjected to routine tests as per applicable IEC Standard. In addition, any special test required shall also be performed. Test reports shall be submitted for approval.

7.5.0 Routine Test

The tests shall be carried out in accordance with IEC 60298 include but not necessarily limited to the following:

i. Withstand voltage at Power Frequency for all current carrying parts including wiring
ii. Measurement of resistance of the main circuit
iii. Gas Leakage test
iv. Withstand voltage on auxiliary circuits
v. Operation of functional locks, interlocks, signaling devices and auxiliary devices
vi. Suitability and correct operation of protections, control instruments and electrical connections of the circuit breaker operating mechanism (primary & secondary injection)
vii. Verification of wiring
viii. Visual Inspection

9.0.0 DRAWINGS, DATA AND MANUAL

8.1.0 The bid shall be submitted with the following:

- Technical data sheet.
- Drawing & catalogue

8.2.0 The following documents shall be submitted by the successful Bidder after the award of contract.

- Sizing calculation
- Technical data sheet
- Schematic diagram
- Equipment Layout drawings
- General Arrangement drawing
- Quality Plan
- Test certificates
- O&M manual

10.0.0 TECHNICAL PARAMETERS

Sl.No.	Description	Unit	Data
a)	Type		Indoor, Ring main Unit
b)	Applicable standard		IEC 62271

Sl.No.	Description	Unit	Data
c)	Rated Voltage (normal / max)	kV	11 /12, 3 phase, 50 HZ
d)	Short circuit withstand current rating for 1 Sec. duration	kA rms	40
e)	Peak withstand current rating	kAp	100
f)	Internal arc withstand rating for 0.2 Sec. duration	kA rms	40
g)	Impulse withstand voltage	kVp	75
h)	One minute power frequency with stand voltage	kV rms	28
i)	Degree of protection for breaker, cable, busbar compartment		IP52
2.0	**Circuit breaker**		
a)	Type		VCB
b)	No. of poles		3
c)	Rated operating duty		O-3min-CO-3min-CO
d)	Rated short circuit breaking current	kA rms	40
e)	Rated short circuit making current	kAp	100
f)	Control supply voltage		
	iii. Closing coil, Spring charging motor	V	110 V DC (80-110%)
	iv. Tripping coil	V	110 V DC (70-110%)
3.0	**RMU SF6 gas chamber**		
	Enclosure		Stainless steel enclosure, IP67 class.
	SF6 gas pressure low alarm		To be Provided
	Provision for SF6 gas filling		To be Provided. But not applicable for `sealed for life' design .
	SF6 gas pressure measurement		Manometer with non return valve indication
	Arc interruption method for SF6 Load break switch		Puffer type / rotating arc type
	Potential free contacts for SF6 gas pressure low		1NO +1NC

SECTION – B3.5: DRY TYPE DISTRIBUTION TRANSFORMER

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of Dry Type Service Transformers for efficient and trouble-free operation of Township.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the applicable IEC Standards, except where modified and /or supplemented by this specification.

3.0.0 DESIGN REQUIREMENTS

3.1.0 Dry type transformers of adequate capacity shall be provided at following locations:

- Main receiving substation
- Distribution substation-1,2,3,4 and 5 ,

3.2.0 Transformers shall be designed with maximum temperature rise of 90 °C over design ambient of 50°C. The core and other associated parts shall also be limited to the same value of temperature rise as for the windings.

3.3.0 Required numbers of service transformers for supplying 415 V loads of entire township shall be provided. Each transformer shall be rated to meet the loads connected on switchgear with 10% design margin.

3.4.0 The transformers shall be capable of delivering the rated output at any particular tap continuously without exceeding the specified temperature limits under the following operating conditions.

- Voltage variation of ± 10% of rated voltage of that particular tap.
- Frequency variation of +3% -5% of rated frequency.
- Combined voltage and frequency variation of 10% (absolute sum).
- Minimum ambient temperature specified in the specification

3.5.0 The maximum flux density in any part of the core and yoke at the rated MVA, voltage and frequency shall be such that under 10 per cent continuous over-voltage condition it does not exceed 1.67 Tesla.

3.6.0 Transformers shall withstand, without injurious heating 125% over fluxing for a period of one (1) minute and 140% over fluxing for a period of five (5) seconds. (Over fluxing caused by combined voltage and frequency fluctuations).

3.7.0 Transformers shall be capable of operating at 125% rated voltage for a period of one (1) minute and 140% rated voltage for a period of ten (10) seconds due to sudden load throw off.

3.8.0 The transformers shall be free from annoying hum and vibration when it is in operation, even at 110% rated voltage.

3.9.0 The transformers shall be designed with particular attention to the suppression of maximum harmonic voltage, especially the third and fifth so as to minimize interference with communication circuit.

3.10.0 The transformers shall be capable of withstanding without injury, the thermal & magnetic stresses caused by faults on any of the winding /through faults with full voltage maintained on

other winding for a period of 2 seconds. Bushing CT shall be rated for the same fault current for a duration of 1 second.

3.11.0 The transformers shall be capable of being loaded in accordance with IEC-600354. There shall be no limitation imposed by bushings, tap changers etc. or any other associated equipment.

3.12.0 The noise level of transformer, when energized at normal voltage and frequency with fans running shall not exceed, when measured under standard conditions, the values specified in NEMA standard publication TR-1.

3.13.0 Efficiency of the transformers shall be about 98.5% at 0.8 PF at full load.

3.14.0 Contractor shall guarantee losses and efficiency figures of each transformer during detail engineering. During testing, if the losses exceed the guaranteed value, penalty shall be applied for at the rates indicated in section B3.1, clause 6.00 of this specification. If the losses exceed the guaranteed value by 10% or more, the transformers may be rejected by the Owner.

4.0.0 CONSTRUCTIONAL FEATURES

4.1.0 Dry type transformers shall be cast resin encapsulated type.

4.2.0 Core & Windings

Windings shall be fully uniformly insulated. The high voltage and the low voltage coils shall be wound with high conductivity copper conductors and the insulation shall be done by cast resin. Coils shall be separated by a uniform air space that permits free circulation of cooling air between the coils. Windings shall be properly sized, insulated and supported for the voltages and currents to be encountered in operation, including short circuits. Insulation shall be class –H.

4.3.0 Core

The transformer core shall consist of thin, individually insulated sheets of high permeability, cold rolled grain-oriented, non-aging silicone steel. They shall be miter-corner-cut without burs, to provide a cross section most nearly resembling the circular cross-section. Laminations shall be cut and stacked utilizing step-lap construction to reduce losses and sound. Designed flux density shall be kept well below saturation.

The assembled core shall be braced with heavy structural steel angle or channel to apply uniform clamping forces across the entire width, top and bottom. The core shall be protected from corrosion with high temperature rated rust-resistant coating.

4.4.0 Core and Coil Assembly

Construction shall consist of separate high and low voltage coils for each phase, mounted coaxially, with high/low air space between coils adequate for the rated voltage potentials. Coils shall be mounted concentrically and supported in place on the transformer core so as to restrain movement in shipping and in service. Each coil shall be supported on epoxy blocks, top and bottom, with resilient pads to retain the coils while permitting thermal expansion under loading. The core-and-coil assembly shall be designed and manufactured to withstand without damage the short circuit testing. All leads from the windings to the terminal board and bushings shall be rigidly supported to prevent injury from vibration or short circuit stresses.

4.5.0 Bus

All bus work shall be designed to withstand maximum short circuit stresses when connected to a supply system having a specified fault capacity, and to meet all test voltage requirements, without audible or visible corona.

Low voltage bus shall be high conductivity copper. Connections of coil windings to bus shall be brazed or welded using shielded arc techniques. Connection and terminal bolting surfaces shall be tin or silver-plated. Bolted connections shall include spring washers to maintain bolted surface pressure. All bus shall be sized to for the amperes involved and maximum specified ambient temperatures.

High voltage bus shall be high conductivity copper. It shall be supported by glazed porcelain insulators for surge strength. It shall have bolt-connected joint and terminal surfaces tin or silver-plated. High voltage leads shall be bus or flexible, insulated cable with suitable terminations. Taps shall have flexible cable or solid copper links or jumpers.

Ground bus shall be copper bus extending the full length of the enclosure. It shall have provisions to mount appropriate terminal connections for external grounding.

4.6.0 Enclosure

The enclosure shall be a ventilated enclosure for indoor use and be designed to provide adequate ventilation for the transformer. Protection of enclosure shall be atleast IP 33. Screens shall be perforated sheet steel type. Mesh size shall be such that lizard, rats etc. cannot enter inside the enclosure.

Double leaf access shall be provided with concealed hinge and neoprene gaskets for easy access to HV links and also for withdrawal of core and coil assembly if required. The enclosure shall be of CRCA sheet steel with a minimum thickness of 2 mm while the roof and vertical supports shall be formed from minimum 3 mm thick sheet steel. The enclosure shall be adequately reinforced to ensure rigidity so as to permit transportation of transformer within enclosure.

The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized adequately. Each transformer shall be provided with one set of bi directional rollers for rolling the transformer parallel to either centre line.

4.7.0 Base

The transformer base shall be a separate rigid steel construction capable of supporting the core and coil assembly and enclosure. Construction shall include provisions for lifting as well as for jacking and skidding or rolling in both directions. Lifting provisions shall be designed for lifting the transformer and the core-and-coil assembly, separately or together.

4.8.0 Temperature Indicators

For measuring temperature in the winding PT-100 Resistance temperature detectors shall be embedded in all three phases in LV windings. Potential free alarm and trip contacts shall be provided in to operate alarm and trip circuits. Four channel temperature scanner & local winding temperature indicator for winding temperature measurement shall be provided in the marshaling box.

4.9.0 Off Circuit Tap Changer

a) Off circuit taps as specified shall be provided on the high voltage winding.

b) The transformer shall be capable of operation at its rated kVA on any tap provided the voltage does not vary by more than 10% of the rated voltage corresponding to the tap.

c) The winding including the tapping arrangement shall be designed to maintain electromagnetic balance between HV and LV windings at all voltage ratios.

d) The tap changing shall be possible without disturbing the transformer in any way except de-energizing.

e) An indicating device shall be provided to show the tap in use.

- A warning plate indicating “The switch shall be operated only when the transformer has been de-energised” shall be fitted.

4.10.0 Safety Interlock

For all dry type transformers following safety interlocks shall be provided:

a) A safety interlock to ensure that the enclosure door can be opened only when transformer is de energized.

b) Safety limit switches operated by door handle for tripping HV breaker.

4.11.0 Limit Switches

Minimum 4 Nos. limit switches shall be provided for transformer enclosure door interlock. Each Limit switch shall have 1 NO & 1 NC contact. All NO contacts of limit switch shall be connected series and NC contacts shall be connected parallel. Limit switch shall be used for HT Circuit breaker tripping and HT Circuit breaker closing permissive.

4.12.0 Bushings

a) All bushings shall be homogenous, non-porous porcelain type, uniformly glazed and free from blisters, burns and other defects complete with suitable terminal connectors of adequate capacity.

b) Bushings located indoor can be epoxy-molded types.

c) Clamps and fittings of steel shall be galvanised.

d) Bushing location shall provide adequate phase and ground clearances.

e) For indoor bushing, creepage distance shall be 25 mm/KV.

4.13.0 Cable Box

a) A dust tight air insulated type cable box with IP55 protection shall be provided for terminating the cables with termination kit.

b) Inspection cover for fixed portion of cable box shall be provided. Handles for lifting cable box shall be provided.

c) Gland plate for single core cable termination shall be of Aluminium.

d) The cable box shall have Pressure Relief Diaphragm (PRD).

4.14.0 Neutral Terminals

a) Two Nos. neutral terminals shall be provided on LV side. One neutral terminal shall be part of phase connection arrangement in LV cable-box (as applicable). Other neutral terminal shall be brought to the transformer bottom for connection to station earth by means of earthing bar of copper, supported on insulators mounted on transformer body.

b) Neutral bushing CT shall be provided for standby earth fault protection. CTs shall be cast resin type. CT shall be located as per protection requirement.

4.15.0 Marshaling Box

a) The marshaling box shall be fabricated using sheet steel of at least 2 mm thickness.

b) Marshaling box shall be complete with all internal wiring and identification ferrules, cables, conduits required for wiring between marshaling box and instruments on transformer.

c) The marshaling box shall be provided with thermostatically controlled space heaters and shall have IP: 54 degree of protection.

d) CT terminals shall be with shorting and disconnecting facility.

e) Cable gland plate shall be of removable type.

f) The marshaling box shall have MCB for incoming power supply.

g) Marshaling box shall have temperature scanner & local winding temperature indicator for winding temperature measurement. Terminal block shall be provided in the marshaling box to connect cabling between RTD's and Temperature scanner. The temperature scanner unit shall continuously monitor the winding temperature and shall be provided with auxiliary relays with potential free contacts for alarm and trip.

4.16.0 Wiring

- All control, alarm and indication devices provided with the transformer shall be wired up to the terminal blocks.
- Wiring shall be done with 1100 V grade XLPE insulated FRLS wires in conduit or XLPE insulated armoured FRLS cable. Minimum wire size shall be 2.5 sq.mm. stranded copper for control & 4 sq.mm. stranded copper for CTs. Not more than two wires shall be connected to a terminal. 20% spare terminals shall be provided.
- All devices and terminal blocks within the marshaling box shall be identified by symbols corresponding to those used in applicable schematic or wiring diagrams. Each wire shall be ferruled by plastic tube with indelible ink print at both end having terminal block no. terminal no. as per approved schematic or wiring diagrams.

4.17.0 Name plate

Each transformer shall be provided with a rating name plate. Plates shall be stainless steel material fitted in a visible position. Name plates shall be of white non-hygroscopic material with engraved black lettering.

5.0.0 PAINTING

All the fabricated surfaces shall be pretreated by degreasing, de-rusting and chemically cleaned prior to application of epoxy resin red oxide primer to give a dry film thickness of 50 microns. The finishing paint shall be half gloss based on an epoxy based. The paint shall be applied in two coats to give a minimum dry film thickness of not less than 50 microns. The final paint shade of external surface of shall be RAL 9002.

6.0.0 TESTS

6.1.0 Offered rating and type of transformer should have type tested.

6.2.0 Type tests/ Routine tests / Special tests / Acceptance tests shall be conducted as per standards and test reports shall be submitted for review.

6.3.0 The following type tests shall be conducted one on each rating of transformer

- Measurement of winding resistance
- Measurement of voltage ratio and check of phase displacement
- Measurement of impedance voltage, short circuit impedance (principal tapping) and load loss.

- Measurement of no load loss and current.
- Separate source voltage withstand test
- Induced overvoltage withstand test
- Lightning impulse test
- Temperature rise Test.
- Noise test

6.4.0 Following routine tests shall be conducted on each transformer

- Measurement of voltage ratio and check of phase displacement
- Measurement of impedance voltage / short circuit impedance (principal tapping) and load loss.
- Measurement of no load loss and current.
- Separate source voltage withstand test
- Induced overvoltage withstand test

7.0.0 DRAWINGS, DATA AND MANUAL

The bid shall be submitted with the following:

- Technical data sheet.
- Drawing & catalogue

The following documents shall be submitted by the successful Bidder after the award of contract.

- Sizing calculation
- Technical data sheet
- General Arrangement drawing
- Quality Plan
- Test certificates
- O&M manual

8.0.0 TECHNICAL PARAMETERS OF DRY TYPE TRANSFORMERS

Sl.No.	Description	Unit	Data
1.	Service		Indoor
2.	Type		Dry type, cast resin, two winding
3.	No. of Phase		Three
4.	Frequency	Hz	50
5.	No. of windings		Two
6.	Nominal system voltage (HV / LV)	kV	11/0.433
7.	Vector group		Dyn1
8.	Type of cooling		AN
9.	Impulse withstand level		
a)	HV side	kV	75

Sl.No.	Description	Unit	Data
10.	One minute Power frequency withstand voltage		
a)	11 side	kV	28
b)	LV side	kV	3
11.	Connections		
a)	HV side		Delta
b)	LV side		Star
12.	Neutral Earthing		
a)	HV side		
b)	LV side		Solidly grounded
13.	Terminal arrangement		
a)	HV side		Cable Box
b)	LV side including neutral		Busduct
a)	LV Neutral side		Ground conductor
14.	Bushings		
a)	Indoor Bushings Creepage distance		25 mm /kV
15.	Tap Changer		
a)	Type		OCTC
b)	Tap provided on		HV side
c)	Range of taps (HV side)	%	+5% to –5% in steps of 2.5%
16.	Short circuit withstand duration	Sec	2
17.	Neutral bushing CT		For Standby earth fault protection

SECTION – B3.6: CAPACITOR BANK

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of Capacitor bank for efficient and trouble-free operation of Township.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the applicable Standards, except where modified and /or supplemented by this specification.

3.0.0 TECHNICAL REQUIREMENT

3.1.0 415 V rated Capacitor banks shall be provided at Main receiving substation and at Distribution substations to improve power factor to unity.

3.2.0 The capacitors shall be connected to the bus of the 415 V PCC and shall be manually as well as automatically switched in and out in steps so as to correct the power factor depending on the actual kVAR requirement of the bus. Compensation to the lagging kVAR shall be made corresponding to the reference power factor as set on the APFC relay at the panel.

3.3.0 The capacitor banks shall be rated for 415 V, 3 phase, indoor panel mounted type. Capacitor bank shall comprise multiple units.

3.4.0 Capacitor bank shall be fed from 415 V PCC through breaker, CT, PT, protection relays etc. Capacitor bank shall be switched on in stages based on power factor of the system. Power factor shall be sensed by an electronic control unit (relay) which shall receive current and voltage inputs from current and voltage transformers of 415 V PCC.

3.5.0 The capacitors shall be of non-PCB type. The units shall consist of small units of capacitor cells series/parallel combination.

3.6.0 Capacitors units shall be suitable for operation at a r.m.s. voltage between terminals not exceeding 1.1 times the rated voltage, excluding transients. All capacitors shall be suitably protected against over current by means of suitable over current trips (other than fuses), which are adjusted to interrupt the circuit when the current exceeds the safe permissible limit. Capacitor units shall also be protected against the internal faults and the affected units / banks shall be automatically and immediately isolated in the event of such faults. Capacitors shall be provided with proper discharge device built into the unit to reduce the residual voltage to a safe value within the specified time as recommended in the relevant standard after the capacitor has been disconnected from the supply.

3.7.0 The capacitors and their control elements like relays, contactors, timers, protective elements shall be housed in well-ventilated panels. Capacitors and their control elements may be installed in different compartments of the same panel to minimize the space requirement. Both manual by ON-OFF push buttons and automatic by Automatic Power Factor Correction relay shall be provided for power factor correction. Auto/Manual selector switch for the above shall be provided on the capacitor control panel.

3.8.0 The built-up unit sizes shall be multiplication of the single unit i.e. 25kVAr, 50kVAr and 100kVAr. The total capacitor bank shall comprise a number of the built-up units of different ratings. The automatic power factor relay shall provide output signals in at least eight (8) stages to enable achieve the set power factor at all possible loading conditions. The control panel shall have digital display of the set and achieved power factors and analog display of current in all the three phases of the line to the capacitor bank. The panel shall be provided with but not limited to following:

a) ACB with motor operated spring charge operating mechanism and electrically operated closing and tripping coil, 415/110 V PTs with set of MCCBs, set of CTs, Ammeter with Ammeter switch, indicating lamps.
b) Required number of capacitor duty contactors with backup fuses to feed capacitor banks of various ratings.

3.9.0 The power loss in capacitors shall not exceed 0.2 watt/KVAR.

3.10.0 Suitable discharge device shall be connected across the capacitor unit. The capacitor units shall be provided with internal HRC fuses.

3.11.0 Suitable Inrush Suppression Series Reactors of air core dry type, shall be provided on each capacitor units to limit the inrush current due to switching within a safe limits.

3.12.0 Interlocking shall be provided to ensure that the access to the capacitor bank enclosure is not possible until the associated main incoming circuit breaker has been racked and the faulty stage has been locked out and circuit earth applied

3.13.0 The Automatic control unit shall be provided to automatically switch ON or switch OFF the capacitor banks. In the event of leading power factor, the control unit shall give a tripping command to the breaker to disconnect the capacitor bank. Overriding provision shall also be made for electrical switching ON or OFF of the capacitor by the operator from ACU panel.

3.14.0 The automatic control unit shall instantly switch OFF the capacitor switch in the following contingencies occurring in any of the phases :

i. Voltage increases by 7% above the rated voltage.
ii. Load current imbalance (due to single phasing and for any other reasons) between any of the two phases exceeding 20% of the lowest current of the 3-phases.
iii. Current increases in any Capacitor unit by 30% above the rated current (only the relevant capacitor switch shall open).
iv. Current between any of the two phases of the capacitor bank differs more than 15% of the lowest current of the 3-phases (only the relevant capacitor switch shall open).

3.15.0 The capacitor units shall be indoor type, air-cooled with low viscosity impregnated paper dielectric/polypropylene hermitically sealed. The impregnation used shall be non-inflammable, non-oxidizing, lower freezing point type synthetic compound. Each individual cell shall be provided with pressure sensitive disconnectors / devices.

3.16.0 Capacitor units shall be provided with externally mounted discharge resistors to reduce the residual voltage to less than 50 Volts in one minute of switching off.

3.17.0 Individual unit shall be provided with HRC fuses/ adequate capacity of MCBs/MCCBs, contactors (capacitor duty) bus bars and terminal chambers to make bank of required KVAR. Terminal chamber shall be suitable for bottom/top cable entry. Two earth terminals shall be provided to each capacitor bank.

3.18.0 The enclosure shall be metal enclosed, suitable for indoor floor mounting. It shall be fabricated using cold rolled sheet steel of thickness 2 mm and enclosure shall have IP 52 protection.

3.19.0 The external and internal surface of the unit shall be powder coated epoxy finish of shade approved by Owner.

4.0.0 PAINTING

Painting of the panel shall be carried out by approved process. After preparation of the under surface the equipment shall be painted with epoxy based paint by powder coating. The final thickness of paint film on steel shall not be less than 85 microns. Final shade shall be RAL9002.

5.0.0 TESTS

4.1.0 Offered rating and type of equipment should have type tested.

4.2.0 Routine tests & Acceptance tests shall be conducted as per standards and test reports shall be submitted for review.

4.3.0 Following routine tests shall be conducted.

a. Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme & proper functioning of the equipment.
b. All wiring and current carrying part shall be given appropriate High Voltage test.
c. Primary current and voltage shall be applied to all instrument transformers.
d. Routine test shall be carried out on all equipment such as circuit breakers, instrument transformers, relays, meters etc.

6.0.0 DRAWINGS, DATA AND MANUAL

The bid shall be submitted with the following:

- Technical data sheet.
- Drawing & catalogue

The following documents shall be submitted by the successful Bidder after the award of contract.

- Sizing calculation
- Technical data sheet
- General Arrangement drawing
- Quality Plan
- Test certificates
- O&M manual

SECTION – B3.7: LT SWITCHGEAR

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of LT Switchgear for efficient and trouble-free operation of electrical system of the Township.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the following IEC Standards, except where modified and /or supplemented by this specification.

IEC: 60947 Specification for low voltage switchgear and control gear

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 The following 415 / 240 V rated switchgear shall be provided at various substations and buildings to derive power supply.

- Power control centre
- Motor control centre
- Main distribution board
- Floor distribution board
- Distribution board
- Sub-distribution board
- Branch distribution board
- Essential DB

3.2.0 The switchgear and its components shall be designed for design ambient temperature of 50ºC. Switchgear shall be designed for natural air cooling.

3.2.0 415V normal system shall be solidly grounded.

3.3.0 Bus bar, breaker and other components shall be designed for continuous operation at rated current considering temperature inside the cubicle.

3.4.0 Operating height of the handles/switches shall be limited to a maximum of 1800 mm and a minimum of 400 mm.

3.5.0 The switchgear shall be of fixed type, single front design. Cable entry shall be from bottom.

3.6.0 110V control supply shall be derived from 415/110V control supply transformer located in each module.

3.7.0 The continuous current rating of the bus bars, incomers, bus couplers of the switch gear which are fed by the transformers shall be rated at the LV side of the full load current of the transformers with 10% margin rounded off to the next higher standard rating.

3.8.0 All the motor starters shall be ‘Direct On Line’ type. All MCC feeders shall conform to Type 2 co-ordination. Motor feeders shall be as detailed below -

- Motors less than 10KW - controlled by “MPCB – Contactor ” combination
- Motors >=10KW and <55KW – controlled by “MPCB –Contactor – Electronic Overload Relay with current display unit”

- Motors >=55KW and <125 KW - controlled by "MCCB –Contactor – Electronic Overload Relay with current display unit"

3.9.0 The switchgear frame shall be fabricated using CRCA sheet steel of thickness not less than 2.0 mm. The frames shall be enclosed by CRCA sheet steel of thickness not less than 1.6 mm.

3.10.0 Switchgear shall be of dust-proof and vermin-proof with a degree of protection of IP-54 for indoor installation.

3.11.0 The handle of incoming switch shall be mounted on the door of the board, with padlocking facility in both 'ON' and 'OFF' positions.

3.12.0 Cable entry facilities shall be provided with removable gland plates of suitable thickness. All incoming and outgoing cables shall be terminated on suitable terminal blocks.

3.13.0 Moulded Case Circuit Breaker (MCCB) shall be provided with spring assisted quick-make, quick-break, current limiting type manually operated trip free mechanism, mechanical ON/OFF/TRIP position indicators, thermal tripping devices of inverse characteristics, instantaneous short circuit tripping devices and necessary auxiliary and alarm contacts. The thermal and short circuit tripping device shall be adjustable type.

3.14.0 When used for motor circuit, shunt trip devices shall be provided and the let through power of controlling MCCB shall be lower than the respective contactor, Contactor and overload relay shall be selected so as to withstand the let-through energy of the connected MCCB in the feeder and consequent thermal and dynamic effects.

3.15.0 The MPCB's shall be in generally similar to that of MCCB's in all the features mentioned above. MPCB's shall be triple pole with adjustable Thermal Over load and Short circuit protection device.

3.16.0 Interlocks shall be provided such that the cubicle door shall not open when the switch is in closed position and the switch shall close only when the door is closed. However, suitable means shall be provided to intentionally defeat these interlocks.

3.17.0 Motor starter contactors shall be of air break, electromagnetic type rated for uninterrupted duty. Contactors shall be double-break, non-gravity type and their main contacts shall be silver faced. Direct-on-line contactors shall be of utilization category AC3. Reversing starters shall comprise of Forward and Reverse contactors mechanically and electrically interlocked with each other. These contactors shall be of utilization category AC4.

3.18.0 Current Transformers shall be cast-resin type and the insulation class shall be E or better. Accuracy class of the current transformers shall be 1.0 for metering.

3.19.0 Voltage transformers shall be cast-resin type. Accuracy class of the voltage transformers shall be 1.0 for metering. Windings of voltage transformer shall be protected by MCB .

3.20.0 For incomers Digital multifunction meter measuring voltage, current of all three phases, kVA, kW, PF shall be provided

3.21.0 Switchgear shall be fully wired at the factory to ensure proper functioning of control, protection, schemes. Wiring shall be done with flexible, 1100V grade, PVC insulated switchboard wires with stranded copper conductors of 2.5 sqmm for control & current circuits and 1.5 sqmm for voltage circuits.

3.22.0 Terminal blocks shall be 600V grade box-clamp type with marking strips. Terminals for CT secondary leads shall have provision for shorting..

3.23.0 Switchgear shall be designed for cable entry from the bottom. Sufficient space shall be provided for ease of termination and connection.

3.24.0 A ground bus, of copper shall extend full length of the switchgear.

3.25.0 Push-buttons shall be of spring return, push-to-actuate type. Where specified push buttons shall be stay put type. Their contacts shall be rated to make, continuously carry and break 6 A at 110 V AC and 1 A (inductive) at 110 V DC. The colour of the button shall be as follows:

- Green for motor START, breaker CLOSE, valve / damper OPEN /CLOSE commands.
- Red for motor TRIP, breaker OPEN.
- Black for all annunciator functions, overload reset and miscellaneous commands.

3.26.0 Indicating lamps shall be of the panel mounting, LED type .The lamps shall have escutcheon plates marked with its function, wherever necessary. Lamps shall have translucent lamp-covers of the following colours, as warranted by the application:

- Red for motor ON, breaker CLOSE.
- Green for motor OFF, breaker OPEN.
- Amber for auto trip.
- Blue for Spring Charged, Trip Circuit Healthy, Lockout Relay Healthy.
- White for Test, Service.

3.27.0 Each starter module shall derive 110V AC control supply through control supply Transformer. The control transformers shall be of insulation class `B' or better.

3.28.0 For panel space heater, 230V AC supply shall be derived from line side. Necessary MCB to isolate and distribute the supply to each panel shall be provided.

3.29.0 Each panel shall be equipped with the following as required:

- Thermostatically controlled space heater(s).
- Illumination lamp with door switch
- 5A 3pin socket with MCB protection.

3.30.0 Switchgear, local push-button stations and local motor starters shall be provided with prominent, engraved identification plates. The module identification plate shall clearly give the feeder number and feeder designation. For single front switchboards, similar panel and board identification labels shall be provided at the rear also.

3.31.0 Caution name plate "Caution Live Terminals" shall be provided at all points where the terminals are likely to remain live and isolation is possible only at remote end.

3.32.0 Energy meters shall be provided in the following locations

Each outgoing feeder of floor DB feeding dwelling units

Each outgoing feeders of all 415V PCC and 415V EDB

Incomer feeder of MCC / DB receiving power for various facilities such as post office, Bank, school etc.

3.33.0 **Busbars and Insulators**

Switchgear shall be provided with three phase and neutral busbars. All busbars and jumper connections shall be of high conductivity copper of adequate size. The cross-section of the busbars shall be uniform throughout the length of switchboard.

The continuous rating of the main busbars shall be same as that of the incomer breaker, and busbar shall carry this continuous current without exceeding the temperature of 90º C.

All busbars shall be adequately supported by non-hygroscopic, non-combustible, track-resistant and high strength sheet moulded compound or equivalent type polyester fiber glass moulded insulators. All busbar joints shall be provided with high tensile steel bolts, belleville/ spring washers and nuts.. All busbars shall have HRPVC sleeves and colour coded.

All horizontal and vertical busbars joints shall be covered by insulating shrouds.

3.34.0 Local Push Button Stations

The local push buttons stations shall be metal enclosed, suitable for outdoor mounting on wall or steel structures with suitable hood on top. The enclosure shall be provided with a hinged guard at the front, covering full length, to avoid inadvertent operation of push buttons. The local push button stations shall be dust and vermin proof and shall have a degree of protection of IP W 55.

The push button station shall comprise a latched type EMERGENCY STOP push button and a self reset START push button each with two NO and two NC contacts and an ammeter.

3.35.0 Wall mounted DB

DBs shall have following features:

a) Recess/ Surface type with integral loose wire box.

b) Phase/ neutral/ earth terminal blocks for termination of incoming & outgoing wires.

c) Din Channel for mounting MCBs.

d) Arrangement for mounting incomer MCB/ RCCB/ RCBO/ MCCB as required.

e) Copper Bus bar.

f) Earthing terminals.

g) Wiring from MCBs to phase terminal block.

h) Interconnection between terminal block/ incoming switch/ bus bar/ neutral terminal block/ earth terminal connector with specified size of FRLS pre-insulated copper conductor cable duly fitted with copper lugs/ thimbles.

i) Terminal blocks should be suitable for termination of conductor/ cable of required size but minimum rated cross section of the terminal blocks should be 6 sq. mm.

j) Terminal block shall be made of fl ame retardant polymide material.

k) Colour terminal blocks and FRLS wires for easy identification of RYB Phases, Neutral and Earth.

l) DB shall be provided with a detachable cassette for safe removal of MCBs, RCCBs. Terminal connectors from the DB without loosening the internal cable connections of phase and neutral circuits. (This is an optional feature.)

m) DB shall have peelable poly layer on the cover for protection from cement, plaster, paints etc. during the construction period.

n) Detachable plate with Knock out holes shall be provided at the top/ bottom of board. Complete board shall be factory fabricated and pre-wired in factory ready for installation at site. The box and cover shall be fabricated from 1.6mm sheet steel, properly pre-treated, phosphatized with powder coated finish.

o) DB shall be of double door construction provided with hinged cover in the front.

p) DB shall be factory manufactured by reputed manufacturer of MCB DBs.

4.0.0 PAINTING

Painting shall be carried out by seven-tank process. After preparation of the under surface the switchgear shall be powder coated with epoxy based paint. The final thickness of paint film on steel shall not be less than 85 microns. Sufficient quantity of touch-up paint shall be furnished for application at site. Final shade shall be RAL 9002.

5.0.0 TESTS

5.1.0 Offered rating and type of equipment should have type tested.

5.2.0 Routine tests & Acceptance tests shall be conducted as per standards and test reports shall be submitted for review.

6.0.0 DRAWINGS, DATA AND MANUAL

The bid shall be submitted with the following:

- Technical data sheet.
- Drawing & catalogue

The following documents shall be submitted by the successful Bidder after the award of contract.

- Sizing calculation
- Single line diagram
- Schematic diagram
- Technical data sheet
- General Arrangement drawing
- Quality Plan
- Test certificates
- O&M manual

7.0.0 TECHNICAL PARAMETERS

Sl.No.	Description	Unit	Parameters
1.	Rated AC voltage	V	415 ±10%, 3 phase, 4 wire
2.	Frequency	Hz	50 (+) 5% to (-) 5%
3.	One minute power frequency withstand voltage • Main circuit • Auxiliary circuit	 kV kV	 2.5 2.0
4.	Bus bar material • Phase & neutral • All vertical bus bars for multi-tier panel • Earth		Copper

Sl.No.	Description	Unit	Parameters
5.	Bus bar clearance in air (minimum) • Phase to phase • Phase to earth	 mm mm	 25 20
6.	Temperature rise over design ambient of 50 ^{o}C (i) Bus bars (ii) Silver plated joints		 40 ^{o}C 55 ^{o}C
7.	Degree of protection		IP-52
8.	Execution		Single front, fixed type.
9.	Short time current for 1 sec.	kA(rms)	25
10.	Rated short circuit breaking current	kA(rms)	25
11.	Rated short circuit making current	kA(peak)	53
12.	Current transformer insulation		E or better

SECTION – B3.8: RISING MAIN, BUS TRUNKING & BUSBAR SYSTEM

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of rising main / bus trunking for efficient and trouble-free operation of electrical system of Township.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the following Standards, except where modified and /or supplemented by this specification.

IEC-60947 Specification for low voltage switchgear and control gear

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 SANDWICH INSULATED TYPE RISING MAINS

3.1.1 Rising mains shall be provided for high rise buildings to feed power supply to various floors for indoor installation. It shall be sandwich insulated type

3.1.2 The insulation of the rising mains shall be capable of withstanding the voltage of 660 V of AC.

3.1.3 Bus bar joints shall be thoroughly cleaned and suitable oxidizing grease shall be applied before making the joint.

3.1.4 High tensile bolts, plain and spring washers shall be provided to ensure good contact at the joints.

3.1.5 The overlap of the bus bars at the joints shall be not less than the area of the cross section of the bus bars.

3.1.6 Expansion joint made of copper strips shall be provided wherever necessary, to take care of expansion and contraction of the bus bars under normal operating conditions. This shall be invariably provided whenever the length of the rising mains exceeds 15 m.

3.1.7 The bus bars shall be provided with thrust pads so that the expansion of the conductors is upwards only. The bus bar clamps and insulators shall be designed to withstand the forces due to short circuit current. They shall also permit free vertical movement of the bus bars during expansion and contraction.

3.1.8 Incoming cable shall be connected to the rising main through an end feed unit, consisting of MCCB/ ACB of required capacity and cable end box.

3.1.9 Tap-off boxes at specified intervals and height shall be provided on rising main to tap power. The box shall consist of MCCB unit, so that power from rising main can be switched ON/OFF and provided with suitable overload/ short circuit protection.

3.1.10 Distribution boards/ switch boards shall not be mounted on rising main. Such boards shall be separately erected on floor/ wall and connected to tap-off box with suitable copper conductor cable

3.1.11 The rising mains shall be manufactured in convenient sections to facilitate easy transportation and installation. The sections shall be connected to form a vertical run at site. Each section shall be provided with suitable wall straps at convenient intervals for fixing to the wall.

3.1.12 The enclosure shall be sturdy so as to withstand the internal and external forces resulting from the various operating conditions.

3.1.13 The front covers shall be detachable. Neoprene gaskets shall be provided between the covers and the side channels. The enclosure shall have a degree of protection not less than IP 42.

3.1.14 The rising main shall be designed for temperature rise not exceeding 40 degree C over ambient temperature of 50 degree C.

3.1.15 Built-in fireproof barriers having 2 hr. fire rating shall be provided to restrict the spread of fire through the rising mains from one section to the adjacent section.

3.1.16 Two numbers of earth shall be provided alongside the rising mains enclosure, and shall be bolted to each section of the rising mains.

3.1.17 Rising mains shall be installed on walls, to which the foundation bolts shall be suitably grouted (in a shaft of adequate size for rising main and floor distribution panel). Suitable shaft/floor opening shall be envisaged in the building layout.

3.1.18 The enclosure shall be made from 16 SWG GI/ CRCA sheet steel powder coated to shade approved by Owner. Bus bars would be in 'Sandwitch' construction and the conductors shall be individually insulated with 4 layers of insulation film. Inner layer shall be of glass MICA and outer layer of polyester material Class 'F'. Alternatively extrusion of Class 'F' material in form of epoxy insulation may be provided. No drilling of bus bars is permitted. Copper conductor of 99.9% purity and ETP grade with radialised edges. Length of section shall be limited to max. 3 Mtrs. Bus bars of one section shall be connected to bus bars of adjacent section by uniblock joint system removable as separate sub-assembly, so that it can be inserted or removed without disturbing the adjacent sections.

3.1.19 For installation as Rising Mains in Vertical installation, at each floor, a set consisting of two Spring Hangers shall be provided for fixing it on channels grouted in wall. At the start of run, Hangers without springs may be used for rigid support. In addition Horizontal supports shall be provided (2 Nos. per floor) to hold bus bars in position. On Rising Mains, on front face of the bus bar trunking tap off points shall be provided for inserting plug in boxes. Number of tap off points at each floor shall be as per requirement but minimum distance between tap off points may be kept around 500 mm. Each Tap off opening shall be closed by insulated shutters forming part of BBT, when not occupied by Plug in Boxes. Neutral cross section shall be same as phase cross section. Enclosure shall be tested for protection degree IP – 54. Necessary Vertical / Horizontal bends / Tees shall be provided as required by layout. Bus bars trunking shall be rigidly fixed to the side walls or suspended from ceiling by supports as per requirement detailed in the layout.

3.1.20 At the termination either on the transformer side or on switchgear panel, bus duct shall be provided with flange ends, adopter box and copper flexible (preferably multispeed types) to connect bus bars of bus duct to bus bars of switchgear panel or transformer terminals or generator terminals. All the components like Busbar ducting, Bends, hanger ends, Adopter Boxes etc. shall be made from CRCA sheet. Two earth strips of copper sized dependent on short circuit withstand capacity required shall be provided throughout the length. Expansion units shall be installed after every uninterrupted run of 50 Mtrs. For composite expansion of complete Bus trunking run.

3.1.21 Bus trunking shall be designed to withstand short circuit current for one second. Bus bar system should be designed for an ambient temperature of 50 deg. C. Maximum temperature of bus conductor with plain bolted joint shall be 90°C and maximum temperature of bus

enclosure shall be 80°C. Bus trunking shall be suitably chosen to give permissible voltage drop.

3.1.22 PLUG IN BOXES

Plug in Boxes shall be of draw out type. Contacts shall be of silver plated copper and spring loaded. Earth connection shall be the first to make and last to break during insertion and withdrawal. Plug in Box shall be made from 1.6 mm CRCA sheet steel powder coated . Inside the plug in Boxes MCCB shall be located as per requirements. The operation handle shall be interlocked with plug in Box cover so that MCCB can be operated only with suitable cover in closed position. If required the plug in Box shall be interlocked with Bus bar trunking so that it can not be inserted or removed with the plug in Box lid opened. MCCB shall be of 4 pole type unless otherwise specified in BOQ. Short circuit breaking capacity of MCCB in PIB should preferably be same as short circuit withstand for one second of Bus Bar Trunking.

3.1.23 END FEED UNIT

The End feed unit shall be manufactured from 1.6 mm thick sheet steel with powder coating to shade approved by Owner. Inside the End feed unit MCCB of required rating shall be located. End feed units at top shall be connected to Bus bars of Rising Mains through solid connections. Terminals at the bottom shall be provided to accept cable connections as required. The operating handle of MCCB shall be interlocked so that the door can be opened only when MCCB are in off position. The current rating of MCCB should correspond with current rating of bus bar trunking and short circuit breaking capacity with one second short circuit withstand of bus bar trunking.

3.1.24 BRACKETS

Mounting Brackets, which can be shifted anywhere on Bus Bar Trunking should be provided to fix bus bar trunking on to assembly grouted in wall where these brackets rest.

3.1.25 EARTH STRIP

Earth strip of copper shall be provided, one on each side all along the Rising Mains of size dependent on short circuit withstand for one second of Rising Mains. Earth strip should be firmly fixed to the body of Rising Main at regular intervals.

3.2.0 BUS TRUNKING

a) Bus trunking shall be provided for interconnections between the transformers / DG sets and their switch board.

b) Sheet steel of minimum 2 mm thickness shall be used for fabricating the enclosure.

c) The enclosure shall be of bolted type, box type, welded type or any other type as per the manufacturer's standard practice, and shall be made out from sheet steel of minimum 2 mm thickness. The front cover only shall be detachable. The section of the bus duct shall be rectangular. The enclosure shall be sturdy so as to withstand the internal and external forces resulting from the various operating conditions.

d) The bus trunking enclosure shall be fabricated in convenient sections for easy transportation and installation. The sections shall be connected to form horizontal and vertical runs as required at site. The enclosure shall be provided with flanged ends with drilling arrangements to suit the flanges at the switchgear and transformer terminals. All flanges shall be provided with gaskets, nuts, bolts, washers etc.

e) The entire bus trunking enclosure shall be designed for dust and vermin proof construction. The enclosure for outdoor installation shall be additionally in weatherproof

construction. The enclosure shall have a degree of protection not less than IP 42 for indoor application, and IP 54 for outdoor application.

f) Bus trunking, if installed outdoors, shall be provided with a metallic protecting canopy of adequate size above the bus trunking, fabricated as part of the enclosure.

g) Neoprene gaskets shall be provided to satisfy the operating conditions imposed by temperature, weather etc. and durability.

h) Two numbers of Copper earth strips of appropriate size shall be provided alongside the bus trunking enclosure and shall be bolted with each section of the bus trunking.

i) Flexible connections shall be provided by braided or multi-leafed conductors for terminations at transformer bushing and switchgear.

j) Expansion joints shall be provided.

k) Each section of the enclosure shall be suspended from the ceiling slab with suitable MS suspenders and support angles/ channels. The runs shall be neat and the route shall be as directed by the Owner.

l) The bus trunking shall be supported such that its weight does not come on the terminations.

m) Danger notice boards shall be provided on the bus trunking enclosure at suitable intervals in every room through which it passes.

n) The earthing strips shall be properly terminated to the earth bars at both ends.

o) Pre-commissioning checks shall be conducted.

3.3.0 OVERHEAD BUSBAR SYSTEM

3.3.1 General

a) The overhead bus bar system shall be provided for distribution of power to a number of distributed power loads, such as motors, as in a workshop.

b) Sheet metal used for fabrication of side channels shall be 1.6 mm thick and the top and bottom covers 1.2 mm thick. The enclosure shall be sturdy to withstand the internal and external forces resulting from the various operating conditions. The enclosure shall have a degree of protection not less than IP 42.

c) The top and bottom cover plates shall be detachable, and shall complete with gaskets to make the enclosure totally dust and vermin proof.

d) The enclosure shall be fabricated in convenient sections for easy transportation and installation. The bus sections shall be jointed together with flanges and tie bolts. Each section of the enclosure shall be suspended from the ceiling slab with suitable and rigid MS suspenders and brackets as required. Detachable blank sheet steel covers shall be provided for enclosing the free ends of the bus bar run.

e) Two numbers of Copper earth strips of appropriate size shall be provided for the complete run of bus bar enclosure and shall be bolted to each section of the bus bar enclosure. Suitable provision should be made to enable earth connection to the plug-in box, when plugged in.

3.3.2 Plug-in Boxes

a) Each section of the bus bar enclosure shall have plug-in points spaced at intervals of approximately 600 mm for the insertion of plug-in boxes.

b) The plug-in boxes shall be fabricated as compact sheet steel boxes with hinged doors and shall house the MCCB/ MCB. The MCCB/ MCB shall be solidly connected to high conductivity copper clip-on contacts and reinforced by spring steel strips. These clip-on contacts shall plug-in directly on to the bus bars at the plug-in points.

c) Two earth points shall be located at the ends of the plug-in boxes. While inserting these boxes into the plug-in points, the earth points shall engage first in the special earth bushes provided on the underside of the bus bar enclosure before the main contacts are made. While withdrawing these boxes, the earth contact is maintained even after the main contacts are isolated.

d) The plug-in boxes after insertion into the plug-in points shall be fastened by wing nuts.

e) Each plug-in box shall be fitted with a brass compression gland suitable for the size of the cable specified. It should be possible to provide this gland in any position, i.e. left hand side, right hand side or lower side of the plug-in box.

f) The unused plug-in points shall be blanked with detachable sheet steel covers.

4.0.0 INSTALLATION

a) The bus sections shall be jointed together with flanges and tie bolts. Each section of the enclosure shall be suspended from the ceiling slab with suitable MS suspenders and support angles/ channels as required.

b) Bus trunking shall be suspended at a uniform height of about 2.4 m above floor level. The layout shall be got approved from the Owner before erection. The runs shall be straight, except at points of changes in direction.

c) A connector assembly shall be supplied loose with each section of the enclosure for coupling two sections, and it shall comprise a rubber locating ring, bus bar insulating tube and a connector insulating tube.

d) The Copper earth strips of the bus duct shall be connected to the earth bus/ earth terminal(s) of the switchboard controlling the bus ducts, by appropriate protective conductors, notwithstanding the connection by the armouring of the feeder cable.

e) Danger Notice Board shall be provided on the enclosure at suitable intervals and not exceeding 5 m.

f) With copper bus bars, only copper wire/ solid bar connections shall be made for incoming/ outgoing mountings on the switchboards.

g) Bus Bar and Main Connections Colour code shall be as follows:
   - Three Phase Red, Yellow, Blue R.Y.B.
   - Two Phase Red, Blue R.B.
   - Single Phase Red R
   - Neutral connection Black N
   - Connection to earth Green E

5.0.0 PAINTING

Painting shall be carried out by approved process. After preparation of the under surface the equipment shall be painted with epoxy based paint by powder coating. The final thickness of paint film on steel shall not be less than 85 microns. Final shade shall be RAL9002.

6.0.0 TESTS

5.1.0 Offered rating and type of equipment should have type tested.

5.2.0 Copies of the following certificates should be submitted.

1. Verification of Temperature Rise limits.
2. Verification of dielectric properties.
3. Verification of short circuit strength.
4. Verification of degree of protection.

5.3.0 Routine tests shall be conducted as per standards , which shall include the following and test reports shall be submitted for review.

1. Verification of insulation resistance.
2. Inspection of assembly, interlocks, locks etc.
3. Check on wiring if provided.
4. Dielectric test.

7.0.0 DRAWINGS, DATA AND MANUAL

The bid shall be submitted with the following:

- Technical data sheet.
- Drawing & catalogue

The following documents shall be submitted by the successful Bidder after the award of contract.

- Sizing calculation
- Single line diagram
- Technical data sheet
- General Arrangement drawing
- Quality Plan
- Test certificates
- O&M manual

SECTION – B3.9: 110 V AND 48 V DC SYSTEM

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of 110 V DC Batteries, 48 V DC Batteries Chargers and DC distribution board for efficient and trouble-free operation of electrical system of Township.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the applicable Standards, except where modified and /or supplemented by this specification.

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 110 V DC system shall be provided in Main receiving substation to provide control supply to 11 kV switchgear and 415 V PCC.

3.2.0 48 V DC system shall be provided in Main receiving substation telephone exchange room to provide power supply to Digital EPABX sub system.

3.3.0 DC system shall provide reliable DC control supply to Switchgears. DC system shall comprise, battery, redundant battery chargers with DCDB.

3.4.0 DC system shall be ungrounded and would float with respect to the ground potential when healthy. A DC earth leakage current monitoring system shall be provided in order to alarm any DC earth fault.

3.5.0 The 110V DC battery shall be lead acid VRLA type and shall have adequate capacity to provide the rated DC power for a period of sixty (60) minutes in case of mains failure.

3.6.0 The 48V DC battery shall be lead acid VRLA type and shall have capacity sufficient for 8 hours full load capacity of the EPABX sub system in case of mains failure.

3.7.0 Safety margin of not less than 1.1 and Ageing factor of at least 1.25 shall be considered in arriving at battery ampere hour.

3.8.0 Batteries shall normally be permanently connected to the load in parallel with a charger and shall supply the load during emergency conditions when AC supplies fail.

3.9.0 When battery is taken out of service, it shall be disconnected from the rectifier/charger by means of MCB / MCCB.

3.10.0 End take off connections from positive and negative poles of batteries shall be made by single core cables having stranded copper conductors.

3.11.0 Racks shall be free standing type, mounted on insulators. Numbering tags for each cell shall be attached on to the racks. The bottom tier of the stand shall not be less than 150 mm above the floor.

3.12.0 The Battery charger system shall consists of 2 x 100 % float cum boost charger. Boost chargers shall be able to automatically change between boost and float mode and also shall have a selector switch for manually selecting the battery charging mode i.e. whether float or boost charging. A design margin of 10% shall be considered in selecting the rating of chargers.

3.13.0 The float charger shall be normally ON, supplying the D.C. load and at the same time trickle charging the battery.

3.14.0 The float charger shall be provided with automatic voltage regulator. The boost charger shall have constant current type electronic controller.

3.15.0 When the charger is feeding the load, the ripple content of the DC voltage shall not exceed 1%. In any other mode of operation, the ripple content of the DC voltage shall not exceed 5%.

3.16.0 Nominal charger output shall be 110 V DC and 48V DC. The DC output voltage shall be adjustable between ±10% of normal rated voltage.

3.17.0 During Normal operating condition, one charger in float mode shall be supplying the DC loads and floating the battery. The other charger shall be in hot standby mode. In case of power failure, Battery shall take over the loads without interruption. Upon resumption of AC power, the charger in float mode shall supply load and floating the battery. Incase the battery gets fully discharged during power failure, on resumption of AC power, the required boost charging shall be taken care by other charger in boost mode.

3.18.0 During boost charging the Boost charger shall recharge the completely discharged battery to full capacity in 8 hours.

3.19.0 Interlock shall be provided such that when the charger is selected in boost mode, it shall be disconnected from DC load.

3.20.0 Each Charger shall be essentially comprise the following:

- AC MCCB (Moulded case circuit breaker) at the incomer
- Double wound dry type rectifier transformer for galvanic isolation
- Electrical protection for all the electronic circuits, including fast acting fuses and surge suppressors if required
- Under voltage, over voltage, earth fault, phase failure & voltage unbalance protection
- Auto / Manual controller
- Set point adjustment in Auto mode.
- Set point adjustment in Manual mode
- LED status indicating lamps
- Meters
- Blocking diodes
- Alarm annunciator or alarm display for DC under voltage & over voltage, Battery under voltage, Battery on boost, AC supply fail, AC under voltage, Overload trip, Charger fail, DC earth fault
- Measurement display for AC input voltage & current, DC output voltage & current, Battery voltage & current.

3.21.0 Chargers shall be metal enclosed, fixed type, suitable for indoor mounting on floor. Panel frame shall be fabricated using cold rolled sheet steel of thickness not less than 1.6 mm. Suitable synthetic rubber gaskets shall be provided to achieve a degree of protection of IP-42.

4.0.0 PAINTING

Painting shall be carried out by approved process. After preparation of the under surface the equipment shall be painted with epoxy based paint by powder coating. The final thickness of paint film on steel shall not be less than 85 microns. Final shade shall be RAL9002.

5.0.0 TESTS

5.1.0 Offered rating and type of equipment should have type tested.

5.2.0 Routine tests & Acceptance tests shall be conducted as per standards and test reports shall be submitted for review.

6.0.0 DRAWINGS, DATA AND MANUAL

The bid shall be submitted with the following:

- Technical data sheet.
- Drawing & catalogue

The following documents shall be submitted by the successful Bidder after the award of contract.

- Sizing calculation
- Single line diagram
- Schematic diagram
- Technical data sheet
- General Arrangement drawing
- Quality Plan
- Test certificates
- O&M manual

SECTION – B3.10: UNINTERRUPTED POWER SUPPLY SYSTEM

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of 230 V parallel redundant UPS with voltage stabilizer for the hospital in the Township.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the following Standards, except where modified and /or supplemented by this specification.

IEC : 62040 Uninterruptible Power Systems (UPS)

3.0.0 DESIGN REQUIREMENTS

3.1.0 UPS system shall be Digital type. It shall provide uninterrupted power supply to critical AC loads in the Hospital.

3.2.0 UPS, which shall be located in air-conditioned area, shall be designed for design ambient temperature of 30°C. Other equipment shall be designed for design ambient temperature of 50°C.

3.3.0 Each UPS shall be parallel redundant UPS system consisting of 2X100% chargers, 2X100% inverters, 1X100% Battery, SMPS based voltage stabilser , Static bypass and Maintenance bypass, UPS DB, interconnecting cables among UPS & voltage stabiliser etc.

3.4.0 UPS shall be located in Air conditioned room.

3.5.0 UPS battery shall be rated for 60 minutes back up.

3.6.0 UPS shall have following features:

- Digital Technology
- True on-line double conversion
- High frequency PWM design
- Programmable power walk-in
- High efficiency
- High input power factor
- Constant voltage & frequency
- Pure sine wave output power with no break output during normal to battery operation
- Wide frequency synchronizing range
- Wide input range
- Soft start capability
- 100% nonlinear load handling capability
- LED mimic
- LCD Display
- RS 232 /RS 485 Interface complete with Communication software
- Permissible harmonics at rated continuous load +/- 2% for linear loads & 3% for non-linear loads.

3.7.0 UPS shall be suitable for connecting to a 415 V, 3 phase, 4 wire, 50 Hz system with a symmetrical fault level of 50 kA rms. Nominal voltage output shall be 230 V, 50 Hz, Single phase with +/- 1% resolution.

3.8.0 Variation in inverter output voltage and frequency shall not exceed specified limits for the load variation between zero and the rated output of the UPS and also for the following input supply variation.

- For the input power supply condition of 415 V +/- 10% and 50 Hz +3%, -5%
- For the DC input voltage over the range corresponding to battery float / boost charge operation and battery operation and battery discharge operation up to battery end cell voltage.

3.9.0 The changeover from inverter to by-pass transformer shall not be more than 5 m.second.

3.10.0 The design shall provide for high availability of equipment by ensuring high mean - time - between failures (MTBF) and low mean-time-to-repair (MTTR).

3.11.0 The UPS shall have an over load capacity of 125 % rated capacity for 10 minutes and 150 % rated capacity for 10 sec. The inverter shall have sufficient I^2t capability to clear fault in the maximum rated branch circuit. The sizing of UPS shall be based on the power factor of the loads being fed subject to a maximum of 0.8.

3.12.0 On failure of one UPS, the other UPS shall take over the 100% load automatically without any interruption and on failure of both UPS, voltage stabilzer shall take over the power supply distribution and shall supply the power without any interruption.

4.0.0 TECHNICAL REQUIREMENTS

4.1.0 The UPS system including the stabilized bypass shall be galvanically isolated from input power supply system by providing double wound Isolation transformers. A rectifier shall have a double wound transformer at its input.

4.2.0 Transient / surge protection circuit shall be provided in the input circuit to rectifiers to protect the UPS from surge & voltage spikes.

4.3.0 The UPS shall be provided with automatic sequence and power walk in circuits with adjustable time delay such that the rectifiers and inverters can start operating automatically when incoming AC power is restored allowing the UPS to be loaded automatically.

4.4.0 The inverters shall operate satisfactorily for variation of DC bus voltage from fully discharged condition of the battery to rapid charge voltage of the battery and inverter output load current waveform having a relative harmonic.

4.5.0 It shall be possible to vary the inverter output voltage steplessly within ± 5% of the specified output voltage. This adjustment shall be possible to be made when the inverter is in operation.

4.6.0 UPS shall be provided with current limit circuit to avoid excessive loading beyond its permissible overload withstand capability. The UPS shall be designed to permit ready access to power switching and control modules and PCBs. The locations of components, test points and terminals shall be such that they are accessible for circuit checking adjustment, trouble shooting, and maintenance from the UPS without removal of any adjacent module or assembly.

4.7.0 The stabilized bypass supply shall have a continuous current rating equivalent to the rated output of the UPS unit and be capable of conducting a current ten times the rated output for

the duration more than the fault clearing time of the type of fuse provided. The load transfer devices shall comprise of continuous rated elements in both inverter and stabilized bypass supply.

4.8.0 The inverters shall be phase locked to the stabilized bypass power supply as long as stabilized bypass supply frequency remain within + 3 % to – 5% of nominal. When bypass supply frequency variation exceeds the above limits, the inverters shall be delinked from mains. Free running frequency tolerance limit shall not exceed ± 1%. Facility shall also be provided for adjustment of synchronizing frequency from 1% to 5% in the steps of 0.5%.

4.9.0 All electronic power devices including thyristors, transistors, diodes etc., shall be rated under operating conditions for approximately 200% of the maximum current carried by the device. All other electrical components such as transformers, reactors, breakers, contactors, switches, bus bars etc., shall be rated for atleast 125% of the maximum required rating. No electronic device shall be subjected to PIV greater than 50% of the rated value.

4.10.0 All the thyristors, diodes and other electronic devices of UPS shall be protected with high speed semiconductor fuses. I^2t co-ordination characteristics between fuse and semi-conducting power devices shall be furnished.

4.11.0 Radio Frequency Filters shall be provided at the input and output of UPS to reduce radio frequency interference.

4.12.0 All PCBs shall be provided with a transparent epoxy coating for environmental protection and tropicalisation. They shall be suitably located away from heat sources.

4.13.0 Maximum noise level from UPS system at 1 metre distance, under rated load with all normal cooling fans shall not exceed 65 dBA.

4.14.0 MCCB shall be TPN type for incoming supply to Rectifier circuit & Standby source, DP type for battery & ACDB incomer/outgoing. It shall be quick make, quick break, and independent manual type with trip free feature. All MCCB shall have the following :

- Short circuit release
- ON/OFF Trip position indicators
- Test trip push button

4.15.0 Copper cable shall be used for interconnection among UPS & voltage stabilzer.

5.0.0 MODE OF OPERATION

5.1.0 Normal Mode

a) During the normal operation the UPS shall be used to provide power to the critical loads. Under normal conditions, the loads shall be supplied by the inverters. The Rectifier shall derive power from normal/primary AC source and supply DC Power to the inverters. Two nos. Chargers shall feed regulated DC power to their individual inverter banks and simultaneously float charge the backup batteries.

b) The individual inverters shall operate in parallel and shall share the load equally. The inverters shall be connected to load side through electronic switches. Outputs of the inverters are paralleled after the electronic switches and connected to load bus.

5.2.0 Emergency Mode

a) Upon failure of the normal AC source, the loads shall continue to be supplied by inverters which, without any switching shall obtain their power from storage battery. In case of

failure of the main supply, battery shall supply back up DC power to UPS system for duration of sixty (60) minutes.

b) Upon restoration of the normal AC source, the rectifier/battery chargers shall power the inverters and simultaneously recharge the battery. This shall be automatic causing no interruption to critical loads.

c) On failure of an inverter due to any one of the following faults the entire load shall be automatically transferred to the other inverter.

- Excess inverter output voltage
- Very low inverter output voltage
- Failure of inverter.

d) On failure of one inverter, the faulty one shall be isolated from load instantaneously and the other inverter shall continue to feed the load. In case, the other inverter also fails, automatic change over to standby transformer shall be effected through electronic switches.

e) Parallel operation (load sharing) shall start automatically when the fault condition clears. If the transfer was due to the inverter failure the retransfer (parallel operation) shall be manually initiated.

f) The entire load shall be automatically transferred to the alternate AC source through electronic switch within a maximum of four (5) milliseconds under the following conditions:

- Battery discharged completely
- Initiation of manual control switch.
- Failures of both the inverters
- Inverter output voltage is more than +/- 5 % of the rated value
- The load current exceeds specified over load rating and time.

g) In case of failure of both inverters, electronic transfer switch shall changeover within five (5) milliseconds to connect the alternate AC source to the load. On restoration, the retransfer shall be manually initiated.

h) Retransfer of load shall be accomplished automatically by synchronizing the inverter to the alternate source and allowing the inverter to ramp into the load and then disconnecting the alternate source.

i) Manual transfer facility through electronic transfer switches shall be provided in either direction.

j) In case of maintenance requirement, it shall be possible to isolate inverters and electronic bypass switches from load and connect alternate AC source to the load through manually operated, make before break manual transfer switch.

6.0.0 EQUIPMENT DETAILS

6.1.0 Charger

6.1.1 Charger shall have following features:

- Switch mode rectifier/Phase controlled rectifier
- DC constant voltage, Constant current

- IGBT/SCR power device
- Advanced electronic protection device backed-up with MCCBs and fast acting fuses
- Soft start
- Built in Harmonic suppression
- Active power factor correction

6.1.2 These chargers shall be of static type and shall be provided with suitable full wave thyristorised rectifiers, transformers, filter circuits, DC & AC Switchgear. Chargers shall share automatically the load during parallel operation of the inverter system and shall maintain output voltage within plus or minus one percent of the nominal value from no load to full load.

6.1.3 The rectifiers / chargers shall be designed to completely charge the battery in a maximum time of 8 hours for lead acid batteries, after complete discharge. Facilities shall be provided to initiate battery rapid charge operation by Manual & Automatic means. An auto charging sequence should be provided for the boost and float charging based on current sensing. In addition to above, the charging shall be transferred from boost to float mode after preset time adjustable through 0-24 hour's timer. Rectifier shall have protection & interlocking against single phase input & reverse phase sequencing.

6.1.4 Facility shall be provided to enable testing of rectifier independently without disconnection of inverter.

6.1.5 Facility for initial charging of batteries shall also be provided. The inverters shall be disconnected during initial charging of the battery.

6.1.6 The rectifiers shall be sized based on the maximum inverter input load when inverter is delivering its rated output at 0.8 PF lagging and recharge the battery to nominal rated capacity of the battery. The DC load imposed by the inverters shall be considered under the worst case where only one rectifier is operating but the UPS load is equally shared by all the inverters.

6.1.7 The DC rectifiers shall sense the battery charging current and adjust the DC bus voltage to maintain the charging current to preset level. A separate current limit circuit shall also be provided for adjustment of battery current. The rectifiers shall be protected against reverse battery connection at DC link voltage bus. Subsequent to a discharge cycle when battery is connected to rectifier, the battery current shall be monitored, controlled and limited to set value automatically irrespective of the inverter input current.

6.1.8 The battery may be taken out of service for maintenance, during which period it shall be possible for the inverter to continue operation by drawing power from the rectifier. Ripple content shall not exceed 1.5%. Ripple current relay shall be provided to indicate the charger capacity failure.

6.1.9 Battery shall be provided with a sensitive earth leakage protection.

6.1.10 The chargers shall be current limiting and shall be provided with surge suppression networks for both float and boost charging. All equipment and devices required to protect the chargers from short circuits e.g. fast acting semiconductor fuses, trip fuses and micro switch with alarm contacts etc., shall be provided. Rectifier shall have protection & interlocking against single phase input & reverse phase sequencing.

6.2.0 Inverter

6.2.1 Inverters shall have following features:

- Digital PWM IGBT design
- Advanced electronic protection device backed-up with MCCBs and fast acting fuses.

- High speed pulse balancing electronic over voltage/under voltage protection
- Electronic overcurrent trip with reset.

6.2.2 Inverters shall be PWM controlled IGBT (Insulated gate bipolar transistor), filters, necessary oscillators, voltage regulators, current limiting and surge suppression networks. Two nos. 100% capacity Inverters shall be provided. In addition the inverters shall have features of soft start, wave shaping, transient recovery etc. Any other equipment required for normal operation of the inverter shall be included irrespective of whether specified or not.

6.2.3 The inverter input voltage shall match with the battery and rectifier charger output voltages and shall be designed to operate over the entire range of variation of input DC voltage to accommodate decrease in battery voltage during discharge and to accept voltage increase under battery boost charge or equalizing charge conditions. The output from the inverter shall be 230 V AC, sine wave 1 phase.

6.2.4 The inverters shall always work on their internal oscillators or frequency variations with plant AC electrical system. Output voltage frequency shall be controlled simultaneously for both the inverters through common control bus. The plant AC electrical system shall provide a signal to each inverter to control the frequency and phase relationship of its output during normal operations. When this signal to an inverter deviates more than one hertz from the desired 50 Hz frequency, the inverter shall transfer automatically to its internal oscillator which shall maintain inverter frequency at 50 Hz. Within 0.5%. During operation on its internal frequency signal source, an inverter shall continuously monitor the frequency of the plant auxiliary AC electrical system.

6.2.5 Upon restoration of the plant auxiliary AC electrical system to 50 Hz. operations, inverter shall automatically adjust the phase relationship between its output and the plant auxiliary AC electrical system and return to the plant auxiliary AC electrical system as its output frequency and phase relationship signal source. During operation on its internal oscillator and inverter shall inhibit transfer of the electronic transfer switch to the alternate source. The automatic adjustment of the phase relationship between the inverter output and plant auxiliary AC system shall be accomplished at a controlled rate which shall not exceed one hertz per second. The inverters shall include a separate voltage distribution and voltage monitoring system for all command and interlock logic.

6.2.6 Selective protection shall be provided for each individual drive card and its associated interlock logic. The two inverters shall be designed for normal continuous parallel operation. To maintain specified output at maximum ambient temperature, inverters may be provided with cooling air fans as required. Fan cooling, if envisaged, shall be achieved with 2 x 100% cooling banks. One cooling fan bank shall be in operation while the other shall remain on standby. In case of failure of running bank / one fan, the standby bank shall start automatically. The power supply for the fans shall be tapped from the inverter output.

6.2.7 All the fuses used in inverter power and control circuits shall be fast acting semiconductor type, operating in less than 5 m.second. Indications and alarms shall be provided to enable fault to be located and rectified at the earliest. Lamps to indicate fault / trouble / failure of each sub group shall be provided on the cubicle front and lamps for each logic card shall be provided on the card itself.

6.3.0 Electronic Transfer Switch

6.3.1 The electronic transfer switches shall use SCRs and other electronic devices, for automatic transfer of load from the Normal source to the Alternate source. The transition shall be “make before break” in both directions. The continuous capacity of each electronic switch shall be equal to the full load capacity of one inverter. Maximum transfer time including sensing shall not be more than ¼ cycle. The voltage failure shall be sensed at the output of the electronic switch. Failure shall cause the electronic switch to transfer. The load from the working

inverter shall be transferred to the alternate source, i.e. second inverter or auxiliary power supply source by electronic switches, whenever the output voltage of the inverter deviates more than +10% from nominal. However transfer shall not be made to the alternate source on over current conditions. Transfer shall be permitted only if voltage of the alternate source is within ± 2% of nominal. .

6.3.2 The electronic switch shall be provided with fuses in both 'normal' and 'alternate' power source. Provision for annunciation of failure of fuse or failure of alternate source shall be made. The switch shall be provided with surge suppression networks and shall also be rated to withstand transient voltages up to 150% of rated voltage. The short time rating of the switch shall be 150% of the rated full load current for two minutes.

6.4.0 Bypass Switch

Make before break type manually operated bypass switch of 100% UPS rated capacity shall be provided in the back up supply circuit to isolate electronic switch and inverter from its load and supply alternate power to load without interruption. Power supply to the loads is continuous during switch operations. Necessary isolators shall be provided to isolate both UPS system completely from back up supply circuit when the UPS loads are fed by back up source through by pass switch.

6.5.0 Transformer and Voltage Stabiliser

Transformers shall be provided at input and as well as output side of UPS.

The transformer shall be dry type, double wound, Class F insulated with copper conductor limiting temperature rise to class B limits, enclosed in CRCA sheet steel panel 2 mm thick. The cooling shall be by means of natural convection. Transformer connection shall also be considered, provided the connection has minimum unbalance on the primary side. The transformer shall be adequately rated for the duty involved. The actual value may be slightly increased to take care of any losses in the voltage stabilizer.

Voltage stabilizer shall employ SMPS controlled circuitry and shall maintain the specified output voltage for 0 to 100% load, with maximum input voltage variation.

6.6.0 Battery

6.6.1 The batteries shall be sealed maintenance free valve regulated lead acid types. Battery sizing and cell selection shall be based on IEEE: 1189 & IEEE 485. While estimating battery capacities the following shall be considered:

- Ambient temperature as per project data in Annexure-A
- 10% design margin
- An ageing factor of 1.25

6.6.2 The battery shall be sized for a discharge rate with end cell voltage not less than 1.8 V. Suitable electrolyte temperature correction factors shall also be considered for the site ambient temperature (10 deg c higher than outside ambient air temperature). Minimum system voltage for DC shall not be lower than 85% and maximum system voltage shall not be more than 110%.

6.6.3 The duty cycle imposed on the battery shall include the following. All momentary loads shall be treated as one-minute loads

- Continuous loads due to Emergency DC lighting, indicating lights, continuously energized coils, Control Panels, Relays.

- Momentary loads due to switchgear operation.

6.6.4 Batteries shall be rated for 10 hour discharge rate (C10) as per manufacturer data. Battery load cycle shall be 1 hour

6.6.5 Batteries shall normally be permanently connected to the load in parallel with a charger and shall supply the load during emergency conditions when AC supplies fail. Batteries shall be suitable for a long life under continuous float operations and occasional discharges.

6.6.6 Containers shall be made of fire retardant polypropylene. Containers shall be clear, robust, heat resistance, shock absorbing, leak proof, non-absorbent, acid/alkaline resistant, non-bulging type and free from flaws such as wrinkles, cracks, blisters, pin holes etc.

6.6.7 Batteries shall have thick Positive plates & negative Plates with low Corrosion, low self-discharge rates & maintenance free characteristics.

6.6.8 Battery terminals shall be specially designed for sustained high current discharges.

6.6.9 The separators shall maintain the electrical insulation between the plates and shall allow the electrolyte to flow freely.

6.6.10 The positive and negative terminals shall be clearly marked.

6.6.11 The following items shall be provided for the Battery.

- Long/Short connectors with insulated cover (if applicable)
- Inter row connectors with insulated cover (if applicable)
- Fasteners
- Cell number plates

6.6.12 Lead coated copper connectors shall be used for connectors. Bolts, nuts and washers shall be effectively lead coated to prevent corrosion. The cell terminals posts shall be provided with connector bolts and nuts, effectively coated with lead to prevent corrosion.

6.6.13 End take off connections from positive, negative and tap cell terminals of the battery shall be suitable for single core cables having XLPE insulated stranded copper conductors. Necessary supports for termination of these cables on the batteries shall be provided by the vendor.

6.6.14 All the inter cell, inter row and inter bank connectors supplied along with the battery shall be capable of continuously carrying the maximum discharge current of the respective batteries and through fault short circuit current which the battery can produce and withstand for the period declared.

6.6.15 Lead-coated bent copper plate, tubular copper lugs, wooden clamp, bolts, nuts, washers, etc. shall be furnished for connection of outgoing copper conductor cables.

6.6.16 Battery Racks shall be free standing insulated steel stand type. Numbering tags for each cell shall be attached on to the racks. The bottom tier of the stand shall not be less than 150 mm above the floor. Wherever racks are transported in dismantled conditions, suitable match markings shall be provided to facilitate easy assembly

6.7.0 UPS Enclosure & Accessories

UPS shall be metal enclosed, fixed type, suitable for indoor mounting on floor. Panel shall be fabricated using cold rolled sheet steel of thickness not less than 2.0 mm for load bearing members and 1.6 mm for non-load bearing members. Suitable synthetic rubber gaskets shall be provided to achieve a degree of protection of IP-31. At bottom removable gland plates of

atleast 3 mm thick shall be provided. All incoming and outgoing cables shall be terminated on suitable terminal blocks.

6.8.0 Metering & Protection

Voltage, current, frequency at input and output shall be measured either through LCD display or separate meters in UPS panel front. For remote metering of essential parameters, 4-20 mA transducer outputs shall be provided. For remote indication/ annunciation, potential free contact shall be provided along with RS485 port. LED status indications and alarm indications shall be provided on the mimic on the panel. The following protections shall be provided.

- MCCB at each input supply
- DC MCCB at Battery supply
- Filter at input
- Surge suppressor across transformer secondary
- Semiconductor fuses for SCR bridges
- HRC fuses for filter capacitors
- DC over voltage protection
- Charger input current limit
- Battery current limit
- Under voltage on input side
- Negative sequence current protection on input side
- Overload on inverter
- DC ground fault protection
- HRC fuses in control circuit
- Under voltage / Over voltage protection
- Any other protection required for safe operation of the UPS.

6.9.0 UPS AC Distribution Board

6.9.1 AC distribution board shall be metal enclosed, fixed type, suitable for indoor mounting on floor, bottom cable entry. The distribution board shall be single front having horizontal and vertical bus bars. All bus bars shall be PVC sleeved. Where specified, it shall be compartmentalized type.

6.9.2 The distribution board shall be fabricated using cold rolled sheet steel of thickness shall be 2.0 mm minimum for load bearing and 1.6 mm for other members and enclosure shall be IP 52. Earthing bus bar shall run in the bottom chamber through the length of the panel. Suitable synthetic rubber gaskets shall be provided to make boards completely dust and vermin proof. Two separate grounding pads shall be provided for each panel.

6.9.3 MCCBs shall be of triple pole construction for panel mounting, operating mechanism shall be trip free, quick make quick break type. MCCB should be current limiting type only. The MCCBs shall be provided with front operating handles & mechanical ON/OFF indicators. MCCBs shall be provided with overload releases setting range of 80% to 100% of rated current and adjustable short circuit magnetic releases from 5-10 times rated current. MCCBs shall have following accessories & features:

- Shunt trip release
- Auxiliary contact set of 1 NO + 1NC
- Fault signaling contact set of 1 NO + 1NC
- Insulation shields to isolate the connection between each pole.
- Finger protection plate to prevent accidental contact.
- The compartment door shall be interlocked with handle of MCCB

6.9.4 MCB shall be rated for 10 kA short circuit rating. It shall be quick make, quick break, and independent manual type with trip free feature. MCB shall have the following :

- Over current protection

- ON/OFF Trip position indicators
- Auxiliary contact block

6.9.5 Painting

The fabricated parts shall undergo a treatment of degreasing, pickling and two coats of primer before being given the epoxy finish. Two coats of final paint shall be applied. The external and internal surface of the board shall be powder coated epoxy finish of RAL 9002 shade. The final thickness of paint film on steel shall not be less than 85 microns.

7.0.0 TESTING & INSPECTION

7.1.0 Equipment offered shall be of type tested and proven type. Type test certificates for test conducted earlier on similar rating shall be furnished. The Owner shall review the type tests certificates furnished by the bidder at contract stage. Routine tests, functional tests and system tests shall be carried out as per applicable standard. Copies of certified reports of all tests carried out at the works shall be furnished.

8.0.0 DRAWINGS, DATA AND MANUAL

The bid shall be submitted with the following:

- Technical data sheet.
- Drawing & catalogue

The following documents shall be submitted by the successful Bidder after the award of contract.

- UPS sizing calculation
- Technical data sheet
- Dimensional general arrangement drawing of UPS & Battery
- Dimensional general arrangement for distribution board.
- Schematic & wiring diagram for UPS.
- Single line diagrams
- Sizing calculation for battery
- Cable schedule/ Interconnection diagram.
- Quality Plan
- Test certificates
- O&M manual

SECTION – B3.11: DIESEL GENERATOR SET

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of DG Set efficient and trouble-free operation of essential system of the Township.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the relevant IEC Standards, except where modified and /or supplemented by this specification.

3.0.0 GENERAL REQUIREMENTS

3.1.0 Diesel General (DG) Set in Acoustic enclosure shall be provided at required distribution substations to feed essential loads.

3.2.0 DG set shall be complete with the following:

a) Engine with Fuel oil system, day tank, Lube oil system, cooling system, radiator, Electronic Governor, Combustion air system, starting system etc.

b) Exhaust system along with piping & structural support till the outlet point to atmosphere.

c) Alternator with brushless excitation system, PMG and AVR panel.

d) All integral piping, valves and specialties, pipe supports, hangers, etc.

e) Foundation bolts, insert plates, embedded parts, nuts, leveling plates, shims etc. for all the equipment and accessories.

f) Auto-Mains-Failure (AMF) Panel with required protection relays, MCCB etc.

g) Battery and battery charger with necessary accessories.

h) Power & Control cables.

i) Acoustic enclosure

j) Consumables, additives, coolants, first fill of diesel tank and first fill of lube oil.

k) Finish paint for touch-up at site.

l) Commissioning spares & Maintenance spares.

3.3.0 The Diesel Generator set and its components shall be designed for design ambient temperature of 50ºC.

3.4.0 Diesel engine shall be directly coupled to a generator, mounted on a common steel base and installed in a separate DG room.

3.5.0 DG set shall be capable of starting the highest rated motor while supplying the other base loads.

3.6.0 Diesel engine shall be suitable for HSD oil.

3.7.0 Normally DG set shall be kept Idle except for a routine test running for a brief period. In case of total blackout of normal supply, DG set shall be started automatically to feed all essential loads. On resumption of normal supply, DG set shall be switched off.

3.8.0 Automatic engine start controls shall be provided in the AMF Panel. When the Diesel Generator is started automatically, it shall continue to operate until manually shut down at the AMF Panel. A switch shall be mounted on the Diesel Generator Control Panel and prevent starting when the Diesel Generator is being serviced.

3.9.0 Alternator neutral shall be solidly grounded.

3.10.0 The diesel engine may stand for a considerable period, yet must be immediately available for full load. Any special lubricating arrangements necessary to meet this condition shall be provided. The lubricating oil capacity shall be sufficient for 24 hours continuous operation.

3.11.0 Noise level shall be less than 85 dB at 1 Metre distance. Suitable industrial type silencers/ noise suppressing device shall be provided. DG set vibration shall not exceed 100 microns.

4.0.0 TECHNICAL REQUIREMENTS

4.1.0 Diesel Engine

The diesel engine shall be a full compression diesel fuel, four stroke cycle, single acting, solid injection, radiator cooled V-type.

The diesel engine shall be provided with a electronic governing system. The governor shall be iso-chronous type to take care of heavy duty motor starting.

The diesel engine shall be provided with combustion controls to minimize air pollutants. A mechanical device operating independently of the governing system shall be provided to limit overspeed to a safe value and to cut-off the fuel supply directly.

Engine shall have 10% overloading capacity for an hour during 12 hours operation.

The engine lubrication system shall include an engine shaft-driven positive displacement lubricating oil pump, pre-lubricating pump, full-flow lubricating oil strainer on the pump suction side, and a full-flow replaceable lubricating oil filter on the pump discharge side.

The lube oil cooler shall be designed to utilize the engine coolant as the cooling medium. The heat exchanger shall be mounted on the unit base.

4.2.0 Fuel System

A fuel system shall be furnished to regulate fuel flow to maintain constant rated engine speed regardless of load variations.

The fuel system shall include an electronic engine governor, fuel metering equipment, filter and fuel cutoff valves, and a diesel fuel oil tank.

The fuel oil tank shall be of all welded steel construction complete with supports, access manhole, moisture drain valve, inlet and outlet connections, valved drain connection, level gauge, level alarm contacts (high and low), air breather, shielded level gauge and strainer. The capacity of the day tank shall be sufficient for atleast 6 hours operation. The tank shall be coated with oil resistant paint. The fuel tank shall be hydrostatically tested.

4.3.0 Engine Cooling System

Cooling shall be by an engine mounted fan cooled radiator. The cooling system shall be designed for the maximum ambient temperature. All fans, motors, ducting, supports, pipe work and valves required for this purpose shall be provided.

Radiator system shall utilize an engine-driven fan. The radiator shall be of sufficient capacity to maintain safe operating temperature at the specified ambient conditions.

Water shall be circulated by an engine-driven pump with a stainless steel shaft. Cooling water for jacket and oil cooling shall be thermostatically controlled to maintain efficient operating temperature.

4.4.0 Combustion Air Intake System

A replaceable dry cartridge-type intake air filter shall be provided with the diesel engine.

The diesel engine may take combustion air directly from inside the DG room. Necessary filter silencer shall be provided in the air intake line to meet the noise criteria.

4.5.0 Exhaust System

A critical type silencer, or equivalent, shall be provided. The silencing system shall be sized to ensure against loss of engine power due to excessive back-pressure.

The exhaust stack shall meet the requirements of local regulation.

4.6.0 Engine Starting System

A DC electric starting system shall be provided for starting the engine, complete with electric starting motor and drive, batteries and rack, charger, charger control and automatic voltage regulator, and thermal cutout in a suitable enclosure.

The Automatic start equipment shall have the following features.

- Energize the starter circuit
- Provide two intermittent cranking cycles
- De-Energize the starting circuit when the engine starts
- Limit the total cranking time and lock out, requiring manual reset in the event of a failure to start.

The Diesel Generator shall be able to start and achieve rated speed within 30 seconds following the initiation of a start signal. After achieving rated speed, voltage and frequency, it shall be capable of maintaining voltage and frequency within +/- 5 & 3% respectively under steady-state load conditions.

After a sudden application of the full rated load (i.e. starting) or other transient load changes, the voltage shall not fall below 85% of rating and the Diesel Generator shall be capable of recovery to 90% of nominal voltage within 2 seconds and recovery to normal (+/- 5% voltage and +/- 3% frequency) within 5 seconds after the load has stabilized.

4.7.0 Generator (Alternator)

The generator shall be direct connected to the engine flywheel with a flexible coupling. The generator shall be mounted on a common structural steel sub-base with the engine. The generator shall be star connected, 3ph, 50Hz synchronous machine.

The generator shall be rated for continuous operation and shall comply with the requirements of the relevant parts of IEC-34 over the specified range of ambient conditions. The generator and exciter insulation shall be Class H. The temperature rise of the generator and exciter windings shall not exceed the limits for Class F limits when the machine is delivering specified load at the ambient conditions specified.

Generator shall be capable of handling 250% of its rating during starting of largest motor.

Generator shall be capable of parallel operation with grid. Generator shall have 10% overload capacity for one hour.

The generator shall be capable of delivering continuously the rated power at rated power factor:

- when frequency variation is + 3% to -3% of the rated value.
- when the voltage variation is within +/- 10% of its rated value.
- when the absolute sum value of combined voltage and frequency variation does not exceed 10 % .

The Generator shall be capable of withstanding 3-phase short circuit at its terminals for 3 seconds when the machine is operating at rated MVA and power factor and permissible maximum over voltage.

The generator shall be totally enclosed fan cooled type with a degree of protection of not less than IP 21.

The Generator shall be provided with the suitable space heater and thermostatic control, winding RTDs and bearing RTDs. Separate terminal box shall be provided for RTDs and Space heater.

The excitation shall be Brushless, with rotating diodes. Power to AC exciter field shall be supplied from directly coupled Permanent magnet type pilot exciter

4.8.0 Automatic Voltage Regulator (AVR)

The AVR shall have negligible dead band and high speed of response. It shall consist Auto and Manual with a selector switch. All essential indications / annunciation system required for AVR / excitation system shall be provided.

The AVR shall be designed to regulate the output voltage of the alternator within ±1% of the setting from No-load to full-load and under worst condition of supply of power. The AVR supplied shall have following characteristics:

- The AVR shall function correctly between frequency variation of +/- 3% on 50Hz and shall ensure a voltage variation not more than ±1% of the set point in steady operating condition between no load to full load.
- It should be able to prevent automatic rise of field voltage in case of failure of potential supply.
- The excitation and voltage regulation should be designed so as to cause necessary de-excitation in case of any short circuit.

4.9.0 Acoustic enclosure

Acoustic enclosure shall be provided covering each DG set. It shall be designed to achieve specified noise level as per Pollution Control Board norms.

The sound absorptive layer shall comprise of bonded type mineral wool/glass wool of adequate thickness and density to comply the design requirements.

The door design shall be compatible to the acoustic treatment. The door shall be provided with heavy duty hinges and handles. The sealing shall be done with neoprene/silicon rubber gasket to avoid leakage of noise.

All ventilation openings shall also be treated adequately to achieve desired sound proof.

4.10.0 AMF Panel

Auto-on-Mains-Failure (AMF) panel shall automatically start the DG set on detection of loss of supply on 415V bus. The DG shall be capable of starting and developing rated voltage and speed automatically without any manual intervention. The panel shall be made up of cold rolled sheet steel of min. 2 mm thickness and shall have protection class of IP:54. The AMF panel shall be complete with MCCB required current transformers, Voltage transformers, digital multi-function meter (V,I,F,PF,KVA,KW,KVAR), energy meter, indicating lamps, control switches, protection relays, annunciation etc.

4.11.0 Control Switches

Control switches shall be provided for the following.

- Battery charger Auto/Manual
- Speed raise/ lower control switch
- Voltage raise/ lower control switch

Push buttons shall be provided for DG trip & start/stop of lube oil pump.

4.12.0 Annunciator

Static type annunciator shall be complete with translucent windows with engraved inscription. Tthe annunciator shall be suitable for operations with normally open contact, which closes on fault. One common audible alarm, acknowledge, reset and lamp test push buttons shall be provided for annunciators. Trip and non-trip shall be segregated by red and white window colours. The following annunciation shall be provided as a minimum.

- Operation of each protection relay
- Emergency push button operated
- Trip fault in AVR
- Generator breaker trip
- Prime mover over speed. (alarm & trip)
- Fuel level low
- Low lubricating oil pressure (alarm)
- Low cooling water pressure (alarm)
- High cooling water temperature(alarm & trip after some time lag)
- DG set fails to start.

4.13.0 Protection relays

The Numerical relays for the following protections shall be provided as a minimum for the Generator.

- Voltage restrained over current protection (51V),
- Stand by Earth fault protection (51N),
- Over voltage protection (59G),
- Under voltage protection (27G),
- Under frequency protection (81G),

4.14.0 Battery & Battery Charger

The batteries shall be used for starting the DG set as well as supply to the various electronic modules like AVR, DC lub oil pump, Control & protection circuit etc. Battery shall have sufficient capacity for three consecutive full starts without recharging. The batteries supplied with DG set shall have sufficient AH capacity. The batteries shall be SMF lead acid or 'Ni-Cd 'type.

Battery charger shall be able to boost charge the battery from fully discharged condition within 10 hours. The charger shall be equipped with transformer, full wave rectifiers, automatic surge suppresser, DC ammeter, voltage regulator, Circuit breaker/ fuse etc. The supply to the charger shall be derived by the Bidder. There shall be facility to charge the batteries either in Boost or in Trickle mode.

4.15.0 Earthing

The neutral of the star-connected alternator shall be solidly earthed through two (2) numbers of copper flats to dedicated earth electrodes.

The Combined base frame on which Engine and Alternator is mounted shall be separately earthed to dedicated earth electrodes.

5.0.0 TESTS

Equipment offered shall be of type tested and proven type. Type test certificates for test conducted earlier on similar rating shall be furnished. For the various bought out items, test certificates from equipment manufacturer shall be furnished.

Routine tests shall be carried out for all the equipment (Generator, AVR, AMF panel, Battery & Charger etc.) as per applicable standards.

Copies of certified reports of all tests carried out at the works shall be furnished. The equipment shall be dispatched from works, only after receipt of Owner's written approval of the test reports.

The following acceptance test shall be carried out on DG set at Shop and as well at Site.

- Full load test
- Temperature rise test
- Regulation test
- Speed & Governing test.
- Check for fuel consumption
- Insulation resistance test
- High voltage test
- Functional test
- Measurement of vibration level
- Measurement of Noise level

6.0.0 PAINTING

Painting shall be carried out by approved process. After preparation of the under surface the equipment shall be painted with epoxy based paint. All exposed metal parts including base channel, radiator cover, air filter, oil filter, dynamo starter etc. shall be in single colour suitably finished to prohibit corrosion under climatic conditions prevailing at site. Oil resistant paint epoxy based, shall be applied as required. The final thickness of paint film on steel shall not

be less than 100 microns and shall not be greater than 150 microns. Final shade shall be ONAN green for engine, generator and fuel tank.

7.0.0 DRAWINGS, DATA AND MANUAL

The bid shall be submitted with the following:

- Technical data sheet.
- Drawing & catalogue

The following documents shall be submitted by the successful Bidder after the award of contract.

- Sizing calculation
- Single line diagram
- Schematic diagram
- Technical data sheet
- General Arrangement drawing
- P & I Diagram for Fuel system
- Quality Plan
- Test certificates
- O&M manual

SECTION – B3.12 : MOTORS

1.0.0 INTENT OF SPECIFICATION

This section covers the technical requirements of LT Motors for the various drives in the township.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest edition (including amendments) of the relevant IEC Standards and other codes except where modified and /or supplemented by this specification.

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 Design ambient temperature

Motors shall be suitable for an ambient temperature of 50 degree C and relative humidity of 95% and shall deliver the rated output without exceeding its guaranteed temperature limits.

3.2.0 Supply voltage

a) Motors rated up to and including 200 watt shall be rated for 240V AC single phase supply and higher capacity motors rated > 0.2 kW and up to and including 200 kW shall be rated for 415 V.

b) Motors shall be capable of delivering the rated output under following voltage and frequency variations without exceeding its guaranteed temperature limits.

- Frequency variation : (+) 3% and (-) 5%
- Voltage variation for LT motors : (±) 10% for 415 V
- Combined variation of voltage and frequency : 10% (absolute sum)

c) All the motors shall be so designed that maximum inrush currents, locked rotor torque and pullout torque developed at extreme voltage and frequency variations do not endanger the motor and the driven equipment.

d) System Earthing**:** 415 V system shall be solidly earthed.

3.3.0 Type

a) All AC motors shall be squirrel cage three phase/ single phase induction motors. All the motor shall be designed for bi-directional rotation.
b) Motors shall be suitable for installation in hot, humid and tropical atmosphere.

3.4.0 Duty

c) Motors shall be rated for continuous duty unless otherwise specified.
d) Motors which are fed through AC Variable frequency drives shall be specially designed for inverter duty application.

3.5.0 Design margin

e) Motor rating shall be selected higher than the maximum load demand of the driven equipment with 10% design margin, unless otherwise stated, under entire operating range, including voltage and frequency variation.

f) The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating; pull up, breakdown and full load torques are available for the intended service.

3.6.0 Method of Starting

a) All the motors shall be suitable for direct on-line starting on full load, unless otherwise specified.
b) LT motors rated up to 55 kW shall be controlled through MPCB and contactor.
c) LT motors rated above 55 and up to 125 kW shall be controlled through MCCB and contactor.
d) LT motors rated more than 125 kW shall be controlled through air circuit breaker.

3.7.0 Efficiency : All the continuous duty motors shall be energy efficient type IE2 as per IEC standard.

3.8.0 Temperature rise: Winding Insulation shall be Class F. Temperature rise of air cooled motors shall not exceed 70°C over air temperature of 50°C by resistance method, while delivering its maximum rated output**.**

3.9.0 Starting voltage : Motors shall be capable of starting and accelerating the load at 80% of rated voltage, with direct on line starting, without exceeding specified winding temperature limits**.**

3.10.0 No. of Starts

Continuous duty motors shall be suitable for the following starting requirements under the specified conditions of load, torque and inertia.

No. of consecutive hot starts shall be 2 and no. of consecutive cold starts shall be 3.

3.11.0 Enclosure

a) Motors shall have IP 55 degree of protection.
b) All electric motors shall be provided with lifting lugs

3.12.0 Cooling

LT motors shall be totally enclosed fan cooled (TEFC), type IC411. The cooling shall be effected by self driven bi-directional centrifugal fan protected by fan cover.

3.13.0 Winding

a) Winding shall be class F insulated with temperature limited to class B. Insulation shall be Non-hygroscopic, oil resistant, and flame resistant.
b) Winding, fittings and hardware shall be corrosion resistant. Winding shall be tropicalized and suitably varnished, baked and treated for operating satisfactorily in humid and corrosive atmosphere.
c) For the VFD operated drives, insulation shall be designed to take care of stresses due to high dV/dt. Motors shall be wound with dual coated winding wires and impregnated with

VPI process. Further for such application, insulated bearings shall be provided to avoid circulating current caused by shaft induced voltages.

d) Space heaters rated for 240V AC, 50 Hz supply shall be provided for motors rated **30kW and above** to maintain windings in dry condition when motor is standstill.

3.14.0 Bearings

a) Motor shall be provided with antifriction bearings.. Bearings shall be provided with seals to prevent leakage of lubricant or entrance of foreign matters like dirt, water etc. into the bearing area.
b) Grease lubricated bearings shall be pre-lubricated and shall have provisions for in-service positive lubrication with grease nipple and relief holes.
c) Vertical shaft motors shall be provided with suitable anti-friction bearings that can take vertical thrust.
d) Lubricant shall not deteriorate under all service conditions. The lubricants shall be limited to normally available types. For motors rated 30kW and above re-lubrication facility shall be provided.

3.15.0 Terminal Boxes

a) Separate terminal boxes of IP 55 degree of protection shall be provided for stator leads. For single core cables, gland plate shall be non-magnetic material. Terminal box shall be capable of being turned 360° in steps of 90°, unless otherwise approved. The terminal boxes shall be split type with removable cover with access to connections.
b) For breaker operated motors, terminal box shall have fault withstand capacity of 50 kA for 0.25 sec.
c) For contactor operated motors, the terminal box shall be capable of withstanding the fault current for 0.2 sec minimum and operating time of MPCB/MCCB.
d) Terminals for motors shall be stud type, thoroughly insulated from the frame. The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.
e) Separate terminal box for space heaters shall be provided.
f) Removable gland plates of thickness not less than 2.5 mm sheet steel or 3 mm aluminium (for single core cables) shall be provided for cable boxes.
g) Cable spreader box shall be provided for larger cable sizes.
h) For motors, terminal box shall be located on top, unless otherwise specified.

3.16.0 Earthing Terminals

The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer. The terminal box shall have a separate grounding terminal.

3.17.0 Noise and Vibration

a) Motors shall be selected with low noise levels in accordance with IEC.
b) The peak amplitude of the vibration shall also be within the specified limits of IEC.

3.18.0 Name Plates

Motor shall have stainless steel nameplate(s) showing diagram of connections, all particulars as per standards.

In addition to the minimum information required by IEC, the following information shall be shown on motor rating plate:

- Temperature rise in ºC under rated condition and method of measurement.

- Degree of protection.
- Bearing identification no. and recommended lubricant.
- Location of insulated bearings for VFD operated motors

4.0.0 PAINTING

Painting shall be carried out by an approved process. Pretreatment shall conform to applicable standard. The equipment shall be subject to a coat of red oxide primer paint. All inside and outside surface shall be painted with epoxy based paint. The final thickness of paint film on steel shall not be less than 100 microns. Finish shade shall be RAL 5012. Sufficient quantity of touch-up paint shall be furnished for application at site.

5.0.0 TESTING AND INSPECTION

5.1.0 Equipment offered shall be of type tested and proven type. Type test certificates for test conducted earlier on similar rating shall be furnished for the motors rated 30 kW and above. Routine tests shall be carried out for all the equipment as per applicable standards.

5.2.0 Copies of certified reports of all tests carried out at the works shall be furnished. The equipment shall be dispatched from works, only after receipt of Owner's written approval of the test reports.

6.0.0 DRAWINGS, DATA AND MANUAL

The bid shall be submitted with the following:

- Technical data sheet.
- Drawing & catalogue

The following documents shall be submitted by the successful Bidder after the award of contract.

- Technical data sheet
- General Arrangement drawing
- Quality Plan
- Test certificates
- O&M manual

SECTION – B3.13 : POWER AND CONTROL CABLES

1.0.0 SCOPE OF WORK

This section covers the requirements Power & Control cables for efficient and trouble-free operation of electrical system of the Township.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the applicable IEC Standards, except where modified and /or supplemented by this specification.

3.0.0 DESIGN CRITERIA

3.1.0 11/11 kV unearthed grade power cables shall be provided for the following

- 11 kV incoming cable from Power plant to township
- 11 kV Cable for ring mains
- 11 kV cable to distribution transformers

3.2.0 1.1 kV earthed grade power cables shall be provided for 415 V system for the following:

- 415 V Power control centre to Main Distribution boards
- Cables to Capacitor banks
- Between various 415 V distribution boards
- Between various panels
- Lighting & small power cables
- Control cables
- Outdoor lighting cables
- 110 V DC system
- 48V DC system

3.3.0 Power cables shall be sized to satisfy the following Criteria:

- Short circuit withstand capacity for applicable fault current and duration.
- Full load current carrying capacity under installation conditions considering Site ambient temperature & site installation (Grouping) conditions based on Manufacturer's recommendation.
- Permissible voltage drop limits under steady state/transient state as applicable.

3.4.0 Cables shall be armoured type only.

3.5.0 Power cables shall be XLPE insulated. Control cables shall be PVC / XLPE insulated.

3.6.0 PVC insulation shall be suitable for continuous conductor temperature of 70°C and short circuit conductor temperature of 160°C. XLPE insulation shall be suitable for continuous conductor temperature of 90 °C and short circuit conductor temperature of 250 °C.

3.7.0 Cables for 11 kV system shall be rated for 11/11 kV unearthed grade. Cables for 415/230 V AC and 110 / 48V DC shall be rated for 1.1 kV grade.

3.8.0 To minimize the damage that can be caused by a fire, conductors installed in electrical cable tray systems shall have jackets which have non-propagating, and self-extinguishing flame retardant, low smoke (FRLS) characteristics. Outer sheath shall be of PVC black in colour. These cables shall meet the following test requirements.

- Oxygen index of minimum 29
- Temperature index of minimum
- Acid gas emission of maximum 20%
- Average light transmission of 40% minimum

- Flame retardant test

3.9.0 Conductor of power cables shall have copper conductor. Minimum size of copper conductor shall be 2.5 sq.mm .

3.10.0 Conductor of control cables shall have plain annealed copper. The minimum size of control cable shall be of 1.5 sq.mm. For CT circuit minimum size shall be 2.5 sq.mm copper. Control cables shall have 20% spare cores.

3.11.0 Power cables shall carry the full load current of the circuit continuously under site conditions considering the various derating factors like thermal resistivity of soil, ambient air/ground temperature, grouping, method of laying, etc.

3.12.0 Design ambient air temperature and ground temperature shall be considered at 50°C and 40°C respectively for cable sizing.

3.13.0 Power cables shall be sized to withstand the fault current of the circuit for the fault clearing time indicated below:

- Breaker operated transformer feeders: 0.16 second.
- Breaker operated outgoing feeders: 0.5 second.
- Tie between two switchgear: 0.5 second.
- Incomers: 1 second.

3.14.0 For 11 kV cables, screen shall be sized to withstand 400A for 3 sec.

3.15.0 For LT motors the voltage drop in the cable, during motor starting condition, shall be limited to 15% and during full load running condition, shall be limited to 3% of the rated voltage. However, the voltage drop from transformer secondary to motor terminals during full load running of motors shall be limited to 6% of rated voltage.

3.16.0 Method of curing for HT XLPE insulation shall be **gas/steam curing**.

3.17.0 Conductor screen and insulation screen shall both be of extruded semi-conducting compound and shall be applied with XLPE insulation in one operation through triple extrusion.

3.18.0 For armoured cables, armouring shall be of aluminium for single core cables. For multicore armoured cables, armouring shall be of galvanised steel.

3.19.0 All the cables shall be protected against rodent and termite attack. Necessary chemicals shall be added into the PVC compound of the outer sheath. The sheath shall be resistant to water, UV radiation, fungus, etc.

3.20.0 Multi-core cable color coding shall be as follows:

- Red, yellow, blue, black and gray for five core cables
- Outer sheath shall be of black in colour.
- For more than 5 cores, core identification shall be by alpha numerical numbering system at an interval of one meter.

3.21.0 Three core 11/11 kV unearthed grade cables shall constitute the following:

- Circular stranded and compacted copper conductor
- Extruded semi conducting compound as conductor screen
- Extruded XLPE insulation
- Extruded semi conducting compound as insulation screen
- Copper tape as metallic screen for each core
- Extruded PVC inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

3.22.0 Single core 11/11 kV unearthed grade cables shall constitute the following:

- Circular stranded and compacted Copper conductor
- Extruded Semi conducting compound as conductor screen

- Extruded XLPE insulation
- Extruded Semi conducting compound as insulation screen
- Copper tape as metallic screen
- Hard drawn aluminium wire armour
- Extruded FRLS PVC outer sheath

3.23.0 Multicore 1.1 kV earthed grade cables shall constitute the following:

- Circular / shaped, stranded Copper conductor (compacted for >10 sq.mm)
- Extruded XLPE insulation
- Extruded PVC inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

3.24.0 Single core 1.1 kV earthed grade cables shall constitute the following:

- Circular stranded and compacted Copper conductor
- Extruded XLPE insulation
- Hard drawn aluminium wire armour
- Extruded FRLS PVC outer sheath

3.25.0 Multicore 1.1 kV earthed grade control cables shall constitute the following:

- Multi stranded annealed copper conductor
- Extruded PVC / XLPE insulation
- Extruded PVC inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

3.26.0 Multi pair 600 V grade, overall screened signal cables shall constitute the following:

- Multi stranded annealed copper conductor
- Extruded PVC insulation
- Twisted pair
- Overall polyester taped, Al-mylar screened with ATC drain wire
- Extruded PVC inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

3.27.0 Multi pair 600 V grade, individual and overall screened signal cables shall constitute the following:

- Multi stranded annealed copper conductor
- Extruded PVC insulation
- Twisted pair
- Individual polyester taped, Al-mylar screened with ATC drain wire
- Overall polyester taped, Al-mylar screened with ATC drain wire
- Extruded PVC inner sheath
- Galvanised steel formed wire/strip
- Extruded FRLS PVC outer sheath

3.28.0 **Cable drums**

Cables shall be supplied in non-returnable wooden or steel drums of heavy construction. All ferrous parts shall be treated with suitable rust protective finish or coating to avoid rusting during transit and storage. All wooden parts shall be manufactured from durable quality wood duly seasoned and treated with copper nepthenates or zinc nepthenates for preserving the wood. The surface of the drum and the outer most cable layer shall be covered with waterproof layer. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/rubber caps, secured by `U' nails so as to eliminate ingress of water during

transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum.

3.29.0 **Cable identification system**

a) In addition to manufacturer's identification on cables as per standards, following marking shall also be embossed/printed on the outer sheath at an interval of one metre throughout the length of cables.

- Manufacturer's name and or trade mark.
- Year of manufacture
- Cable code
- Type of cable and voltage class.
- Nominal cross section area of conductor and no.of cores.
- Progressive sequential length making.

b) Cables shall be marked as having FRLS outer sheath at every 5 meters.

c) The embossing/printing shall be progressive, automatic, in line and marking shall be legible and indelible.

d) Multi-core cable color coding shall be as follows:

- Red, yellow and blue for three core cables
- Outer sheath shall be of black in colour.
- For more than 5 cores, core identification shall be by alpha numerical numbering system at an interval of one meter.
- For multi pair cables, each pair shall be coloured and numbered.

4.0.0 TESTS

- Cables offered shall be type tested and proven type.
- Routine tests shall be carried out on 100% drums.
- Type tests (in case of non availability of reports as mentioned below) , special tests and acceptance tests shall be carried out on 1 drum selected on random basis, out of every 10 or less number of drums of each type and size of cable of each lot. Size shall mean area of cross section in sq.mm read in conjunction with the number of cores. Type shall mean type of insulation, sheath, volt grade FRLS/FS etc.
- Type test report of all the type tests listed in the applicable standard carried out within last ten years from the date of bid opening shall be provided. These tests shall be either conducted at an independent laboratory or witnessed by a client. In case type test reports not submitted / not meeting the above criteria, test shall be conducted as mentioned above without any price impact.

5.0.0 DRAWINGS, DATA AND MANUAL

The bid shall be submitted with the following:

- Technical data sheet.
- Drawing & catalogue

The following documents shall be submitted by the successful Bidder after the award of contract.

- Technical data sheet
- General Arrangement drawing
- Quality Plan

- Test certificates
- O&M manual

SECTION – B3.14: ILLUMINATION SYSTEM

1.0.0 SCOPE OF WORK

This section covers the requirements illumination system for the Township.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the applicable IEC Standards, except where modified and /or supplemented by this specification.

3.0.0 DESIGN CRITERIA

3.1.0 Lighting shall be provided for all the buildings, structures, roads, parks/lawns and indoor/outdoor areas.

3.2.0 The design of a lighting system shall involve:

a) careful planning of the brightness and colour pattern within both the working areas and the surroundings so that attention is drawn naturally to the important areas, so that details can be seen quickly and accurately, and so that the appearance inside the room is free from any sense monotony

b) use of directional lighting to assist perception of task detail,

c) controlling direct and reflected glare from light sources to eliminate visual discomfort,

d) minimizing flicker from certain types of lamps and paying attention to the colour rendering properties of the light,

e) the correlation of lighting throughout the building to prevent excessive differences between adjacent areas, so as to reduce the risk of accidents, and

f) The installation of Essential lighting systems, wherever necessary.

3.3.0 Where work takes place over the whole utilizable area of a room, the general illumination over that area shall be reasonably uniform and the diversity ratio of minimum to maximum illumination shall not be less than 0.7. This diversity ratio does not however take into account of the effects of any local lighting provided for specific tasks.

3.4.0 In order to determine the necessary number of lamps and luminaires for a specified illumination level or the average illuminance obtained from a particular lighting design, the Lumen Method of calculation shall be employed.

3.5.0 Unless the reflection factors are known to the lighting designer, the triplet 0.7/0.5/0.3 for the reflectances of ceiling, walls and working plane respectively shall be used for offices and the triplet 0.7/0.5/0.1 for other premises.

3.6.0 **Conference Hall :**Special attention to be paid for functional areas and functional requirements in coordination with the Architect and to provide for specialized services like Audio visual system, P.A. System, Sound reinforcement, Stage lighting, Conference system, Security needs, etc.

3.7.0 **Hospitals:** Planning of such buildings require high degree of professionalism, for application of latest technology to provide efficient and effective installation.

3.8.0 **Outdoor Lighting, High Mast Lighting, Road Lighting, Security Lighting, Garden Lighting, Illuminated Fountains:** The buildings will require highly aesthetic lighting making use of a variety of lighting design, themes and fixtures available. For proper aesthetic effect, high level of professional approach is needed based on computer aided design and calculations.

3.9.0 **Night Sky Pollution & Light Trespass:** All exterior lighting should be designed to minimize night sky pollution. Only those areas shall be lighted that are required for safety and comfort. Installation of luminaires on site and building shall be such that no light trespassing occurs on the neighboring site and buildings.

3.10.0 **For Interior Lighting:** The angle of maximum candela from each interior luminaire as located in the building shall intersect opaque building interior surfaces and not exit out through windows.

3.11.0 **The lighting system shall comprise following categories :**

- Normal Lighting System
- Essential Lighting System

3.12.0 Normal AC lighting shall be provided by distribution substation. Essential lighting shall be provided by DG set.

3.13.0 **Lux level proposed in various areas are given below:**

Area or Activity	**Illuminance (lux)**
a) Dwelling houses	
Bedrooms General	70
Bed-head, Dressing table	250
Kitchens	200
Dining rooms (tables)	150
Bathrooms General	100
Shaving, make-up	300
Stairs	100
Lounges	100
Garages & Porches	100
Basement Car Park	100
Porches, Entrances	70
Sewing and darning	600
Reading (casual)	150
Home work and sustained reading	300
b) Hostels	
Entrance halls	150
Reception and accounts	300
Dining rooms (tables)	150
Lounges	150
Bedrooms General	100
Dressing tables, bed heads, etc.	250

Writing rooms (tables)	300
Corridors	70
Stairs	100
Kitchens	
Food stores	100
Working areas	250
Goods and passenger lifts	70
Bathrooms	100
Above mirror in bathrooms	300
c) School	
General	150
When used for examinations	300
Platforms	300
Class and Lecture Rooms Desks	300
Black boards	250
Embroidery and sewing rooms	500
Laboratories	300
Art rooms	400
Offices	300
Staff rooms and common rooms	150
Corridors	70
Stairs	100
Gymnasia General	150
Matches	300
d) Hospitals and Clinics	
Reception and waiting rooms	150
Outpatient department	150
Wards General	100
Beds	150
Operating theatres General	300
Tables (with adjustable operation lamp lighting)	
Minor	2000
Major	5000
Doctor's examination rooms	150
Radiology departments	100
Casualty	150
Stairs and corridors	100
Dispensaries	250
e) Cinemas	
Foyers	150
Auditorium	70
Corridors	90
Stairs	150
f) Libraries	
Shelves (stacks)	100
Reading rooms (newspapers and magazines)	200
Reading tables	300
Book repair and binding	300
Cataloguing, sorting and stock rooms	150

g) Restaurant	
Dining rooms	100
Cash desks	300
Self- carrying counters	300
Kitchens	200
Cloak rooms and toilets	100
h) Theatres	
Foyers	150
Auditorium	70
Corridors	90
Stairs	150
i) Indoor Sports Centre	
Halls	200
Swimming pools	250
Lawn or table tennis, badminton, volley ball	
Tournament	300
Club	200
Recreational	150
j) Offices	
Entrance lobby and reception areas	150
Conference rooms and executive offices	300
General offices	300
Business machine operation	450
Drawing office	
General	300
Boards and tracing	450
Corridors and lift cars	70
Stairs	100
Lift landings	150
k) Telephone exchanges	
Manual exchange rooms (on desk)	200
Main distribution frame room	150
l) Shops and Stores	
General areas	150 to 300
Stock rooms	200
Display windows	500
m) Outdoor Car Parking Lot	**100**
n) Roads inside a Housing Area	**50**

3.14.0 For indoor Areas, average lumen method shall be adopted to calculate luminance. Lighting level design shall include a Maintenance factor as follows to account for lamp lumen depreciation, luminaries' surface dirt and room surface dirt, etc.

- Air-conditioned clean interiors : 0.8
- Clean interiors : 0.75
- Industrial areas with normal interiors. : 0.7

3.15.0 Lighting level design shall also include the coefficient of utilization factor as calculated from table of reflectance provided by manufacturer for respective type of fixture.

3.16.0 For Outdoor flood lighting design, 'point by Point' method shall be adopted based on computer aided design package of the Contractor software. Uniformity in horizontal illuminance Emin/Eavg should be greater than 0.25.

3.17.0 Aviation obstruction lights: Tall buildings shall be provided with aviation obstruction lights. Aviation obstruction lights shall meet the requirements of Annexure-14 of 'International Civil Aviation Organization' (ICAO). Lights shall be of low intensity type.

3.18.0 **Exit Signs & Escape Lighting**

All required exit signs shall be illuminated at night, or during dark periods within the area served. Exit signs shall be illuminated by lamps contained within the sign. The source of illumination shall provide not less than 50 lux at the illuminated surface with a contrast of not less than 0.5. Exit signs within an area where the normal lighting may be deliberately dimmed or extinguished, such as places of entertainment, shall be illuminated either by lamps contained within the sign or by approved self-luminous signs.

The means of escape and exit access in buildings requiring more than one exit shall be equipped with artificial lighting. The lighting facilities so installed shall provide the required level of illumination continuously during the period when the use of the building requires the exits to be available. The intensity of illumination at floor level by means of escape lighting shall not be less than 10 lux.

The illumination of exit signs and the lighting of the means of escape and exit access shall be powered by in built battery to ensure continued illumination for a duration of not less than 30 minutes after the failure of primary power supply.

3.19.0 Switch control shall be provided for controlling lighting fixtures located indoor.

3.20.0 Electric power to light fixtures located outdoors shall be switched with photoelectric controllers and timers. Provision shall be made to bypass the photoelectric controller and timer. For Road lighting, alternative lighting fixtures shall be fed from different phases.

4.0.0 EQUIPMENT DESCRIPTION

4.1.0 Lighting fixtures

4.1.1 All the lamps shall be LED type.

4.1.2 For all commercial buildings, mirror optic type LED luminaires shall be used.

4.1.3 In residential buildings, general purpose luminaires with LED lamps shall be used.

4.1.4 For industrial buildings/installations having room height of up to 5 metre, Iindustrial trough type/Industrial General purpose Rail type LED light fittings shall be used:

4.1.5 In false ceiling areas, type of light fixtures shall suit the type of false ceiling provided.

4.1.6 Road lighting / Flood lighting poles shall be of galvanised steel pole. Each Street lighting pole/Flood lighting pole shall be provided with MCB protection.

4.1.7 Winch operated high mast lighting shall be provided in select outdoor areas.

4.1.8 AC lighting fixtures and accessories shall be suitable for operation on 240 V, AC, 50 Hz supply with supply voltage variation of ± 10%, frequency variation of ± 5% and combined voltage and frequency variation of absolute sum of 10%.

4.1.9 Luminaires shall meet atleast Electrical safety class-I as per relevant IEC.

4.1.10 The lighting fixtures shall be designed for minimum glare. The finish of the fixtures shall be such that no bright spots are produced either by direct light source or by reflection.

4.1.11 Recommended luminaries at various places are listed below :

Sl.No.	Area	Type of Luminaries
1)	Residential area, Hostel	Enclosed type rail type fixture with LED lamps
2)	Residential area small rooms	Fitting with LED lamps
3)	Substation, transport center	LED industrial fixture
4)	Stair cases, Passages, Toilets	LED rail type fixture/Mini lights
5)	Office	LED fixture & Spot lights
6)	Non residential buildings such as commumity center, Club, Training center, shoping center	LED fixture & Spot lights
7)	Non residential buildings such as police station, cyclone shelter	Enclosed type rail type fixture with LED lamps
8)	Pump houses, stores	LED industrial fixture
9)	Roads	street lighting fixtures on steel poles with LED lamp
10)	Outdoor area	flood lighting fixtures on steel poles with LED lamp / High mast lighting with LED lamp

4.2.0 Distribution boards/Panels for lighting and small power

4.2.1 The DB/panels shall be rated for 415 V, 3 phase, 4 wire, AC with neutral bus and suitable for either wall/column mounting. Indoor DB/panels shall have degree of protection of IP 54 and outdoor type shall have degree of protection of IP 55 and shall have a sloping canopy. DB/Panels shall be constructed from CRCA sheet. Sheet thickness shall be 2.0 mm.

4.2.2 Miniature circuit breakers (MCB) shall have thermal elements for overload protection and an instantaneous magnetic trip to protect against severe faults. All MCBs provided shall be suitable for breaking capacity of 10 kA (minimum) at 240 V AC.

4.2.3 Contactors shall be of the air break type fitted with arc shields. Time switch shall be suitable for automatic switching ON and OFF of street lighting / flood lighting circuits. Time switch has 00 - 24 hours clock base. Time switch shall indicate actual time and shall permit accurate time setting. Time switch shall be provided with Ni-Cd gel battery.

4.2.4 DB/Lighting panel shall be provided with 415 V AC, 63 Amp, TPN MCB with RCCB as incomer, required nos. of 20 A, 240 V AC, single pole MCBs for outgoing circuits, Separate neutral at terminal block for each outgoing circuit. For residential quarters, DB/Lighting panel shall be provided with phase changeover switch, to enable auto & manual changeover to healthy phase, in case of loss of power supply in an phase.

4.2.5 Street lighting panel shall be provided with 415 V AC, 63 Amp, TPN MCB isolator as incomer, 63 Amp Three pole AC Contactor, 00 - 24 hours timer and a photo-electric switch for

automatic switching of contactor, a by-pass switch for timer/photo switch, 6 Nos. 20 A, 415 V AC, TPN MCBs for outgoing circuits, Separate neutral at terminal block for each outgoing circuit. One number light sensor in weather proof enclosure having IP: 55 degree of protection shall be installed separately with necessary interconnecting cable for each street lighting panel. Additionally 100% sensors shall be supplied for future use

4.3.0 Lighting mast

4.3.1 Each Lighting Mast shall be 30 M high, complete with the following accessories.

- High mast shaft in two/three section, hot dip galvanised
- Head frame, steel wire rope & double drum winch.
- Galvanised Lantern carriage arrangement
- Integral power tool installed inside base compartment for its operation.
- Foundation bolts
- Luminaires
- Aviation obstruction light with 2 nos. LED lamps.
- Control panel
- Power & control cables and cabling accessories required for the installation.
- Special tools & tackles

4.3.2 The High mast shall be of continuously tapered, polygonal cross section, at least 20 sided, presenting a good and pleasing appearance and shall be based on proven design to give an assured performance, and reliable service. The entire fabricated mast shall be hot dip galvanized, internally and externally, having a uniform average thickness of atleast 85 microns.

4.3.3 An adequate door opening shall be provided at the base of the mast and the opening shall permit clear access to equipment like winches, cables, plug and socket, etc. and also facilitate easy removal of the winch.

4.3.4 A fabricated Lantern Carriage shall be provided for fixing and holding the flood light fittings and control gearboxes. The lantern carriage shall be of steel tube construction, the tubes acting as conduits for wires, with holes fully protected by grommets.

4.3.5 The winch shall be completely self-sustaining type, without the need for brake shoe, springs or clutches. Each driving spindle of the winch shall be positively locked when not in use, gravity activated PAWLS. Individual drum also shall be operated for fine adjustment of lantern carriage. The minimum-working load shall be not less than 750 kg. The winch shall be self-lubricating type by means of an oil bath and the oil shall be readily available grades of reputed producers.

4.3.6 The suspension system shall essentially be without any intermediate joint and to consist of only non-corrodible stainless steel of AISI 316 grade. The breaking load of each rope shall not be less than 2350 kg, giving a factor of safety of over 5 for the system at full load. The thimbles shall be secured on ropes by compression splices.

4.3.7 A suitable, high-powered, electrically driven, internally mounted power tool with motor, with manual over ride shall be supplied for the raising and lowering of the lantern carriage for maintenance purposes. The power tool shall be of single speed, provided with a motor of the required rating. The power tool shall be supplied complete with suitable control.

4.4.0 Lighting poles

Lighting pole shall be octagonal type, galvanized steel, supplied with base plate, foundation bolts, and necessary fixing-bracket for fixing the luminaire. Street lighting pole shall have integral junction box. All poles shall be provided with heavy square nuts on the anchor bolts

under the pole base plate and hex nuts on the top. GI conduits shall be embedded in muff for incoming and outgoing cables. Junction box shall be integral to the pole, supplied along with MCB and neutral link.

4.5.0 Wires

XLPE/PVC insulated wires shall have multi stranded copper conductor. Wires shall be of 1.5 sq.mm/2.5 sq.mm/4 sq.mm sizes. The insulation material shall be resistant to flame, oil, acid and alkali and shall be tough enough to withstand mechanical stresses during handling. Wires shall have following colors.

- Red for R phase
- Yellow for Y phase
- Blue for B phase
- Black for Neutral
- Yellow-Green for Earth wire
- Grey & white for positive and negative connections respectively.

5.0.0 TESTS

Equipment offered shall be of type tested and proven type. Type test certificates for test conducted earlier on similar rating shall be furnished. For the various bought out item test certificates from equipment Manufacturer shall be furnished. Routine tests shall be carried out for all the equipment as per applicable standards.

6.0.0 DRAWINGS, DATA AND MANUAL

The bid shall be submitted with the following:

- Technical data sheet.
- Drawing & catalogue

The following documents shall be submitted by the successful Bidder after the award of contract.

- Technical data sheet
- Lighting calculation
- General Arrangement drawing
- Quality Plan
- Test certificates
- O&M manual

SECTION – B3.15 : CABLE TRAYS & ACCESSORIES

1.0.0 SCOPE OF WORK

This section covers the requirements of Cable trays, supports, cable terminations, joints, glands, lugs, clamps, conduits, receptacles, Junction boxes, fire stop system etc. for efficient and trouble-free operation of electrical system of the Township.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the applicable IEC Standards, except where modified and /or supplemented by this specification.

3.0.0 DESIGN CRITERIA

3.1.0 The items shall generally include, but not limited to, the followings:

- Cable trays and accessories
- Cable tray supports
- Cable joints & terminations
- Cable glands
- Cable lugs
- Camps
- Tags
- Conduits & Pipes
- Junction boxes
- Fire stop system
- Any other equipment required for the system
- All accessories, fittings, supports, anchor bolts etc. which form part of the equipment or which are necessary for safe and satisfactory installation and operation of the equipment shall be furnished.

3.2.0 Cable Trays and Accessories

3.2.1 Cable trays shall be prefabricated ladder / perforated type, made of 2 mm thick sheet steel with hot dip galvanised with zinc coating not less than 460 gm/ m2, furnished in standard lengths of not less than 2.5 m. The cable trays of width 150 mm, 300 mm, 450 mm and 600 mm shall be used.

3.2.2 Separate cable trays shall be provided for the following cables:

- HT Cables
- LT power cables
- Electrical Control cables
- Telephone / data / Signal cables
- Fiber optic cables

3.2.3 Cable trays shall be complete with matching fittings and accessories (like elbows, bends, reducers, tees, crosses, side coupler plates, tray covers etc.) and hardware (like bolts, nuts, washers, etc.) as required. At both the ends of cable trays, four holes shall be provided for fixing side coupler plates. All the slots and coupler holes shall be machine punched.

3.2.4 Cable trays, fittings and accessories and covers shall be hot dip galvanized. Thickness of galvanizing shall be not less than 460 grams/sq.m. Fasteners like bolts, nuts; screws washers etc. shall also be hot dip galvanized.

3.2.5 For branch cabling routes involving fewer cables, sheet steel galvanized cable trough of size 50/75/100 mm shall be provided.

3.3.0 Cable Tray Support System

3.3.1 Cable tray supports shall be of prefabricated preformed sections of sheet steel, bolted type and shall be hot dip galvanized.

3.3.2 Cable tray support system shall be similar or equivalent to "Unistrut make". Support system for cable trays shall essentially comprise of the two components i.e. main support channel and cantilever arms. The main support channel shall be of following two types:

- Single channel strut support for supporting cable trays on one side
- Double channel strut support for supporting cable trays on both sides

3.3.3 Cable supporting steel work for cable racks/cables shall comprise of various channel sections, cantilever arms, various brackets, clamps, floor plates, all hardware such as lock washers, hexagon nuts, hexagon head bolt, support hooks, stud nuts, hexagon head screw, channel nut, channel nut with springs, fixing studs, etc.

3.3.4 The system shall be designed such that it allows easy assembly at site by using bolting. All cable supporting steel work, hardware fittings and accessories shall be prefabricated factory galvanised.

3.3.5 The main support and cantilever arms shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc.

3.3.6 after completing welding, cutting, drilling and other machining operation.

3.3.7 The typical arrangement of flexible support system shall comprise the following:

3.3.8 The main support channel and cantilever arms shall be fabricated out of minimum 2.5 thick rolled steel sheets.

- Cantilever arms of required length to match cable tray width. The arm portion shall be suitable for assembling the complete arm assembly on to component constructed of standard channel section. The back plate shall allow sufficient clearance for fixing bolt to be tightened with tray in position.
- The size of structural steel members or thickness of sheet steel of main support channel and cantilever arms and other accessories as indicated above or in the enclosed drawings are indicative only.
- Main support channels may be supplied in any suitable lengths to minimize the wastage. Nevertheless, the support system shall be designed by the bidder to fully meet the requirements of type tests as specified.

3.3.9 Thickness of galvanizing on steel sections shall be not less than 610 gm/sq.m on all steel sections.

3.3.10 Horizontally running cable trays shall be clamped by bolting to cantilever arms at an interval of 1500 mm for outdoor and 2000 mm for indoor locations. Vertically running cable trays shall be bolted to main support channel by suitable bracket/clamps on both top and bottom side rails at an interval of 1500 mm. For vertical cable risers/shafts cable trays shall be supported at an interval of 1000 mm.

3.3.11 The cantilever arms shall be positioned on the main support channel with a minimum vertical spacing of 300 mm.

3.4.0 Joints & terminations

3.4.1 Termination and jointing kits shall be of proven design and make which have already been extensively used and fully type tested. Kits shall be complete with all accessories and

consumables required for complete termination or jointing. Copper cable lugs & jointing ferrules for straight through joints shall form part of the kit.

3.4.2 Termination and jointing kits shall be suitable for the following types of cables.

- 11kV unearthed grade cable
- 1.1 kV grade power cables

3.4.3 Termination kits shall be ‘elastimold’ or ‘Push on type’ or ‘heat shrinkable type’.

3.4.4 Cable joints shall be avoided to the extent possible. If joints are unavoidable due to circuit length, in excess of permissible maximum drum length. Jointing kits shall be ‘heat shrinkable type’.

3.4.5 Straight through joint and termination shall be capable of withstanding the fault level of 40 kA for 11 kV cables.

3.4.6 Straight through joints shall be protected against mechanical damage, rodent and termite attack. It shall be suitable for directly buried cables.

3.5.0 Cable glands

Cables shall be terminated using cable glands suitable for the voltage grade of cables. Cable glands shall be heavy duty brass machine finished and tinned. Cable glands shall be supplied with neoprene seal and earth lugs suitable for the fault capacity of the armour of the installed cables. Cable glands shall be double compression, weather proof type for armoured cables.

3.6.0 Cable lugs

3.6.1 Cable lugs shall be of tinned copper for copper cables. Thickness of tinning shall be not less than 10 microns Type of end connection shall be solder less crimping type.

3.6.2 Cable lugs for conductors of power cables shall be "heavy duty" long barrel type. The type & size of cable lugs for power cables shall be selected according to the number and sizes of strands of the cable.

3.6.3 Solderless crimping of terminals shall be done by using corrosion inhibiting compound. Cable lugs for control cable termination shall be insulated. These lugs shall be pin type/flat type/ ring type/U Type to suit the terminals provided in the panels.

3.6.4 Type of cable lugs shall be as follows:

- Power cables with copper conductor : Copper crimping type.
- Control Cables : Copper pin type /Copper screw type
- Special cables : pin type / maxi-termi type

3.7.0 Trefoil Cable Clamps

- Clamps required for single core cables carrying alternating current shall be suitable for holding three cables together in delta formation. Clamps shall be of FRP material.
- Clamps shall be of suitable sizes to firmly hold the cables of various outer diameters including tolerance in OD.
- Clamps should have been type tested for Short Circuit Withstand Test.
- For Trefoil clamps run spacing shall be 2000 mm and axial spacing shall be double the diameter of larger adjacent trefoils cable or 150 mm whichever is less. Supports shall also be provided at each bend

3.8.0 Omega Cable clamps

- Omega clamps shall be of galvanized mild steel and shall be used to fasten the individual multi-core cables.
- Clamps shall be of simple construction, made of 2 mm thick, 25 mm wide strip of omega shape and suitable for clamping on the rungs / perforated sheet of tray with the help of two bolts.
- Clamps shall be of different sizes for different outer diameters of cables. Omega cable clamps shall be used for individual cables above 35 mm outer diameter.
- Steel clamps shall be hot dip galvanized. Weight of zinc not less than 610 grams. per sq. metre
- For cables of above 35 mm OD, cables shall be individually clamped at 5000 mm interval for Horizontal runs and shall be individually clamped at 1000 mm interval for Vertical runs. Supports shall also be provided at each bend.
- For cables of up to 35 mm OD, cables shall be collectively clamped at 5000 mm interval for Horizontal runs and shall be collectively clamped at 1000 mm interval for Vertical runs. Supports shall also be provided at each bend.
- For cables supported along structures/ceiling, clamp spacing shall be 750 mm. Supports shall also be provided at each bend.

3.9.0 Strip Cable Clamps

- Strip clamps shall be of galvanized mild steel and shall be used to fasten the group of multi-core cables up to 35 mm diameter only on a full or part of the tray width.
- Clamps shall be of simple construction, made of 3 mm thick Steel, 25 mm wide strip to cover the entire width up to 300 mm wide tray and part of the tray for more than 300 mm wide trays. Strip shall have two right angle bends at each end for fixing on to the rung/ perforated sheet of tray with the help of two bolts.
- Clamps shall be of different sizes for different sizes of tray width. However, the maximum size of clamp shall be 300 mm and for cable trays of greater width, two clamps shall be used.
- Clamps shall be hot dip galvanized. Weight of zinc not less than 610 grams. per sq. metre

3.10.0 Self-locking Clamps

- Clamps shall be of FRP material. Clamps shall have self-locking feature when the cord is looped. Clamps shall be provided with manual lock release.
- Clamp cord shall not move in the backward position once it has been locked, unless the lock release is applied.
- Not more than four (4) cables shall be clamped together, wherever collective clamping is permitted.
- Clamp length shall be selected such that not more than 80% of lockable length is utilised for clamping.
- Nylon self-locking tie strips for collective clamping (up to 35 mm OD max. group of 4 cables) shall be 4 mm having Tensile strength 30 kg.
- Nylon self-locking tie strips for individual multicore clamping (above 35 mm OD up to 55 mm OD) shall be 4 mm having Tensile strength 20 kg.
- Nylon self-locking tie strips for individual multicore clamping (above 55 mm OD) shall be 7 mm having Tensile strength 60 kg.

3.11.0 Tags

- Cables shall be provided with cable number tags for identification.
- Cable tags shall be of aluminium.
- Cable numbers shall be engraved type

- Tags shall be of durable quality of size 60 mm x 12 mm with a tie hole at each end.
- Samples of tags shall be approved by the Owner before delivery.
- Tags shall be provided with non-corrosive wire of sufficient strength for tagging.

3.12.0 Junction Boxes

3.12.1 Junction box with IP 55 degree of protection made of galvanized sheet steel. The junction box shall be provided with canopy. The boxes shall include brackets, bolts, nuts, screws, glands, lugs, M8 earthing stud etc.

3.12.2 Terminal blocks shall be of 650 Volt grade, rated for 10 A and in one piece moulding. It shall be complete with insulating barriers, clip-on-type terminal numbering on wiring diagrams. Terminal block shall be suitable for terminating 2Cx2.5mm^2 cable on both sides and arranged to facilitate easy termination. Cable entry shall be from bottom.

3.12.3 The boxes shall have provision for wall, column, pole or structure mounting and shall be provided with cable / conduit entry knockouts and terminals.

3.13.0 Conduit and Accessories

Surface laid conduits shall be of rigid steel, hot-dip galvanized, furnished in standard lengths and threaded at both ends. All conduits shall be heavy duty suitable for electrical installation. Sizing of conduit shall be based on maximum 40% fill criteria. Conduits shall be complete with all accessories such as bends, ties, couples, inspection box, etc. Flexible conduits shall be made of bright, cold rolled, annealed and electro-galvanized mild steel strips.

3.14.0 Fire stop system

3.14.1 Fire barriers shall be provided for all fire rated wall and floor penetrations and for all direct cable entries into electrical equipment/electrical room. Sleeves and openings for the passage of electrical cable or raceway shall be sealed with fire stops. Fire barriers and fire stops shall have a fire rating not less than 2 hours.

3.14.2 All fire stops shall be installed in accordance with the manufacturer's recommendations including installation by trained personnel when so recommended by the manufacturer. All fire stop materials, fire stop testing, and installation methods shall be approved by the Owner prior to installation.

3.14.3 The fire proof cable penetration sealing system shall prevent spreading of fire in cable beyond the seal system in case of fire and shall have minimum two hour fire resistance rating

3.14.4 The fire proof cable penetration sealing system shall comprise either of the following methods:

a) Panel sealing method complete with
   - Encasing Panels
   - Cavity fill material
   - Sealant

b) Mortar sealing method shall basically include Mortar based fire seal compound. The process shall include
   - Surface preparation like dusting / removal of any oil substance
   - Mixing Mortar with water
   - Damming / Shuttering
   - Filling
   - Curing with water

3.14.5 The fire proof cable penetration sealing system offered should have been tested and evaluated.

3.14.6 The fire proof cable penetration sealing system shall be physically, chemically, thermally stable and shall be mechanically secured to the masonry / concrete / structural members. The system shall be mechanically robust and capable of giving satisfactory performance under vibrations encountered in power stations.

3.14.7 The encasing panel (support frame) shall be of single panel of uniform density. Paper laminated gypsum boards shall not be used.

3.14.8 Sealing putty shall not be based on chlorinated rubber.

3.14.9 The fire proof cable penetration sealing system should not affect the current carrying capacity of cables passing through it.

4.0.0 TESTS

Equipment offered shall be type tested and proven type. Tests shall be carried out for galvanizing thickness of trays and supports.

5.0.0 DRAWINGS, DATA AND MANUAL

The bid shall be submitted with the following:

- Technical data sheet.
- Drawing & catalogue

The following documents shall be submitted by the successful Bidder after the award of contract.

- Technical data sheet
- General Arrangement drawing
- Quality Plan
- Test certificates
- O&M manual

SECTION – B3.16: EARTHING SYSTEM

1.0.0 SCOPE OF WORK

This section covers the requirements of earthing system for efficient and trouble-free operation of electrical system of the Township.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the applicable National standards and IEC Standards, except where modified and /or supplemented by this specification.

3.0.0 DESIGN CRITERIA

3.1.0 The object of an earthing system is to provide a system of conductors, as nearly as possible at a uniform and zero, or earth potential. The purpose of this is to ensure that, in general, all parts of equipment and installation other than live parts shall be at earth potential, thus ensuring that persons capacity coming in contact with these parts shall also be at earth potential at all times.

3.2.0 “System Earthing” shall be provided to preserve the security of the supply system. This is done by limiting the potential of live conductors with reference to earth, to such values as consistent with the level of insulation applied. Earthing the neutral point of the transformer ensures reasonable potential to earth, including at the time when the HV supply is impressed on the transformer. Earthing also ensures efficient operation of protective gear in the case of earth faults. Earthing may not give protection against faults that are not essentially earth faults. For example, if a phase conductor on an overhead spur line breaks, and the part remote from the supply falls to the ground, it is unlikely that any protective gear relying on earthing, other than current balance protection at the sub-station, shall operate, since the earth fault current circuit includes the impedance of the load that would be high relative to the rest of the circuit.

3.3.0 “Equipment Earthing” shall be provided to ensure that the exposed conductive parts in the installation do not become dangerous by attaining a high touch potential under conditions of faults. It should also carry the earth fault currents, till clearance by protective devices, without creating a fire hazard.

“Static Earthing” shall be provided to prevent building up of static charges, by connections to earth at appropriate locations. Example, operation theaters in hospitals.

3.4.0 “Clean Earth’’ will be needed for some of the data processing equipment. These shall be independent of any other earthing in the building.

Earthing will be required in protection of buildings against lightning.

3.5.0 Type of system earthing shall be as follows:

TN-C-S System: (Also called Protective Multiple Earthing – PME system) Neutral is earthed at source. No separate PE conductor is run with the supply line.The PE and N are combined in one conductor at supply line. This is earthed at source as well as at frequent intervals. There shall be independent protective conductor in the installation. Consumer also normally provides earth electrode terminating on to main earth electrode in his installation, and this is in turn “linked” to the PE & N conductor from supply line. All the exposed conductive parts in the installation are connected to the PE & N conductor, through protective conductors and this main earthing terminal link.

T-TN-S System (for 11 KV bulk supply): No earth is provided with HV supply line, which is terminated in delta connected transformer primary. Neutral of the transformer (star connected) secondary is earthed. Independent earth electrodes and bus are provided for the body earthing. Protective conductors are run throughout the LT distribution from the same for equipotential bonding.

4.0.0 TECHNICAL REQUIREMENTS

4.1.0 Electrical Installation for Buildings

The following types of earthing are required to be installed.

- Equipment Earthing
- Transformer Neutral Earthing
- DG Neutral earthing
- Buried earthing conductor around the Building
- Electronic earthing
- Special earthing for hospital equipment

The value of resistance from the consumer's main earthing terminal to the earthed point of the supply, or to earth, shall be in accordance with the protective and functional requirements of the installation, and expected to be continuously effective.

Earth fault currents and earth leakage currents likely to occur are carried without danger, particularly from the point of view of thermal, thermo-mechanical and electromechanical stresses.

Where a number of installations have separate earthing arrangements, protective conductors running between any two of the separate installations shall either be capable of carrying the maximum fault current likely to flow through them, or be earthed within one installation only and insulated from the earthing arrangements of any other installation.

4.2.0 Integral parts of an Earthing System

The integral parts of an Earthing System are:

a) Earth Electrode(s) buried under the ground

b) Earth Lead Cables/ Wires connecting the Earth Electrode(s) with the Earthing Busbar System.

c) Earth Continuity Conductors (ECC) for linking Earthing Busbar at the Substation LT panel or main distribution DB of a building.

d) Earth Electrode Clamp.

Connections of (i) Earth Continuity Conductors (ECC), (ii) Earth Lead Cables/ Wires and (iii) Earth Electrode(s) must be made in appropriate and long lasting manner because poor connection or loss of connection shall render the earthing system ineffective.

4.3.0 Earth Continuity Conductors (ECC)

ECC runs along the circuits / sub-circuits, socket circuits, interlinking circuits between a BDB and a SDB, between a SDB and a DB, between a DB and a FDB, between a FDB and a MDB, between a MDB and the LT Panel Earthing Busbar of the Substation. At each point an ECC shall be terminated in a copper earthing busbar. In metal switch boards back boxes and in metal socket back boxes appropriate copper or brass bolt nut termination shall be provided.

ECC of an earthing system joins or bonds together all the metal parts of an installation.

PVC insulated wiring copper cables of appropriate size having Green+Yellow bi-colour insulation shall be used as ECC.

The minimum size of the ECC shall be 4.0mm2 PVC insulated wiring copper cables of appropriate size having Green+Yellow bi-colour insulation.

4.4.0 Earth Lead Cable/ Wire

Earth Lead Cable/ Wire runs between an Earth Electrode and the Earthing Busbar of the MDB /DB or between an Earth Electrode and the LT Panel Earthing Busbar of the Substation.

Often more than one Earth Electrodes are needed. In such a case duplicate Earth Lead Cables/ Wires from each Earth Electrode must be brought to the MDB /DB or to the LT Panel Earthing Busbar of the Substation and properly terminated. In addition, in the case of multiple Earth Electrodes, the Earth Electrodes must be interlinked by additional Earth Lead Cables/ Wires.

PVC insulated wiring copper cables of appropriate size having Green+Yellow bi-colour insulation shall be used as Earth Lead Wire. At both ends of the Earth Lead Cable/ Wire, copper cable lugs must be fitted using crimp tools or hydraulic press.

The ends of the earth lead wires shall be terminated using crimp tool fitted cable lugs for fitting on the bus bar or with the Earth Electrode Clamp.

Earth Lead Cables/ Wires shall run, at least, 2 in parallel down to the earth electrode so as to increase the safety factor of the installation. The two cables shall be terminated in two separate cable lugs and bolts at both ends.

Earth Lead Cables/ Wires shall be pulled from the Earth electrode up to the terminating Earthing Busbar through PVC conduits or GI pipes of appropriate dimension.

Minimum cross-sectional area of copper ECCs in relation to the area of associated phase conductor is given below:

Phase Conductor(s) (mm2)	**Minimum Cross-sectional Area of the Corresponding Earth Conductor (mm2)**
Less than 16	Same as cross-sectional area of phase conductor but not less than 4mm2
16 or greater but less than 35	16mm2
35 or greater	Half the cross-sectional area of phase conductor

4.5.0 Earth Electrodes and their installation

The Earth Electrode shall, as far as practicable, penetrate into moist soil (which shall remain moist even during the dry season) preferably below ground water table. The resistance of an Earthing system after measured after the installation of Earth electrodes (individually or combined as a single group) shall be around one ohm as per BNBC.

GI Pipe Earth Electrodes driven by tube well sinking method are suggested. For this purpose 50 mm dia GI pipes are recommended.

The length of GI pipe to be driven below the ground level depends on the earthing resistance which in turn depends on the availability of water table during the dry season in this country.

Multiple number of GI Pipe Earth Electrodes need to be used and connected in parallel in order to lower the earthing resistance measured with an earth resistance measuring meter.

A Brass Clamp must be fitted on top of a GI Pipe Earth Electrode to terminate the Earth lead wire and to maintain electrical contact with the earth electrode. The Brass clamp shall be made using at least 9.5mm thick and at least 50 mm wide

Brass plate bent and shaped properly to fit tightly around the GI pipe earth electrode and shall have sufficient length (at least 35mm) on both sides for fixing bolts and cable lugs. After fitting

the lugs of the Earth Lead Cables the Brass clamp and the GI pipe head should be coated with two coats of synthetic enamel paint on top of one undercoat paint layer.

4.6.0 Earthing Busbars

A Copper Earthing Busbar must be provided inside the LT Panel or MDB/ DB of a building. The Earth Lead Wire coming from the Earth Electrode (s) shall be terminated on this bus bar using cable lugs (cable lugs must be fitted using crimp tools or hydraulic press) and brass bolts and nuts.

Copper Earthing Busbar must also be provided inside the DBs, FDBs, SDBs andBDBs. Hexagonal Head brass screw, nuts and washers are needed for fixing the ECC and Earth Lead cables with this busbar.

4.7.0 Earthing Pit

An Earthing Pit must be constructed around the top of the Earth Electrode, below the ground level using 254mm brick walls on a PCC floor with a 152mm thick RCC slab cover on top having lifting hooks. The top of the Earth electrode (in case of pipe earthing) shall remain 380mm above the top of the bottom CC floor of the pit. The minimum inside dimension of the Earthing Pit shall be 610mm X 610mm X 610mm. The outside as well as the inside of the walls of the pit and the floor of the pit shall be cement mortar plastered. The inside shall be net cement finished. The top of the RCC slab pit cover shall remain 38mm above the ground level. The pit shall be made in such a way that water cannot get in to the pit. One Earthing Pit is needed for one Earth Electrode.

4.8.0 Earthing conductor shall be of copper material.

4.9.0 Number of Earth Electrodes

Non-current carrying metal parts of all apparatus utilizing power supply at voltage exceeding 250 volts shall be earthed by two separate and distinct connections to the earth bus, or to two separate and distinct earthing sets.

The number of earthing electrodes for sub-stations shall be as under:-

- For neutral earthing of each transformer : 2 sets
- For body earthing of all the transformers : 2 sets
- HT/LT Panels and other electrical equipment in the Sub-station : 2 sets
- For neutral earthing of each generating set : 2 sets
- For body earthing of all the generating sets, : 2 sets

Where the generator and sub-station equipment are located together in the same building, the body earthing can be common for all the electrical equipment in the building.

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All nuts, bolts, washers etc shall be cadmium plated or zinc passivated.

4.10.0 Installation

a. Equipment shall be generally be furnished with two separate ground pads with tapped holes, bolts, nuts and spring washers etc. Equipment ground connections, after being checked and tested shall be coated with anti-corrosive paint.

b. Metallic frame of all electrical equipment shall be earthed by two separate and distinct connections to earthing system, each of 100% capacity. Steel RCC columns, metallic stairs, hand rails etc. of the building housing electrical equipment shall be connected to the nearby earthing grid conductor by one earthing. Every alternate post of the metallic fence shall be connected to earthing grid by one Copperflat and gates by flexible lead to the earthed post.

c. Metallic sheaths, screens, and armour of all multi core cables shall be earthed at both ends. Sheaths and armour of single core cables shall be earthed at switchgear end only.

d. For prefabricated cable trays, a separate ground conductor shall run along the entire length of cable tray and shall be suitably clamped on each cable tray at periodic intervals. Each continuous laid out lengths of cable tray shall be earthed at minimum two places by copper flats to earthing system.

e. The LV neutral of LT Service transformer shall be directly connected to earth and also connected to neutral of LT switchgear.

f. Each earthing lead from the neutral of the Transformers shall be directly connected to two electrodes in treated earth pits which in turn shall be connected to earthing grid.

g. Connections between earth leads and equipment shall normally be of bolted type. Contact surfaces shall be thoroughly cleaned before connections.

h. Normally an earth electrode shall not be located closer than 1.5 m from any building. Care shall be taken to see that the excavation for earth electrode does not affect the foundation of the building; in such cases, electrodes may be located further away from the building.

i. The location of the earth electrode shall be such that the soil has a reasonable chance of remaining moist as far as possible. Entrances, pavements and roadways, should be avoided for locating earth electrodes.

j. When more than one electrode (plate/pipe) is to be installed, a separation of not less than 2 m shall be maintained between two adjacent electrodes.

k. Earth bars/terminals at all switch boards shall be marked permanently, either as “E” or as

l. Main earthing terminal shall be marked “SAFETY EARTH – DO NOT DISCONNECT”.

4.11.0 Guidelines for selection and application of RCCB

Use of RCCBs is only one of the means that would provide automatic disconnection of supply in the event of shock hazard.

In general, every circuit is provided with a means of over current protection. If the earth fault loop impedance is low enough to cause these devices to operate within the specified times, such devices can be relied upon to give the requisite automatic disconnection of supply. Where the earth fault loop impedance is too large, efforts are required to make it low enough.

When protection against indirect contact is decided to be provided by RCCB, the product of its rated residual current (rated tripping current) in amperes and the earth loop impedance in ohms should not exceed the value 50.

Fault voltage operated circuit breakers voltage operated ELCB are not preferred devices against shock protection.

The preferred rated currents of RCCBs are 10, 30, 100 and 300 mA. RCCBs having minimum operating currents of 30 mA are intended to give protection against ‘indirect contact’. RCCB having minimum operating currents of 30 mA and below are generally referred to as having ‘high sensitivity’ and can give protection against ‘direct contact’ in case of failure of other protective measures..

When using RCCBs, it is necessary to assess the prospective current value in the location where it is likely to be installed and ensure that where higher withstanding or breaking capacities are desirable, suitable back-up protection is available in the system. This could be by means of circuit breaker (MCB), which is in series with the RCCB. The over current/ short circuit protective device is then said to provide back-up protection for the RCCB. Alternately, RCCBs with integral over current/short circuit protection could be employed.

Data Processing Installations/ Industrial Control/ Telecommunication Equipment

Radio frequency interference suppression filters fitted to these equipment may produce high earth leakages. Failure of the protective earth connection may cause a dangerous touch voltage. Use of RCCBs under such circumstances should be carefully considered owing to their frequent tripping, besides capacitor charging currents at switching on shall have to be considered. Under such circumstances, where leakages exceed 10 mA, one of the three measures given below may be necessary:

(a) Use of high integrity protective earth circuits by robust or duplicate conductors,

(b) Earth continuity monitoring, or provision for automatic disconnection when earth continuity fails, or

(c) Use of double wound transformers to enable localization of path of leakage and minimize the possibility of breakages.

The presence of generating sets within an installation may change the conditions of application of RCCB. The contribution to the prospective short circuit current by the generating set should be taken into account.

Medical Establishment and Electrical Installations in Hazardous Locations

The use of RCCB and their selection in such installations has to be carefully considered.

SECTION – B3.17: LIGHTNING PROTECTION SYSTEM

1.0.0 SCOPE OF WORK

This section covers the requirements of lightning protection for the Township.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the applicable National standards, IEC Standards, except where modified and /or supplemented by this specification.

3.0.0 DESIGN CRITERIA

3.1.0 Lightning protection system shall be provided for all the buildings and structures.

3.2.0 Number of Lightning Protection Air Spikes in a building shall depend on the nature of the roof top, on the total area of the roof top, on the height of the building, height of the adjacent buildings, height of the nearby towers or other similar structures..

3.3.0 The principal components of a lightning protective system are:
(a) Air terminations,
(b) Down conductors,
(c) Joint and bonds,
(d) Testing joints,
(e) Earth terminations, and
(f) Earth electrodes.

3.4.0 External metal on a building should be bonded to the lightning conductor with bonds at least as large as the conductor. When a lightning conductor carries a stroke to earth, it is temporarily raised to a potential considerably above that of earth. There is, therefore, a risk that the discharge shall flash over to nearby metal and cause damage to the intervening structure. This can be prevented by either providing sufficient clearance between conductor and other metal or by bonding these together to ensure that there can be no potential difference between them.

3.5.0 Air Terminations

a) Air termination networks may consist of vertical or horizontal conductors, or combinations of both. For the purpose of lightning protection, the vertical and horizontal conductors are considered equivalent and the use of pointed air terminations, or vertical finial is, therefore, not regarded as essential.

b) When there are several parallel horizontal conductors the area between them has been found by experience to be better protected than one would expect from the above considerations only.

c) A vertical air termination, where provided, need not have more than one point, and shall project at least 30 cm, above the object, salient point or network on which it is fixed.

d) For a flat roof, horizontal air termination along the outer perimeter of the roof shall be used. For a roof of larger area a network of parallel horizontal conductors shall be installed.

e) Horizontal air terminations should be carried along the contours such as ridges, parapets and edges of flat roofs, and, where necessary, over flat surfaces, in such a way as to join each air termination to the rest, and should themselves form a closed network.

f) All metallic projections including reinforcement, on or above the main surface of the roof which are connected to the general mass of the earth, should be bonded and form a part of the air termination network.

g) If portions of a structure vary considerably in height, any necessary air terminations or air termination network for the lower portions should be bonded to the down conductors of the taller portions, in addition to their own down conductors.

3.6.0 Down Conductors

a) The down conductor is the conductor which runs from the air termination to the earth termination. The distance between down conductors and between ring conductors shall be according to IEC 62305 Ideally, every air spike should have a down conductor going down up to the earth electrode.

b) A down conductor should follow the most direct path possible between the air terminal network and the earth termination network. Where more than one down conductor is used, the conductors should be arranged as evenly as practicable around the outside walls of the structures.

c) The walls of light wells may be used for fixing down conductors, but Elevator shafts should not be used for this purpose.

d) Metal pipes leading rainwater from the roof to the ground may be connected to the down conductors, but cannot replace them, such connections should have disconnecting joints.

e) In deciding on the routing of the down conductor, its accessibility for inspection, testing and maintenance should be taken into consideration.

f) Provision when External Route is Not Available

i. Where the provision of external routes for down conductors is impracticable, for example, in buildings of cantilever construction from the first floor upwards, down conductors should not follow the outside contours of the building. To do so would create a hazard to persons capacity standing under the overhang. In such cases, the down conductors may be housed in an air space provided by a non-metallic and non-combustible internal duct and taken straight down to the ground.

ii. Any suitable covered recess, not smaller than 76 mm x 13 mm, or any suitable vertical service duct running the full height of the building may be used for this purpose, provided it does not contain an unarmoured or a non-metal sheathed cable.

iii. In cases where an unrestricted duct is used, seals at each floor level may be required for fire protection. As far as possible, access to the interior of the duct should be available.

3.7.0 Installation

a) The lightning protective system should be so installed that it does not spoil the architectural or aesthetic beauty of the building.

b) The entire lightning protective system should be mechanically strong to withstand the mechanical forces produced in the event of a lightning strike.

c) Conductors shall be securely attached to the building, or other object to be protected by fasteners, which shall be substantial in construction, not subject to breakage, and shall be of galvanized steel or other suitable materials, with suitable precautions to avoid corrosion.

d) The lightning conductors shall be secured not more than 1.2 m apart for horizontal run, and 1 m for vertical run.

e) All air terminals shall be effectively secured against overturning either by attachment to the object to be protected, or by means of substantial bracings and fixings which shall be permanently and rigidly attached to the building. The method and nature of the fixings should be simple, solid and permanent, due attention being given to the climatic conditions and possible corrosion.

f) The down conductor system must, where practicable, be directly routed from the air termination to the earth termination network, and as far as possible, be symmetrically placed around the outside walls of the structure starting from the corners. In all cases consideration to side flashing must always be given.

g) Practical reasons may not sometimes allow the most direct route to be followed. While sharp bends, such as arise at the end of roof are inescapable (and hence permissible), re-entrant loops in a conductor can produce high inductive voltage drops so that the lightning discharge may jump across the open side of a loop. As a rough guide, this risk may arise when the length of the conductor forming the loop exceeds 8 times the width of the open side of the loop.

h) When large re-entrant loops as defined above cannot be avoided, such as in the case of some cornices or parapets, the conductors should be arranged in such a way that the distance across the open side of a loop complies with the requirement indicated above. Alternatively, such cornices or parapets should be provided with holes through which the conductor can pass freely.

i) Any metal in, or forming a part of the structure, or any building services having metallic parts which are in contact with the general mass of the earth, should be either isolated from, or bonded to the down conductor. This also applies to all exposed large metal items having any dimension greater than 2 m whether connected to the earth or not.

j) A lightning protective system should have as few joints as possible. Joints should be mechanically and electrically effective, for example, clamped, screwed, bolted, crimped, riveted or welded. With overlapping joints, the length of the overlap should not be less than 20 mm for all types of conductors. Contact surfaces should first be cleaned, and then inhibited from oxidation with a suitable non-corrosive compound. Joints of dissimilar metals should be protected against corrosion or erosion from the elements, or the environment and should present an adequate contact area.

k) Bonds have to join a variety of metallic parts of different shapes and composition, and cannot therefore be of a standard form. There is the constant problem of corrosion and careful attention must be given to the metals involved, i.e. the metal from which the bond is made, and those of the items being bonded. The bond must be mechanically and electrically effective, and protected from corrosion in, and erosion by the operating environment. External metal on, or forming part of a structure, may have to discharge the full lightning current, and its bond to the lightning protective system should have a cross-sectional area not less than that employed for the main conductors. Structures supporting overhead electric supply, telephone and other lines must not be bonded to a lightning protective system without the permission of the appropriate authority. Gas pipe in no case shall be bonded to the lightning protective earth termination system.

l) Each down conductor should be provided with a test joint in such a position that, while not inviting unauthorized interference, it is convenient for use when testing.

m) A 18 SWG GI sheet made Earth Inspection Box must be provided for each down conductor 1000mm above the plinth level of the building (concealed inside the wall) which shall contain a copper strip made clamp on the insulation peeled down conductor to check the continuity of the Earth Lead Down Conductor and the Earth Electrode and also to measure the Earth Resistance of the system. The box shall have a GI sheet made cover plate.

n) All welded/brazed joints shall be coated with anti- corrosive paint for rust protection.

o) Lighting protection conductor shall not be connected to other earthing conductors above ground level.

p) No connections other than the one direct to an earth electrode shall be made below a test point. All joints in the down conductors shall be of brazed type.

q) Lightning conductor on roof shall not be directly cleated on surface of roof. Supporting blocks of PCC/insulating compound shall be used for conductor fixing at an interval of 1200mm.

3.8.0 Sizes of the Components of Lightning Protection Systems

- Vertical Air Terminals: 12 mm dia copper rod.
- Horizontal Air Termination: 25X3 mm copper strip.
- Down conductor: 25X3 mm copper strip.
- Earth conductor to earth electrode buried in ground: 25X3 mm copper strip.
- Earth electrode : 50 mm dia Galvanised steel pipe

3.9.0 Earth Termination Network

a) An earth station comprising one or more earth electrodes as required, should be connected to each down conductor.

b) The earth termination is that part which discharges the current into the general mass of the earth. In other words, it is one or more earth electrodes. Earth electrodes for lightning protection are no different from earth electrodes for short circuit protection systems. The total resistance of an electrode for a lightning protection system must not exceed 2 ohms as per BNBC.

a) If the value obtained for the whole of the lightning protection system exceeds 2 ohms, a reduction can be achieved by extending or adding to the electrodes, or by interconnecting the individual earth terminations of the down conductors by a conductor installed below ground, sometimes referred to as a ring conductor.

b) Buried ring conductors laid in this manner are considered to be an integral part of the earth termination network, and should be taken into account when assessing the overall value of resistance to earth of the installation.

c) Earth electrodes should be capable of being isolated and a reference earth point should be provided for testing purposes.

SECTION – B3.18 : TELEPHONE AND TELEVISION SYSTEM

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of communication system for the Township.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the National Standards.

3.0.0 GENERAL REQUIREMENTS

3.1.0 Electronic Private Automatic Branch Exchange (EPABX) Sub System

3.1.1 The EPABX sub system shall be micro-processor based, fully integrated, modularly expandable digital type. The EPABX sub system equipment shall employ Stored Program Control (SPC) digital switching techniques. The system shall be capable of being upgraded or evolved to the next latest EPABX model to increase the system line.

3.1.2 The exchange should have PCM/TDM technology, non-blocking, modular and with minimum 32 bit CPU processor.

3.1.3 The system shall be equipped with necessary electronic cards for trunk lines and extension lines, housed in a weatherproof enclosure, suitable for mounting in a non-air-conditioned area.

3.1.4 GPS signal input shall be provided from plant GPS system if required.

3.1.5 The quantity of the trunk cards and extension cards shall be selected in such a way so as to provide 10% spare capacity. Electronic cards with intelligent processors shall be provided. The system shall have compatibility for analogue telephone instruments, digital (key) telephone instruments, and special feature telephones. The system shall be supplied with the operator console as an in-built feature. One spare port for operator console shall be provided.

3.1.6 The system shall have 100% non-blocking feature. Redundancy for power supply modules, control and processor card shall be provided. The system shall be 100% fault tolerant. It should have computer (PC) compatibility for data transmission.

3.1.7 Call accounting system with full accounting software for external calls and logging of internal calls shall be provided in the Management PC. Software shall support Events reporting also.

3.1.8 Using the Intercom handsets, operator's handset, it shall be possible to access any of the other handsets selectively without operator intervention using suitably coded dialing with the calls being routed through the EPABX. All such calls shall also be recorded.

3.1.9 The power supply equipment shall incorporate all necessary devices for protecting all items of equipment in the power supply and the whole EPABX sub system, against the effects of voltage surges on the power supply line due to lightning, switching transients or other causes.

3.1.10 Voltage stabilizers, spike busters etc. as required for protection of the system shall be provided such that EPABX / its allied systems are in no way affected by quality of power supply. Suitable protection against supply voltage fluctuations and protection against abnormal voltage/current on all extensions and junction lines shall be provided.

3.1.11 The EPABX shall have full self-diagnostic. All faults besides being annunciated by high intensity LED on the EPABX and audio alarm shall also be displayed on the computer with component level fault being displayed in plain English.

3.1.12 The offered system should have filter circuits on all PCBs, filtering extensions, trunk lines, operator console, maintenance terminal, call billing port, etc. The exchange should also have a fully distributed power supply architecture wherein all the cards of the exchange (line/trunk) should be loaded with their own power supply in the form of DC-DC converters. Each card should draw its own power from the motherboard of the exchange. Hence, there should not be any single point of failure in such architecture.

3.1.13 The exchange should be supplied to run on 48V DC battery with float cum boost charger facility. Capacity of the battery should be sufficient for 8 hours full load capacity of the system.

3.1.14 The exchange shall enable power on maintenance i.e. rectification of faults in hot condition. Hot standby facility for control cards/units shall be available with the system.

3.1.15 The exchange should have both decadic and DTMF outgoing dialing facility from extensions and console.

3.1.16 The exchange should have DID facility to call individual extensions from outside through junctions. It will also have programmable DIL facility. Extended calls not answered within a certain time shall be re-routed to the operator.

3.1.17 The offered system should support CLIP facility on analog extensions with display of number as well as name i.e. both DTMF and FSK should be supported.

3.1.18 The exchange should have an operator console (non-computer) with visual indicators for all extensions and junction lines, alarm facility, display facility and other standard facilities of EPABX.

3.1.19 The exchange shall be suitable for minimum up to 4 digit extension numbering scheme. System shall allow mixed numbering also. System shall have different classes of service during the day and during the night.

3.1.20 It shall be possible via a code, to ring up to specified numbers of extensions for emergency calling simultaneously. These extensions could be analog phones, digital phones or a combination of both.

3.1.21 Suitable commands should be available in the system for re-configuration, peripherals and line tests, fault localization, system initialization, etc. The system should offer an in-built periodic testing program and report generation programs.

3.1.22 The exchange should have standard facilities of an EPABX including the following:-

- Minimum 3 party conference including up to one external line.
- Minimum 8 different classes of service (Cos).
- Music on hold to both internal and external lines.
- Distinctive ring for external and internal calls.
- Emergency switching of junctions to specified extensions on system failure/ power failure.
- Call transfer facility, Call park facility, call privacy, Call forward, Speed dial, Automatic call back
- Howler tones alert on line lock out.
- Call metering facility excluding computer.
- System alarm facility.

- Executive override facility.
- E and M Connectivity
- Do not disturb facility(Individual and group)
- Video conferencing equipment
- Multiple trunk grouping
- Mobile PIN Function
- Personal number future
- Flexible barring facility on trunk lines
- Flexible night service facility
- Call billing, Call pickup with single digit key, call budgeting and CLI facility to all intercom numbers.
- Authorization code, Dial by name.
- Automatic Call Distribution (ACD)
- Customized Key Set
- Direct Inward Dialing (DID)
- Direct Outward Dialing
- Voice announcement
- Call Detail Recording
- Hunting
- Busy lamp field
- Save number redial
- Network Time Synchronization
- Auto call release
- Chief / secretary function
- Auto faulty trunk line isolation
- All other standard features of digital EPABX system.

3.1.23 The PC based attendant console shall be compact, ergonomically designed, aesthetically pleasant and efficient and shall have windows based operating system. . It shall have the necessary controls, dial pad and displays including volume control to supervise and co-ordinate the various functions. It shall have Loop keys, feature keys, function keys, directory, feature dial strings. Dialing shall be done both from Mouse and key pad in PC.

3.1.24 It shall be possible to change the dial tone, ringing tone, call waiting tone, conference tone, override tone etc. as per requirement.

3.1.25 The cables for telephone system, television system and data communication shall be routed in separate conduits.

3.2.0 Telephones and Telecommunications in Buildings

a) Telephones of Analog type, digital type, IP Phone, ISDN phone, PC with soft phone, Video conference device shall be considered.

b) 2 pair PVC insulated PVC sheathed annealed copper telecommunication cable shall be drawn through sufficient number of pre-laid 20mm / 25mm / 40mm PVC concealed conduits to establish Telecommunication Network inside a building. A clearance of at least 40% must be maintained inside the PVC conduits. Sufficient number of 18SWG GI sheet made pull boxes (with Perspex sheet / ebonite sheet cover plates) at all suitable places must be placed for the ease of pulling these cables.

c) 2 pair PVC insulated PVC sheathed annealed copper telecommunication cable shall be used for wiring between a Telephone DP / Patch panel and a Telecommunication outlet. The extra pair shall remain for future maintenance.

d) The minimum size of the copper wire of this cable shall be 0.5mm. The copper shall be preferably tinned.

e) Wall mounted Telecommunication outlets shall contain RJ11 or RJ45 connectors / jacks (shuttered). For simple telephone connection RJ11 shuttered jacks are sufficient. The outlet box shall have a back-box which may be made of the same polymer material as the front panel or shall be made using18 SWG GI sheet.

f) Telephone room should be located near the vertical riser duct of the building so that the incoming multi stranded Telephone cable can be terminated in the Patch Panel for distribution among the Flats of a multistoried residential building or among the offices of a multistoried commercial / office building through JBs located in each floor

g) A separate Earth Electrode with earth lead wire shall be required for the PABX.

h) Fiber optic cable shall be provided for telecommunication between telephone exchange and Main Distribution Frame.

The Quantity and type of telephone units mentioned in the below table is indicative only. The number of telephone units to be provided shall be based on the finial building layouts and the functional requirements and the same shall be without any price implication.

Sno	Buildings	Analog type	Digital type	IP Phone	ISDN phone	Video conference device	PC with soft phone
1.	Executive Residence – Type – A	8	8	-	-	-	-
2.	Executive Residence – Type – B	32	32	-	-	-	-
3.	Executive Residence – Type – C	-	32	-	-	-	-
4.	Staff Residence – Type – D	-	32	-	-	-	-
5.	Head of Plant Bungalow	1	1	-	1	-	-
6.	Guest House	-	52	-	-	-	-
7.	Studio Apartments	-	64	-	-	-	-
8.	Field Hostel – Staff	-	64	-	-	-	-
9.	Trainees Hostel and training Centre	13	20	-	-	-	-
10.	Security Force and army Barracks	2	16	-	-	-	-
11.	Gate and Security	2	-	-	-	-	
12.	Car Parks	-	-	-	-	-	-
13.	Nursery and High School	-	11	-	-	-	-
14.	Mosque	-	1	-	-	-	-

Sno	Buildings	Analog type	Digital type	IP Phone	ISDN phone	Video conference device	PC with soft phone
15.	Hospital	6	20	-	-	-	-
16.	Shopping Center with Post Office, Bank and Estate Office	-	7	-	-	-	-
17.	Temple	-	1	-	-	-	-
18.	Community Center	-	2	-	-	-	-
19.	Executive Club	1	2	-	-	-	-
20.	Non - Executive Club	1	2	-	-	-	
21.	Swimming Pool	1	-	-	-	-	-
22.	Indoor Sports Complex	2	-	-	-	-	-
23.	Outdoor sports area	-	-	-	-	-	-
24.	Potable Water, Service Water and Fire Water Pump House	1	-	-	-	-	-
25.	Main Receiving Substation	1	-	-	-	-	-
26.	Distribution Substations	-	-	-	-	-	-
27.	Maintenance Store	1	-	-	-	-	-
28.	Underground Water Tank	-	-	-	-	-	-
29.	Watch Tower	-	-	-	-	-	-
30.	Police Station	2	1	-	-	-	-
31.	Cyclone Shelter	1	1	-	-	-	-
32.	Storm Water Retention Pond	-	-	-	-	-	-
33.	Gas Cylinder Godown	1	-	-	-	-	-
34.	Transport Center	2	-	-	-	-	-

3.3.0 Master Antenna Television system

a) Master antenna television system shall be provided for various residential buildings enabling the individual user to receive television and radio signals without having personalized antennas. The system with master antenna, filters, distribution amplifiers, attenuators, splitters, tap offs, cables, conduits, distribution up to individual dwelling units complete with all accessories shall be considered. Necessary head end room for installing the equipment shall also be considered.

b) RF and Video cables shall be PVC sheathed Co-axial Cables shall be made with solid Copper centre conductor, foamed polythene insulated and further sealed alluminium foil taped and Copper wire braided.

c) Vertical duct and easy entry to each flats/ offices must be provided as sharp bending of these cables is difficult and harmful to the cables. These cables must not be placed in the same conduit with power cables. A distance of at least 350mm must be maintained if a portion runs in parallel with the power cable conduits.

d) Wall mounted Television coaxial cable outlets shall contain high quality coaxial connectors / jacks. The outlet box shall have a back-box which may be made of the same polymer material as the front panel of 18 SWG GI sheet.

3.4.0 Data Communication Network for LAN and Internet Services inside a Building

a) Data Communication Network for LAN and Internet Services inside the Buildings shall be installed using Cat 6/ Cat 7 unshielded twisted pair (UTP) cables in a concealed manner.

b) Each of the cables shall be terminated at one end at the 8P8C (RJ45) connector based data socket outlet board in the required rooms at the power socket level. On the other end, the cable shall be terminated in the patch panel. From the patch panel up to the data socket outlet the cable shall be in one piece i.e., no joints shall be allowed. As a result the concealed conduit work needs to be done carefully to have a straight line path and without any bend in the roof slab.

c) Sufficient pull boxes shall be required in the roof slab. Pull box shall also be needed close to the vertical bend near the bend and ceiling at any downward drop of the conduit. The conduits must have 20 SWG GI pull wires during laying for pulling the cables later.

d) If the conduits are running parallel to the power cables then there should be at least a distance of 410mm between these two.

SECTION – B3.19 : INTERNAL ELECTRIFICTION

1.0.0 SCOPE OF WORK

This section covers the requirements of internal electrification for efficient and trouble-free operation of Township.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the applicable IEC Standards, except where modified and /or supplemented by this specification.

3.0.0 DESIGN CRITERIA

3.1.0 General

3.1.1 Internal electrification for the buildings shall include provision of the following :

- Main distribution board
- Raising mains
- Floor DBs/DBs/Sub DBs/Branch DBs
- Circuit wiring
- Point wiring
- Bus trunking

3.1.2 Each main distribution board and branch distribution board shall be controlled by an incoming circuit breaker. Each outgoing circuit shall be controlled by a circuit breaker.

3.1.3 Only MCCB/MCB/RCCB type DBs shall be used. Fuses shall not be used.

3.1.4 Three phase DBs shall not be used for final circuit distribution as far as possible.

3.1.5 'Power' wiring shall be kept separate and distinct from light wiring, from the level of circuits, i.e., beyond the branch distribution boards. Conduits for light/power wiring shall be separate.

3.1.6 Essential/non-essential/UPS distribution each shall have a completely independent and separate distribution system starting from the main, switchboard up to final wiring for each system. As for example, conduit carrying non-essential wiring shall not have essential or UPS wiring. Wiring for essential and UPS supply shall have their own conduit system. No mixing of wiring is allowed.

3.1.7 Generally, no switchboard shall have more than one source of incoming supply. More than one incoming supply shall be allowed only at main board with proper safety and interlocking so that only one source can be switched on at a time.

3.1.8 Each MDB/DB/Switch Board shall have reasonable spare outgoing ways for future expansion.

3.1.9 For the calculation of current (for the selection of cables and breakers) of the lamps, fans and small inductive loads (up to 1.0 KW), the ratings shall be multiplied by a factor of 1.65 to take care of the power factor and the starting current situation.

3.1.10 Balancing of 3-phase circuit shall be done.

3.1.11 It is recommended to provide MCB in proper enclosure as power outlet for window type AC units, geysers etc.

3.1.12 The type of wiring, surface conduit/recessed conduit, steel/PVC, channel, shall be selected for the type of buildings to match function and aesthetic. In general, residential and commercial buildings shall have recessed PVC conduit and industrial buildings shall have surface steel conduit.

3.1.13 Copper conductor cable only shall be used for sub main/ circuit/ point wiring. Minimum size of wiring:

- Light Wiring : 1.5 sq.mm.
- Power Wiring : 4.0 sq.mm.
- Power circuit rated more than 1 KW: Size as per calculation.

3.1.14 Number, rating and layout of outlets for general illumination, fans and other known loads should accurately be distributed among a number of branch circuits. These branch circuits should then be carefully loaded with due regard to voltage drop, operating voltage and possible increase in lighting levels in future. Socket loads shall be determined from projections based on the utility of the building and type of applications.

3.1.15 Every installation shall be divided into small circuits (following the rules given in this document) to avoid danger in case of a fault, and to facilitate safe operation, inspection, maintenance and testing. For the establishment of the circuits appropriate type of wiring is needed and appropriate terminations / connections / junctions of these circuits are needed. At the same time appropriate types of protection against faults must be given at different levels. These shall be achieved through installation of appropriate distribution wiring in the building.

3.1.16 Efficient working of street lights and staircase lighting is required for security of the colony and safety and convenience of the residents. Therefore adequate street lighting, staircase lighting is to be provided. Back lanes of residential blocks are also to be covered by basic street lighting for security.

3.1.17 In Kitchen, Exhaust fans opening with one point outlet to be provided irrespective of yardstick of provision of exhaust fans..

3.1.18 Location of washing machine to be finalized in consultation with the Architect. A power outlet plus water supply/drainage to be coordinated with Architect/Civil Engineer.

3.1.19 Generally for a block of quarters, electric supply for each block is received in a Main DB located at ground floor. Further power shall be distributed to each floor DBs for distribution to each dwelling unit. Energy meter for individual dwelling unit shall be located in the floor DB..

3.1.20 Stair case lighting is to be treated as an extension of street lighting, for security and convenience of the residents. LED lighting shall be provided to reduce load. Incandescent stair case lighting and bulk head fittings should not be provided, in view of excessive energy consumption and low burning hours.

3.1.21 For ensuring essential water supply and security lighting, supply through D.G. set to be provided to take care of water supply pump set, street lighting and essential load requirement of buildings.

3.1.22 Subject to limit of yardstick of fittings for various types of quarters following guidelines to be provided:

- Every room to be provided with one LED lamp fitting for energy saving.
- Each dwelling unit shall be provided with one number decorative light fitting in drawing room / dining room
- Kitchen to be provided with a LED fitting, tapped from a batten holder (through an adopter), so that in case of need batten holder can be used with bulbs.
- Incandescent bulkhead fittings not to be used.
- Quality fittings of reputed make to be used.

3.1.23 Main Board of Each Quarter shall be MCB type with provision of RCCB with the incoming MCB. It shall be located in a nitch with ventilated door cover, in the room connecting to the entry of the quarter. MCB DB shall be pre-wired type, for trouble free service.

3.1.24 Starting from a suitable room, pipe network may be provided to lay telephones/TV cables for the colony. Suitable road cross pipe and manholes to be provided for drawing such cables and their maintenance.

3.1.25 Residential colonies may require support services like intercom system, basic security system etc. for the safety and convenience of the residents. Basic provisions for the same shall be considered.

3.1.26 All lamps shall be LED type.

3.1.27 Ceiling fans shall be rated at 60W. Exhaust fans, LED lamps etc. shall be rated according to their capacity.

3.1.28 6A and 16A socket outlet points shall be rated at 100W and 1000W respectively, unless the actual values of loads are specified.

3.1.29 Lighting circuit shall feed light/fan/ call bell points. Each circuit shall not have more than 800 Watt connected load or more than 10 points whichever is less.

3.1.30 Power circuit in non-residential building shall have only one outlet per circuit. Each power circuit in residential building can feed following outlets:

- Not more than 2 Nos. 13A outlets.
- Not more than 3 Nos. 5A outlets.
- Not more than 1 No.13A and 2 Nos. 5A outlets.

3.1.31 Load more than 1 KW shall be controlled by suitably rated MCB and cable size shall be decided as per calculations.

3.1.32 Wooden plugs for fixing of devices/wiring/conduit to wall/ceiling shall not be allowed. Fixing shall be done with the help of PVC sleeves/Rowel plugs/ dash fasteners as required. Drilling of holes shall be done by drilling machines only. No manual drilling of hole shall be allowed.

3.1.33 To meet large-scale power requirement in a hall, or floor, with use of single phase or 3 phase factory fabricated bus-trunking of reputed make, conforming to relevant IEC standards and with standard accessories like End feed unit, tap off with necessary safety features like over current, short-circuit and earth fault protection. Such trunking shall be of specified breaking KA rating.

3.1.34 Telephone wiring is to be provided for each quarter. Such telephone wiring to be brought to a tag-block at a suitable point in ground floor and further to Main distribution frame. Provisions shall be kept for suitable entry-pipe for laying incoming telephone cable.

3.1.35 Internal TV cabling shall be provided. Similarly, from suitable point at Roof/ ground floor, MATV cabling shall be provided.

3.1.36 False ceiling electrical layout shall be coordinated with the Architect and the Civil Engineer so that reflected drawing provides for symmetrical and aesthetic layout of the following:

- Fans
- Light fittings
- A/C Diffuser
- Fire detectors
- Sprinklers
- Speakers etc.

3.2.0 Switches, Socket Outlets and Plugs

a) All 13A socket outlets must be switched (combined) and shuttered and shall be for 3 pin Flat pin type (rectangular cross section). The corresponding plugs must be fitted with fuse. The maximum fuse rating shall be 13A for 13A Sockets.

b) The phase wire (Red cable) shall be connected to the L terminal of the socket outlet through the combined switch and the neutral wire (Black cable) shall be directly connected to the N terminal of the socket. Earth Continuity Conductor (ECC) (Yellow + Green bi-colour cable) for such a socket outlet shall be connected to the Earth terminal of the socket. The feed cables for such a circuit must have miniature circuit breaker (MCB) at the originating point in the Distribution Board.

c) 15A /20A rated Round Pin socket outlets may be used for Air Conditioner Outlets and Water Heater Outlets along with a circuit breaker protection in a box adjacent to the sockets. Each 15A / 20A socket outlet shall be provided with its own individual MCB. The feed cables for such a circuit must have miniature circuit breaker (MCB) at the originating point in the Distribution Board. The corresponding plugs should be fitted with fuse.

d) Wiring for sockets shall be radial type of wiring. However, ring type wiring may be used by strictly following the rules given in IEE Wiring regulations BS 7671: 2008, 17th Edition and by using appropriate size of cable.

e) Three pin Switched Shuttered Socket outlets shall be mounted on a wall at a height 230 mm above floor level. For certain applications like computers, printers, UPS, IPS such sockets may be mounted at a higher level for the ease of operation.

f) No socket outlets shall be provided inside Bath Rooms / Toilets or any other place where the floor may remain wet.

g) The number of socket outlets in a building depends upon the specific requirements of occupants and the type of building. Adequate number of 13 A switched flat pin (rectangular cross section pin) shuttered socket outlets shall be provided and arranged around the building to cater to the actual requirements of the occupancy.

h) 15 A round pin (rectangular cross section pin) socket outlets shall be provided for specially Air conditioners and water heaters of such ratings only.

i) For residential buildings, the minimal guidelines given below shall be used to determine the required number of 13 A switched flat pin (rectangular cross section pin) shuttered socket outlets, when actual requirements cannot be ascertained. All socket outlets shall conform to BDS 115.

j) Minimum Number of 13A flat pin Socket Outlets

Location	**No. of Switch Socket Outlets**
Bed room	3
Living room	3
Drawing room	3
Dining room	1
Toaster / Snack Toaster	1
Kitchen	5
Bathroom	1
Verandah	1
Refrigerator	1
Air-conditioner	one for each room (15A /20A rated Round Pin socket outlets)

k) Restriction on installation of two socket outlets in room fed from two phases:

Installation of two socket outlets in a room fed from two different phases should be avoided as far as possible.

l) Switches and Socket outlets in exposed places where chances of dripping / falling rain water exist should not be placed. In case of necessity, weather proof/ waterproof covered socket outlets may be mounted with appropriate precautions. In such a case the back box should preferably be of bakelite or Acrylic or plastic material.

m) In industrial premises light fittings shall be supported by suitable pipe/conduits, brackets fabricated from structural steel, steel chains or similar materials depending upon the type and weight of the fittings.

n) Modular type switches to be provided for all the buildings. Switch box shall be hot dip galvanized, factory fabricated, suitable in size for surface/ recess mounting and suitable in size for accommodating the required number of switches and accessories. Switches shall be provided for the control of every light fitting. A switch may control an individual light point or a group of light points.

o) Where control at more than one position is necessary for a lighting fitting or a group of lighting fittings, as many two way or intermediate switches may be provided as the required number of control positions.

p) A ceiling rose is needed for terminating the point wiring for a Light or a Fan in the ceiling. A ceiling rose shall not be installed in any circuit operating at a voltage normally exceeding 250 volts. A single pendant be suspended from only one ceiling rose using a flexible cord. A ceiling rose shall not be used for the attachment of more than one outgoing flexible cord.

q) Lamp holders may be batten, angle, pendant or bracket holder type as required. The holder shall be made of brass and shall be rigid enough to maintain shape on application of a nominal external pressure. There should be sufficient threading for fixing the base to the lamp holder part so that they do not open out during attention to the lamp or shade. Lamp holders for use on brackets and the like shall have not less than 1.3 cm nipple, and all those for use with flexible pendant shall be provided with cord grips. All lamp holders shall be provided with shade carriers.

r) Switches and socket outlets shall be installed as follows:

- Non-residential buildings – 23 cm above floor level.
- Kitchen – 23 cm above working platform and away from the likely positions of stove and sink.
- Bathroom – No socket outlet is permitted for connecting a portable appliance thereto. MCB/IC switch may be provided above 2 m for fixed appliances, and at least 1 m away from shower.
- Rooms in residences – 23 cm above floor level.
- Control switches for the 6A and 16A socket outlets shall be kept along with the socket outlets.
- The switch box shall normally be mounted with their bottom 1.25 m from floor level
- All accessories like switches, socket outlets, electronic fan regulators, call bell pushes and regulators shall be fixed in flush pattern inside the switch/regulator boxes. Accessories like ceiling roses, brackets, batten holders etc. shall be fixed on outlet boxes. Aluminium alloy or cadmium plated iron screws shall be used to fix the accessories to their bases.

3.3.0 Ceiling fans

- Ceiling fans including their suspension shall conform to BDS 818.
- With respect to the position of a lighting fitting, placing a fan in a way that shadows are thrown on the working planes is not acceptable.
- For domestic, office and commercial buildings, for every part of a module to be served by the ceiling fans, it is necessary that the unit module area shall be so

chosen that the required number of fans could be suitably located in it, to avoid creation of pockets receiving little or no air circulation.

- Fans in large halls may be spaced at 3 to 3.5 m in both the directions in the horizontal plane. If building modules do not lend themselves to proper positioning of the required number of ceiling fans, other types of fans, such as air circulators or wall mounted bracket fans shall have to be installed for the areas uncovered by the ceiling fans. In such cases, necessary electrical outlets shall have to be provided for the purpose.
- Wiring for a ceiling fan outlet from the switch board up to the ceiling fan outlet shall be done through pre laid 20 mm dia PVC conduits using 1.5 mm2 PVC insulated 2 cables of Red and Black insulation. A high quality ceiling rose is to be installed at the ceiling fan point for the termination of the wiring and the connection of the two wires of the Fan.
- Ceiling Fans shall be suspended from Fan hooks. A fan hook is required to be placed during casting of the roof. The fan hook is to be made using a 12.7 mm dia MS rod having at least 600mm on both sides and shall be placed above the MS rod mesh of the roof slab.
- For Wall mounted bracket fans shall be mounted on the wall using appropriate rowel bolts. Wiring for a Wall mounted bracket fan outlet from the switch board up to the Wall mounted bracket fan outlet shall be done through pre laid 20 mm dia PVC conduits using 1.5 mm2 PVC insulated 2 cables of Red and Black insulation. A high quality ceiling rose is to be installed at the ceiling fan point for the termination of the wiring and the connection of the two wires of the Fan.
- The height of fan blades above the floor should be (3H + W)/4, where H is the height of the room, and W is the height of the work plane.
- The minimum distance between fan blades and the ceiling should be about 0.3 meters.
- When actual ventilated zone does not cover the entire room area, then optimum size of ceiling fan should be chosen based on the actual usable area of the room, rather than the total floor area of the room.
- Ceiling fans shall be Energy Efficient fans with star rating and minimum service value of fans shall be 3.5 m3/min/W and air delivery 200 m3/min. Air delivery values are on the basis of air velocity measurements up to 15m/min.
- Step Type Electronic regulators should be used instead of resistance type regulators for controlling speed of fans.
- All ceiling fans shall be wired to ceiling roses or to special connector boxes, and suspended from hooks or shackles, with insulators between hooks and suspension rods. There shall be no joint in the suspension rod.
- Canopies on top of suspension rod shall effectively hide the suspension.
- The leading in wire shall be of nominal cross sectional area not less than 1.5 sq. mm. and shall be protected from abrasion.
- Unless otherwise specified, all ceiling fans shall be hung 2.75 m above the floor.
- In the case of measurement of extra down rod for ceiling fan including wiring, the same shall be measured in units of 10 cm. Any length less than 5 cm shall be ignored.
- The number of fans and the optimum sizes for rooms of different dimensions are given in the following table:

Optimum Size/Number of Fans for Rooms of Different Sizes

Room Width						Room Length					
m	4m	5m	6m	7m	8m	9m	10m	11m	12m	14m	16m
3	1200/1	1400/1	1500/1	1050/2	1200/2	1400/2	1400/2	1400/2	1200/3	1400/3	1400/3
4	1200/1	1400/1	1200/2	1200/2	1200/2	1400/2	1400/2	1500/2	1200/3	1400/3	1500/3
5	1400/1	1400/1	1400/2	1400/2	1400/2	1400/2	1400/2	1500/2	1400/3	1400/3	1500/3
6	1200/2	1400/2	900/4	1050/4	1200/4	1400/4	1400/4	1500/4	1200/6	1400/6	1500/6
7	1200/2	1400/2	1050/4	1050/4	1200/4	1400/4	1400/4	1500/4	1200/6	1400/6	1500/6
8	1200/2	1400/2	1200/4	1200/4	1200/4	1400/4	1400/4	1500/4	1200/6	1400/6	1500/6
9	1400/2	1400/2	1400/4	1400/4	1400/4	1400/4	1400/4	1500/4	1400/6	1400/6	1500/6
10	1400/2	1400/2	1400/4	1400/4	1400/4	1400/4	1400/4	1500/4	1400/6	1400/6	1500/6
11	1500/2	1500/2	1500/4	1500/4	1500/4	1500/4	1500/4	1500/4	1500/6	1500/6	1500/6
12	1200/3	1400/3	1200/6	1200/6	1200/6	1400/6	1400/6	1500/6	1200/7	1400/9	1400/9
13	1400/3	1400/3	1200/6	1200/6	1200/6	1400/6	1400/6	1500/6	1400/9	1400/9	1500/9
14	1400/3	1400/3	1400/6	1 400/6	1400/6	1400/6	1400/6	1500/6	1400/9	1400/9	1500/9

3.4.0 Exhaust Fans

- Exhaust fans are necessary for spaces, such as toilets, kitchens, canteens and godowns to provide the required air changes. Since the exhaust fans are located generally on the outer walls of a room, appropriate openings in such walls shall be provided right from the planning stage. The sizes and the rpm of the exhaust fans shall vary according to the application and the volume for which a fan used. In all cases appropriate types of fan need to be chosen and appropriate arrangement need to be made so that rain water cannot get inside the rooms.

Room Area (m2)	**Fan Sweep**
Up to 6	915 mm
Over 6 to 9	1220 mm
Over 9 to 12	1442 mm

- For fixing an exhaust fan, a circular opening shall be provided in the wall to suit the size of the frame, which shall be fixed by means of rag bolts embedded in the wall. The hole shall be neatly plastered to the original finish of the wall. The exhaust fan shall be connected to the exhaust fan point, which shall be wired as near to the opening as possible, by means of a flexible cord, care being taken to see that the blades rotate in the proper direction.
- Exhaust fans for installation in corrosive atmosphere, shall be painted with special PVC paint or chlorinated rubber paint.
- Installation of exhaust fans in kitchens, dark rooms and such other special locations need careful consideration; any special provisions needed shall be specified.
- The metallic body of ceiling fans/exhaust fans shall be connected to earth by protective conductor.

3.5.0 Wiring System

3.5.1 Submain wiring shall mean the wiring from one main/distribution switchboard to another.

3.5.2 Circuit wiring shall mean the wiring from the distribution board to the 1st tapping point inside the switch box, from where point wiring starts.

3.5.3 Conduit carrying submain shall not carry circuit/point wiring. Similarly conduit carrying circuit wiring shall not carry submain/point wiring. Conduit carrying point wiring shall not carry submain/circuit wiring.

3.5.4 Point Wiring: A point (other than socket outlet point) shall include all work necessary in complete wiring to the following outlets from the controlling switch or MCB.

- Ceiling rose or connector (in the case of points for ceiling/exhaust fan points, prewired light fittings, and call bells).
- Ceiling rose (in case of pendants except stiff pendants).
- Back plate (in the case of stiff pendants).
- Lamp holder (in the case of goose neck type wall brackets, batten holders and fittings which are not prewired).

3.5.5 Following shall be deemed to be included in point wiring:

- Conduit/channel as the case may be, accessories for the same and wiring cables between the switch box and the point outlet, loop protective earthing of each fan/ light fixture.
- All fixing accessories such as clips, screws, Phil plug, rawl plug etc. as required.
- Metal switch boxes for control switches, regulators, sockets etc, recessed or surface type, and phenolic laminated sheet covers over the same.
- Outlet boxes, junction boxes, pull-through boxes etc. but excluding metal boxes if any, provided with switchboards for loose wires/conduit terminations.
- Control switch or MCB, as required.
- 3 pin or 6 pin socket, ceiling rose or connector as required. (2 pin and 5 pin socket outlet shall not be permitted.)
- Connections to ceiling rose, connector, socket outlet, lamp holder, switch etc.
- Bushed conduit where wiring cables pass through wall etc.
- In areas where false ceiling are provided, termination of wires should be at the fittings. Flexible conduits from ceiling junction box to the fittings shall be provided duly coupled at both ends. This shall be included within the scope of point wiring.
- Interconnecting wiring between switches within the switch box on the same circuit.

3.5.6 In wiring, no joints in wiring shall be permitted anywhere, except in switch box or point outlets, where jointing of wires shall be allowed with use of suitable connector.

3.5.7 The wiring throughout the installation shall be such that there is no break in the neutral wire except in the form of linked switchgear.

3.5.8 Light, fans and call bells shall be wired in the ‘lighting’ circuits. 13 / 15 / 20 A socket outlets and other power outlets shall be wired in the ‘power’ circuits. 5A socket outlets shall also be wired in the ‘power’ circuit both in residential as well as non residential buildings.

3.5.9 Colour Coding: Following colour coding shall be followed in wiring:

- Phase : Red/Yellow/Blue.(Three phase wiring)
- Live : Red (Single phase wiring)
- Neutral : Black
- Earth : Yellow/Green.

3.5.10 Termination of Circuit into Switchboard: Circuit shall consist of phase/neutral/earth wire. Circuit shall terminate in a switch board (first tapping point, where from point wiring starts) in following manner:

- Phase wire terminated in phase connector.
- Neutral wire terminated in neutral connector.
- Earth wire terminated in earth connector.
- The switchboard shall have phase, neutral and earth terminal connector blocks to receive phase/ neutral/ earth wire.

3.5.11 Conduits shall not normally be allowed to cross expansion joints in a building. Where such crossing is found to be unavoidable, special care must be taken to ensure that the conduit runs and wiring are not in any way put to strain or are not damaged due to expansion/contraction of the building structure. In unavoidable situations PVC conduits through an oversize Flexible PVC conduits may be used with pull boxes on both sides of the expansion joints.

3.5.12 Pull boxes / Joint boxes must be placed closed to the ceiling where conduits from the ceiling are going downward toward a switch box or are going toward a socket box or are going toward a PDB/ SDB/ DB / FDB. Pull boxes are extremely essential for pulling the cables without injuring the cables and thus should not be avoided under any circumstances. Pull boxes / Joint boxes must be placed in the ceiling of office / factory building where conduits are running over a long distance between two walls (terminal points) and where fixed walls are not available and also where heavy beams are used.Pull boxes / Joint boxes must be made with 18 SWG GI sheet or with 18 SWG MS sheet but coated with two coats of Grey Synthetic Enamel paint. Covers of Pull boxes should be ebonite or Perspex sheet of not less than 1/8 inch thickness.

3.5.13 Run of Wiring

- Surface wiring shall run as far as possible along the walls and ceiling, so as to be easily accessible for inspection.
- Above false ceiling, in no case, open wiring shall be allowed. Wiring shall be done in recessed conduit or surface steel conduit.
- In recessed conduit system, routes of conduit shall be planned, so that various inspection boxes provided don't present a shabby look. Such boxes can be provided 5 mm above plaster level, and they can be covered with plaster of paris with marking of junction boxes.
- Where number of electrical services like electrical wiring, telephone wiring, computer cabling, pass through corridors, it may be proper to plan such service with properly designed aluminium/PVC channels duly covered by a false ceiling, so that subsequently such service can be maintained and additional cables can be provided.
- Generally conduits for wiring shall not be taken in floor slabs. When it is unavoidable special precaution to be taken to provide floor channels with provision for safety and maintenance. Alternatively false flooring can be provided.
- When wiring cables are to pass through a wall, these shall be taken through a protection (steel/ PVC) pipe of suitable size such that they pass through in a straight line without twist or cross in them on PVC or other approved material.
- All floor openings for carrying any wiring shall be suitably sealed after installation.
- No bare conductor in phase and/or neutral or twisted joints in phase, neutral, and/ or protective conductors in wiring shall be permitted.
- There shall be no joints in the through-runs of cables. If the length of final circuit or submain is more than the length of a standard coil, thus necessitating a through joint, such

joints shall be made by means of approved mechanical connectors in suitable junction boxes.

- Termination of multistranded conductors shall be done using suitable crimping type thimbles.

3.5.14 Circuit Wiring

Separate branch circuits for separate control Separate branch circuits shall be provided for different parts of a building area which need to be separately controlled. A branch circuit should be independently working and should not be affected due to the failure of another branch circuit.

The number of final circuits (also termed as sub-circuits or circuits) required and the points supplied by any final circuits shall comply with

a) the requirement of over-current protection,

b) the requirement for isolation and switching, and

c) the selection of cables and conductors.

All final circuits shall be wired using loop wiring system; no joint box shall be used.

Sufficient number of 18 SWG sheet steel made (painted with two coats of grey synthetic enamel paint) pull boxes, with ebonite / perspex sheet cover plate, must be given on the walls near the ceiling. If brick walls are not available, pull boxes must be given in the ceilings.

5A Light / Fan Circuits must be used for all Domestic and Residential buildings. 5A Light / Fan Circuits are also to be used for Office and commercial Buildings. The corresponding circuit wire in the BDB/ SDB/ DB then shall be not less than 1.5 mm2.

For Office and Commercial Buildings having large open floor areas, under unavoidable circumstances, in case of difficulties in forming 5A Light / Fan Circuits for Office and commercial Buildings having large open floor areas, 10A Light / Fan Circuits may be used. The corresponding circuit wire in the BDB/ SDB/ DB then shall be not less than 2.5 mm2. However use of 5A Light / Fan Circuits is still emphasized.

For Industrial / Factory Buildings having large open floor areas, 10A Light / Fan Circuits may be used. The corresponding circuit wire in the BDB/ SDB/ DB then shall be not less than 2.5 mm2.

For Industrial / Factory Buildings having very large open floor areas, 15A Light / Fan Circuits may be used as exceptional cases only. The corresponding circuit breaker in the BDB/ SDB/ DB then shall be not less than 4 mm2.

Increase in the sizes of the above mentioned cables may be required if the distance is too long. Voltage drop calculation shall give the guidance in that case.

3.5.15 Branch circuits from miniature circuit breaker (MCB)

Separate branch circuits shall be provided from miniature circuit breaker (MCB) of a BDBD/ SDB for Light / Fan.

Separate branch circuits shall be provided from miniature circuit breaker (MCB) of a BDBD/ SDB for automatic and fixed appliances with a load of 500 watt or more and socket outlets. Each automatic or fixed appliance shall be served by a protected socket circuit.

Less than 50% loading of Circuits with more than one outlet

Circuits with more than one outlet shall not be loaded in excess of 50% of their current carrying capacity.

Branch circuits must have spare capacity to permit at least 20% increase in load.

Each branch circuit running between a DB and a SDB, between a SDB and a BDB must have spare capacity to permit at least 20% increase in load before reaching the level of maximum continuous load current permitted for that circuit

At least one spare circuit must be allowed in the distribution board for each five circuits in use.

Additional space for a circuit breaker along with the provision for connecting a pair of outgoing cables shall be kept.

Each final circuit shall be connected to a separate way in a distribution board

Where an installation comprises more than one final circuit, each final circuit shall be connected to a separate way in a distribution board. The wiring of each final circuit shall be electrically separate from that of every other final circuit, so as to prevent unwanted energization of a final circuit.

Size of cables in a branch circuit shall be at least one size larger than that needed for the

computed load current Size of cables to be used in a branch circuit shall be at least one size larger than that computed from the loading if the distance from the over-current protective device to the first outlet is over 15 m.

4 mm2 (7/0.036) and 6 mm2 (7/0.044) wiring cable for a 15A socket outlet branch circuit

The minimum size of wiring cable used for a 15A socket outlet branch circuit shall be 4 mm2 (7/0.036). When the distance from the over-current protective device to the first socket outlet on a receptacle circuit is over 30 m the minimum size of wire used for a 15A branch circuit shall be 6 mm2 (7/0.044).

The length of a lighting circuit shall be limited to a maximum of 30 m, unless the load on the circuit is so small that voltage drop between the over-current protective device and any outlet is below 1%.

Use of common neutral for more than one circuit is prohibited

Each circuit must have it’s own neutral cable. Use of common neutral cable for more than one circuits is not permitted.

During wiring, correct colour codes of the insulation of the cables must be used. For a single phase circuit Red colour insulated cable must be used for the live wire and the Black colour insulated cable must be used for the neutral and green +yellow bi-colour insulated cable must be used for the ECC. For a three phase circuit Red colour must be used for the live (L1), Yellow colour for the live (L2), Blue colour for the live (L3) wire and the Black colour for the neutral and green + yellow bi-colour must be used for the ECC. The above mentioned colour coding must be indicated in the design drawing. This should also be mentioned in the specification.

Colour Codes of Cables which shall be used for wiring Pre-2004 IEE Standard

Protective earth (PE) or ECC or Earth Lead Wire	Green + yellow bi-colour
Neutral (N)	Black
Single phase:	Live (L)
Three phase:	L1 Red
Three phase:	L2 Yellow
Three phase:	L3 Blue

In a 3 phase distribution system special care must be taken during wiring to obtain balancing of loads among the three phases.

In a 3 phase SDB, DB, FDB, MDB connections of the circuits to the busbars must be made in such a way so that the load current remains balanced among the three lines during low load as well as full load. After completing the installation balancing should be checked by clamp

meter current measurement of each phase. The above mentioned current balancing must be indicated in the SDB (if 3 phase), DB, FDB, and MDB circuit diagram of design drawing. This should also be mentioned in the specification.

Light and Fan circuits must not be mixed with the Socket Circuits

In designing the wiring layout, power (socket) and heating (socket) sub-circuits shall be kept separate and distinct from light and fan sub-circuits. All wiring shall be done on the distribution system with main and branch distribution boards placed at convenient positions considering both physical aspects and electrical load centres. All types of wiring whether concealed or surface, shall be as near the ceiling as possible. In all types of wiring due consideration shall be given to neatness and good appearance.

3.5.16 Surface Wiring or Exposed Wiring

Wiring run over the surface of walls and ceilings, whether contained in conduits or not, is termed as surface wiring or exposed wiring.

Single core PVC insulated flame retardant copper through GI pipes of approved quality may be used for surface wiring.

GI pipes, when used for surface wiring, shall be clamped with saddles at a spacing not exceeding 600 mm, to the wall or ceiling using plastic rowel plugs with countersunk galvanized screws.

3.5.17 Concealed Wiring

The wires in this type of wiring shall be placed inside GI conduits or PVC conduits that are concealed in roofs and in brick/concrete walls. The conduits in the walls shall be run horizontally or vertically, and not at an angle. Conduits in concrete slabs shall be placed at the centre of thickness and supported during casting by mortar blocks or 'chairs' made of steel bars or any other approved means. All conduits shall be continuous throughout their lengths.

Appropriate planning should be made in which there shall be adequate spare capacity in the conduits placed in roof slabs so that unforeseen situation during execution of the installation can be taken care of. Conduits shall run through the roof and then bend downward for going up to the outlets, DBs, Switch Boards, Sockets. In a column structure building having no permanent walls, Switch Boards and Socket Boards, Pull Boxes shall be placed in Columns and must be done during the casting of columns. Concealed wiring through floors and upward mounting of PVC / GI pipes from the floor is strongly discouraged because of the occurrence of condensation and accumulation of water from condensation eventually leading to damaging of the simple PVC insulated cable insulation. This method should not be followed as a general practice.

Underground cables for electrical distribution in the premises/garden/compound of the building shall be encased in GI or PVC pipes and laid in earth trenches of sufficient depth. Armoured cables need not be encased in conduits except for crossings under road, footpath, walkway or floors.

The conduits placed concealed inside roof or in wall must have 20 SWG GI pull wires placed during laying of the pipes for pulling the cables later.

3.5.18 Wiring inside Suspended Ceilings (False Ceilings)

Wiring inside Suspended Ceilings (False Ceilings) shall be surface wiring through conduits.

Cables shall not be placed loosely and haphazardly on the suspended ceilings. Placing naked cables inside the suspended ceiling is not permitted.

Cable joints with PVC tape wrapping is not allowed for connection of a fitting from the ceiling rose or from a junction box inside the gap space.

3.5.19 Mounting Height of Light and Fan Switch Boards

Light and Fan Switch Boards shall be placed 1220mm above floor level in the Domestic Buildings (i.e, the clearance between the floor and the bottom of the Switch Board shall be 1220mm).

This above mentioned height shall be1300 mm above floor level in the Office Buildings, Commercial Buildings and Industrial Buildings. However, the minimum height shall not be below 1220mm.

3.5.20 Cable Joints and Cable Joint Boxes in Concealed and surface wiring

Both the Red (L) and Black (N) cables of a final circuit shall run from a BDB/ SDB up to the Switch board without a joint. Similarly, both the Red (L) and Black (N) cables of a point shall run from the point up to the switch board. Cable joints shall be made in the switch board back box. Circumstances might arise where this is not possible. Under those circumstances, joints shall be made using approved cable joint methods.

Where a wiring system is located in close proximity to a non electrical service both the following conditions shall be met:

- the wiring system shall be suitably protected against the hazards likely to arise from the presence of the other service in normal use, and appropriate protection against indirect contact shall be taken.
- A wiring system shall not be installed in the vicinity of a service which produces heat, smoke or fume likely to be detrimental to the wiring, unless protected from harmful effects by shielding arranged so as not to affect the dissipation of heat from the wiring.

Where a wiring system is routed near a service liable to cause condensation (such as water, steam or gas services) precautions shall be taken to protect the wiring system from deleterious effects.

No cable shall be run in a lift (or hoist) shaft unless it forms part of the lift installation as defined in BS 5655.

3.5.21 Design for Electrical Wiring in Bedrooms and Drawing Rooms

The location of a switch board must be near the entrance door of a bedroom like any other room. The location of the wall mounted light fittings must be chosen based on the possible locations of furniture which is also needed in other rooms. Sufficient number of 3-pin 13 A switched shuttered flat pin sockets must be provided in a bed room.

The same ideas are applicable for a Living room.

Design must be made in such a way that sufficient clearance (space) is left inside the concealed conduits (i) for the ease of pulling the cables and also for adding few more cables in case of necessity during future modification.

For Bedrooms and Drawing Rooms the Light + Fan sub circuits for shall not be of more than 5A rating.

3.5.22 Design for Electrical wiring in a Kitchen especially providing 3 pin sockets near Kitchen sink

The sensitive item in a kitchen is placing 3-pin 13 A switched shuttered flat pin sockets on wall of the kitchen side table near the wall. Good distance must be maintained between the kitchen water tap and the socket. The Socket for the Refrigerator (if any) shall also be a 3-pin

13 A switched shuttered flat pin socket, and may be placed at the same level as the other socket. For the ease of operation a 3-pin 13 A switched shuttered flat pin socket for this purpose may be placed at the bottom level height of a switch board provided this is acceptable in terms of aesthetics.

For Kitchens, the Light + Fan sub circuits for shall not be of more than 5A rating.

3.5.23 Switches for Toilets and Bath Rooms

Switches for toilet lights and toilet ventilating fans must be placed outside the toilets adjacent to the entrance door but must not be placed inside the Toilet. The same rule should be followed for Bath Rooms. Using ceiling mounted chord switch at the entrance path of the door of a toilet is a good idea for small toilets attached to bed rooms. Ceiling mounted chord switches may be used with a chord suspended from the ceiling near the opening of the door

3.5.24 Design for Electrical Wiring in Office Rooms

The location of a switch board must be near the entrance door of an office room. The location of the light fittings must be chosen based on the possible locations of work table, furniture. Sufficient number of 3-pin 13 A switched shuttered flat pin sockets must be provided in each office room. In this regard special consideration need to be given on the possible location of computers and other office equipment. Sufficient conduits and cables must be left for future modification as often rearrangement of tables need to be made. Generally, Single core PVC insulated Stranded Electrolytic Annealed Copper Cables shall be used for wiring by using the concealed wiring technique or the other two methods mentioned in the wiring section.

3.5.25 Methods of Point Wiring

Wiring between a Light / fan point and its corresponding switch board is termed as Point Wiring. It is assumed that the load of such a point is not in excess of 100watts in general in special this may be up to 200 watts. Wiring for a Light / Fan point shall be made using one of the methods i.e, (i) Surface Wiring or (ii) Concealed Wiring. For wiring of a point one Red and one Black PVC insulated copper cable shall run between a point and its switch board. Cable joints inside conduits or within channels are forbidden. The current carrying capacity for such a circuit shall not be more than 5A for a domestic or a commercial building. The minimum size of a cable for such wiring shall be 1.5 mm^2. Common neutral shall not be used under any circumstances.

3.5.26 Methods of Circuit Wiring

Wiring between a switch board and a BDB / SDB / DB shall be called Circuit Wiring. Circuit wiring shall be done with a live cable a neutral cable and an ECC cable for a single phase circuit. Some times this circuit is also referred to as sub-circuit.

An ECC must be provided with each circuit. The ECC at the Switch Board end shall be terminated in the earth terminal of the metal part of the Switch Board using a brass screw/ bolt and a nut. The BDB / SDB / DB end of the ECC shall be terminated in the Earthing Busbar of the BDB / SDB / DB.

The ECC in this case shall be PVC insulated copper cable of appropriate size but with yellow + Green bi-colour insulation.

For each circuit, the live wire must be drawn using red colour insulated PVC cable and the Neutral Wire shall be drawn using black colour insulated PVC cable.

Common neutral shall not be used under any circumstances.

The minimum size of cable for a 5A circuit protected by a 5A circuit breaker shall not be below 1.5 mm2

The minimum size of cable for a 10A circuit protected by a 10A circuit breaker shall not be below 2.5 mm2.

The minimum size of cable for a 15A circuit protected by a 15A circuit breaker shall not be below 4 mm2.

The minimum size of cable for a 20A circuit protected by a 20A circuit breaker shall not be below 6 mm2.

The above mentioned sizes must be increased for long cables as mentioned elsewhere in this document.

In general, the minimum size of cable for a particular circuit shall depend on the rating of the fuse or circuit breaker used for the protection of that circuit. A voltage drop check is to be made for each length of the circuit to ensure that the voltage drop at the farthest end of the load from the main distribution point does not exceed 2.5 percent.

Sockets shall get direct connection from the BDB/ SDB through breaker protection. Depending on the assessed requirements sockets may be grouped / looped at the socket end. Such grouping shall not exceed 3 numbers of sockets in one circuit.

3.5.27 Flexible Cable

- Conductor of flexible cables shall be of copper. The cross sectional area of conductor for flexible cable shall be as per design. Only 3 core flexible cables shall be used for connecting single-phase appliances.
- Unless the flexible cables are mechanically protected by armour, or tough rubber, or PVC sheath, these shall not be used in workshops and other places where they are liable to mechanical damage.
- Flexible cable connection to bell push from ceiling rose shall be taken through steel conduit/metallic casing and capping.

3.6.0 Location of Switchboards

a) Switchboards shall be located in common areas like corridors, lobby etc. and not to be located in locked room.

b) Switchboard shall be located only in dry situation and in well-ventilated space.

c) They shall not be placed in the vicinity of storage battery or exposed to chemical fume.

d) Switchboards shall not be erected above gas stove, or sinks or within 2.5 meter of any washing unit in washing rooms of launderings or in the bath rooms, toilets, or kitchen.

e) As far as possible main boards shall not be located in basement. Such main boards can be located in ground floor.

f) It is preferable to locate floor main boards in rising main shafts of adequate size, with steel doors (having ventilation) or in suitable room.

g) Similarly DBs can be in suitable nitches in corridor walls having doors.

h) Locating main boards under staircase or standing open in corridor is not a desirable practice, besides being highly unaesthetic.

i) The main switchboard, which receives power to the building, should be invariably located in a switch room, having round the clock access, for emergency attendance to the switchboard.

j) Each main board/submain board shall be marked indicating rating of each incoming/ outgoing switch and the details of load/area it feeds. Detail/size of incoming and outgoing cable also shall be marked indicating from where the incoming cable has originated.

k) Each Distribution Board shall be marked indicating detail of incoming switch (Size of cable and from where it is fed) and marking of each outgoing MCB indicating the area it feeds. Suitable marking sticker shall be suitably fixed to indicate such details.

l) Power/light DBs shall be marked ‘P’ and ‘L’ respectively.

m) Each switchboard shall be marked essential/non-essential/UPS to indicate the nature of such switchboards.

n) Main earthing terminals in main/submain switchboard shall be permanently marked, as “Safety Earth – Don’t Remove”.

4.0.0 METALLIC CONDUIT WIRING SYSTEM

4.1.0 Conduits

Metallic conduit wiring shall be provided in industrial buildings such as pump house, substation etc.

Recessed conduit is suitable generally for all applications. Surface conduit work may be adopted in places like, plant rooms, pump rooms, wiring above false ceiling/below false flooring, and at locations where recessed work may not be possible to be done.

All rigid conduit pipes shall be of steel. The wall thick- ness shall be not less than 1.6 mm (16 SWG) for conduits upto 32 mm dia and not less than 2 mm (14 SWG) for conduits above 32 mm dia. These shall be solid drawn or reamed by welding, and finished with galvanized or stove enameled surface. No steel conduit less than 20 mm in diameter shall be used

The maximum number of PVC insulated wires that can be drawn in one conduit is given size wise below and the number of wires per conduit shall not be exceeded. Conduit sizes shall be selected accordingly in each run.

Nominal Cross sectional area of conductor in sq.mm	20 mm		25 mm		32 mm		38 mm		51 mm		64 mm	
	S	B	S	B	S	B	S	B	S	B	S	B
1	2	3	4	5	6	7	8	9	10	11	12	13
1.50	5	4	10	8	18	12	–	–	–	–	–	–
2.50	5	3	8	6	12	10	–	–	–	–	–	–
4	3	2	6	5	10	8	–	–	–	–	–	–
6	2	–	5	4	8	7	–	–	–	–	–	–
10	2	–	4	3	6	5	8	6	–	–	–	–
16	–	–	2	2	3	3	6	5	10	7	12	8
25	–	–	–	–	3	2	5	3	8	6	9	7
35	–	–	–	–	–	–	3	2	6	5	8	6
50	–	–	–	–	–	–	–	–	5	3	6	5
70	–	–	–	–	–	–	–	–	4	3	5	4

Note:

(1) The above table shows the maximum capacity of conduits for a simultaneous drawing in of wires.

(2) The columns headed 'S' apply to runs of conduits which have distance not exceeding 4.25 m between draw in boxes and which do not deflect from the straight by an angle of more than 15 degrees. The columns headed 'B' apply to runs of conduit, which deflect from the straight by an angle of more than 15 degrees.

(3) Conduit sizes are the nominal external diameters.

4.2.0 Conduit Accessories

The conduit wiring system shall be complete in all respects, including their accessories.

All conduit accessories shall be of threaded type, and under no circumstances pin grip type or clamp grip type accessories shall be used.

Bends, couplers etc. shall be solid type in recessed type of works and may be solid or inspection type as required, in surface type of works.

Saddles for surface conduit work on wall shall not be less than 0.55 mm (24 gauges) for conduits upto 25 mm dia and not less than 0.9 mm (20 gauges) for larger diameter. The corresponding widths shall be 19 mm & 25 mm.

4.3.0 Outlets

The switch box shall be made of metal on all sides, except on the front. In the case of welded mild steel sheet boxes, the wall thickness shall not be less than 1.2 mm (18 gauge) for boxes upto a size of 20 cm x 30 cm, and above this size 1.6 mm (16 gauge) thick MS boxes shall be used. The metallic boxes shall be hot dip galvanised.

Where a large number of control switches and/or fan regulators are required to be installed at one place, these shall be installed in more than one outlet box adjacent to each other for ease of maintenance.

An earth terminal with stud and 2 metal washers and terminal block shall be provided in each MS box for termination of protective conductors and for connection to socket outlet/metallic body of fan regulator etc.

Clear depth of the box shall not be less than 60 mm and this shall be increased suitably to accommodate mounting of fan regulators in flush pattern.

4.4.0 Installation

a) Conduit Joints

The conduit work of each circuit or section shall be completed before the cables are drawn in.

Conduit pipes shall be joined by means of screwed couplers and screwed accessories only. Threads on conduit pipes in all cases shall be between 13 mm to 19 mm long, sufficient to accommodate pipes to full threaded portion of couplers or accessories.

Cut ends of conduit pipes shall have no sharp edges, nor any burrs left to avoid damage to the insulation of the conductors while pulling them through such pipes.

No bare threaded portion of conduit pipe shall be allowed, unless such bare threaded portion is treated with anticorrosive preservative or covered with approved plastic compound.

b) Bends in Conduit

All necessary bends in the system, including diversion, shall be done either by neatly bending the pipes without cracking with a bending radius of not less than 7.5 cm, or alternatively, by inserting suitable solid or inspection type normal bends, elbows or similar fittings, or by fixing steel inspection boxes, whichever is most suitable.

No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet.

Conduit fittings shall be avoided as far as possible on conduit system exposed to weather. Where necessary, solid type fittings shall be used.

c) Outlets

All outlets such as switches, wall sockets etc. shall be modular either flush mounting type, or of surface mounting type.

d) Surface Conduit Work

The outer surface of conduit including all bends, unions, tees, junction boxes etc. forming part of the conduit system, shall be hot dip galvanised.

Conduit pipes shall be fixed by saddles, secured to suitable approved plugs with screws in an approved manner at an interval of not more than one meter, but on either side of the couplers or bends or similar fittings, saddles shall be fixed at a distance of 30 cm from the center of such fittings.

Where conduit pipes shall be laid along the trusses, steel joists etc. the same shall be secured by means of saddles or girder clips or clamps.

In long distance straight run of conduit, inspection type couplers at reasonable intervals shall be provided, or running threads with couplers and jam nuts shall be provided.

Only portion of the switch box shall be sunk in the wall, the other portion being projected out for suitable entry of conduit pipes into the box.

e) Fixing Inspection Boxes

- Suitable inspection boxes to the minimum requirement shall be provided to permit inspection and to facilitate replacement of wires, if necessary.
- These shall be mounted flush with the wall or ceiling concrete. Minimum 65 mm depth junction boxes shall be used in roof slabs and the depth of the boxes in other places shall be as per standards.
- Suitable ventilating holes shall be provided in the inspection box covers.

f) Fixing Switch Boxes and Accessories

Switch boxes shall be mounted flush with the wall. All outlets such as switches, socket outlets etc. shall be flush mounting type, unless otherwise specified in the Additional Specifications.

g) Fish Wire

To facilitate subsequent drawing of wires in the conduit, GI fish wire of 1.6 mm/1.2 mm (16/18 SWG) shall be provided along with the laying of the recessed conduit.

h) Bunching of Cables

- Where the distribution is for single phase loads only, conductors for these phases shall be drawn in one conduit.
- In case of three phase loads, separate conduits shall be run from the distribution boards to the load points, or outlets as the case may be.

4.5.0 Earthing Requirements

(i) The entire system of metallic conduit work, including the outlet boxes and other metallic accessories, shall be mechanically and electrically continuous by proper screwed joints,

or by double check nuts at terminations. The conduit shall be continuous when passing through walls or floors.

(ii) A protective (loop earthing) conductor(s) shall be laid inside the conduit between the metallic switch boxes and distribution switch boards and terminated with proper earth lugs/ terminals. Only PVC insulated copper conductor cable of specified size green in colour shall be allowed.

(iii) The protective conductors shall be terminated properly using earth studs, earth terminal block etc. as the case may be.

(iv) Gas or water pipe shall not be used as protective conductor (earth medium).

5.0.0 NON-METALLIC CONDUIT WIRING SYSTEM

5.1.0 PVC conduits and conduit fittings shall be of heavy wall water grade type. All bends shall be large radius bends formed by heat or by mechanical bending machine. The cross- section of the conduit shall remain circular at the bend and the internal diameter shall not be reduced due to bending. PVC pipe fittings shall be sealed with PVC solvent cement or adhesive for PVC of approved quality.

5.2.0 Conduits installed in floors, if installed, shall have a slope of at least 1:1000 towards floor mounted pull box or cable duct.

5.3.0 Conduits placed concealed inside roof or in wall must have 20 SWG GI pull wires placed during laying of the pipes for pulling the cables later.

5.4.0 Water grade PVC conduits must be used for both concealed and surface wiring. Water grade PVC conduits of different diameters shall be used as per necessity.

5.5.0 Appropriate high grade bends and circular boxes must be used with the PVC pipes.

5.6.0 18SWG metal sheet made and synthetic enamel paint coated quality boxes of matching sizes shall be used as pull boxes and junction boxes. Appropriate pull- box covers of ebonite or perspex sheet shall be fitted with GI machine screw and washer.

5.7.0 The PVC conduits placed concealed inside roof or in wall must have 20 SWG GI pull wires placed during laying of the pipes for pulling the cables later.

5.8.0 PVC flexible conduits shall be used with surface wiring only and only in places where PVC bends cannot be used. Except special circumstances flexible PVC conduits shall not be used.

5.9.0 Recessed PVC conduit work shall be provided for residential and commercial installations. If the pipes are liable to mechanical damages, they should be adequately protected. Non-metallic conduit shall not be used for the following applications:-

- In concealed/inaccessible places of combustible construction where ambient temperature exceeds 60 degrees C.
- In places where ambient temperature is less than 5 degrees C.
- For suspension of light fittings and other fixtures.
- In areas exposed to sunlight.

5.10.0 Conduits

The conduits shall be circular in cross-section. The conduits shall be designated by their nominal outside diameter.

Dimensional Details of Rigid Non-metallic Conduits

S. No.	Nominal Diameter Outside (in mm)	Maximum Diameter Outside (in mm)	Minimum Diameter Inside (in mm)	Maximum Eccentricity Permissible (in mm)	Minimum Ovality Permissible (in mm)
1.	20	20 + 0.3	17.2	0.2	0.5
2.	25	25 + 0.3	21.6	0.2	0.5
3.	32	32 + 0.3	28.2	0.2	0.5
4.	40	40 + 0.3	35.8	0.2	0.5
5.	50	50 + 0.3	45.0	0.4	0.6

i. No non-metallic conduit less than 20 mm in diameter shall be used.

ii. The maximum number of PVC insulated copper conductor cables that can be drawn in one conduit of various sizes is given in metallic wiring system.

5.11.0 Conduit Accessories

(i) The conduit wiring system shall be complete in all respect including accessories.

(ii) Rigid conduit accessories shall be normally of grip type.

(iii) Flexible conduit accessories shall be of threaded type.

(iv) Bends, couplers etc. shall be solid type in recessed type of works, and may be solid or inspection type as required, in surface type of works.

(v) Saddles for fixing conduits shall be heavy gauge non-metallic type with base.

(vi) The minimum width and the thickness of the ordinary clips or girder clips shall be as per above Table.

5.12.0 Outlets

(i) The switch box shall be made of mild steel, on all sides except at the front.

5.13.0 Installation

a) The erection of conduits of each circuit shall be completed before the cables are drawn in.

b) All joints shall be sealed/cemented with approved cement. Damaged conduit pipes/fittings shall not be used in the work. Cut ends of conduit pipes shall have neither sharp edges nor any burrs left to avoid damage to the insulation of conductors while pulling them through such pipes.

c) All bends in the system may be formed either by bending the pipes by an approved method of heating, or by inserting suitable accessories such as bends, elbows or similar fittings, or by fixing non-metallic inspection boxes, whichever is most suitable. Where necessary, solid type fittings shall be used.

d) Radius of bends in conduit pipes shall not be less than 7.5 cm. No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet.

e) Care shall be taken while bending the pipes to ensure that the conduit pipe is not injured, and that the internal diameter is not effectively reduced.

f) All switches, plugs, fan regulators etc. shall be fitted in flush pattern.

g) For Recessed Conduit Work, the conduit pipe shall be fixed by means of staples, or by means of nonmetallic saddles, placed at not more than 60 cm apart, or shall be fixed by any other approved means of fixing. At either side of the bends, saddles/staples shall be fixed at a distance of 15cm from the centre of the bends.

5.14.0 Earthing Requirements

(i) A protective (earth) conductor shall be drawn inside the conduit in all distribution circuits to provide for earthing of non-current carrying metallic parts of the installation. These shall be terminated on the earth terminal in the switch boxes, and/or earth terminal blocks at the DBs.

(ii) Gas or water pipe shall not be used as protective conductors (earth medium).

6.0.0 TRUNKING CABLE MANAGEMENT SYSTEM

6.1.0 Adaptable trunking shall be used for power cables and data cables to run parallel in two different compartments with partition.

6.2.0 Mini Trunking is suitable for surface wiring work indoors where necessitated, either due to aesthetics or technical requirements, such as case of extension of existing wiring, avoidance of recessed wiring in RCC columns etc. PVC insulated cables and / or other approved insulated cables shall be used in this type of work.

6.3.0 Wherever data cables are used for information outlets, adaptable trunking shall be used.

6.4.0 PVC trunking for distribution of Voice Data and Power should be used for cable management and should accept RJ45 Data socket and Power socket or other wiring accessory like switches, indicators etc.

6.5.0 Preferred size of the mini trunking should be 25 x 16 mm, 32 x 16 mm, 40 x 25 mm, 40 x 40 mm and for adaptable trunking it should be 100 x 34 mm or 100 x 50 mm or 160 x 50 mm or 200 x 50mm for making upto four isolated compartments.

6.6.0 Trunking should be equipped with rail on its surface on which clip-on partition can be clipped which should accept frames/plates for wiring devices upto 6/8 modules.

6.7.0 Trunking should have insulation rating of 5 mega Ohm.

6.8.0 **Material**

The mini trunking and adaptable trunking shall be of the same material, viz. either PVC or anodized aluminium in extruded sections.

The mini trunking shall have a square or rectangular body. The trunking cover shall be “CLIP-ON” type with double grooving in the case of PVC wire-ways, and CLIP-ON type for the metallic wire ways. All surfaces shall have smooth finish inside and outside.

The top of the side walls of the body shall be suitable for the above types of fixing arrangement of trunking. PVC trunking or Aluminium trunking should have uniform thickness throughout its length and shall be of factory finish.

PVC trunking shall be of good quality PVC, free from defects like deformation, unevenness, blisters, cavities etc.

6.9.0 **Dimensions**

The thickness of the mini trunking & adaptable trunking shall be 1 mm minimum. When mini trunking cover is clipped onto the trunking body, cover should completely overlap on the base (casing).

6.10.0 **Outlet Boxes**

The outlet boxes such as switch boxes, regulator boxes and their phenolic laminated sheet covers shall be as per requirements.

6.11.0 **Installation**

a) Attachment to Wall and Ceiling

- The mini trunking and adaptable trunking shall be fixed by means of suitable screws to approved type of asbestos or fibre fixing plugs, at intervals not exceeding 60 cm for all sizes for mini trunking. In case of Adaptable trunking, the screwing distance shall be such that the weight of the trunking & cable hold firmly on the wall or ceiling. On either side of the joints, the distance of the fixing arrangement shall not exceed 15 cm from the joint.
- All trunking body shall be fixed directly on wall or ceiling as above.
- Trunking shall be used only on dry walls and ceiling, avoiding outside walls as far as possible and shall not be concealed in walls not fixed in proximity to gas, steam or water pipes or immediately below the heater.
- Adaptable trunking shall be with pill off cover for protection against dust. Pill off cover shall be removed only on completion of painting of walls.

b) Joints in Casing and Capping

- The wire ways in straight runs should be in single piece as far as possible so as to avoid joints. Trunking shall be of 2 m or 3 m standard length for the ease of installation.
- All joints shall be scarfed or cut diagonally in longitudinal section, and shall be smoothed down by filing to make the joints a very close fit as far as possible and without burrs. They shall be screwed at joints with two or more screws as would be necessary.
- Joints arising out of bends or diversion shall be done using standard accessories like Internal angle, External angle, Flat angle (elbows), Flat junction (T) and end caps. For the separation of data and power cables there shall be partition in both trunking and accessories. Internal and external angle shall have variable angle for the alignment at the wall corners. In no case the radius of curvature of the cables inside a bend shall be less than 6 times their overall diameter.
- Trunking should be of white colour in case of PVC trunking and of white or grey colour in case of Aluminium trunking.
- Mini Trunking attached to ceiling shall be carried completely across the ceiling/ wall whenever required by the Owner, instead of being stopped at an outlet location and in all such cases, dummy mini trunking must be provided.

c) Attachment of Capping

- Wherever required by the Owner, capping shall not be fixed until the work has been inspected with the wires in position and approved. The inspection shall be done from time to time as the work progresses.
- Cover shall be attached to body after all the insulated wires are laid inside.
- No screws or nails shall be used for fixing PVC cover to the body.
- Aluminium cover shall be fixed by using cadmium plated flat head / round head screws with an axial spacing not exceeding 30 cm.

6.12.0 **Installation of Cables**

- For ease of maintenance, cables carrying direct current or alternating current shall always be bunched so that the outgoing and return cables are drawn in the same trunking.
- Mini trunking shall be of such a design that it holds the wires inside the trunking body (casing) at suitable intervals, so that at the time of opening of the trunking cover (capping), the wires may remain in position in the trunking body (casing) and do not fall out.

6.13.0 Earth Continuity

- A protective (earth continuity) conductor shall be drawn inside for earthing of all metallic boxes of the installations as well as for connections to the earth pin of the socket outlets.
- In the case of metallic trunking there shall be a metallic link between adjacent trunking covers with screw connections, and also connections from the end casing to the earth terminal of metallic boxes / outlets / switch boards as per the case may be, for the complete body earthing of the system.

6.14.0 Inspection of Lighting Circuits

The lighting circuits shall be checked to see whether:

a) Wooden boxes and panels are avoided in factories for mounting the lighting boards, switch controls, etc.

b) Neutral links are provided in double pole switch fuses which are used for lighting control, and no fuse is provided in the neutral;

c) The plug points in the lighting circuit are all 3-pin type, the third pin being suitably earthed;

d) Tamper proof interlocked switch socket and plug are used for locations easily accessible;

e) Lighting wiring in factory area is enclosed in conduit and the conduit is properly earthed, or alternatively, armoured cable wiring is used;

f) A separate earth wire is run in the lighting installation to provide earthing for plug points, fixtures and equipment;

g) Proper connectors and junction boxes are used wherever joints are in conductors or cross over of conductors takes place;

i) Clear and permanent identification marks are painted in all distribution boards, switchboards, sub-main boards and switches as necessary;

j) The polarity has been checked and single pole switches are connected on the phase conductor only and wiring is correctly connected to socket outlets;

k) Spare knockouts provided in distribution boards and switch fuses are blocked;

l) The ends of conduits enclosing the wiring leads are provided with ebonite or other suitable bushes;

m) The fittings and fixtures used for outdoor use are all of weatherproof construction, and similarly, fixtures, fittings and switchgears used in the hazardous area are of flameproof application;

n) Proper terminal connectors are used for termination of wires (conductors and earth leads) and all strands are inserted in the terminals;

o) Flat ended screws are used for fixing conductor to the accessories;

p) Flat washers backed up by spring washers are used for making end connections.

6.15.0 Polarity Test of Switch

In a two wire installation, a test shall be made to verify that all the switches in every circuit have been fitted in the same conductor throughout, and such conductor shall be labeled or marked for connection to the phase conductor, or to the non-earthed conductors of the supply.

In a three wire or a four wire installation, a test shall be made to verify that every non-linked single pole switch is fitted in a conductor which is labeled, or marked for connection to one of the phase conductors of the supply.

The installation shall be connected to the supply for testing. The terminals of all switches shall be tested by a test lamp, one lead of which is connected to the earth. Glowing of test lamp to its full brilliance, when the switch is in “on” position irrespective of appliance in position or not, shall indicate that the switch is connected to the right polarity.

SECTION – B3.20 : ERECTION, TESTING & COMMISSIONING

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of Erection, Testing & Commissioning of all the Electrical equipment and system for efficient and trouble-free operation of Township.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the National Standards.

3.0.0 GENERAL REQUIREMENTS

3.1.0 Manufacturer's drawings, instructions and recommendations shall be correctly followed in handling, erecting, testing and commissioning of all items/equipment and care shall be exercised in handling to avoid distortion to stationary structures, the marring to finish, or damaging of delicate instruments or other electrical parts.

3.2.0 All electrical equipment shall be installed in a neat, professional manner so that it is level, plumb, squat and properly aligned and oriented. Tolerances shall be as established in the Manufacturer’s drawings. Clearances around Electrical panels, switchgears shall be as per relevant standards.

3.3.0 The Contractor shall ensure workmanship of good quality and shall assign qualified supervisors/Engineers and competent labor who are skilled having valid license, careful and experienced in carrying out similar works.

3.4.0 The Contractor shall be fully and finally responsible for proper erection, safe and satisfactory operation of the equipment under his scope of work to the entire satisfaction of the Owner. Equipment and material, which are wrongly installed, shall be removed and re-installed to comply with the design requirement at the Contractor’s expense, to the satisfaction of the Owner.

3.5.0 The installation shall be carried out in such a manner as to provide access to other equipment installed. The Contractor shall restore floor / wall chipping, road cuttings & other such works done including replacement of equipment removed back to its place and make good damages done to original.

3.6.0 The Contractor shall effectively protect his work, equipment and materials under his custody from theft, damage or tampering. Finished work where required shall be suitably covered to keep it clean and free from defacement or injury. Contractor shall be held responsible for any loss or damage to equipment and material issued to him until the same is taken over by the Owner according to contract.

3.7.0 All safety rules and codes as applicable to work shall be followed without exception. All safety appliance and protective devices including belts, hand gloves, aprons, helmets, shields, goggles, safety shoes etc. shall be provided by the Contractor for his personnel.

3.8.0 The Contractor shall provide guards and prominently display caution notices if access to any equipment / area is considered unsafe and hazardous. In order to avoid hazards to personnel moving around the equipment such as switchgear etc. which is kept charged after installation, before commissioning, such equipment shall be suitably cordoned off to prevent anyone accidentally going near it

3.9.0 The contractor shall have a separate cleaning gang to clean all equipment under erection as

well as the work area and the project site at regular intervals to the satisfaction of Owner. In case this is not done, the Owner shall have the right to carry out the cleaning operation and any expenditure incurred in this regard shall be to the contractor account.

3.10.0 The Contractor shall ensure that instruments and gauges to be used for testing and inspection have valid calibration and the accuracy can be traced to National Standards.

3.11.0 It shall be the Contractor's responsibility to obtain approval from local statutory authorities including Electrical Inspector, wherever applicable, for carrying out any work or for installation carried out which comes under the purview of such authorities.

4.0.0 SPECIFIC REQUIREMENTS

4.1.0 Distribution Board

A Distribution Board is the junction point of the incoming line and the outgoing lines for the distribution of Electricity throughout the building. The incoming as well as the outgoing lines must have Circuit Breaker protection. The junctions and terminations of the incoming and outgoing cables are made through copper bars containing bolts and nuts for cable lugs known as bus-bars. A Distribution board may be named as **MDB** or **FDB** or **DB** or **SDB** or **BDB.**

a) MDB stands for Main Distribution Board. This is the distribution box where the main incoming cable enters and terminates from the main service feed connection of a large building. The FDBs get feed from MDB.

b) FDB stands for Floor Distribution Board located in each of the floors of a multistoried building. The DBs get feed from FDB. Usually more than one **FDB**s are needed.

c) DB is the abbreviation for Distribution Board. This may be the box where the main incoming cable enters and terminates from the main service feed connection. The SDBs get feed from a DB.

d) SDB is used to represent Sub- Distribution Board. This board is located in the same floor of a building and connected to the **DB.** Usually more than one **SDB**s are needed. The **BDB**s get feed from SDB.

e) BDB stands for Branch- Distribution Board located in the same floor of a building and connected to the SDB. Usually more than one **BDB**s are needed.

f) EDB, EFDF, ESDB, EBDB Sections of DB, FDB, SDB, BDB receiving feed from the Emergency Busbar which in turn is getting feed from Standby Generator through changeover switch. These may be separate DBs placed by the corresponding normal supply DBs.

Each of these distribution boards must have bus bars for Line, Neutral and Earthing for a single phase box. A 3-phase distribution board must have bus bars for Line1, Line2, Line 3, Neutral and Earthing. These boxes shall be made with sheet steel of not less than 18 SWG thickness and must be appropriately paint finished to match the wall paint.

Enclosures for sub-distribution boards located inside the building shall be dust-proof and vermin-proof using sheet steel fabrication of a minimum thickness of 20 SWG. The boards shall be safe in operation and safe against spread of fire due to short circuit.

A Sub-distribution board shall be located as close as possible to the electrical load centre for that SDB. This is also applicable for determining the locations of FDBs, DB and BDBs. These boards shall never be located on a water soaked or damp wall.

In wiring a sub-distribution board, total load of the consuming devices shall be distributed, as far as possible, evenly between the number of ways of the board, leaving the spare way(s) for future extension.

All connections between pieces of apparatus or between apparatus and terminals on a board shall be neatly arranged in a definite sequence, following the arrangements of the apparatus mounted thereon, avoiding unnecessary crossings.

Cables shall be connected to terminals only by soldered or welded lugs, unless the terminals are of such form that it is possible to securely clamp them without cutting away the cable strands.

Wiring between a BDB and an SDB, an SDB and a DB, a DB and an FDB, an FDB and an MDB needs special attention and the rules are similar to Circuit Wiring. ECC must be present for each of the feed connections. The ECC in this case also shall be PVC insulated copper cable of appropriate size but with Green+ Yellow bi-clour insulation.

At both ends the ECC must be terminated at the Earthing Bus Bar.

Appropriate cable lugs / cable sockets must be used for terminating the L1, L2, L3, N and E connections on the bus bars of both the boards. The sizes of the cables must be chosen to match with the rating of the circuit breaker ratings as mentioned above.

Circuit breakers must be provided at the outgoing and incoming sides of each of the bus bars of each BDB/ SDB/ DB/FDB boxes.

4.2.0 Electrical Wiring for exterior purposes

Electrical Wiring for Garden Lighting

For garden lighting PVC insulated FRLS PVC sheathed underground cables shall be used. For protection purpose these may be drawn through PVC pipe of appropriate dimension so that adequate clearance remains for the ease of pulling. In general, no junction of cables shall be provided in underground level. However, in case of necessity, metal sleeve cable ferrule joints using Crimp Tool or hydraulic press and heat shrink insulated sleeve shall be used on top.

Electrical Wiring for Street Lighting

For street lighting PVC insulated FRLS PVC sheathed underground cables shall be used. For protection purpose these may be drawn through PVC pipe of appropriate dimension so that adequate clearance remains for the ease of pulling. In general, no junction of cables shall be provided in underground level. However, in case of necessity, metal sleeve cable ferrule joints using Crimp Tool or hydraulic press and heat shrink insulated sleeve shall be used on top. Joining the cables at the bottom of a street pole must be done inside a metal joint box located sufficiently above the street level so that water cannot reach the box even during the worst rain / flood situation.

Electrical Wiring for Boundary Light

For boundary lighting PVC insulated FRLS PVC sheathed underground cables shall be used. For protection purpose these may be drawn through PVC pipe of appropriate dimension so that adequate clearance remains for the ease of pulling. In general, no junction of cables shall be provided in underground level. However, in case of necessity, metal sleeve or cable ferrule joints using Crimp Tool or hydraulic press and heat shrink insulated sleeve shall be used on top. However, for the portion of the cable running concealed through a wall, PVC insulated cables through PVC conduits may be used.

4.3.0 Electrical Services Shafts

For buildings over six-storey or 20 m high there shall, in general, be a minimum of one vertical electrical service shaft of 200 mm x 400 mm size for every 1500 m2 floor area. The electrical service shaft shall exclusively be used for the following purposes:

- Electric supply feeder cables or riser mains,

- Busbar Trunking,
- telephone cables,
- Data Cables,
- fire alarm cables,
- Other signal cables,
- Area circuit breakers,
- Floor Distribution board / sub-distribution boards for individual floors.

The construction of the floors of the duct area shall be constructed in such a way so that the empty space after putting the cables/ busar trunking / pipes / conduits in position the remaining open space is filled up with RCC slab(s) or any other non-inflammable material so that fire or molten PVC cannot fall from one floor to the next lower floor(s). For this purpose arrangements need to be made during the main floor casting.
Free and easy access to the electrical shaft room in each floor must be available for operation, maintenance and emergency shut downs.

Vertical cables other than electrical cables shall be placed at a sufficient distance from the nearest electrical cable.

A vertical separating brick wall between electrical and non electrical wall is preferable.

Vertical Service Shaft for Electrical Risers as mentioned above must not be placed adjacent to the Sanitary Shafts.

They should be placed at significant separation in order to ensure that the Vertical Service Shaft for Electrical Risers remains absolutely dry.

Riser Main Cables

For low rise building Riser Main Cables shall serve to bring L.T. connection to the Floor Distribution Boards (FDBs) of each floor from the Main Distribution Board. For a 5 storied building or lesser having a floor space of less than 600 m2 in each floor the riser cables may be PVC insulated flame retardant cables through PVC or GI pipes.

For bringing the riser main cables a common vertical wall and holes or slots in the floors must be given by the building construction people.

However, for larger floor area or for higher buildings PVC insulated PVC sheathed underground cables must be used with protection and spacing.

For more than 9 storied building Busbar preferably sandwiched copper Busbar Trunking should be used for safety reasons.

PVC insulated FRLS PVC Sheathed underground cables must be used as Riser Main Cables. These cables shall be placed in or pulled through a PVC pipe of higher diameter so that the cable can be easily pulled through it. The PVC pipes must be fixed vertically in a straight line on the wall of the shaft using appropriate saddles. However, in some cases PVC insulated PVC Sheathed underground cables may be directly fixed on the wall using appropriate saddles with 37mm spacing between two adjacent cables. Sheet metal made Joint Boxes (with ebonite cover plates) must be placed at each floor tapping point.

The cable work shall be done neatly so that no suspended cables are seen around the place and no suspended flexible pipes are seen. Each riser cable must have appropriate circuit breaker protection at the source busbur junction and also at the tap off point.

Busbar Trunking

For high rise buildings, LT busbar trunking sytem is used instead of riser main cables to minimize space in the vertical electrical shaft, to minimize the risk of spreading of fire from one floor to another due to electrical short circuit in one of the cables or sparks, to have a neat distribution system. Most part of the Busbar Trunking are installed vertically. The horizontal portion of the Busbar Trunking usually connects the vertical portion with the Substation LT panel.

a) Busbar Trunking are especially useful to minimize voltage drop on account of high amperage intermittent loads. The conductors supported by insulators inside the busbar trunking shall be copper of solid rectangular cross-section. The copper bars are insulated. A busbar trunking system shall be laid with minimum number of bends for distribution system. Typical rating of feeder busbar trunking for 3-phase- 3-wire or 3-phase- 4-wire system shall range from 200 amperes to 3000 amperes although lower amperes are not impossible.

b) Horizontal busbar trunking of suitable size may be provided along the roads for a group of buildings to be fed by a single substation but with heavy weather protection and covered with appropriate weather resistant water proof material. Extreme care need to be taken in these cases for protection against moisture, water and outside weather.

c) Busbar Trunking must not be placed in places which is even slightly exposed to weather/ moisture/ spray or sprinkle of water.

4.4.0 Location of Substation

To determine the rating of the substation required, a load factor of at least 80% shall be applied to the estimated load of the building. The future expansion requirements should definitely be taken into consideration.

In a multi-storied building, the substation shall preferably be installed on the lowest floor level, but direct access from the street for installation or removal of the equipment shall be provided. The floor level of the substation or switch room shall be above the highest flood level of the locality. Suitable arrangements should exist to prevent the entrance of storm or flood water into the substation area.

The location of a substation shall depend on (i) the feed point of the 11 KV Supply Authority line and (ii) the location of the LT vertical riser cables.

In case the electric substation has to be located within the main building itself for unavoidable reasons, it should be located on ground floor or Basement floor or the floors above the ground floor (GFL) with easy access from outside.

Height, Area, Floor Level and other requirements of a Substation Room

The minimum height of a substation room should be 3.5 to 4 metre depending upon the size of the transformer.

All the rooms shall have significant ventilation. Special care should be taken to ventilate the transformer rooms and where necessary louvers at lower level and exhaust fans at higher level shall be provided at suitable locations in such a way that cross ventilation is maintained. Fans should be provided so that the transformer gets air supply from the fans.

The floor level of the substation should be high. Arrangement shall be made to prevent storm water entering the transformer and switch rooms through the soak pits, if floor level of the substation is low.

Sub-Station of higher voltage may also be considered to the basement floor having proper & safe building design.

In an Electrical Substation significant amount of forced ventilation is very much needed apart from natural ventilation. Exhaust Fans (minimum 18” dia) must be provided in sufficient numbers on all sides of the substation above the lintel level. Grill fitted Windows having window panes must be provided on all sides for natural ventilation. The windows must have sun sheds to ensure that no rain water can come inside the substation.

If due to space constraint or due to any other difficulties, sufficient number of windows and ventilating fans cannot be installed, high velocity forced ventilation using ducts must be provided.

4.5.0 Main Switch and Switchboards

a) The location of the main board shall be such that it is easily accessible for firemen and other personnel to quickly disconnect the supply in case of emergencies.

b) Main switchboards shall be installed in boxes or cupboards so as to safeguard against operation by unauthorized personnel.

c) Open type switchboards shall be placed only in dry locations and in ventilated rooms and they shall not be placed in the vicinity of storage batteries or exposed to chemical fumes.

d) In damp situation or where inflammable or explosive dust, vapour or gas is likely to be present, the switchboard shall be totally enclosed or made flame proof as may be necessitated by the particular circumstances.

e) Switchboards shall not be erected above gas stoves or sinks, or within 2.5 m of any washing unit in the washing rooms or laundries.

f) In case of switchboards being unavoidable in places likely to be exposed to weather, to drip, or in abnormally moist atmosphere, the outer casing shall be weather proof and shall be provided with glands or bushings or adapted to receive screwed conduit.

g) Adequate illumination shall be provided for all working spaces about the switchboards, when installed indoors.

4.6.0 Mounting of Metal clad switchgear

The distribution boards shall be located as near as possible to the centre of the load they are intended to control.

a) They shall be fixed on suitable stanchion or wall and shall be accessible for replacement and shall not be more than 2 m from floor level.

b) They shall be either metal clad type, or all insulated type. But if exposed to weather or damp situations, they shall be of the weather proof type and if installed where exposed to explosive dust, vapour or gas, they shall be of flame proof type. In corrosive atmospheres, they shall be treated with anticorrosive preservative or covered with suitable plastic compounds.

c) Where two or more distribution boards feeding low voltage circuits are fed from a supply of medium voltage, these distribution boards shall be:

   i. fixed not less than 2 m apart, or

   ii. arranged so that it is not possible to open two at a time, namely, they are interlocked, and the metal case is marked "Danger 415 Volts" and identified with proper phase marking and danger marks, or

   iii. installed in rooms or enclosures accessible to authorized persons capacity only.

d) All distribution boards shall be marked "Lighting" or "Power", as the case may be, and also be marked with the voltage and number of phases of the supply. Each shall be provided with a circuit list giving diagram of each circuit which it controls and the current rating for the circuit and size of fuse element.

4.7.0 Laying of HT underground Cables

The HT underground armoured cables shall be laid using one of the three methods.

In the first method (i) brick wall prepared 915mm deep trenches with cover plates shall be used for placing the cables at the bottom of the trench.

In the second method, 915mm deep trenches prepared by ground excavation (underground direct burial method) shall be used for placing the cables on top of a 75mm sand layer. . In

this second method (underground direct burial method), two layers of brick on top, marking tape and then back filling the trench shall have to be done. The depth of the trench in general shall be 915mm.

In the third method, pre-laid PVC pipes having sufficient clearance compared to the cable size (s) may be required at places. The PVC pipes must be laid in trenches of the 915mm depth.

For pre-laid PVC pipe ducts, Brick wall made underground inspection pits shall be required at an interval of at least 9.15 meter for cable pulling and future extensions or alterations.

PVC pipe having sufficient clearance may be used for bringing the cable up to the trench of the Metering Panel or HT panel. The PVC pipes must have 18 SWG GI pull wires placed during laying of the pipes for pulling the cables later.

4.8.0 Laying of LT underground Cables

Underground LT cables shall be laid using one of the three methods.

In the first method, brick wall prepared 915mm deep trenches with cover plates shall be used for placing the cables at the bottom of the trench.

In the second method, 915mm deep trenches prepared by ground excavation (underground direct burial method) shall be used for placing the cables on top of a 75mm sand layer. . In this second method (underground direct burial method), two layers of brick on top, marking tape and then back filling the trench shall have to be done. The depth of the trench in general shall be 915mm.

In the third method, pre-laid PVC pipes having sufficient clearance compared to the cable size (s) may be required at places. The PVC pipes must be laid in trenches of the 915mm depth. For pre-laid PVC pipe ducts, Brick wall made underground inspection pits shall be required at an interval of at least 9.15 meter for cable pulling and future extensions or alterations.

5.0.0 TESTING & COMMISSIONING

5.1.0 The Contractor shall take full responsibility of testing at erection, pre-commissioning and commissioning stages of all the equipment/system system being installed by him.. The Contractor shall submit to the Owner a checklist for testing and commissioning and the activities shall be carried out in accordance with the checklist. The Contractor shall carry out the commissioning tests and checks after erection at site as per applicable standards and also as recommended by the Manufacturers.

5.2.0 On completion of erection work, the contractor shall request the Owner for inspection & test. The Owner shall arrange for joint inspection of the installation for completeness and correctness of the work. Any defect pointed out during such inspection shall be promptly rectified by the Contractor. The installation shall be then tested and commissioned in presence of the representative of Owner and put on trial run for stipulated contract period.

5.3.0 The Contractor shall arrange for inspection of his installation work by Electrical Inspector and shall obtain necessary approval certificate for his installation work. Any modification work required by Electrical Inspector must be undertaken by the Contractor at his own cost. All rectification, repair or adjustment work found necessary during inspection, testing, commissioning and trial run shall be carried out by the Contractor without any extra cost.

5.4.0 Following successful inspection and testing, all the equipment shall be commissioned and put on trial run in a manner mutually agreed upon based on the commissioning schedule.

5.5.0 On completion of installation, the following tests shall be carried out:-
(1) Insulation resistance test.
(2) Polarity test of switch.
(3) Earth continuity test.

(4) Earth electrode resistance test.

5.6.0 Testing shall be carried out for the completed installations, in the presence of and to the satisfaction of the Owner by the contractor..

5.7.0 All necessary test instruments for the tests shall be arranged by the contractor if so required by the Owner.

5.8.0 The insulation resistance shall be measured by applying between earth and the whole system of conductors and all switches closed, and except in earthed concentric wiring, all lamps in position, or both poles of the installation otherwise electrically connected together, a direct current pressure of not less than twice the working pressure, provided it need not exceed 500 volts for medium voltage circuits. Where the supply is derived from a three wire D.C., or a poly phase A.C. system, the neutral pole of which is connected to earth either directly or through added resistance, the working pressure shall be deemed to be that which is maintained between the phase conductor and the neutral.

The insulation resistance shall also be measured between all the conductors connected to one pole, or phase conductor of the supply, and all the conductors connected to the neutral, or to the other pole, or phase conductors of the supply with all the lamps in position and switches in “off” position, and its value shall be not less than that specified.

The insulation resistance in mega ohms measured as above shall not be less than 12.5 mega ohms for the wiring with PVC insulated cables, subject to a minimum of 1 mega ohm.

Where a whole installation is being tested, a lower value than that given by the formula, subject to a minimum of 1 mega ohm, is acceptable.

A preliminary and similar test may be made before the lamps etc. are installed, and in this event the insulation resistance to earth should not be less than 25 mega ohms for the wiring with PVC insulted cables, subject to a minimum of 2 mega ohms.
The term “outlet” includes every point along with every switch, except that a switch combined with a socket outlet, appliance or lighting fitting is regarded as one outlet.

5.9.0 Testing of Earth Continuity Path

The earth continuity conductor, including metal conduits and metallic envelopes of cables in all cases, shall be tested for electric continuity. The electrical resistance of the same along with the earthing lead, but excluding any added resistance, or earth leakage circuit breaker, measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation shall not exceed one ohm.

5.10.0 Inspection and Testing

5.10.1 General

Every installation shall, on completion and before being energized, be inspected and tested. The methods of test shall be such that no danger to persons capacity or property or damage to equipment occurs even if the circuit tested is defective.

5.10.2 Periodic inspection and testing

Periodic inspection and testing shall be carried out in order to maintain the installation in a sound condition after putting it into service. Where an addition is to be made to the fixed wiring of an existing installation, the latter shall be examined for compliance with the recommendations of the Code.

5.10.3 Checking the conformity with the Bangladesh Standard

The individual equipment and materials which form part of the installation shall generally conform to the relevant Bangladesh Standard (BDS) wherever applicable. If there is no relevant Bangladesh standard specification for any item, these shall be approved by the appropriate authority.

5.10.4 Inspection of the colour identification of cables of wiring

For single phase, Red for Live, Black for Neutral, Gree+Yellow bi-colour for ECC. For three phase, Red for L1, Yellow for L2, Blue for L3, Black for Neutral and Gree+Yellow bi-colour for ECC and Earth Lead Wire.

5.10.5 Inspection of Earthing Terminal, Earthing Bus

Inspection should be made to check whether Brass made Earthing Terminals have been provided inside the metal back boxes of the switchboards and socket boards (welded or screwed to the metal back box) and whether the ECCs of the sub circuit have been terminated in these terminals. Inspection should be made to check whether at least one copper Earthing Bus Bar has been provided in the BDBs, SDBs, FDBs, DBs, MDBs and the LT panel and whether ECCs have been appropriately terminated in these Busbars using hexagonal head brass bolt and nuts. Also it should be checked whether the Earth Lead Wires have been properly terminated in the LT Panel / MDB / DB as appropriate.

5.10.6 Insulation Tests

Insulation test is one of the most important tests for Electrical Installations in a Building.

Insulation resistance test shall be made on all electrical equipment, using a self-contained instrument such as the direct indicating ohm-meter of the generator type. DC potential shall be used in these tests and shall be as follows or an appropriate Meggar:

Circuits below 240 Volts 500 volts Meggar

Circuits between 240 Volts to 415 Volts 1000 volts Meggar

The minimum acceptable insulation resistance value is 5 mega ohms for LT lines. Before making connections at the ends of each cable run, the insulation resistance measurement test of each cable shall be made. Each conductor of a multi-core cable shall be tested individually to all other conductors of the group and also to earth. If insulation resistance test readings are found to be less than the specified minimum in any conductor, the entire cable shall be replaced.

All transformers, switchgears etc. shall be subject to an insulation resistance measurement test to ground after installation but before any wiring is connected. Insulation tests shall be made between open contacts of circuit breakers, switches etc. and between each phase and earth.

5.10.7 Earth Resistance Test and the Continuity Resistance Test

Earth resistance tests shall be made on the system, separating and reconnecting each earth connection using earth resistance meter.

The electrical resistance of the Earth Continuity Conductor of different segment shall be measured separately using sensitive digital Ohm meter or by means of resistance bridge instrument. The resistance of the Earth Lead Wire shall be measured from the Earthing Busbar of the LT Panel / MDB /DB and the Earth Electrode(s). The electrical resistance of any section shall not exceed 1 ohm.

Where more than one earthing sets are installed, the earth resistance between two sets shall be measured by means of sensitive digital Ohm meter or by means of resistance bridge instrument. The earth resistance between two sets shall not exceed 1 ohm.

Operation Tests

Current load measurement shall be made on equipment and on all power and lighting feeders using Clamp on Ammeters.

The current reading shall be taken in each phase wire and in each neutral wire while the circuit or equipment is operating under actual load conditions.

Clamp on Ammeters are required to take current readings without interrupting a circuit.

All light fittings shall be tested electrically and mechanically to check whether they comply with the standard specifications.

5.10.8 Inspection of the Installation

On completion of wiring a general inspection shall be carried out by competent personnel in order to verify that the provisions of this Code and that of the Electricity Act of Bangladesh have been complied with.

Inspection of Substation Installations

In substation installations, it shall be checked whether:

a) The installation has been carried out in accordance with the approved drawings;

b) Phase to phase and phase to earth clearances are provided as required;

c) All equipment are efficiently earthed and properly connected to the required number of earth electrodes;

d) The required ground clearance to live terminals is provided;

e) Suitable fencing is provided with gate with lockable arrangements;

f) The required number of caution boards, fire fighting equipment, operating rods, rubber mats, etc., are kept in the substation;

g) In case of indoor substation sufficient ventilation and draining arrangements are made;

h) All cable trenches have covers of non-inflammable material;

i) Free accessibility is provided for all equipment for normal operation;

j) All name plates are fixed and the equipment are fully painted;

k) All construction materials and temporary connections are removed;

l) Bus bar tightness, transformer tap position, etc. are in order;

m) Earth pipe troughs and cover slabs are provided for earth electrodes/earth pits and the neutral and LA earth pits are marked for easy identification;

n) Earth electrodes are of GI pipes or CI pipes or copper plates. For earth connections, brass bolts and nuts with lead washers are provided in the pipes/plates;

o) Earth pipe troughs are free from rubbish, dirt and stone jelly and the earth connections are visible and easily accessible;

p) HT and LT panels and switchgears are all vermin and damp-proof and all unused openings or holes are blocked properly;

q) The earth bus bars have tight connections and corrosion free joint surfaces;

r) Control switch fuses are provided at an accessible height from ground;

s) Adequate headroom is available in the transformer room

t) Safety devices, horizontal and vertical barriers, bus bar covers/shrouds, automatic safety shutters/door interlock, handle interlock etc. are safe and in reliable operation in all panels and cubicles;

u) Clearances in the front, rear and sides of the main HT and LT and subswitch boards are adequate;

v) The switches operate freely; the 3 blades make contact at the same time, the arcing horns contact in advance; and the handles are provided with locking arrangements,

w) Insulators are free from cracks, and are clean;

y) Connections to bushing in transformers are light and maintain good contact;

z) Bushings are free from cracks and are clean;

aa) Accessories of transformers like breathers, vent pipe, buchholz relay, etc. are in order;

bb) Connections to gas relay in transformers are in order;

cc) In transformers, winding temperature are set for specific requirements to pump out;

dd) In case of cable cellars, adequate arrangements exist to pump off water that has entered due to seepage or other reasons; and

ee) All incoming and outgoing circuits of HT and LT panels are clearly and indelibly labeled for identifications.

Inspection of Low Tension (LT) Installation

In Low Tension (LT) or Medium Voltage (MV) Installations, it shall be checked whether:

a) All blocking materials that are used for safe transportation in switchgears, contactors, relays, etc. are removed;

b) All connections to the earthing system have provisions for periodical inspection;

c) Sharp cable bends are avoided and cables are taken in a smooth manner in the trenches or alongside the walls and ceilings using suitable support clamps at regular intervals;

d) Suitable linked switch or circuit breaker or lockable push button is provided near the motors/apparatus for controlling supply to the motor/apparatus in an easily accessible location;

e) Two separate and distinct earth connections are provided for the motor apparatus;

f) Control switch fuse is provided at an accessible height from ground for controlling supply to overhead travelling crane, hoists, overhead bus bar trunking;

g) The metal rails on which the crane travels are electrically continuous and earthed and bonding of rails and earthing at both ends are done;

h) Four-core cables are used for overhead travelling crane and portable equipment, the fourth core being used for earthing, and separate supply for lighting circuit is taken;

i) If flexible metallic hose is used for wiring to motors and other equipment, the wiring is enclosed to the full lengths, and the hose secured properly by approved means;

j) The cables are not taken through areas where they are likely to be damaged or chemically affected;

k) The screens and armours of the cables are earthed properly;

l) The belts of belt driven equipment are properly guarded;

m) Adequate precautions are taken to ensure that no live parts are so exposed as to cause danger;

n) Installed Ammeters and voltmeters work properly and are tested; and

o) The relays are inspected visually by moving covers for deposits of dusts or other foreign matter.

5.11.0 Test Certificate

On completion of an electrical installation (or an extension to an installation), a certificate shall be furnished by the contractor, countersigned by the certified supervisor under whose direct supervision the installation was carried out.

SECTION – B3.21 : SAFETY REQUIREMENTS

1.0.0 INTENT OF SPECIFICATION

This section covers the safety requirements of Electrical equipment and system for efficient and trouble-free operation of electrical system of the Township.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the National codes & Standards.

3.0.0 GENERAL REQUIREMENTS

3.1.0 The following items shall be provided:

3.2.0 Insulation Mats: Insulation mats conforming to relevant codes shall be provided in front of main switch boards as well as other control equipment as specified.It shall be 11 kV grade, made of elastomer, black in colour with certified marking. It shall have following parameters.

- Thickness : 2.5 mm
- Width : 1000 mm
- Dielectric strength : 45 kV rms
- AC proof voltage ; 22 kV rms

3.3.0 Shock treatment chart shall be printed in English and Local language fitted in wooden frame & glass at front side and hard board at back side as required. Charts shall display methods of giving artificial respiration to a recipient of electrical shock shall be prominently provided at appropriate place.

3.4.0 Standard first aid boxes containing materials as prescribed by Red Cross should be provided in each sub-station. First aid box shall include first aid leaflet issued by chief Advisor of Factories, wound dressing, burn dressing large, absorbent cotton wool, dressing scissors, antiseptic solution, liquid iodine, ointment for burns etc.

3.5.0 Danger Plates shall be provided on HV and LV equipment. Danger notice plate shall be 200 mm x 150 mm made of mild steel at least 2 mm thick vitreous enamelled white on both sides and with the descriptions in signal red colour on front side as required. Notice plates of other suitable materials such as stainless steel, brass or such other permanent nature material shall also be accepted with the description engraved in signal red colour.

3.6.0 Portable CO2 Extinguishers conforming and Portable chemical Extinguishers shall be installed in the sub-station at suitable places. Other extinguishers recommended for electric fires may also be used.

3.7.0 Fire buckets shall be installed with the suitable stand for storage of water and sand. Fire bucket set shall comprise 3 Nos. Bucket of 9 Ltrs. capacity with hooks for holding the buckets painting with red paint and Lettering Fire on each bucket and filling them with sand complete as required

3.8.0 A Standard tool box containing necessary tools required for operation and maintenance shall be provided in the sub-station.

3.9.0 Necessary number of caution boards such as “Danger’’, “Man on Line” ‘Don’t Switch on’ etc. shall be available in the sub-station.

3.10.0 A keyboard of required size shall be provided at a proper place containing castle keys, and all other keys of sub-station and allied areas.

4.0.0 SAFETY PROCEDURE

4.1.0 For each building, a comprehensive schematic diagram is prepared starting from the main board upto the final DBs. All such boards shall be duly marked and numbered. Similarly, for each campus consisting of sub-station/ sub-stations and a number of buildings, a comprehensive power distribution schematic diagram for the entire campus shall be prepared. Based on additions/ alterations such diagrams should be updated from time to time.

4.2.0 Premises like sub-stations, switch rooms, pump house, generating rooms etc. shall be kept clean. Such premises should not be used to store broken furniture, dismantled materials, waste material, packing boxes etc.

4.3.0 All premises like sub-station, pump house etc. to be maintained as protected area, admission allowed to authorized persons capacity only. Also, the frontage of such areas shall be kept free and parking etc. in front shall not be allowed.

4.4.0 No inflammable materials shall be stored in places other than the rooms specially constructed for this purpose in accordance with the provisions of Explosives Act.

4.5.0 Rubber or insulating mats should be provided in front of the main switchboards or any other control equipment of medium voltage and above.

4.6.0 Protective and safety equipment such as rubber gauntlets or gloves, earthing rods, linemen's belt, portable artificial respiration apparatus etc. should be provided in each sub-station, service center/enquiry office and important installations. Where electric welding or such other nature of work is undertaken, goggles shall also be provided.

4.7.0 Necessary number of caution boards such as "Man on Line, Don't switch on" should be readily available in each sub-station, enquiry office and important installations.

4.8.0 Standard first aid boxes containing materials as prescribed by the Red Cross should be provided in each sub-station, enquiry office and important installations and should be readily available.

4.9.0 Periodical examination of the first aid facilities and protective and safety equipment provided at the various installations shall be undertaken for their adequacy and effectiveness and a proper record shall be maintained.

4.10.0 Charts (one in English and another one in the regional language) displaying methods of giving artificial respiration to a recipient of electrical shock should be prominently displayed at appropriate places.

4.11.0 A chart containing the names, addresses and telephone numbers of nearest authorized medical practitioners, hospitals, fire brigade and also of the officers in executive charge shall be displayed prominently along with the First Aid Box.

4.12.0 Electrical wiring and control switches should be periodically inspected and any defective wiring, broken parts of switches which shall expose live parts, should be replaced immediately to make the installations safe for the user.

4.13.0 No work shall be undertaken on live installations, or on installations, which could be energized unless another person is present to immediately isolate the electric supply in case of any accident and to render first aid, if necessary.

4.14.0 When working on or near live installations, suitably insulated tools should be used, and special care should be taken to see that those tools accidentally do not drop on live terminals causing shock or dead short.

4.15.0 The electrical switchgears and distribution boards should be clearly marked to indicate the areas being controlled by them.

4.16.0 Before starting any work on the existing installation, it should be ensured that the electric supply to that portion in which the work is undertaken is preferably cut off.

4.17.0 Precautions like displaying “Men at Work” caution boards on the controlling switches, removing fuse carrier from these switches, and these fuse carriers being kept with the person working on the installation, etc. should be taken against accidental energisation. “Permit to Work” should be obtained from the Owner. No work on H.T. main should be undertaken unless it is made dead and discharged to earth with an earthing lead of appropriate size. The discharge operation shall be repeated several times and the installation connected to earth positively before any work is started.

4.18.0 Before energizing on an installation after the work is completed, it should be ensured that all tools have been removed and accounted, no person is present inside any enclosure of the switch board etc., any earthing connection made for doing the work has been removed, “Permit to Work” is received back duly signed by the person to whom it was issued in token of having completed the work and the installation being ready for re-energising and “Men at Work” caution boards removed.

4.19.0 In case of electrical accidents and shock, the electrical installation on which the accident occurred should be switched off immediately and the affected person should be immediately removed from the live installation by pulling him with the help of his coat, shirt, wooden rod, broom handle or with any other dry cloth or paper. He should be removed from the place of accident to a nearby safe place and artificial respiration continuously given as contained in Standard prescribed by Fire Brigade.

4.20.0 Following instructions should be followed. Besides, based on the requirement of a particular building, other instructions may be issued for avoidance of possible fire hazard.

a) No over loading of main board, DB, submain, wiring.
b) No loose wiring.
c) One socket outlet to feed one appliance only and do not use multiple outlets.
d) Shall have an annual inspection of the building and list out deficiencies and report to take necessary remedial action.
e) Only MCB type DBs to be provided, so that overload, short circuit currents are interrupted immediately. Rewirable type fuses not to be used.
f) Change old/ outlived wiring, switchboard, and appliance.
g) Extension to wiring only after proper design and capacity of augmentation of the existing installation.
h) No power outlet / switches should be provided inside the room.
i) Local fire extinguishers for various electrical Switchgears Locations, Elevator Machine Room, Electrical Sub-station, Generating Rooms, Pump Houses etc.
j) Only quality and genuine material should be used.
k) When repairs are needed, act immediately, don’t postpone repairs.
l) Keep telephone/ address details of Fire Station/ Police/ Hospital/ Owner Department Officials, both Office and Residence (in case of emergency).
m) All switch rooms/ electrical shafts to be kept clean and duly locked. All locks shall have common key, with keys available to all authorized personnel.
n) Keep appliances ‘OFF’ after office hours. Instruction to be issued, so that all switches and appliances are ‘OFF’ after office hours.

SECTION – B3.22: CONSTRUCTION POWER

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of construction power supply system for the Township.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the applicable IEC Standards of latest edition including amendments, except where modified and /or supplemented by this specification.

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 The Owner shall provide power supply for construction power at one location, in main plant EPC contractor construction power substation, on chargeable basis at commercial tariff rate. Prevailing tariff rate as per the norms of power supply agency shall be levied as per the usage.

3.2.0 One number 11 kV feeder shall be provided at the above mentioned substation for township construction power. The contractor shall receive the same and establish 11 kV Construction Power Substation and distribute 11 kV supply to various distribution substations in the township and further step down to 415 V supply to provide construction power for various locations.

3.3.0 The Owner may not be able to guarantee on the reliability of the power supply and it is the responsibility of the contractor to make alternative arrangement during not availability of power supply. The Owner shall not be responsible for the delay in the project execution due to non-availability of power supply.

3.4.0 After commissioning the permanent power supply, the same shall not be used for construction power supply requirements.

3.5.0 The scope of work shall include supply, installation, testing and commissioning of the following items.

a) 11 kV overhead line / Cable
b) Required 11/0.433 kV distribution transformers distributed at various locations
c) 415 V power distribution boards
d) 11 kV double pole structure complete with switch, fuse, lightning arrester, insulators and hardware, clamps & connectors, ACSR conductors, spacers, shield wires, etc.
e) Metering kiosk
f) Capacitor banks
g) 11 kV Cables and terminations
h) LT power cables and control cables.
i) Illumination system including lighting panels, poles, masts, lighting fixtures, switches, sockets, conduits, wires, fittings & accessories.
j) Below ground earth mat, equipment earthing & lightning protection.
k) Cable glands and lugs for all the cables.
l) Miscellaneous items like danger boards, caution boards, rubber mats, fire buckets, etc.
m) Any other equipment/item as required

3.6.0 The Substation equipment shall be suitable for outdoor application having saline atmosphere and shall have tropical and fungicidal treatment. Electrical equipment selection and derating shall be based on ambient temperature of 50 deg. C and relative humidity of 95% maximum.

3.7.0 11 kV system shall be designed considering the following design parameters.

- Nominal system voltage : 11 kV (rms), 50 Hz
- Highest system voltage : 12 kV (rms), 50 Hz
- Basic impulse level : 75 kV peak
- Power frequency withstand voltage : 28 kV
- Short time current and duration : 25 kA for 3 sec.
- Dynamic rating : 63 kAp
- Creepage distance : 31 mm /kV.

3.8.0 For the overhead 11 kV connection, ACSR conductor shall be provided. Insulator shall be made of hard porcelain. For tension locations where the line is sectionalized, disc type of insulators shall be used, while on tangent locations pin type insulators are used. The insulators shall be glazed and finished in brown colour.

3.9.0 11 kV load break switches shall have triple pole construction suitable for assembling with light weight insulators made of high alumina body and for vertical mounting

3.10.0 Lightning arrester shall be 9 kV class, heavy rating, gapless, metal (zinc) oxide surge arrestors complete along with clamps, complete fitting and accessories for installation on outdoor type 11 kV transmission lines & transformers.

3.11.0 A separate metering kiosk shall be provided to locate tariff meters of power supply agency.

3.12.0 Transformers shall be suitable for outdoor installation in a hot, saline, humid and tropical climate. The transformers shall be capable of operating continuously at its rated output without exceeding the specified temperature limits.

3.13.0 415 V switchgear shall be indoor, single front, metal-clad, floor mounted, fully draw-out with ACB breaker as incomer fed from distribution transformer and MCCB breaker as outgoing feeders.

3.14.0 At all road crossings overhead lines shall be avoided and cables shall be provided.

3.15.0 11 kV cables shall be earthed grade armoured type conforming to relevant IEC standard.

3.16.0 LV Power cables shall be of 1.1 kV grade, XLPE insulated, armoured type conforming to relevant IEC standard.

3.17.0 Control cables shall be of 1.1 kV grade, XLPE/PVC insulated, armoured type with copper conductor conforming to relevant IEC standard.

3.18.0 Earthing system of substation shall conform to Bangladesh national code. Neutral of each LT transformer shall be solidly grounded through 2 nos. treated earth pits.

3.19.0 Lightning protection shall be provided by shield wires including connections, earth pits etc..

3.20.0 Capacitor bank shall be provided improve power factor.

3.21.0 Contractor shall submit drawings (layout and single line diagram) for construction power supply arrangement for approval.

3.22.0 It shall be the Contractor's responsibility to obtain approval from local statutory authorities including Electrical Inspector for the power supply arrangement.