ROURKELA
SMART CITY LTD.

REQUEST FOR PROPOSAL

For

Re-development of Birsa Munda stadium (Design, Execucation, Operation & Maintenance) at Rourkela (Odisha) under Smart City Mission On Turn Key Basis

Volume 2: Scope of Work, Design Criteria & Technical Specification

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By

Rourkela Smart City Ltd.

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A. Scope of Work & Design Criteria

1. General Scope of work

The work specified hereinabove shall be treated as an approximate assessment. The actual works as required on the basis of detailed topographical survey, Geotechnical investigation and design shall be determined by the Contractor in accordance with the Specifications and Standards.

The Contractor shall establish a design liaison office at site within 28 days from the Commencement Date to facilitate preparation and submission of designs, drawings, construction documents, etc., for review and approval by the Employer's Representative. The design liaison office shall preferably be located near the Employer's office to facilitate communications and frequent interactions with the Employer's Representative and the Employer. The Contractor shall provide full-time design staff and continuously maintain the design liaison office until such time as all necessary designs and Construction Documents have been completed, reviewed, and approved by the Employer's Representative. The Contractor will be fully responsible for ensuring that its designs, drawings, and construction documents satisfy all requirements for constructing Works that are complete and fully functional in all respects

The scope of works consists of design, engineering & construction of Birsa Multipurpose Sports Complex with training facilities. The Stadium is proposed to be developed as a multi-purpose sports complex (Sports plex) based on the standards issued by Sports Authority of India. Brief scope of works is outlined as follows;

The scope also includes obtaining all type of approvals, NOC, certifications from different competent authorities.

All the buildings shall be GRIHA IV rating.

- Foot ball play ground
- Athletic track including equipments
- VIP gallery
- Sitting block
- Swimming pool
- Fire fighting
- Electrical works
- HVAC
- Water supply and sewerage including plumbing & sanitary installations
- Site drainage and rain water harvesting

- Landscaping work
- ICT (Information & Communication technology)
- Other misc. Works such as compound wall, gate, watchman cabin and grading, dismantling of existing structures etc.

The concept prepared by the employer has to be followed by the contractor. However contractor is allowed to present a better option during concept plan presentation.

The scope of works shall be read along with the drawings provided in tender document. The Contractor shall submit a detailed work plan considering the project completion time frame mentioned in the tender document.

2. Particular Scope of work

2.1. Architecture

2.1.1. General

Contractor shall be responsible for making the facility fit for the intended purpose while performing all of its obligations covered under the Contract Document in its entirety. The work shall be done in accordance to the drawings approved by the statutory authorities.
Currently tender drawings and Design Criteria, Brief Technical Specifications for certain items of work are available. Scope includes further detailing, as deemed necessary (without changing the foot print of the proposed “buildings and space planning”, design intent), developing required specifications, preparing Good for Construction (GFC) ,coordinated drawings and construct entire campus in accordance with the same. The scope shall also include preparation of as built drawings before handing over the work to the Employer. Maintaining the Quality assurance & Quality control (QA&QC) including control, corrective actions, reporting and arranging for regular inspections by all concerned.

Contractor has to obtain IGBC Gold rating. The contractor should demonstrate feasibility of achieving a minimum of 64 points at the time of submission of bids. The buildings are to be designed as per NBC, GDCR and IGBC Guidelines.

2.1.2. Architecture, Interiors, Softscape & Hardscape

The Architecture, Interiors, Softscape & Hardscape scope includes design, detailing, procure, supply, construction, installation, furnishing, equipping, testing, commissioning and execution for "Birsa Munda Stadium" building complex that includes Central pavilion, south and north Pavillion, Football turf; Swimming pool, and ancillary structures, in accordance with the Employer’s Requirements.

Design and detailing shall include:

1 Appointment of consultants

2 Preparation of coordinated GFC drawings
3 Obtaining Employers / PMC''s approval on the GFC drawings
4 Preparation of approval drawings, documents, calculations, etc, as may be necessary by the statutory authorities, at the relevant stages
5 Providing material samples and mock-ups and obtaining Employers / PMC''s approval for the same
6 Preparation of As-built drawings

Procurement, supply, construction, installation, furnishing, equipping, testing and commissioning shall be carried out for the following works:

1 Masonry
2 Plastering
3 Painting
4 Glazing & Facade works
5 Stone cladding
6 Flooring And finishing
7 GRC Works
8 Fabrication works
9 Dry Partition/Glass partition
10 False ceiling
11 Panelling
12 Specialised flooring if any other than that specified in schedule of Finishes
13 Painting other than that specified in schedule of Finishes
14 Glass doors/interior doors specified in schedule of doors
15 Good garden earth & manure
16 Trees, shrubs, ground covers, lawns
17 Irrigation system
18 Fountain system
19 Gates including automation

2.1.3. Architectural design criteria

The contractor shall prepare architectural design of all the components and get it approved prior to start the detailed design of the works. The area and facility requirements have been provided below for all buildings.

MAIN BUILDING

GROUND FLOOR: 1644.89SQM

1. Canteen with kitchen and washroom facility – 90pax
2. Control room
3. Support room
4. Store room
5. Conference hall facility
6. First aid room
7. Doctor room
8. Dope testing facility
9. Changing room for 2 teams
10. Gym for the players
11. Coach room for both the team
12. Admin staff area with separate waiting

FIRST FLOOR BELOW SEATING: 1644.89SQM

1. Smoke less cafeteria with seating facility for 15 to 20 pax (2 no.)
2. Stalls 5no.
3. Toilet and drinking water facility
4. CCTV control room
5. Normal seating facility for spectators (plastic chairs as per approval).

SECOND FLOOR BELOW SEATING: 1644.89SQM

1. Normal seating facility for spectators (plastic chairs as per approval)
2. Utility and services as per the norms

THIRD FLOOR: 1082 SQM

1. Normal seating for spectators (plastic chairs as per approval) with supporting facilities like toilet block.
2. VIP lounge with seating facility.
3. Commentator box with retiring room and supporting facilities like AV room and toilet block

NORTH CIRCULAR SEATING

BASEMENT FLOOR: 951.45 SQM

1. SERVICES AND UTILITY

GROUND FLOOR: 951.45 SQM

1. Toilet block for male and female with drinking water facility
2. Handicapped toilet
3. Handicapped seating
4. Stall 4no.
5. Record room
6. Media lounge
7. Services and utility
8. store

FIRST FLOOR: 951.45 SQM

1. Normal seating as per approval of architect (Plastic chairs) 1400 ppl capacity

SOUTH CIRCULAR SEATING

BASEMENT FLOOR: 951.45 SQM

2. SERVICES AND UTILITY

GROUND FLOOR: 951.45 SQM

9. Toilet block for male and female with drinking water facility
10. Handicapped toilet
11. Handicapped seating
12. Stall 4no.
13. Services and utility
14. store

FIRST FLOOR: 951.45 SQM

2. Normal seating as per approval of architect (Plastic chairs) 1400 ppl capacity

SWIMMING POOL

BASEMENT FLOOR: 339.26 SQM

1. Filtration plant

GROUND FLOOR: 2790.66 SQM

1. Waiting and recption
2. Canteen facility with kitchen and seating
3. Changing room with locker, shower and toilet facility, separately for male and female
4. First aid room
5. Pool racing track 8lane
6. Seating facility for players
7. Seating facility for spectators
8. Space for life guard
9. Press and photography stand both side of track
10. Judge seating
11. Timing and scoring facility

FIRST FLOOR: 709.67 SQM

1. Office with store facility
2. Player lobby
3. Commentary box
4. AV box
5. Judge retire room
6. Toilet block
7. Seating facility for spectators

Foot Ball Field

Scope includes design, detailing and construction of FIFA certified foot ball field. The minimum obligations are:

- Preparation of National level Natural grass foot ball filed with required sub base, base, top soil and grass as approved by Sports Authority of India (SAI)
- Water sprinkler system including piping and pumping machinaries
- Under Drainage System to collect infiltration water
- RCC Side drain to collect surface water
- Supply of all required equipments
- Line marking.

Athletic Track

Scope includes design, detailing and construction of 400mm long 8 lane synthetic athletic track as per specification. Scope includes following additional sports facilities along with the track:

- Jumping pits duly sand filled – 4 nos
- IAAF approved hurdle – 1 set
- Javelin – 4 nos
- Shout put(7.26 kg, 129mm) – 4 nos
- Discuss throwing cage – 1 no
- Discuss – 3 nos
- Shot put / Discuss circle – 1 no
- Long jump (take off tray, take off wooden board, & dummy board cover) – 1 set

2.1.4. Special Conditions

2.1.4.1. Look & feel of the project

The Contractor shall study the drawings, visualizations, specifications, material finishes indicated in the contract document and understand all parameters of the design including the architectural look & feel intent of the design consultants. The contractor shall clarify any doubts / discrepancies during the technical discussions with RSCL /consultants.

The contractor is bound to maintain and deliver the core and shell of the building as per the design intent of the consultants.

2.1.4.2. Construction Documents / Documents

The Contractor shall provide multiple options of the design of necessary element of the Work for the Employers Representative to review along with Employer / RSCL and shall proceed further only after its approval and sign off. And related Construction activities shall not commence prior to approval of the same. Any minor modification or alteration to one design shall not be construed as “option of the design”.

The drawings issued along with the tender are based on the applicable statutory regulations and guidelines. In due course of time the RSCL shall issue the drawings approved by the statutory authorities for "commencement of works at site", and these shall become the basis for

preparation of the GFC drawings by the contractor. All development works shall conform to, shall be designed and constructed / executed in compliance with the applicable statutory regulations and guidelines and comments received from the concerned statutory agencies.

2.1.4.3. Approval Drawings / Documents For Subsequent Approvals

Contractor shall prepare and submit approval drawings, documents, calculations, certificates, etc, as may be necessary by the statutory authorities, at the relevant stages. The contractor shall prepare and modify the GFC drawings based on the drawings approved by the statutory authorities.

2.1.4.4. Construction Drawings / Documents Approval Process

Contractor shall submit at least following number of sets for approval of Employer‟s Representative.

A. Construction Documents - 08 sets
B. Samples, datasheets etc - 08 sets

Each of the submission should clearly identify the Work, purpose of the submission, document number etc. as approved in the procedure referred above. Upon review of the said submission Employer‟s Representative shall return the submission with following codes

a. Work may proceed.
b. Revise and Resubmit. Work may proceed subject to resolution of indicated comments.
c. Revise and Resubmit. Work may not proceed.
d. Review not required. Work may proceed.

Although Work may proceed on receipt of a drawing coded 2, Contractor must resolve the comments indicated, resubmit and obtain a Code 1 before release for shipment or completion of the affected Work.

Employer/ Employer‟s Representative and Consultant/RSCL‟s review and permission to proceed does not constitute acceptance or approval of submittals including, but not limited to, design details, calculations, analyses, test methods, construction methods, plans, certificates or materials developed or selected by Contractor and does not relieve Contractor from full compliance with the Contract requirements.

2.1.4.5. Technical Standards And Regulations

Contractor shall refer and implement all relevant and all applicable codes, technical standards, regulations, as amended, required for performance of Work covered under this Contract. Also, all the conditions of statutory approval already taken by the Employer need to be complied during construction stage, the same need to be complied for future approval required if any.

2.1.4.6. Samples

Contractor shall necessarily submit samples of all finishing materials that may affect the look and feel of the project, especially those for which basic rates are indicated in the BOQ and where generic materials are indicated. Submission of samples shall not be limited to the above, and the Employer/ Employer‟s Representative and Consultant/PMC reserves the right to demand any sample of materials, as deemed necessary.

Where samples are required, they shall be submitted by and at the expense of Contractor allowing at least fourteen (14) calendar days for review by Employer/ Employer‟s Representative and Consultant/PMC unless otherwise shown on the Contract Schedule. The materials represented by such samples shall not be manufactured, delivered to the Site or incorporated into the Work without Employer/ Employer‟s Representative and Consultant/PMC review.

Each sample shall bear a label showing Contractor's name, Work name, Contract number, name of the item, manufacturer's name, brand name, model number, supplier's name, and reference to the appropriate drawing number, technical specification section and paragraph number, all as applicable.

Samples, which have been reviewed, may at Employer‟s option, are returned to Contractor for incorporation into the Work.

2.1.4.7. MOCK-UP

As deemed necessary by the Employer/Employer‟s Representative/PMC, Contractor shall execute necessary mock-ups of all items/activities related to the Work performed required under this Contract as indicated below and the cost for the same shall be deemed to be included in the Contract price.

The following mock-ups shall be executed by the contractor:

Item	**Extent / Size**
1. Facade / Glazing systems	Height - One floor Width - 03 modules [including one operable module, if any]
2. GRC Jail	1.0 x 1.0 M
3. GRC mural	1.5 x 1.5 M.
4. Stone cladding, including window glazing, aluminium louvers, flashings and interface details	6.0 x 6.0 M
5. All finishing items including but not limited to toilets, flooring, wall cladding, doors & windows, false ceiling, etc.	Toilets - 01 module including all fittings, fixtures and modular partitions Hard & soft finishes - approx 50 sqft, including all typical interfaces and details.
6. Railings and other metal fabrication works	Min 2.0 RM including all types of details [turns, bends, ends, etc]
7. Pergola	3.0 x 3.0 M including all interface details
8. Tensile structure	Min 3.0 RM including all interface details
9. Polycarbonate Skylights	3.0 x 3.0 M including all interface details

2.1.4.8. Documents At Site

The contractor shall maintain in a conspicuous place on the site a copy of development permission and a copy of approved drawings and specifications.

AS-BUILT DRAWINGS.

Progress As-Builts / GFC drawings.

During construction, Contractor shall keep a marked-up-to-date set of progress as-built / GFC drawings and specifications on the Site as an accurate record of all deviations between Work as shown and Work as installed. These drawings and specifications shall be available to Employer for inspection at any time during regular business hours.

Final As-Builts.

A. Contractor shall at his expense and not later than thirty (30) calendar days from Taking over Certificates and before Final Payment furnish to Employer a complete set of marked-up as-built reproducible drawings and specifications with "AS-BUILT" clearly printed on each sheet and on the specification cover.

B. Contractor shall accurately and neatly transfer all deviations from progress as-built to final asbuilt drawings and all annotations from progress as-built to final as-built specifications.

C. Contractor will provide eight (8) copies of the as-built drawings of which one (1) is in fully editable electronic format in a form acceptable to the Employer. Employer shall provide editable electronic copy of the requisite drawings such as floor plans, to facilitate preparation of electronic as-built-drawing.

Endorsement.

A. Contractor shall sign each final as-built drawing and the cover of the as-built specifications and shall note thereon that the recording of deviations and annotations is complete and accurate.

2.1.4.9. Specifications

The specifications forming part of this Contract have been drawn up with all possible care and are intended to cover the supply of all the materials, tools, plants and equipment, labour and the execution of all works necessary to complete the entire Work in all respects under this Contract. In case there are any details of construction or materials which have not been referred to in the specifications, detailed descriptions of items, schedule quantities, or the drawings but which are usual or essential in the true completion of the purpose of the Work, the same shall be deemed to have been included in the price quoted by the contractor. Wherever specifications are not stipulated, the Work shall be as per latest ISI specifications and/or directed by the Employer/ Employer‟s Representative and Consultant/RSCL following good Engineering practice.

2.2. Civil

The Scope of Work under this contract includes but is not limited to the following in relation to the design, construction, and operation of the Works:

- Contractor shall prepare and submit Design Basis Report for approval based on the design Intent.

- Site Topographic Survey and Geotechnical Investigations as deemed necessary by the Contractor as per BIS latest codes, NBC etc as applicable through any nationally accredited lab. Employer may verify the results submitted by contractor, if need be.
- Construction enabling works like site office, labour camp, material stacking, laboratory, etc. shall be the responsibility of contractor.
- Setting out of the works.
- Site Clearing, Site Grading, and Excavation, disposal of excavated earth and bailing out & disposal of water.
- Contractor shall do Structural Design based on approved Civil Structural Design Criteria.
- Preparation of complete structural design, drawings for foundation, basements, podiums, superstructure and for other related structures in the housing pocket. i. e. UGRs, pump house, DG set meter room, substation building, gate , compound wall, chambers, trenches etc to be provided as per provision contained in IS codes/NBC but not lower than the minimum criteria mentioned in the tender. , Scales for each detail in drawing and drawing sheets shall be use as per BIS standards.
- Contractor shall submit Structural stability certificate for 10 years and life span building structure certificate for 50 years for all structures and components to Rourkela smart city corporation with his own cost.
- Construction of all Civil Structures and Building finishes Work of all structures in housing pocket.
- For all structural designs and drawings the contractor must get the proof check done by accredited agencies at his own cost before submitting for the approval of the client.
- One Copy of structural design calculations and details in soft and hard copy (latest version of software) based on the approved building plan shall be submitted before commencement of the construction work at site for information and record.
- Submission of Detailed Engineering Designs, Drawings, Process Calculations, Data Sheets for approval.
- Execution of all Civil Works at Site including Construction, Erection, Testing and Handing over.
- Design and Construction of Internal Roads, Curbs, Pavements, Parking Spaces, Compound Wall, water supply and sewage disposal and Storm Water Drains etc.
- Water tanks shall be designed for limited crack width as per BIS code and checked for water tightness after construction.
- Implementing Anti-termite treatment / Water proofing / Insulation works. Contractor shall submit warranty certificate for same in approved format.
- Plantation and Landscaping works.
- Preparation and Submission of As-Built drawings for Civil and Structural Works.
- Issuing Warranty certificate for Anti-termite treatment / Water proofing / Insulation works.
- Maintaining safety requirements and relevant Government Regulations, and ensure their implementation.
- Safety reporting: Brief reports of all accidents and hazardous incidents including descriptions of causes, extent of injuries, action taken, and precautions instituted to prevent repetition of such events.

- Contractor has to erect batch mix plant (minimum 60 cum/hr capacity) fully automatic, computerised for preparation of design mix concrete as per latest BIS codes at his own cost and shall prepare all concrete accordingly. RMC to be used for 6 cum or more than 6 cum of concrete to be done in single pour.

Guarantee for construction defect/manufacturing defects during defect liability period: Contractor shall guarantee the entire work for period of 60 months after completion of work. Any damage or defect that may arise or that may remain undiscovered at the time of issue of completion certificate connected in any way with the equipment or materials supplied by him or in the workmanship be rectified or replaced by contractor at his own expense as desired by engineer-in-charge or in default may cause the same to be made good by other agency and deduct expenses there of (for which the certificate of engineer-in-charge shall be final) from any sums that may then or any time thereafter become due to contractor or of sale thereof or a sufficient portion thereof. The contractors shall be liable to construction defect/ manufacturing defects and not liable to damage caused by occupants if any.

The Contractor shall institute a Quality Assurance and Quality Control (QA/QC) system in accordance with the requirements to demonstrate compliance with the requirements of the Contract. The Contractor shall submit, within 14 days of signing of the Contract Agreement, the required Quality Assurance and Quality Control (QA/QC) Program for approval by the Employer's Representative. The Employer's Representative will either approve the submittal or provide comments thereon to the Contractor within 14 days of submission by the Contractor. The Employer's Representative's, approval, disapproval, comments, or failure to provide any of these to the Contractor, shall in no way relieve the Contractor of any of its obligations or responsibilities under the Contract. The Contractor, prior to commencement of work at the Site, shall set up his own laboratory, with prior notification to the Employer's Representative. The calibration of the laboratory equipment and instruments shall be certified by agencies approved by the Employer's Representative. Laboratory equipment shall be properly maintained and calibrated throughout the period of the Contract by the Contractor at his own expense. The Contractor shall give the Employer's Representative reasonable advance notice prior to conducting any tests required by the Bid Documents, which the Employer's Representative may choose to witness at his discretion. The Employer's Representative will also inspect the laboratory if deemed necessary and the Contractor shall provide adequate facilities to the Employer's Representative that may be necessary for witnessing testing or for independent verification of the accuracy and adequacy of the

facilities and equipment. Compliance with the QA/QC system shall not relieve the Contractor of any of his duties, obligations, or responsibilities under the Contract. Contractor shall maintain Quality Control records. QA/QC records till the completion of Defect liability Period shall be maintained.

Weekly/Fortnightly/Monthly Progress Reports, along with photographs depicting the progress achieved in the month, shall be prepared by the Contractor in a format approved by the Employer's Representative and the Employer and submitted to the Employer's Representative. Contractor shall submit Weekly/Fortnightly/Monthly Progress Reports in review meetings for Project Progress and approval.

2.3. Electrical

2.3.1. Scope

The scope consists of design, engineering and manufacturing; testing at Manufacturer's works, packing, forwarding and delivery to site; unloading and handling at site (shifting from unloading point to the storage area, storage and shifting from the place of storage to the place of installation), assembly, erection, cleaning & touch up painting; testing & commissioning at site for **Football stadium cum Athletic Track and Swimming Facility** at **Birsa Stadium** in Rourkela.

Following shall be considered for the Electrical Works:

(a) Metering equipments as per OERC Net Metering / CERC regulation. Provision for a HT (11kV) meter room (4.0x4.0m) with an isolator switch to be made as per DISCOM requirement. The meter room shall have access from road with locking facility. The access to this room shall be restricted to DISCOM representatives only.

(b) 11kV Compact substation having VCB / Disconnecting switch, Dry Type Transformer & LT breaker.

(c) Aluminium sandwiched type bus duct.

(d) 2 No. Diesel Generator set with Synchronising Panel.

(e) 3 Phase, 415 V, 50 Hz LT Power Control Centre (PCC) panels.

(f) 3 Phase, 415 Volts, 50 Hz, Automatic Power Factor Control (APFC) Panel.

(g) HT and LT cables and associated cable laying and interconnection system.

(h) Power Distribution Board (PDB) and Lighting Distribution Board (LDB).

(i) Recessed point wiring for fan, light, power receptacle, exhaust fan, etc

(j) Earthing System.

(k) Lightning Protection System

(l) Indoor and Outdoor Lighting Work including decorative lighting fixtures, power receptacle, exhaust fan and decorative poles.

(m) Football stadium cum athletic track flood lighting for CTV Telecasting with Metal Halide fixtures. The scope shall also include provisioning for escape cum maintenance lighting for the stadium also.

(n) Swimming pool area for recreational / practice level lighting using LED fixtures

(o) Passenger Elevator

(p) Miscellaneous statutory equipment needed for completion of work.

The soil resistivity at site by Wenner's four electrode method as per IS: 3043 – 1987 and its latest amendments, at minimum two (2) locations shall be carried out by the Contractor. The measurements shall be carried in the presence of the EMPLOYER and the results/ report shall be certified by Govt. Authorised Labs or agencies.

Necessary statutory approvals, new connection from WESCO for the electrical systems installed shall also be in the Contractor's scope.

All mounting and foundation supports and hardware accessories for electrical equipment/system installations.

All civil works associated with equipment/system electrical installations like embedment, chipping, punching, making holes, openings in walls, pipe sleeves, fire/ water proof sealing etc.

The CONTRACTOR shall be responsible for the selection and design of appropriate equipment to provide the best co-ordinated performance of the entire system. The design of various components, assemblies and sub-assemblies shall be so done that it facilitates easy field assembly and maintenance.

Equipments furnished shall be complete in all respects with all mountings, fittings, fixtures, and standard accessories normally provided with such equipment and / or needed for erection, completion and safe operation of the equipment as indicated in applicable codes, though they may not have been specifically detailed in the Technical Specification, unless included in the list of exclusions. Materials and component not specifically stated in the specification but which are necessary for commissioning and satisfactory operation unless specifically excluded shall be deemed to be included in the scope of specification and shall be supplied without any extra cost. All similar standard components/ parts of similar standard equipment provided shall be inter-changeable with one another.

All SAFETY considerations in design, manufacturing and installation of equipments and systems for safe operation & maintenance by EMPLOYER personnel and safe practices during installation at site shall be in the scope of the Contractor. Cost towards accomplishing the same shall be included in the BID price and no extra claim shall be entertained later.

2.3.2. General System Requirements

Equipment/ system Detail Engineering Drawings, Data sheets, sizing Calculations etc shall be submitted for review and approval by EMPLOYER before execution/ procurement and manufacturing; Test reports, commissioning reports and performance reports of all electrical system/ equipment shall also be submitted for review & acceptance by EMPLOYER.

Submission of Type test reports carried out at accredited laboratories like ERDA, CPRI or equivalent as per requirements of state DISCOM.

Submission of all "As Built" drawings, Data sheets, Calculations etc. after execution and commissioning of the equipment and systems above.

Submission of relevant documents and drawings to the concerned statutory authorities/ agencies and getting clearance and approval for the supplied and installed equipment under this specification is solely the responsibility of the CONTRACTOR.

All coordination for Liaison and obtaining required mandatory approvals/ NOCs from Electrical Inspector and any other Statutory Authority as applicable for drawings & documents, initiation of works, load release, charging and commissioning of entire power distribution system within the scope of this Document.

2.3.3. List of Submissions

The proposed Electrical Power Distribution and Lighting System shall be designed to provide:

(a) Electrical supply to equipment and machinery within the design operating limits.

(b) Safety to Personnel and equipment during both operation and maintenance.

(c) Reliability & Continuity of Service.

(d) Minimal fire risk with fail safe feature.

(e) Ease & flexibility of maintenance and operation.

(f) Adequate provision for future expansion and modification.

(g) Maximum inter-changeability of equipment.

(h) Energy efficient equipment/ system with BEE (Bureau of Energy Efficiency) Rating above 3 stars.

(i) Suitability for applicable environmental factors.

(j) Service Condition

All the components of the electrical system shall be sized to suit the maximum load under the most severe operating conditions. Accordingly, the maximum simultaneous consumption of power, required by continuously operating loads shall be considered and an additional margin shall be taken into account for intermittent service loads, if any. The amount of electrical power consumed by each area shall be calculated for its operation at the design capacity.

The equipment shall be designed and manufactured in accordance with the best engineering practices and shall be suitable for the intended purpose.

2.3.4. Applicable Code and Standards

The design, material, construction, manufacture, inspection, installation, testing and performance of electrical equipments & systems should conform to the latest applicable Central Electrical Authority (CEA) guidelines, all currently applicable IS, IEC and IEEE standards, Central PWD (CPWD) Specifications, Odisha PWD Specifications, National Building Code, National and International codes of practice, statutes, regulations and safety codes in the locality where the equipment will be installed.

2.3.5. System Design Parameters

The electrical system shall be designed as per relevant standards and local regulations with the stringent of the two regulations being the governing parameter.

Following System Parameter shall be adopted for designing the electrical system:

Nominal (Rated) System Voltage	11kV	0.415kV
Highest System Voltage	12kV	1.1kV
Lightning Impulse Withstand Voltage (1.2/ 50 microsecond)	75 kVp	-
Power Frequency Withstand Voltage for 1 minute	28 kV rms	3 kV rms
System Neutral Earthing	Solidly Earthed	Solidly Earthed
Fault Level of System	20kA for 1sec.	Contractor to calculate
Frequency	50 Hz	50 Hz
Dynamic Short Circuit Current Rating	62.5 kA peak	As calculated

2.3.6. Service Conditions

a) Design Ambient Temperature (Reference Ambient temperature for temperature rise consideration) – 50 ºC.

b) Relative Humidity – Maximum - 100%; Minimum – 15%

2.3.7. System Design Criteria:

The system shall be designed taking in to consideration the following system variation:

Voltage: +10% to -10%

Frequency: +3% to -3%

Combined voltage and frequency variation: +10% to -10%

The load distribution should be such that the load unbalances does not exceed 5% at the point of commencement of supply as per OERC regulation.

The system power factor shall be at least greater than 0.92.

In normal operating condition, cumulative voltage drop from PMCC to the last equipment in the topmost floor shall not exceed 6% (measured at load end).

Voltage dip at the Motor terminals during motor starting of the highest rating motor with regular base load shall not exceed 15%.

Fault level for HT shall be considered as 20kA for 1 sec or actual calculated during detailed design stage by the Contractor, the stringent being applicable.

The fault level for LT system at transformer terminal shall be calculated based on the transformer rating and its impedance, as per relevant IS 2026 / 11171. The transformer losses shall be limited as per ECBC guidelines. However, minimum short circuit rating of switchgear and cable withstanding capacity shall be considered as per actual fault level or next higher market available rating for MCCB, 50kA for 1 sec for ACB switchgear and Busbar Short Circuit as per SLD or actual calculation.

For Lighting, Air conditioning and other Miscellaneous Power outlets following shall be the parameters to be considered:

Nominal Voltage	240V
Phases	1
Frequency	50Hz
Connection	3 wires(Phase, Neutral & Earth)

2.3.8. Estimation of Load/ Max Demand

The following considerations are to be followed to arrive at the maximum electrical demand.

a) Load Factor

i.	Motors (Fire Hydrant system)	:	0.1
ii.	Auxiliary load (Elevator, Crane/ Hoist, etc.)	:	0.5
iii.	Lighting load	:	1.0
iv.	Miscellaneous Power loads	:	0.9
v.	Watering Pump	:	0.9
vi.	Ventilation System	:	0.9

b) Power factor of Motors : As per the Manufacture's Data sheets

c) Efficiency of IE2 motors : As per the Manufacturer's Data sheets

d) Overall Diversity for final Demand calculation shall be considered as 1.25.

e) A design margin of 10% shall be considered.

f) The improved power factor shall be considered as 0.95.

2.3.9. Electrical Power Supply

The Orissa Electricity Regulatory Commission Distribution (Conditions of Supply) Code, 2004 provides for the following supply voltage connection based on contract demand:

Sr. No.	Contract Demand (kVA)	Supply Voltage
1	Not exceeding 5.55kVA	1ph, 2wire, 230V
2	Above 5.55kVA upto and including 70kVA	2ph, 3wire or 3ph, 3 or 4 wire, 400V (L-L)
3	Above 70kVA but below 555kVA	3ph, 3wire, 11000V (L-L)
4	555kVA and above but below 1110kVA	3ph, 3wire, 11000V (L-L) or 33000V (L-L)

As per OERC regulation, the incoming supply voltage shall be decided.

Independent power for the Birsa stadium shall be provided from State Distribution Company, Western Electricity Supply Company of Orissa Ltd. (WESCO) at 11kV through underground laid HV cables till the plot substations. The power supply shall be provided by WESCO at the meter room designated preferable near the plot boundary with a separate access from the nearby approach road. Necessary cabling work from last pole / RMU shall be in the CONTRACTOR's scope.

The tariff meter shall be installed as per OERC or CERC guidelines amended as on date. The Contractor shall take necessary approval from DISCOM after installation of the meters.

The incoming 11kV voltage shall be stepped down at the Compact Substation to 415V for further distribution to the various buildings such as Stadium, Gallery, Swimming Pool and Hall of Fame (future expansion load) from the Main LT Distribution Power-cum-Control panel. Power feeders from this Distribution PCC shall feed the respective building load requirements through the Main LT panel located at each building. There shall be 2 Nos of Diesel Generator set with a synchronising panel. Refer TCE.10839A-EL-4002-AU-40020 for the distribution schematic.

2.3.10. Compact Substation (CSS)

Compact Sub-Station (CSS) shall comprise of 1 No. of 11kV VCB ICOG, 1 No Dry type distribution transformer and ACB accommodated in HT, Transformer and LT

compartments respectively. CSS shall be 'sealed for life' type. Further distribution from CSS to LT common services, indoor lighting and outdoor area lighting will be through PMCC panel. The CSS shall be located outdoor with IP 55 enclosure.

As per CEA regulations, if the length of cable exceeds 15m from point of supply to the consumer breaker then a point of supply isolation shall be provisioned. Hence, need for an outdoor 11kV RMU with VCB ICOG shall be assessed. In case of requirement, the same shall be located outdoor near to the metering room.

2.3.11. 11/0.433kV Dry Type Transformer

The 11/0.433kV transformer shall be Dry type with Off-circuit tap changer (OCTC) complying with IS 11171, IS 2026, ECBC and other relevant standards as amended till date.

The transformer shall be sized taking into the following consideration:

a) Connected loads

b) Load factor, Diversity factor as indicated above

c) 10% contingency factor over cumulative maximum demand

d) 80% loading of the transformer

e) Voltage dip at the largest motor terminal during its starting on base load condition. The voltage dip shall be less than 15% taking into consideration motor starting method.

f) Power factor improvement to 0.95.

2.3.12. Emergency Power Supply – Diesel Generator (DG) Set

The capacity of the DG shall be calculated based on the total simultaneous maximum demand of all the loads (calculated based on the load factors, efficiency and diversity indicated above). A contingency factor of 10% over the cumulative maximum demand (MD) shall be considered. The size of the selected DG set shall be calculated such that the maximum loading shall not exceed 80% at 0.8 PF. Paralleling of the DG sets shall also be considered while estimating the capacity.

The adequacy of DG sizing shall also be checked on the basis of voltage dip at the motor terminal during the starting of the largest motor considering base loading condition, i.e., all other loads except the highest rated motor . The voltage dip at motor terminal shall not exceed 15% taking into consideration the use of appropriate starter.

The step loading of the engine of the DG shall not exceed 40% of the maximum load catering capacity, i.e., 80% of rated capacity.

The DG set shall have acoustic enclosure ensuring the noise level shall be 75dB (A) at 1m from enclosure, as per relevant state pollution control board regulation. The enclosure shall provide IP55 protection to the DG set

100% emergency backup shall be provided for Birsa stadium with **2Nos of LT DG set with Synchronising panel**.

The synchronising arrangement shall ensure optimum utilisation of the DG sets with reduced fuel consumption as it shall operate one DG set on sensing failure of incoming mains. When the load on the DG set exceeds 80% of rated capacity, another DG set shall be switched on and synched with load sharing. As the loads on DG decreases,

the synchronising panel shall turn of one of the DG first such that the working one is loaded less than 80% of rated capacity. This mechanism shall ensure efficient working of DG sets and optimum fuel consumption.

There shall be a manual over-ride option provided also. The manual over-ride shall be utilised for providing power to the Football stadium loads during national level matches as per standard's requirement.

DG Exhaust Height calculation

As per NBC standard, for DG set up to 1000kVA, the height of exhaust stack shall be calculated based on the below mentioned formula:

$$H = h + 0.2 \times \sqrt{(\text{kVA rating of DG set})}$$

where,

H= Height of exhaust stack.

h= Height of nearby building.

2.3.13. Fault Level

Fault level at transformer secondary and at 415V LT panels shall be calculated based on the transformer rating and impedances of transformer and cables. In case of large motors, the same shall be considered.

2.3.14. Power Factor Improvement

The required capacitor rating shall be calculated based on the system power factor requirement of achieving 0.95 power factor, i.e., 0.81 or actual (whichever is lesser) to be corrected for 0.95.

APFC Panel shall be selected considering following design criteria:

a) Optimum no of steps to ensure proper regulation with minimum two (2) nos. of spare steps subject to a maximum of 12 steps

b) Minimum steps of 5 kVAR and 10 kVAR bank in adequate nos. for fine regulation of power factor at low loads shall be considered. Balance capacity can be considered with 25 kVAR, 50 kVAR or 100kVAR capacitor bank.

c) Capacitor banks shall be All Poly Propylene (APP), double layer type.

d) For no load condition power factor regulation, following shall be the provisions made:

Sr. No.	Transformer kVA Rating	Capacitor provision to be made (% of rated kVA)
1	≤315	5
2	>315 to <1000	6
3	≥1000	8

2.3.15. Sandwich LT Bus Duct

If the full load current of an incomer increases beyond 1800A, after deration, using cables for interconnection shall not be a viable option and bus duct shall be recommended. For Package I, the connection from CSS, Synchronization panel of DG sets to the LT PMCC shall be through Sandwiched type Aluminium Bus duct.

For bus duct sizing following are the factors to be considered:

a) Design ambient temperature of 50^0 C.
b) Final temperature of the bus-bars complying with requirements of IEEE C37.23-2003 / IS 8048.
c) Suitability for carrying rated current continuously taking into consideration design margin. The current density (A/mm²) of the bus bar shall not exceed 0.8 for Aluminium bus and 1.6 for Copper bus.

The bus duct shall be provided with necessary support structure with flexi bus duct at the termination ends. Space heater shall be provided inside the bus duct to avoid presence of moisture.

2.3.16. LT Panels

All Panels shall be indoor / outdoor type having incoming sectionalisation and outgoing switchgears as specified. The design shall be cubical type. The degree of enclosure protection shall be IP 52 for indoor and IP55 for outdoor as per IS: 13947 (Part-I). All LT Panels except for PMCC shall conform to FORM 3B whereas PMCC shall conform to FORM 4B as per IS 61439. The LT Panels shall be as per the standards IEC 61439.

PMCC shall be of internal arc type tested with Internal Arc withstands level at rated fault level for 0.3s.

Busbar: All panels shall be provided with Aluminum busbar. Distribution boards with incomers below and including 63A shall be provided with tinned copper bus bars.

The bus-bars shall be sized considering the following criteria:

a) Sleeves made of insulating material on all bus bars.
b) Design ambient temperature 50^0 C.
c) Final temperature of the bus-bars complying with requirements of relevant standards.
d) Bus bars being inside the panel; De- ration for enclosure and ventilation.
e) Bus bar suitability for carrying rated current continuously. The current density (A/mm²) of the bus bar shall not exceed 0.8 for Aluminium bus and 1.6 for Copper bus.
f) Configuration of bus bars and Proximity effect.
g) The main bus shall be designed based on the load rating as well as the actual fault level for specified duration at the location of the panel with 10% positive tolerance.

Earth bus of the panel shall be sized suitable for the above fault level for the same duration.

Switchgear Sizing/ Selection:

Switchgear shall be sized/ selected considering the following:

(a) Rating suitable for carrying full load current of the equipment / feeder.

(b) Suitability for Short Circuit Rating for specified duration.

(c) Switchgear for motors shall be suitable for motor duty application with Type – 2 co-ordination.

(d) In panel de-ration of minimum 20% or as provided in Manufacturer's catalogue, whichever is higher shall be considered.

(e) Switchgear rating for individual capacitor bank shall be sized at 1.5 times the rated current rating.

(f) ACBs shall be considered for switchgear ratings above 630A and MCCB shall be considered up to 630A. All ACBs and MCCBs shall be rated for Bus fault level or next higher market rating available with Ics=Icu=Icw=100% for ACB and and Ics=Icu=100% for MCCBs.

(g) Miniature Circuit Breaker (MCB) shall be considered where fault level is below 10kA.

(h) The Main LT Switchgear panel shall be provided with Microprocessor based overload (O/L), Short circuit (SC) and Earth fault (E/F) release at the panel incomer and outgoing.

(i) Multi-function meter for measuring current, voltage, power, frequency, harmonics shall be provided for all the incomers (Transformer as well as DG), outgoing power / tie feeders. Ammeter shall be provided for other load feeder such as motor feeder, lighting feeder, etc.

(j) Motor starter selection shall be done as follows:

i. Direct On Line (DOL) Starter – For motors rated up to 5.5 kW

ii. Star- Delta Starter - For motors rated above 5.5 kW to 45 kW or as per local Electricity board requirements, whichever is more stringent.

iii. DOL starter shall be provided for the main Fire Pump.

iv. DOL starter shall be provided for Jockey pumps.

(k) Motor feeders shall have the following protection and components:

i. Motor Protection Circuit Breakers (MPCBs) with inbuilt thermal overload and air break contactors for motors up to and including 50 kW rating suitable for type 2 co-ordination.

ii. MCCB with separate thermal overload and air break contactors for motors above 50kW up to and including 100 kW rating suitable for type 2 co-ordination.

iii. ACB/MCCB and Composite motor protection relay (a minimum of protections such as over current, short circuit, earth fault, locked rotor, Negative phase sequence, thermal alarm etc.) for motors above 100kW rating.

iv. For fire pump, overload relay shall be provided with a plug setting of 110%.

(l) In case the fault level at transformer LT side increases to more than 10kA, cascading of breakers so as to accommodate MCBs in the PMCC shall be adopted. This shall ensure cost saving.

(m) 20% spare capacity shall be considered on each panel for future.

2.3.17. Cabling System

HT cables shall be 11kV earthed grade, multi-core, stranded and compacted aluminium contractor, extruded XLPE insulated (dry cured), extruded semi conducting compound screen with a layer of non-magnetic metallic tape screen, extruded PVC inner sheath (Type ST-2), armoured and extruded overall sheath with Fire Retardant Low Smoke (FRLS) PVC compound (Type ST-2). The cables shall conform to IS-7098 Part -II.

LT Cables shall be 1100V earthed grade, single/multi-core, stranded and compacted aluminium conductor, extruded XLPE insulated, extruded PVC inner sheath (Type ST-2), armoured and extruded overall sheath with Fire Retardant Low Smoke (FRLS) PVC compound (Type ST-2). The cables shall conform to IS-7098 Part -I.

Cables up to & including 6 mm² shall be Copper multi-stranded conductor with PVC insulation galvanized steel round wire armoured & cables beyond 6 mm² shall be Aluminium multi-stranded conductor with XLPE insulation & galvanized steel flat strip armoured.

All control cables shall be 650 V grade copper conductors FRLS PVC insulted cables conforming to IS 1544- Part I. For cables above 7 cores, minimum two spare cores shall be considered.

All LT cable shall be conforming to IS 7098 Part I for XLPE cables and IS 1544 – Part I for PVC cables.

The following main aspects shall also be considered while deciding the size of the cables/ wires:

(a) Supply voltage and frequency.

(b) Corresponding full load current under site conditions, i.e, necessary de-rating considerations.

(c) Route length and method of laying of cables.

(d) Maximum allowable temperature rise under normal full load condition based on the material of cable insulation (XLPE/ PVC).

(e) Maximum short circuit current duration (fault clearing time) and final temperature of cable during short circuit current flowing through the cable.

(f) Following shall be the fault clearing time consideration::

(i) From HT breaker to Transformer Primary shall be 0.16s.

(ii) From transformer secondary to Power Control Centre (PCC) incomer shall be 1s.

(iii) From ACB outgoing of the PCC shall be considered as 0.16s (for Tie feeders if any it shall be 0.5s).

(g) Appropriate de-rating factors as per cable manufacturer's catalogue and enlisted below shall be considered for sizing the cable:

(i) Ambient Air Temperature (minimum 50^0 C).

(ii) Ambient ground temperature (minimum 40^0 C to be considered).

(iii) Method of cable laying.

(iv) Depth of cable burial (minimum 750 mm for LT and 900 mm for 11kV HT).

(v) Thermal Resistivity of Soil (minimum 150^0 C Cm/ W to be considered).

(vi) No. of cables in a group

(vii) No. of cable trays in tier.

(viii) Any other de-ration factors as applicable & as per Manufacturer's catalogue.

Bending radius of 12D and 15D shall be provided for LT & Control Cables and HT cables respectively where D is the outer diameter of the cable.

RCC pipes shall be provided where cables need to cross the roads, drive ways. For HT cables, one cable shall be laid in one pipe section of minimum 150mm internal diameter. LT, control and ICT cables shall be laid in separate pipes.

2.3.18. Earthing & Lightning Protection system

The earthing system shall comprise one or more earth electrodes, earthing network, mesh or a combination of these in order to obtain grid resistance of less than 1Ω or as per local regulatory requirements.

Latest version of following standards and codes shall be referred to for designing the Earthing and Lightning protection system:

IS 3043	Code of practice for Safety Earthing
IS/ IEC 62305	Code of Practice for the protection of buildings and allied structures against lightning.
CEA guidelines 2010	Measures related to safety & electric supply.
IEEE 80	IEEE Guide for Safety in AC Substation

Soil Resistivity: The earthing system shall be designed by considering measured soil resistivity during detailed engineering and the earthing calculation shall be done.

Size of Earthing Conductors: The earthing conductor sizes shall be calculated as per IS 3043.

Following factors will be considered for sizing the earthing conductor:

Design Ambient Temperature	50°C

Allowable temperature rise	500°C
For steel welded joints Fault clearing time	1.0 s
Overall earthing resistance of the grid	Less than 1Ω

The maximum values of earth fault current for the design of the earthing system will be considered based on system requirement as follows:

a) 11 kV system : 20kA for 1s

b) 415 V system : 36kA for 1s (will be decided as per actual fault level calculation)

c) DB MCB : 10kA for 1s

Equipment Earthing

GI pipe electrode as specified in IS 3043 or as per local electricity board, CEIG, PWD requirements, whichever is stringent, shall be provided for the earthing of non-current carrying parts and enclosures of all electrical equipment such as CSS, LT panels, motors, Lighting Distribution Boards, cable trays, socket outlets, steel structural supports and high mast etc.

2 nos. dedicated copper plate electrode shall be provided for neutral grounding of both the transformer and the DG set each.

A grid earthing network shall be provided, laid buried 600mm deep in the ground at a distance of 1500mm from the building connecting all the dedicated Earth electrodes for all equipments and systems.

Materials used for earth electrodes shall be designed to suit the ground conditions and shall be galvanized.

Earthing network shall also be connected / formed through the cable trays. Double run GI strips (of adequate size as per the fault level) shall be laid on the cable tray along the length. The strips shall be welded to the cable tray at every 10m interval. For multi tier trays, the strip can be laid in one tray and connected to all at 10 M interval. These strips shall be connected to the main earthing grid buried around the building at minimum two places. The minimum size of Galvanized Steel Strip shall be 2nos of 50x6 mm.

Earthing requirements for Conduit wiring for Sub main, circuit and point wiring shall be carried out as per PWD guidelines.

Earth pits & Earthing conductor shall be laid around the building with a minimum clear distance of 300mm with respect to the other utilities and atleast 1500mm from the building plinth.

Lightning Protection

The need for lightning protection system shall be established by calculating the risk factor value of each building, structure etc. as per methodology/ procedure prescribed in IS/IEC

62305 - 2010. This will be provided for building(s) whose risk factor is exceeding the limiting values. The Risk factor shall be evaluated for Level 2 risk.

Based on the calculation, if found necessary, air termination system comprising of horizontal roof conductors shall be provided. The horizontal mesh shall be provided as per IEC 62305 - 2010 above the roof. The down conductors for this system shall be fixed and run along the outer surface of the building and connected to the earth electrodes.

The function of the air-termination systems of a lightning protection system is to prevent that direct lightning strikes damage the volume to be protected. They must be designed to avoid uncontrolled lightning strikes to the building / structure to be protected. Air-termination systems can consist of the following components and can be combined with each other as required;

(a) Roof conductor / rods / Meshed conductors / Air termination

(b) Down conductors

(c) Earth termination

All connection between the conductors shall be welded/brazed type. Metallic pipe, conduit, structures shall be bonded to lightning protection conductors to prevent the side flashover. But no metallic pipe, conduit, structure shall be used as air termination conductor or down conductor.

Earth pits provided for down comers of lightning protection will be connected with general earth pits through earth strips below ground to reduce the overall earthing resistance of the grid.

2.3.19. Point Wiring

Internal point wiring to light point/Fan point/ Exhaust fan point/Call bell point with 1.5 sq.mm FRLS PVC insulated single core multi-strand copper conductor of ISI marked with 20 mm dia non-metallic PVC flexible conduit with 6Amp, 250V Modular switch ISI marked and ceiling rose ISI marked mounted on metal box having front Modular cover of suitable size, metal box with 1.5 sq.mm FRLS PVC insulated single core multi-strand copper conductor as earth wire including all accessories and connection.

Lighting in external areas shall be installed using multi core armoured cable of suitable sizes.

Small Power Outlets

Switched single phase three pin 5 A and 15A receptacles shall be provided throughout. In offices and control rooms they shall be the decorative type and industrial type in all other areas.

The number of such outlets shall be as follows, unless additional numbers are required for specific loads:

- 5 A type one outlet per 5 m or part thereof of perimeter in offices;
- 5 A type one outlet per 20 m or part thereof of perimeter in all other areas;
- 15 A type one outlet per 20 m or part thereof of perimeter in offices;
- 15 A type one outlet per 20 m or part thereof of perimeter in all other areas.
- 32 A switched three phase and neutral receptacles shall be provided in Switchgear room, where appropriate.

The location of outlets shall be approved by the Engineer-in-charge. The spacing of 5 A and 15 A outlets shall be arranged to suit the intended location of equipment, desks etc.

Receptacles for outside areas shall have a degree of protection of IP 55.

The 6A light plug shall be installed with 2 x 2.5 sq.mm FRLS PVC insulated single core multistrand copper conductor of ISI marked with 20mm dia non-metallic PVC flexible conduit along with 1 x 1.5 sq.mm FRLS PVC insulated single core multistrand copper conductor for loop earthing as required.

The 16A power plug shall be installed with 2 x 4 sq.mm FRLS PVC insulated single core multistrand copper conductor of ISI marked with 20mm dia non-metallic PVC flexible conduit along with 1 x 2.5 sq.mm FRLS PVC insulated single core multistrand copper conductor for loop earthing.

2.3.20. Illumination System

Latest version of related IS standards, NBC and National Lighting Code (NLC) shall be referred for designing Illumination for different areas.

All lighting design shall be carried out on Dialux latest version or OEM specific software.

All lighting fixtures shall be of LED type.

Emergency Lighting: Critical lighting load for escape lighting pathway shall be catered through a UPS. Exit lights shall be provided so as to ensure safe evacuation in the event of fire, accident, etc. The UPS shall be sized adequately with battery backup of 15 minutes.

The basis of design shall be based on the following lighting engineering criteria, as per relevant standards or specified herewith:

- Lighting lux level
- Luminance distribution
- Glare restriction
- Direction of incidence of light and shadow effect
- Color appearance and color rendering of the light source
- Uniformity

Illumination Level:

The following LED luminaries shall be provided for various areas in order to achieve the average illuminance as per various relevant lighting standards or those indicated below, which ever be stringent:

Sr. No.	AREA	Average Illuminance (Lux)	Type of Fixture
a)	Utility Areas of building like Electrical Room, Store Room, Pump House, Ventilation	150	Surface / Recess mounted LED batten

Sr. No.	AREA	Average Illuminance (Lux)	Type of Fixture
	Rooms, Metering rooms, Ticket counter, entry exit of car park area etc		
b)	Common areas – Corridor and Lobby, Passage, Toilets, Staircase, etc	100	LED Surface / Recess mounted decorative down lighter fitting with polycarbonate cover LED Mirror Lights in toilets
c)	Areas involving concentrated working - First aid room, Office, Media Room, ICT room, Umpire's room, etc	500	Surface/ Recessed LED decorative down lighter fitting with polycarbonate cover
d)	Areas relating to discussion and planning - Coach room, Pantry, Meeting room, VIP seating, etc	200	Surface / Recessed LED decorative down lighter fitting with polycarbonate cover
e)	Street lighting	10 – 15	LED post top on 4m pole similar to Philips BGP161LED2300/WW PSU or equivalent
f)	Landscape	Min 10 (As per architectural requirement)	1x12W LED angle adjustable spot lighters 9W LED Bollards 1x8W tree uplighters Building uplighters

Following factors shall be considered while arriving at the utilization factor to determine the number of fixtures for each area/buildings:

Maintenance Factor

- Indoor Area Lighting with LED Luminaire : 0.8
- Outdoor Area Lighting with LED Luminaire : 0.7

Reflection factor for Indoor Lighting to be considered are as follows:

- Ceiling : 0.5
- Walls : 0.3
- Floors : 0.1

However Reflection factor can be selected based on the Colour of the wall and Ceiling as given below:

- White and very light colours : 0.7

- Light colours : 0.5
- Middle tints : 0.3
- Dark colours : 0.1

Colour temperature shall be 5600K.

Room index at applicable surface reflection factors need to be considered.

The working plane shall be considered at 0.75 m from the floor level.

Uniformity factor shall be considered as per National Lighting code/NBC/IS code.

The power supply for lighting shall be distributed from Lighting Distribution Boards located inside each unit.

2.3.21. Swimming Pool Lighting

The swimming pool proposed shall be for recreational, training purpose without any need for telecasting. The lighting shall be done using LED sports light fixtures to achieve normal sports arena lighting requirements of IS 3646 or NBC 2016:

Horizontal Illumination – 350 – 700 lux

Horizontal uniformity – Min/Max – 0.5; Min/Avg – 0.7

These lights shall be mounted on the truss over the swimming pool area. The swimming pool is proposed to be open from sides hence daylight factor is to be considered during the lighting design. The designer shall take into consideration necessary requirements of Operation & Maintenance.

2.3.22. Outdoor Football Stadium cum Athletic track Lighting

Football Stadium

The Football Flood Lighting shall be designed for two conditions – National event and Recreational event with the following requirements:

Event	**CTV Telecasted (National Event) as per FIFA Class IV guidelines**	**Non Telecasted (Recreational Event)**
Parameter		
Horizontal Lux	2500	300 – 750
Horizontal Uniformity	Min / Avg > 0.8	-

Event	CTV Telecasted (National Event) as per FIFA Class IV guidelines	Non Telecasted (Recreational Event)
	Min / Max >0.6	
Vertical lux	>1400	-
Vertical uniformity	Min / Avg > 0.6 Min / Max > 0.35	-
Glare	<50	-

Notes:

- Vertical illuminance refers to illuminance towards a fixed or field camera position.
- Vertical illuminance uniformity for field cameras can be evaluated on a camera-bycamera basis and variation from this standard will be considered.
- All illuminance values indicated are maintained values. A maintenance factor of 0.7 is recommended; therefore initial values will be approximately 1.4 times those indicated above.
- In all classes, the glare rating is GR ≤ 50 for players on the pitch within the player primary view angle. This glare rating is satisfied when the player view angles are satisfied. – Constant Illumination Lamp technology is acceptable and encouraged.

The lighting system shall have switching arrangement so as to achieve the requisite illumination standards. The lighting shall be using 2kW Metal Halide sports lighting fixtures. The lights shall be mounted on high mast at locations as per the standard practice for the sport. There shall be suitable arrangement being made for maintenance of lights at such height. Control Gear Panel for each of the high masts shall be located near to the pole with IP 55 protection and forced cooling provision. Necessary earth pits shall be provided for the panel and high mast light. Each high mast light shall be provided with 2 Nos of LED aviation obstruction luminaries. The high mast shall be made of GI with zinc powder coating. The high mast shall be designed taking into consideration the weight of the luminaries to be mounted at the top, wind load and other loads as per relevant IS standard.

The masts should be situated outside the over-run area. For Football, they should be minimum 5m beyond the backline and 4m beyond the sideline.

Athletic track

The lighting requirements for the athletic track as per IAAF 2008 for CTV transmission shall be:

Average Vertical illuminance level	**Vertical uniformity**		**Average horizontal illuminance level**	**Horizontal uniformity**	
(lux)	**U1(min/ max)**	**U2(min/ avg)**	(lux)	**U1(min/ max)**	**U2(min/ avg)**
1000	0.40	0.60	1000 - 1500	0.50	0.70

The above requirement shall be meet from the football stadium floodlighting system with adequate switching arrangement.

2.4. HVAC

The Contractor shall carry out Design, Supply, Install, Inspection, Testing and Commissioning of the Air-conditioning and Ventilation System of various building, which shall be as follows:

a. Central Pavilion
b. Swimming Pool Complex

2.4.1. DESIGN BASIS

OUTSIDE DESIGN CONDITIONS:

The Air conditioning & Ventilation System shall be designed considering continuous operation. The following outside design condition shall be considered for cooling load estimation:

Season	Summer	Monsoon	Winter
Dry Bulb Temperature (DBT) (^{0} C)/ (^{0} F)	43.3/ 110	30.55 / 87	12.22/ 54
Wet Bulb Temperature (WBT) (^{0} C)/ (^{0} F)	25.5 / 78	27.78 / 82	6.67 / 44
Relative Humidity (%)	24	80	41

Presently, Air-conditioning loads are estimated using tentative equipment heat load and diversity factor as per general practice.

Air Quantities for various ventilated areas shall be based on Air Changes per Hours (ACPH) which are as follows:

1	Toilet/Store	10
2	Pantry	12
3	Electrical Room /Pump /Utility Room	15

2.4.2. INPUT DATA FOR COOLING LOAD ESTIMATION:

Following Inside design conditions shall be considered for cooling load estimation:

S.No.	Location	Inside Design Conditions	
		Dry Bulb Temperature (DBT) (^{0} C)	Relative Humidity (%)
1.	Seating Area- Central Pavilion/ Swimming Pool, Media Room Room/Meeting Room, Commentary Box etc	24 ± 1	50-60
2.	Commercial areas at MLCP	25 ± 1	55-65
3.	Gym areas	25 ± 1	55-65

2.4.3. Noise Level Design Criteria

Office Area	50 - 55 dBA approx.
Conference Room	35 - 40 dBA approx
HVAC Unit	65 dBA at 1.5 m distance approx

2.4.4. EQUIPMENT CONFIGURATION FOR COOLING LOAD ESTIMATION & equipment selection :

Area : Swimming Pool						
Sl. No.	**Location**	**Unit Capacity (TR)**	**Unit Qty.**	**Total Selected (TR)**	**Unit Type**	**ODU SELECTED IN HP**
Ground & First Floor						
1	RECEPTION	2.00	2	4.00	4 WAY CASSETTE	20 HP-VRF
2	CANTEEN SEATING	2.00	1	2.00	4 WAY CASSETTE	
3	JUDGE RETIRE ROOM	2.00	1	2.00	4 WAY CASSETTE	
4	OFFICE	2.00	2	4.00	4 WAY CASSETTE	
5	AV & COMMENTRY BOX	1.5	3	4.5	4 WAY CASSETTE	
2nd Floor						
6	VIP SEATING	4.0	4	16.00	4 WAY CASSETTE	20 HP-VRF
Area : Central Pavilion						
Sl. No.	**Location**	**Unit Capacity (TR)**	**Unit Qty.**	**Total Selected (TR)**	**Unit Type**	**ODU SELECTED IN HP**
Circular Seating						
1	MEDIA ROOM	3.50	2	7.00	4 WAY CASSETTE	10 HP-VRF
Rectangular Block – Ground Floor						
2	CONFERENCE HALL	2.5	2	5.00	4 WAY	

					CASSETTE	20 HP x 1 +16 HP x2- VRF
3	DOPE TESTING, NURSING STATION,DOCTOR CABIN,COACH ROOM	1.25	6	7.5	4 WAY CASSETTE	
4	GYM	3.5	2	7.00	4 WAY CASSETTE	
5	RECEPTION	2.1	2	4.2	4 WAY CASSETTE	
6	INCHARGE, STAFF SEATING,ESTATE	1.5	3	4.5	4 WAY CASSETTE	
7	CHANGING ROOM -2 NOS	2.1	4	8.4	4 WAY CASSETTE	
8	CONTROL ROOM,SUPPORT ROOM	1.25	3	4.5	4 WAY CASSETTE	
Rectangular Block – 2nd Floor below Seating and 3rd Floor						
9	CAFETERIA	2.5	4	10	4 WAY CASSETTE	18 HP x 2 – VRF
10	VVIP,VIO SEATING	4.5	2	9	AHU	
11	AV ROOM COMMENTATOR BOX	1.25	3	3.75	4 WAY CASSETTE	
12	CCTV CONTROL ROOM	2.5	2	5	4 WAY CASSETTE	

2.4.5. EQUIPMENT CONFIGURATION FOR ventilation system & equipment selection:

1	**Swimming Pool**			
	Ground Floor & Ist Floor			
1.1	Toilet Blocks	900	1	Ducted Cabinet Fan
	2nd Floor			

1.2	Toilet Blocks	800	2	Cabinet /Axial Fan
	Basement			
1.3	Pump House	2500	2	Cabinet / Axial Fan
2	**Central Pavilion**			
	Ground Floor			
2.1	Toilet Blocks	1800	4	Ducted Cabinet Fan
2.2	Kitchen	2800	1	Cabinet /Axial Fan
2.3	Electrical Room	1400	2	Cabinet /Axial Fan
	Ist Floor, 2nd Floor below Seating and 3rd Floor			
2.4	Toilet Blocks	1800	6	Ducted Cabinet Fan
2.5	Electrical Room- 3 Nos	1400	5	Cabinet /Axial Fan
2.6	Basement Ventilation for Electrical & Pumping Station in Curved Pavilion	2200	12	Cabinet /Axial Fan

2.4.6. Air Conditioning and Ventilation DESIGN APPROACH

The Contractor is to note that air-conditioning and Ventilation load table given above is for reference only. Contractor shall work out detailed cooling load calculations based on latest Architectural drawings, actual areas, actual occupancy and equipment loads and select their equipment.

The Air-conditioning load shall be estimated based on fresh air shall be provided at the rate of 1.0 air change per hour or 12.75 CMH per person and 0.102 CMH per Sq. Ft in line with ASHRAE-62.1 latest revision, whichever is higher, light load, wall /ceiling/floor heat gains.

Sustainable design is to be adopted for increasing the efficiency with which buildings use energy, water, & materials, and also for reducing impacts on human health and the environment for the entire lifecycle of a building.

2.4.7. Brief proposed system description:

Variable Refrigerant Flow (VRF) / Variable Refrigerant Volume (VRV) System has been proposed to meet the air-conditioning requirements. Air-conditioning indoor units catering the areas shall be wall mounted Hi /cassette units and ducted units like Floor Mounted / ceiling mounted AHUs shall be located inside the room. The Outdoor units shall be top discharge type and preferred to be located in a open space / terrace of each building. The

Drain from all the Indoor Units shall be terminated to the nearby pantry/ toilet wash basin block/risers. The indoor and outdoor units shall be inter-connected by Refrigerant Copper Piping and Electrical Cabling. Access doors shall be provided for Volume control dampers installed in branch ducts for Service and maintenance purpose. There shall be provision of Treated Fresh Units to supply fresh as ASHRAE Guidelines.

The ODU of VRF/VRV unit shall deliver actual capacity at 39 deg C outside temperature. COP (Co-efficient of Performance) of the individual VRF/VRV Outdoor units shall be at least 3.5 at 100% Load at 39 Deg C outdoor, 27 Deg C DBT,19 Deg C WBT Inside temperature.

2.4.8. INSULATION:

Duct Insulation

Supply and return air ducting in air conditioned areas will be thermally insulated with 19 mm thick and 9 mm thick class 'O' closed cell elastomeric rubber (UL/FM approved) respectively, while in non-conditioned areas it will be around 25 mm thick and 13 mm thick respectively. The ducts shall also be suitably acoustically insulated at the outlet of the AC indoor units to maintain noise level as mentioned. Thermal conductivity of insulation material shall not exceed 0.035 W/(m.K) at mean temperature of 0°C as per EN 12667. Density of insulation material shall be between 40 to 55 Kg/m3.The material shall have ODP (Ozone Depletion Potential) and GWP (Global Warming Potential) of Zero.

Roof Insulation

Under deck insulation will be provided for air-conditioned spaces exposed to roof above.

2.4.9. AIR CONDITIONING & VENTILATION EQUIPMENT DESIGN CRITERIA

i. The Air cooled direct expansion type Full Inverter VRF outdoor unit shall be factory assembled, powder coated GI sheet metal cabinets, all hardware of anti rust quality, conformal coating on PCB to protect from duct & humidity, hydrophilic blue fin material for better corrosion resistance, top discharge type with Brushless DC Motor only. Outdoor Units must be Hot Air Top Discharge Type, as per site requirement.

ii. The Top Discharge type VRF ODU must have bigger condenser coil face area with higher CFM fan resulting in improved efficiency, less deration due to higher ambient temperatures.

iii. The ODU capacity must be delivering actual capacity at 39 deg C. Please note, the mentioned capacity is actual capacity. COP of the individual VRF Outdoor units shall be at least 3.5 at 100% Load at 39 Deg C outdoor, 27 Deg C DBT 19 Deg C WBT Inside temperature.

iv. The Outdoor unit must consist of Inverter Scroll Compressor only. Each ODU shall consist of single / multiple Full Inverter Scroll compressors. There should not be any fixed compressor or Partial inverter.

v. The VRF system must compatible with R410A / Eco friendly green Refrigerant only. System must be pre-charged at Factory. If required additional, based on the site, then it will be charged additional at site.

vi. ALL Inverter VRF must be designed with the new generation Refrigerant Cooled PCB, which helps maintain the drive within allowable temperature range. It enhances the reliability of the system when it is working under very high ambient conditions.

vii. Each Indoor units must be connected (with VRF Outdoor unit) by means of individual Copper Refrigerant network or Y distribution joints only. The mentioned "Y" joint or refnet joints must factory make & tested by OEM. The individual size of refnets or "Y" joints , connecting to individual indoor units, to be calculated & supplied by OEM / Bidder / OEM approved bidder only. Bidder must submit design - drawing, showing IDU ODU location, piping layout, drain piping, with actual sizes also to be shown as per site requirement.

viii. All Inverter VRF should have emergency back operation. In-case of double compressor ODUs, it must operate or function even if there is a failure or maintenance downtime of one compressor.

ix. In modular VRF, where multiple units have been combined to run, as one larger unit, the system must operate even in case of failure or maintenance downtime or shutdown of one VRF ODU. It will help to ensure that cooling remains largely unaffected even during servicing.

x. As all the Indoor units are interconnected by the communication cable, if there is any break in any communication cable , subsequent IDUs are affected and must not function. By activating the IDU emergency operation on the Next Generation All Inverter VRF, the other IDUs must function despite of such break.

INDOOR UNITS:

xi. **Ductable Indoor Units :** The Unit shall be Ductable type (ceiling suspended/ Floor Mounted as applicable). The unit shall include pre-filter, fan section and DX-coil section. The housing of the unit shall be powder coated/heat treated galvanized steel. The unit shall have high static fan for ductable arrangement and it should have inbuilt drain pump for suitable arrangement for drain water.

xii. CASSETTE type indoor - The indoor can be cassette type with drain pump facility, with pre-filter, fan section and DX coil.

xiii. **HI - WALL SPLIT type** – The indoor can be Hi wall split type unit, with Pre- filter, fan section and DX coil.

xiv. **VRF Outdoor Unit Technical Data Sheet (to be filled during Technical Bid Submission) :**

Details of Technical Requirement	**To be filled up by Bidder**
Model	
Combination of Base Model	
Actual Cooling Capacity at 39 Deg C Outside (TR),	
Total Power Consumption at 39 Deg C Outside (KW)	
Power Supply Voltage	
Overall Dimension (w x d x h in mm)	
Net weight (kg)	
Type of Refrigerant	
Pre charged refrigerant Qty (kg)	
Number of Accumulator	
Type of Expansion Valve	
Type of Compressor	
Make & model number of individual compressor	
Compressor quantity	
Cooling capacity of each compressors (kw)	
Input Power of Compressor motor (kw)	
Type of Condenser coil	
Type of Condenser Fan	

Type of Condenser Fan- Motor	
Total Number of Fans for specified capacity ODU	
Power input of Condenser Fan - Motor (kw)	

xv. VRF Indoor Unit Technical Data sheet :

Details of Technical Requirement	**To be filled up by Bidder**
Model	
Type of VRF Indoor	
Combination of Base Model	
Nominal Cooling Capacity (KW)	
Input Power (KW)	
Overall Dimension (w x d x h in mm)	
Net weight (kg)	
Sound pressure level (db A)	
Air Flow (CFM) in high / med / Low	
External Static Pressure (Pa)	

xvi. Refrigerant piping:

i. The Refrigerant pipe material shall be of hard seamless copper tubes with pipes material being hard drawn copper pipe. Forged copper fittings shall be used for the refrigerant piping. The refrigerant piping arrangements shall be in accordance with good engineering practice as applicable to the air-conditioning industry, and shall include charging connections, suction line insulation and all other items normally forming part of proper refrigerant circuits except y joint/separation tubes.

ii. Before joining any copper pipe or fittings, its internals shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints. Subsequently it shall be thoroughly blown out using nitrogen gas.

iii. After completion of installation of the refrigerant piping, the refrigerant piping system shall be pressure tested using nitrogen gas at a suitable pressure as specify by OEM (Original Equipment Manufacturer). Pressure shall be maintained in the system for 48 hours. The system shall then be evacuated to a vacuum of not less than 700 mm Hg and held for 24 hours.

iv. The supplier of air-conditioning system shall choose sizes as designed and erect proper interconnections of the complete refrigerant circuit the thickness of copper piping shall not be less than 18 SWG for pipes upto 19.1 mm and 16 SWG for larger dia.

v. The suction line pipe size and the liquid line pipe sizes shall be selected according to the manufacturer's specified diameter. All refrigerant pipes shall be properly supported and anchored to the building/structure using steel hangers, fastener, brackets and supports from the building/structure.

vi. The refrigerant piping should be laid in such a way that it should not distort the interior of the room, wherever the refrigerant pipe has to be laid across the room, it should be laid in a concealed manner by making appropriate boxing arrangement matching with the interior of the room. All associated minor Civil Engineering works (like chasing on wall, ceiling & re-plastering and repainting etc.) related with the above items are to be included .

vii. Entire liquid and suction refrigerant pipe lines including all fittings, valves and strainer bodies etc. Shall be insulated with 19-mm/ 13 mm thick elastomeric Nitrile rubber as applicable.

xvii. Ventilation :

The Ventilation fan Catalogue, for fans shall be submitted by bidders along with the bid. Final selection or rating charts/ performance curves for fans with duty point marked, detailed working (fabrication/ construction) drawings for complete ventilation equipment/ system including ducting, final G.A drawings for fans, detailed foundation / mounting arrangement drawings for fans, static and dynamic loads for fans, wall/ roof opening requirement details, operation and maintenance manuals etc. shall be furnished by the contractor for the Engineer's approval / reference, after award of contract. All fans shall be AMCA certified.

Drive motors for all ventilation fans shall be rated at least 15 % higher than the power requirement at duty point or 10 % higher than the maximum power requirement at selected speed, whichever is higher. Starting torque requirements of fans shall also be considered to finalize the motor ratings.

2.4.10. EQUIPMENT DESIGN PARAMTERS:

i. Ventilation Fans

Maximum fan outlet velocity for fan upto 450 mm dia, m/sec	9.0
Maximum fan outlet velocity for fan above 450 mm dia, m/sec	11.5
Maximum fan speed for fans upto 450 mm dia, rpm	1440
Maximum fan speed for fans above 450 mm dia, rpm	1000

ii. Air Distribution System

Max. allowable air flow velocity in ducts for Air conditioning m/sec	7.5
Max. air flow velocity in ducts for Ventilation, m/sec	10
Max. Friction, inch wg. / 100 ft duct length	0.1
Max. Outlet velocity at Grille/ Diffusers, m/sec- other area	2.5

iii. Filtration

Re-circulated air (mixed fresh & return air) at Indoor Unit and ventilation units.	Washable synthetic type air filters having 90% efficiency down to 10microns (MERV 8)

iv. The general layout of the ducting and location of air handling units, grilles, diffusers etc., shall conform to the arrangement shown in the drawings enclosed with the specification.

v. Ducting shall be fabricated at site from galvanized steel as specified.

vi. The construction of ducts shall conform to IS:655 /SMACNA as applicable. All duct seams shall be filled with bitumastic cold emulsion or equivalent vapor seal.

vii. All duct supports shall be provided at centre preferably not exceeding 2.5 Meter. The duct supports shall consist of structural steel angles and if required flats and jointed by bolting. Whenever duct support angles are to be fixed with reinforced concrete roof/floor slab, the anchoring screw shall be connected with duct support angles by means of intermediate angle plates with bolted connection, so as to facilitate early erection and dismantling.

viii. Fire proof Canvas or equal flexible connection shall be provided at each connection between duct work and AHU so as to isolate vibration.

ix. Damper blades shall be manufactured of minimum 20 BWG Sheet Steel.

x. All ducted indoor units shall have motorised fire damper as per UL 555 for 90 minutes rating for supply/ return duct (as applicable).

xi. All diffusers and grilles shall be made up of extruded aluminium section finished in powder.

xii. Coating shall be of approved colour to match interiors.

xiii. Selection and placing of diffusers, grilles etc. shall by the contractor matching the lighting fitting and the décor of the office.

2.4.11. APPLICABLE STANDARD

S.No.	Standard	Description
1.	NBC : 2016	National Building Code – Air- Conditioning & Fire Protection
2.	ASHRAE standard 90.1-2016	Energy standard for buildings except low rise residential buildings.
3.	ASHRAE 55	Thermal comfort
4.	AHRI -1230 Standard	Performance Rating of Variable Refrigerant Flow Units.
5.	ASHRAE Handbooks	American Society for Heating, Refrigerating and Air- Conditioning Engineers.
6.	IS: 655/SMACNA	Duct construction standards
7.	ASHRAE 52.2-2012	Air Filters
8.	IS 277	GI Sheet
9.	ASHRAE Standard 62.1-2016.	Ventilation for Acceptable Indoor Air quality
10.	ECBC 2016	Energy Conservation Building Code
11.	ISHRAE	HVAC Handbook - Air conditioning & Ventilation
12.	IS: 661	Thermal Insulation for Cold Surfaces
13.	IS 2312	Propeller type ventilation fans
14.	IS 3588	Electric axial fans

15.	IS 4894	Centrifugal fans
16.	UL 555	Fire dampers
17.	IS 12065	Permissible limits of noise level for rotating electrical machines
18.	IS 12075	Mechanical vibration of rotating electrical machines

2.4.12. Acceptance Requirements

Before acceptance, Air-conditioning and Ventilation system shall be completely adjusted and properly balanced to provide specified uniform space temperature. Proper damper settings shall be indicated clearly in a manner permanent for operations as required.

The Contractor to submit the Guaranteed Particulars for all the Equipment during Bidding:

2.4.13. Operation and Maintenance

The Contractor shall be required to operate and maintain the system designed, supplied, installed, tested and commissioned by him, for the duration of Five years. The Operation and Maintenance Contract shall be comprehensive type. The Contractor shall take full responsibility for the care of the mechanical services/ system and other allied systems during the contract period till it is handed over to the employer at the end of 5 years of O&M.

If any loss or damage occurs to the treatment works or to any other system, during the period for the contractor is responsible, the contractor shall rectify such loss or damage, at his cost, so that all the mechanical services/ system conforms to its condition when the contractor took possession of the treatment works at the commencement of the contract.

The Contractor shall be responsible for, but not limited to, the following:

- Providing the required staff, but not less than the minimum specified numbers/ level, during operation and maintenance period and additional staff as per requirement during periodic maintenance and in emergencies.
- Providing all required consumables such as spares, tools, tackles & Equipment and consumables required for functioning of equipment.
- Establish work control procedures including preventive and corrective maintenance so

that the entire mechanical services/ system shall work in automatic mode and/or semiautomatic at all times.

- Submission of monthly report.
- The Contractor shall be solely responsible for the safety and security of the goods in the store and will be responsible for any loss or damages in stores for any reason.
- Proper maintenance and housekeeping along with provision of all tools & equipment.
- Insurance: The Contractor shall, without limiting his or the Employer's obligations and responsibilities undertake the following;
- The insurance shall be at the Contractor's cost and shall cover the Employer and the Contractor against all losses or damages from whatsoever cause arising from the start of the O&M until the date of completion of O&M in respect of the facility or any section or part thereof as the case may be.
- Insurance shall cover for all the Civil, mechanical, electrical and instrumentation works together with material to the full replacement cost.
- Any amount not insured or not recovered from the insurer shall be borne by the Contractor.

2.4.14. RECOMMENDED LIST OF MAKES:

Copper pipe : Nippon/ Nissan / Rajco

Fans / Blowers : Nicotra /System Air / Comefri / Green-heck / Kruger

Glasswool Insulation : Lloyds/ U P Twiga

Grilles/ Diffusers/ Fire Damper : Dynacraft/ Trox / System Air

G I Sheets : Jindal / Sail / Nippon.

Nitrile Rubber Insulation : A-flex / K Flex / Armacell.

VRF Units/Split AC : Voltas/ Blue Star/Hitachi / LG/ Samsung/ Daikin/Toshiba

2.4.15. REFERENCE DOCUMENTS:

I. Swimming Pool - HVAC Scheme(Drawing No. TCE.10839A-ME-6054-FD-65000 & 65001)

ii. Central Pavilion-HVAC Scheme (Drawing No. TCE.10839A-ME-6054-FD-65003, 65004 & 65005)

2.5. INFORMATION & COMMUNICATION TECHNOLOGY (ICT)

The scope consists of design, engineering, built, supply, testing and commissioning at site, operations & maintenance of all ICT components for the period of 5 years after final acceptance testing of services at **Birsa Munda Stadium, Rourkela (Odisha)**.

1. Supply Installation Testing & Commissioning (SITC) of **Fire Detection & Alarm System (FDAS)** in Administrative Block and Spectator Stands at Birsa Munda Stadium.
2. Supply Installation Testing & Commissioning (SITC) of **Closed Circuit Television (CCTV)** at Administrative Block, Spectator Stands, Swimming Pool & Parking Stands at Birsa Munda Stadium.
3. Supply Installation Testing & Commissioning (SITC) of **Digital Signage (Smart Display)** in Administrative Block, Spectator Stands & Swimming Pool at Birsa Munda Stadium.
4. Supply Installation Testing & Commissioning (SITC) **of Public Address System (PAS)** in Administrative Block, Spectator Stands & Swimming Pool at Birsa Munda Stadium.

2.5.1. Fire Detection & Alarm System (FDAS)

Scope of work considerations include, but not limited to:

A) SUPPLY :

The scope of work includes the complete design, manufacture, supply, testing, packing, transportation to site, storage, handling of Automatic Fire Detection and Alarm System and its associated equipments, cables and installation accessories required on a Design Build & Operate (DBO) basis.

System shall broadly consist of following sub systems installed in one free standing

- Addressable Fire Alarm Detection Panel
- Multi-Level Sensor & Beam Detectors in all coverage areas
- Battery Backup for Fire Alarm System with UPS System
- Interfaces and Group Alarms to PA system and other BMS Systems
- Repeater Panel in Security Cabin and ICT Control Room & LV Room.
- Manual Call Point & Repeater Panels

B) IMPLEMENTATION, TESTING & COMMISSIONING :

Implementation, testing and commissioning of Fire Detection & Alarm System. The scope shall broadly cover but not limited to the following:

- State of art microprocessor based intelligent addressable analog fire detection and alarm system comprising of Response Indicators, Microprocessor based intelligent fire alarm control panel, Hooter and accessories, addressable analogue intelligent smoke/fire/heat/beam detectors for all Indoor Coverage, Corridors, Rooms, VIP Lounge & Spectators Zones at Birsa Stadium.
- SMF Battery backup for 4 hours and float cum boost charger in – built to the panel.
- All types of cables & cabling accessories.
- GI Pipes / GI Conduits / Metallic and other accessories wherever required for laying of cables.
- Minor civil work required for installing fire alarm system equipment.
- All erection accessories, consumables and miscellaneous material not indicated in specification but required for completing the job in all respects.
- Preparation of Design and detailed engineering drawings.
- Submission of operation and maintenance manuals.
- Submission of as built drawings.
- Earthing – Extension of nearest available power earth ring to the panel location and connecting the equipments to the earth ring as per IE rules and safety guidelines. Provision of special earth for equipment electronics.
- Manual Call Point & Repeater Panels

2.5.2. Closed Circuit Television (CCTV)

Scope of work considerations include, but not limited to:

- Supply, installation, testing and commissioning high quality fast-acting IP CCTV surveillance system along with power supply, power distribution and required accessories in different blocks of Birsa Munda Stadium campus on Design Build and Operate (DBO) basis.
- The CCTV surveillance system should consist of IP Fixed cameras (indoor type), PTZ & fixed box cameras (outdoor type), software, server, power supply and cables.
- Video management software shall offer both video stream management and video stream storage management. Recording frame rate and resolution in respect of individual channel shall be programmable.
- Network Video Recorder (NVR) for storage of video footage up to 30 days backup.
- The system is presently designed for 48 cameras where as not limited to the same and scalable up to unlimited cameras if required in the future.
- Cat 6cable/fiber cable connectivity with all required hardware up to ICT control Room or networking switch room,
- 220 volts AC Power supply distribution from UPS to each location of cameras along with DBs ,JBs, cabling work etc. with required accessories.
- Integrated testing and commissioning of CCTV system on Command Control Centre (CCC) of Rourkela in further phase.
- System shall support ONVIF, Open Standards and Scalable

2.5.3. Digital Signage (Smart Display)

Scope of work considerations include, but not limited to:

- Design, Supply, Installation Testing & Commissioning of Digital Screen (Smart Display) at Birsa Munda Stadium.
- Supply, Installation Testing & Commissioning of Scheduler & Designer Software for Digital Screen
- Supply, Installation Testing & Commissioning of Thin Client SW License & Hardware.
- Interconnections of Digital Signage to Central Server at ICT control Room at Birsa Munda Stadium and Command Control Building in latter stage.

2.5.4. Public Address System (PAS)

Scope of work considerations include, but not limited to:

- PA system / AV system Installation design, layout and schematics sufficiently sized for Birsa Munda Stadium with Spectator Seating Zone space.
- Installation work schedule and timeline submittal for approval.
- Wide-Range, Commercial Grade Cinema Surround Sound Speakers.
- Audio Processing and Amplification System equipment.
- Install all necessary mounting hardware, cabling and connectors to ensure a completed and fully operational enclosure.

2.6. Fire Fighting

2.6.1. General

The scope of this section consists of but is not necessarily limited to Design, supply, installation, testing and commissioning of the fire protection system. The philosophy of the system is as follows :

a. The Fire Suppression System shall comprise the Fire Hydrants System, sprinkler system, Safety fire hose reel, Hand Appliances.
   i. Water from the RCC Fire Water Storage tanks shall be supplied for the Fire Hydrant System (Pressurized) both for the internal landing valves and the hose reels at landings.
b. The Hydrant System under normal conditions, shall be lowest pressurized by means of the electric motor driven Jockey Pump.
c. The Hydrant System shall be provided with one electric pump sets and one diesel engine driven pump.
d. The starting and stopping of the Jockey pump shall be automatic based on the pressure switches at preset low and high pressure.
e. The electric motor driven Pump starts automatically at a preset pressure by means of a pressure switch. As soon as the main electric Pump starts, the Jockey Pump Stops. If for any reason the electric motor driven main Pump does not start at the preset pressure or is unable to maintain the pressure, the diesel engine driven Pump starts at the preset pressure.

f. The main Pump, whether electric motor driven or the diesel engine driven shall be stopped only manually.
g. Contractor shall ensure Hydro Testing for the complete system.
h. The Contractor shall obtain the necessary approval of the drawings and the schemes from the local authority(Fire Noc) as called for.
i. The contractor shall design and after approval of Project Manager display near each staircase landing at floor levels, a glass covered framed floor plan clearly showing the locations of all landing valves, hose reels, hand appliances, as well as the DO's and DON'T's for the personnel and the exit direction in case of an emergency. The dimensions of the floor plan, its scale, lettering size, color scheme etc shall be as directed by the Project Manager.

2.6.2. Applicable Codes & Standards

All equipment, supply, erection, testing and commissioning shall comply with the requirements of Indian Standards and code of practice given below as amended up to the date of submission of Tender. All equipment and material being supplied shall meet the requirements of BIS and other relevant standard and codes.

MS Tube upto 150mm	-	IS:1239
MS Tubes above 150mm	-	IS:3589
Malleable Iron Fittings	-	IS:1239 - 1982 (Part-I&II)
Cast Iron Sluice Valves	-	IS: 780 - 1984
Check Valves	-	IS:5312 - 1984
Internal/External Fire Hydrant Valve		IS:5290 - 1993
Rubberized Fabric Lined Hose	-	IS: 636 - 1988
Couplings, Branch Pipe, Nozzles	-	IS: 903 - 1993
First Aid Fire Hose (Rubber)	-	IS:5132 - 1969
First Air Hose Reel Drum	-	IS: 884 - 1985

2.6.3. Basic Concept Design

Type of the Building -- Assembly building .

Categories as per NBC -- Moderate Hazard

Max. Height of Building -- Less than 15 mtr.

Building is classified as Assembly building as per NBC with height less than 15mtr. The firefighting arrangement shall be designed as per the requirement of local guidelines, NBC, NFPA, guideline issued by **Local fire Authority** & engineering design standard.

The entire firefighting installation shall be compliant with the most stringent codes / standard for the entire premise to ensure the highest safety standard and uniformity of system. Further, before property is opened to work, the firefighting shall be fully operated and tested under simulated conditions to demonstrate compliance with the most stringent standards, codes and guidelines. Following functional system shall be provided; strictly in compliance with the listed reference standards:

a.	Piping System	:	Piping system confirming to IS: 1239, IS: 3589 (for pipe size > 150NB) & IS 10221 M.S /GI. Heavy Class for Hydrant system (Pipe material to be verify with Fire NOC)
b.	Fire water static Storage	:	Fire water static storage has been provided in accordance to NBC requirement.
c.	Fire Pumping system	:	Pumping system comprising of independent pumps for hydrant system & jockey application has been provided.
d.	Hydrant system	:	External & internal hydrant complete with hose reel.
e.	Hand held fire Extinguishers	:	Strategically placed at designated areas.

2.6.4. System Description

The firefighting system shall be provided as per National Building Code of India 2016 (Part IV), as per local Chief Fire Officer guidelines/approval, guidelines of other relevant I.S codes and it shall be consisting of as follows: :-

(a) Fire main of 150 mm dia. Connected to internal and external hydrants.

(b) Wet - riser system with landing hydrant valves and fire hose cabinet.

(c) sprinkler system for multi level car parking.

2.6.5. Fire Water Storage

Fire water storage tank for Fire Protection System has been provided at under-ground level of 200 KL capacity.

In addition to this, as a mandatory application as mentioned in NBC-2016 guidelines, an additional static fire water tank of 5 cum capacity shall be provided Part of OH tank.

Fire department connection shall also be provided on the external wall of the property near the main entrance. These shall comprise of 4 Nos. 63 mm dia male outlets with double landing valves capable of directly feeding the ring mains through non return valves or directly filling the static fire storage tanks. These shall be mounted in specially identified boxes.

2.6.6. Fire pumping system

The fire pumping system shall comprise of electrical pump for hydrant system, diesel engine driven pump & jockey pump for hydrant system in pump room at site located as shown in site plan and another electric pump for hydrant system near OH tank.

(a)	Electric Pump(1 No.s)	Capacity 2280LPM,70 Mt head.
(b)	Diesel Engine Driven Pump	Capacity 2250LPM 70 Mt head.
(c)	Jockey Pump	Capacity 180-LPM 70- Mt head.
(d)	Electric Sprinkler Pump(1 No.s)	Capacity 2280LPM,70 Mt head.
(e)	Water transfer Pump	Capacity 900-LPM 20 Mt head.
(f)	Booster Pump	Capacity 450-LPM 35 Mt head.

Electrical pump shall provide adequate flow for catering requirement of hydrant system. Diesel engine driven fire pumps shall be provided for ensuring operation & performance of the system in case of total electrical power failure. Jockey pumps shall compensate for pressure drop and line leakage in the hydrant installation.

Individual suction lines shall be drawn from the fire suction header and connected to independent fire suction of pumps. The electric fire pumps, diesel engine driven fire pumps and the jockey pumps shall all draw from this single common suction header.

Delivery lines from various pumps shall also be connected to a common header in order to ensure that maximum standby capacity is available. The ring main shall remain pressurized at all times and Jockey pumps shall make up minor line losses. Automation required to make the system fully functional shall be provided.

2.7. Plumbing, Water Supply & Sewerage

2.7.1. Scope

This section covers design and execution of internal & external water supply works for all utility buildings, landscaping irrigation, sanitary installations, etc. The brief items of works included are;

a) External Water Supply System includes Underground tank, Tube wells, pumping machineries, electrical works, rising main, distribution system etc.

b) Internal plumbing

c) Sanitary fixtures and accessories.

d) Soil, Waste, and vent pipe system.

e) Rainwater piping system for terrace floor.

2.7.2. Design Objectives

1. Minimize water consumption and maximize the water efficiency within Buildings, to reduce the burden on Municipal water supply and wastewater supply.
2. Dual plumbing systems in each building for use of recycle water.
3. Maintaining self-cleaning and no scouring velocities in the sewer lines and maintains other important parameters as per reference codes and standards.
4. Establish piping network designs to ensure that adequate pressure available at all the user points.

2.7.3. Concept

Over all water supply system is categorized into two types based on the uses i.e domestic and non domestic. Domestic includes drinking, washing, flushing, bathing etc. and non domestic includes landscaping irrigation, water for spraying in Football turf and water for swimming pool.

Further domestic water categorized as potable and recycle water based on the quality uses. Recycled water will be used for flushing purpose in buildings and landscaping irrigation. Potable water will be used for all other domestic uses.

Presently all water supply for domestic uses will be supplied by PHED and for non domestic uses Tube wells will be drilled and will be used. In future if recycle water is made available then flushing water and landscaping irrigation water will be fulfilled using recycled water. For enabling use of different water dual plumbing system in each building as well as dual distribution system will be designed and executed.

1. For the domestic purpose connection will be taked from PHED supply line laid adjacent to the plot boundary. Water Supply tapped from the main line is to be collected in the underground water tanks.
2. Underground water tanks (fire, domestic, treated) will be designed with a partition for maintenance purpose. The material of construction for Overhead tanks & Underground tanks shall be RCC.
3. The potable water first supplied in fire water tank and overflow of the same shall be transferred to the domestic water tank. From domestic UGT water will be pumped to different over head tank in each building.
4. Provision of flushing water tank shall be provided to store recycled STP treated water, which will be used for flushing and irrigation purpose, this is applicable If there will be availability of recycled water in near future, otherwise water to flushing water tank will also be supplied from municipal supply water collected in the underground tanks .
5. The water level in the RCC underground and overhead water tanks shall be controlled by solenoid valve & Float valve installed in the water tank inlet.
6. The sizing of the entire water distribution network will be based on the simultaneous use of fixture unit's demand. Individual toilets will be provided with isolation valve for isolation and maintenance of the system.
7. For non domestic uses such as landscaping irrigation and swimming pool required tube wells will be drilled based on the yield of tube well.

Soil and wastewater drainage from the stadium will be transferred to existing nearby sewer line and then ultimately to sewage treatment plant (STP for whole city) through the external sewage system.

2.7.4. Water Demand

Population and water demand is provided below:

		Domestic	**Flushing**
1)	Resident population	@90 lpcd	@45 lpcd
2)	Commercial Population	@ 20 lpcd	@ 25 lpcd
3)	Floating population	@5 lpcd	@10 lpcd
4)	Landscape		@ 5 l/sqm/day

Population considered as

1. **Residential: 10 nos. + 50 nos. (Administrative & Regular maintenance)**
2. **Commercial: 50 nos.**
3. **Floating: 5500 nos.**

Population type/land use	Population/ Area/Size	Unit rate (LPCD)		Water demand (LPD)	
		Potable	Flushing	Potable	Flushing
Residential	60	90	45	5400	2700
Commercial	50	20	25	1000	1250
Floating	5500	5	10	27500	55000
Landscaping	8725 sqm	5 l/sqm/day		43625	

- Total Potable water demand : 33900 L/Day
- Total Flushing demand : 58950 L/Day
- One time water requirement for swimming pool will be 1181958 Litres, & 20000 L/Day water requirement will be there for maintaining the level of swimming pool.
- Landscaping Irrigation water demand : 43625 L/Day

2.7.5. Description of The Works

- Service connection from PHED supply lines for domestic water
- Drilling and development of 200mm dia 150m deep tube wells (3 nos) for non domestic water including installation of submersible pumps of required head and discharge and all required mechanical & electrical works.
- Design and construction of RCC underground water tank for fire, potable, recycle water for one day capacity of daily demand.
- Design, installation of pumps and construction of pumping station including all electrical, mechanical works.
- Laying of pumping network for domestic and non domestic water including required valves, fittings, water meters at inlet and outlet of tanks. For water network DI K7 pipe will be used for size 100mm dia & more and for lesser diameter GI pipe will be used.
- Complete internal plumbing and sanitary installation for dual water supply including provisioning of twin over head storage tank for potable and recycle water supply.
- Sewer network from all the buildings including construction of collection chamber and connection to the existing nearby sewer network.

2.7.6. List of Indian Standard

All services being planned generally in conformity with the requirement/recommendation contained in the following Indian standards (BIS)

a) National Building Code - 2016

b) SP: 35: Hand Book on Water Supply & Drainage

c) UPC – Uniform Plumbing Code

d) CPHEEO – Manual on Water Supply and Treatment

e) CPHEEO – Manual on Sewer and Sewage Treatment

IS 1172: 1993 – Code of basic requirements for water supply, drainage and sanitation.

2.7.7. Water Distribution System

- The water shall be first filled into the central underground fire water storage tank from available tapping at the plot. From there it shall be overflow in Domestic Water Tank.
- From common underground tank, water will be pumped to the individual over head service tanks (One for drinking water + One for flushing) provided for each building. Further for domestic purpose water will be supplied directly to the fixtures under gravity.
- For flushing water uses, provision of dual plumbing system shall be provided. The treated water stored in underground flushing tank will be pumped to the individual overhead tanks in each building for flushing purpose, by using transfer pumps set through a separate network of pipes.
- Water for landscaping irrigation is planned by direct pumping from tube well. Watering to the landscape shall be done for 4 hours in day. Required pipe line network for landscaping irrigation has been considered.
- One time water requirement for swimming pool will be 1181958 Litres, when it needs to be filled in the starting of swimming pool, considering the average depth of 1.125m for swimming pool and length, width as 50m, 21 m respectively. This will be supplied through in-house bore well setup. Although there will be the provision of filtration and recirculation of water for swimming pool. If Swimming pool filled once and use regularly for 12 hrs in a day then this same water can be used for 3 years. If it is used less than that, then around 20000l/day additional water will be required for fulfilling the requirement of filtration and recirculation of swimming pool. It is proposed to provide bore well specifically for swimming pool.
- The sizing of the ring main and vertical piping shall be based on the simultaneous demand of fixture units. An isolation valve shall be provided at each tapping, before entry into toilets which serves the purpose of maintenance.

2.7.8. Domestic Water Supply System

Water from municipal water supply main for the domestic purpose will be stored in an RCC water storage tank after overflow from underground fire water tank. The water meter will be installed externally near water tank before the inlet of the underground water tank. To fulfill shortfall of domestic water demand, bowser water or bore well will be used. Water from municipal water supply main will be stored in fire water tank & overflow of the same will be transferred to the domestic water tank. Domestic water shall be treated using water treatment plant & then shall be stored in the treated domestic water tank if required. On

constant interval, water quality report of water treatment plant will be required. Accordingly, water treatment will be done for the multiuse water use in stadium.

Gravity system will be considered to distribute domestic water. Water shall be pumped from Centralized underground tank to the Overhead tank. If required Booster pump shall be proposed for the top floor to obtain necessary pressure.

Electronic sensor based water level indicator will be considered in the design for water tanks to monitor the water level in the tanks. The sizing of the ring main and vertical piping shall be based on the simultaneous demand of fixture units. Domestic water supply system and pipe sizing will be designed considering sanitary wares and fixtures selected and approved by the Client.

2.7.9. Flushing Water Supply System

In future treated tertiary water from STP will be used for flushing & irrigation and will be stored in a separate underground tank. Recycled water from underground tank will be supplied to roof water tank and further distribution by gravity to the entire floor via vertical stacks. The water distribution system will have vertical pipes from the ring main on the roof for each shaft.

Booster pump set will be provided for irrigation purpose. The water meter will be installed on delivery line of STP treated water before the water is stored in recycled water tank. Electronic sensor based water level indicator will be provided for water tanks to monitor the water level in the tanks.

The sizing of the ring main and vertical piping shall be based on the simultaneous demand of fixture units and will be designed by the contractor.

2.7.10. Irrigation Water Supply System

At present Irrigation water will be supplied from directly from borewell. However, provisioning will be kept for use of recycled water in future as per the availability. Irrigation pumping system will be designed to pump irrigation water for four hours a day.

Drip irrigation system with timer based solenoid/control valve will be considered for an automatic system.

2.7.11. Water Supply System for Football filed

Water will be supplied to Football filed from tube well by pumping. The rate supply will be 5 litres / sqm/day

2.7.12. Internal Soil And Wastewater Drainage System

Soil and waste water drainage system from the building is designed as dual stack system (soil and waste stack separately). The vent pipe is designed for soil vertical stack only. Vent vertical stack is connected to soil line at each floor to protect water seal of European water closet against siphoning. Each shaft will have independent soil and waste vertical stack.

The waste generated from the pantry, utility, etc., shall be collected through a separate vertical pipe waste stack. The waste stack shall be extended minimum 750mm above the terrace parapet level as a waste vent through the roof. Sewage from the water closets and urinals shall be connected through a soil stack. The soil stack shall be extended minimum 1200mm above the terrace parapet level as a soil vent and fitted with vent cowl.

The minimum outside diameter of the 110 mm for vertical soil and 82 mm for waste stack will be designed. Diameter will vary as per the design flow and load. The soil stack shall be directly connected to the inspection chamber. The waste stack shall be connected to the inspection chamber through a gully trap. The gully trap shall have deep water seal, which will prevent foul gases and the entry of cockroaches into the toilet area. The spacing of the inspection chambers shall be kept to a maximum of 15 - 18mtrs.

Sewage from the collection chamber shall be connected to sewer network and transfer to STP (which is under-construction and it will serve as STP for whole city, sewer lines laying work is in progress at present dated: 14/05/2018). The sewerage network comprises series of inspection chambers with varying invert level with interconnecting pipes. The minimum outside diameter of the external sewer network will be 160mm and the maximum diameter will vary as per the design flow. The drop manholes shall be constructed at places where the depth of drop exceeds 600mm from building sewer to the main sewer. It is ensured that the flow from building a sewer to the main sewer shall be smooth and free from noise.

Internal soil and waste pipes for toilet blocks will be designed within the sunken portion. Floor cleanout will be provided as per design for ease of maintenance. Toilet sunk of 250 to 350 mm is considered to fulfill minimum slope requirement of soil and wastewater drainage piping in sunken portion. Deep seal P traps shall be provided for Floor drains and Urinal traps. All fixtures and appliances shall be fully trapped to prevent backflow of foul gases and odour into the toilets.

Sewers are designed to carry wastewater along with the suspended solids in such a manner that deposition and odour nuisance is kept to a minimum. Sewers are also designed for self-cleansing velocities. The pipe design at the change in the direction of flow shall be designed in such a way that the hydraulic jump phenomenon will not occur.

2.7.13. Design Criteria

Under ground water tank

The storage capacity of underground ugt is proposed for 24 Hours capacity which shall be constructed in RCC with RCC roof. The treated water from this tank shall be pumped to the individual over head tank in each building This tank shall have two compartments from the point of view of O & M. Necessary appurtenances such as inlet, outlet, overflow, vent pipes etc shall be provided.

Domestic Water Pump House (Potable & Recycle)

The domestic water pump house shall be provided adjacent the reservoir. The pumps shall be horizontal split casing centrifugal type and with 50% standby. The pumping shall be considered

for 6 hrs working per day. Power supply arrangement shall be made for the pump house. Automation shall be provided for operation of pumps. Bulk flow meters shall be provided on clear water transmission mains for recording quantum of water supplied.

Salient features of pump house are

- Pump : 12m3/hr - 2 (1+1) nos
- Head-35 m

Criteria adopted in the design of Pumping Station for water supply are as follows:-

i. Velocity in suction and delivery pipes shall be restricted to 1.5 m/s to 2.5 m/s respectively.
ii. Velocity in pumping main range from 0.6 m/sec (minimum) to 2.5 m/sec (maximum).
iii. Hazen William`s Coefficient will be considered as 130 for DI pipe.
iv. Safe working load of lifting equipment will be at least 50% higher than maximum weight required to be handled at the pumping station.
v. The preferred range of specific speed shall be 3000 to 4000 USCU.
vi. Type of pumps shall be horizontal split case.
vii. Hours of operation for pumps shall be 6.
viii. Design head shall include static head, friction loss in suction, delivery and rising main and head loss in valves and fittings.
ix. The sizes of valves shall be same as size of individual pipes.

Rising Main

- Minimum Residual Pressure above FSL of ESR – 2.0m
- Pumping hours – 6 hours for domestic and 4 hours for non domestic
- Design Velocity – 0.6m/s to 1.50m/s
- Maximum Unit head loss – 6m/km
- Pipe Material – DI for 100mm & above, GI for below 100mm

The Pipe line should be designed in conformity with CPHEEO Manual and relevant IS codes

Tube Well

Scope under this works include broadly as follows:

- Hydrogeological investigation
- Drilling of bore well. The size and depth of bore well be shall be so decided that, the safe yield of all bore wells shall meet the demand of non domestic demand.
- Yield test, draw dawn test
- Construction of pump house at each bore well
- Installation of submersible pumps of required capacity and head to discharge water from bore wells to different points.
- All Electrical works
- Designing and laying of rising main from bore wells to different units.

The above works are for reference purpose, the contractor shall have to execute all the works as required by employer to complete the work in all respect.

Design specifications

- Type of drilling method – As per nature of formation below the ground the best suitable drilling methods are either Direct or Reverce rotary method, with drilling diameter of minimum 20”/18”.
- As per expected presence of good quality of groundwater the casing assembly of PVC casing pipe (8” Diameter) plain & stainer pipes may be lowered in the tubewell.
- The annular space between wall of the bore & casing assembly, should be filled by well sorted “Pea Gravel”.
- The development of tubewell to be recommended first by high capacity air compressor (Min. 300 cfm / 150 psi as per IS - 2800 part II) followed by an over pumping unit.
- Additonal gravel should be filled, after completion of development.
- The tubewell shall be sealed at top, by Cement sealing, preferably upto 1 m depth, to prevent percolation of surface run-off in the tubewell.
- The litho-logs obtained from the tubewell to be collected & preserved at every 3 m interval for further study & record.
- The submercible pump set related to expected discharge, water level, drawdown & total head, to be recommended for installation in the tubewell.
- The tubewell should be plugged at bottom by “bail plug” & at top by “well cap”.
- The pump set should be of approved make, confirming to IS specifications, suitable for 415 volts, 3 phase, 50 cycles AC supply, having delivery outlet, suitable for connecting 100 mm outer diameter GI pipe.
- The pump set shall be lowered by 100 mm outer diameter, threaded GI pipes, which shall be connected by sockets. Flat MS flanges may be applied at joints for additional support.
- A steel rope may also be used for connection of pump, along with GI pipes, for additional support.

Storage Tanks

- Common under ground Tank – One day storage capacity
- Material of construction - RCC
- Individual Over head Tank- 12 hours storage capacity of daily demand.
- Material of construction – PVC tank up to 2000 ltr capacity and RCC for more than 2000 ltr capacity.

Self Cleansing Velocity

Self-cleansing velocity is determined by considering the particle size and specific weight of suspended solids in sewers. The velocity of 0.60 m/sec to 1.2 m/sec at design peak flow is considered.

Erosion and Maximum Velocity

To avoid erosion caused by excessive velocity and presence of sand and gritty materials in the sewer. The system is designed in such a way that velocity in sewer shall not exceed 2.4 m/sec.

Plumbing Fixtures

a) Plumbing Fixtures, Chrome Fittings, and Accessories shall be of the best available Indian maker selected in consultation with Architect and Client. All sanitary wares shall be best quality vitreous china of desired color and brand.

b) Water Closet: Wall Hung type EWC's shall be provided with a Flush valve.

c) Ablution: C.P. hand shower/health spray with lever operation is also been proposed in place of ablution tap. This will be connected to an angle valve.

d) Washbasin: Counter wash basin (as per the architectural details) shall be provided with a C.P. Pillar tap in toilets.

e) Urinal: Urinal as per the architectural details is shown in layout shall be provided.

Soil, Waste & Vent pipe system

a) Soil and waste water drainage system from the building is designed as dual stack system (soil and waste stack separately).

b) The vent pipe is designed for soil vertical stack only. All vertical pipes will be terminated as vent pipe at terrace level. The waste stack shall be extended minimum 850mm above the terrace level as a waste vent through the roof. The soil stack shall be extended minimum 1200mm above the terrace level as a soil vent and fitted with vent cowl.

c) The size of vertical stacks will be not less than 110 mm dia for soil stack, 110 mm diameter for the waste stack, and 75 mm dia for vent stack.

d) uPVC type B (SWR) pipes and fittings with rubber ring joints is being proposed for soil, waste, vent disposal for all floors.

e) All ground floor toilets/waste appliances shall be connected to the Manholes directly. Gully traps have been proposed for waste connections.

f) All toilets are proposed to be sunken by 450mm and internal Soil & Waste pipes area designed to run in the sunken area.

Pipework

a) All stacks shall be installed in shafts on the external face of the buildings or in internal shafts within the building as per the architectural planning of the toilet.

b) It is proposed to provide suitable access to pipe shafts from with-in the toilets or from outside for maintenance as per the architectural plans and feasibility.

c) The provision includes providing clean-out doors and plugs for maintenance where necessary and required.

d) Deep seal P traps shall be provided for floor drains and urinal traps. All fixtures and appliances shall be fully trapped to prevent backflow of foul gases and odor into the toilets.

e) Self-cleansing velocity is determined by considering the particle size and specific weight of suspended solids in sewers. The velocity of 0.75 m/ sec to 1.2 m/ sec at design peak flow is considered.

f) To avoid erosion caused by excessive velocity and presence of sand and gritty materials in the sewer. The system is designed in such a way that velocity in sewer shall not exceed 2.4 m/sec.

Design Criteria for Sewer Collection Network

- Peak factors shall be considered based on contributory population to arrive at the peak flows as per CPHEEO manual.
- Design formula: Manning's formula
- System design: Gravity system
- Coefficient of Roughness: as prescribed in CPHEEO manual,1993 / 2013.
- Pipe Material: RCC of NP3 Class as per IS 458.
- Bedding for Sewers: as per the relevant standards.
- Minimum size of sewers: 200mm
- Design capacity of sewers: 80 % at ultimate peak flow
- Self cleansing velocities: Minimum velocity : 0.6 m/s (present peak flows)
  : 0.8m/s (design peak flows)
- Maximum velocity: 2.5m/s
- As per relevant CPHEEO guidelines
- Depth of cover: The minimum depth of cover at sewers start is 1.0 meters
- Per capita sewage generation shall be 80% of potable water supply and 100% of non-potable water supply. Sewage generation from industrial area (Hitech, IT, Biotech and R&D) shall be 80% of non-potable water supply per area basis.
- In the hydraulic design of sewers, an allowance for infiltration for the project area shall be considered as per Part A of CPHEEO Manual, Nov 2013
- Peak factor for sewerage system shall be based on contributing population for domestic sewage as per CPHEEO sewerage manual, 2013.
- Manning's formula shall be adopted for design of gravity sewers with coefficient of roughness as specified in CPHEEO manual.

Sr. No.	Design Parameters	Value
1.	Ground water infiltration	500 ltr/day/manhole
2.	Peak Factor	2.25
3.	Capacity of conduits	80% full at peak flow
4.	Minimum velocity	0.6 m/s – minimum velocity at initial peak flow 0.8 m/sec –peak flow
5.	Depth of cover	1.2 m Minimum depth of cover will be provided over top of pipe at the start of the sewers.
6.	Bedding for Sewers	Bedding Factor — Type of Bedding Up to 1.9 — Granular 1.9 -2.8 — Concrete Cradle Bedding with Carefully compacted backfill (PCCB) 2.8-3.4 — Reinforced concrete cradle (RCCB) > 3.4 — Reinforced concrete encasement (RCE)
7.	Manholes	@ 30 m c/c distance and at junctions

8.	Pipe Material	RCC- NP3 class

Manhole

- Brick Masonry manholes for depths up to 2.3m and RCC manholes for higher depth .
- The manhole frame and cover proposed shall be of Steel Fibre Reinforced Concrete (SFRC) conforming to the relevant IS codes.
- Sizes of Manhole is as per relevant IS codes.

2.7.14. Commissioning of the System

On completion of the Trial Run, commissioning of the System shall be done by the Contractor. The total time allotted for commissioning of the full system is 30 days. The commissioning of the system shall be considered as fully achieved after the entire system has run continuously for a period of 7 days without any breakdown to the satisfaction of Engineer. If continuous run is not achieved fully to the satisfaction of Engineer, the Contractor has to do the needful to achieve the same at his cost.

All the Costs including the cost of staff, water , electricity,chemicals, other consumables that are required for Operation & Maintenance of System during Commissioning period shall be borne by Contractor. It is the obligation of contractor to dispose off the water from the pipe line, if required as per the direction of employerto the nearest water body/ drain in an environmental friendly manner without affecting the project area.

2.7.15. Documents to be submitted by Contractor

Contractor shall submit following documents/drawings for approval from employer before execution of work.

- Topographical survey and drawing
- Geotechnical Investigation report
- Hydraulic Design of all components
- Structural Design of all RCC structures
- Design, general arrangement and drawing for instrumentation and automation system
- Design Calculations of all components
- Drawings for all components

2.8. Storm Water Drainage

SCOPE OF WORK:

Scope includes survey, rain fall analysis for the execution of internal drainage network and rain water harvesting structure has been defined below:

INTERNAL DRAINAGE

The contractor on board shall design the drainage network considering the National Building code and 2 years return IDF curve with following design criteria:

- **Computation of Design Flow:** Rational formula Qp = CIA/360 shall be used
- **Return Period :** 2 years
- **Depth-Duration of Rainfall**: Past 30 year rain fall data collected from the Nearest Rain Gauge Station (From IMD station) shall be used
- **Time of Concentration**: The empirical formula, (Kirpich) shall be used
- **Co-efficient of Runoff** : CPHEEO / as per the Surface drainage design Manual, US department of Transportation)
- **Method of Computing Flow**: Manning's formula
- **Co-efficient of Roughness**: as per Relevant IS / International standards
- **Minimum drain size :** 300 mm
- Other Design Parameters

The design parameters for the drainage system shall be followed as per the following table.

Table: Design Parameters

Sr. No	Design Parameter	Value	
1	System	Gravity system	
2	Minimum and maximum velocity	As per CPHEEO manual	
3	Time of Concentration	As per CPHEEO manual	
4	Coefficient of Run off	As per CPHEEO manual	
5	Manning's 'n' value	As per CPHEEO manual	
6	Minimum Free Board	**Drain Width (m)**	**Free Board (m)**
		< 0.3	0.1
		0.3 to 0.9	0.15
		0.9 to 1.5	0.3
		>1.5	Depends on discharge

RWHS

Scope includes identification of location for ground water recharge structure based on the topography and location of outfall. The out let of drainage network shall be arranged such that

Before Execution of RWHS, the contractor on board shall perform the hydrogeological and geotechnical investigation at site to determine the ground water table depth, type of subsoil strata and permeability of the soil in the region so as to fix the depth of bore hole and type of PVC pipes required in bores for recharge pits.

As per the concept, the rainwater shall be diverted to the Inlet chamber of recharge structure by means of channel/pipe. The recharge pit shall be designed for the recharge of

aquifer only for the flow corresponding to Qexcess (Qafter-Qbefore) and remaining flow Qbefore will be diverted to the road side drain by provision of bypass flow arrangement for maintaining the same water environment even after the development.

Here, Qbefore is the flow/runoff generated before the development in the stadium premises, Qafter is the flow/runoff generated after the development in the stadium premises and Qexcess is the difference of flow after and before the development. Typical detail plan and section of Rain Water Harvesting Structures have been shown in drawing no. TCE.10839A-CV-3018-C-30001.

2.9. Road

Construction of internal road as per architecture plan in proposed layout

1. 6 m wide carriageway construction with the bituminous pavement. Length of road is 835 meter and pavement thickness SDBC (20mm), DBM(50mm), WMM (225mm) GSB(150mm), Subgrade (500mm. With 8% CBR) and earthwork.
2. Road entry and exit must be safe with the existing public road.
3. Footpath, Parking, and kerb/ kerb with channel construction as per plan and architecture requirement with a physically challenged friendly facility like drop off the kerb and tactile.
4. Road safety sign, warning sign, information sign, and mandatory signboard should be marked as per design requirement.
5. Road marking, zebra crossing marking, arrows marking, road studs and delimiters must be as per traffic and pedestrian circulation plan.

   Road construction must be followed by the latest code of IRC and MoRTH standard for design and material.

2.10. Land Scaping Works

The detail scope of work shall include (but not shall be limited to) the following:

- Preparation and development of land for plantation by digging exiting earth and replacing with suitable earth and cow dung.
- All Landscaping and horticulture works including planting operations (Lawn, shrubs, ground-covers & trees)
- Cement concrete interlocking paver blocks/ Chequerred Tiles/ Tactile flooring tiles/ as per design.

Work Description

Paving & flooring works

- Providing Grass Pavers (Precast paver block with 50% grass area) (Size: 450mmX450mmX80mm) – Approximately 900 sqm.

- INTERLOCKING PAVER BLOCKS (Colour: Terracotta) (60 mm thick) – Approximately 8600 Sft.
- STONE PAVING (Jodhpur Ita Gold Sandstone) (Size: not exceeding 600mmX600mm) - Approximately 200 sqm.
- STONE PAVING (Leather finished Mint Sandstone) (Size: not exceeding 600mmX600mm) - Approximately 3015 sqm.
- STONE PAVING (Polished kota stone) - Approximately 200 sqm.

Trees

- Erythrina indica variegated - 9 nos
- Roystonea regia - 393 nos
- Terminalia arjuna - 50 nos
- Lagerstroemia sp - 16 nos
- PLUMERIA ALBA - 42 nos
- Mesua ferrea - 30 nos
- Bambusa vulgaris - 154 nos

Shrubs

- Verbena officinalis - 4875 nos
- Golden Duranta - 2588 nos
- Murraya paniculata - 975 nos
- Asparagus meyerii - 16500 nos
- Plumbago capensis blue - 375 nos
- Zoysia japonica tinufolia-carpet lawn - 32280 sft

The above items and quantities are provided for reference only. Contractor has to design the landscaping work and gets it approved from the client before execution. The works shall include all land preparation works as required.

2.11. Other MISC works

Scope of work includes design and construction of following works:

- Dismantling of existing structures
- Site development and land grading
- Design and construction of new compound wall of approximately 900m length and gate as per attached drawing.
- Design and construction of watchman's cabin/ guard room as shown in drawing
- 60mm thick inter locking paving block for surface parking area.

2.12. Survey and Investigations:

All the necessary surveys and investigations such as Geotechnical investigations, topographical survey, etc. need to be carried out by the contractor as per the project requirement under the concurrence of Engineer in charge.

2.13. Time Period for Completion

The total period of contract including Survey, Investigation, Soil Exploration and Laboratory Testing, detailed Design, and Execution shall **be 24 calendar months**. The defect liability period for the building shall be **Five (5) years** from the date of completion of the project.
The Contractor shall carry out the design proofing from the Engineer in Charge or any Engineering Institute of National Repute at his own cost..
The Contractor shall submit all designs, drawings, technical specifications and methodology to the Client. The Client shall give approval on all sketches, drawings, reports and recommendations and other matters and proposals submitted for approval by the Bidder in such reasonable time as not to delay or disrupt the performance of the Contractor's services.

2.14. Schedule for completion of tasks

The reports have to be submitted in the following phasing in the number of copies indicated against each of them.

SL No	Description	Schedule of Completion
1	Details of survey including laboratory test report	15 days from the date of signing of Agreement
2	Architectural and draft structural drawings with detail engineering designs and technical specifications & methodology	30 days from the date of signing of Agreement
3	Statutory Approval from relevant authorities	60 days from the date of signing of Agreement
4	Final structural drawings with detail engineering designs and technical specifications & methodology	90 days from the date of signing of Agreement
5	Changes in Scope during construction	As and when directed by the Client/Engineer

1. The Bidder shall be required to form a multi-disciplinary team for this assignment with qualified & experienced key personal and other required supporting staff for delivering the final output . The design as well as Architectural team should have the requisite experience and expertise for design of similar works as offered by the bidder and accepted by the Client.

The CVs of the Key Personnel's would have to be got approved by the Client during contract negotiation and prior to signing of contract

2. Final Outputs (Reports, Drawings etc) required from the Bidder

- Report with details of all Survey including laboratory test (3 Hard copies along with one Soft copy)
- Draft detailed Architectural drawing and engineering designs report (3 Hard copies along with one Soft copy)
- Final detailed Architectural drawing and engineering designs report (3 Hard copies along with one Soft copy)
- As Built Drawing after Completion of Construction(3 Hard copies along with one Soft copy)

B. TECHNICAL SPECIFICATION

The works shall be performed conforming to the Indian Standard codes, specifications as per P.W.D, PHED, FIFA IAAF (International Association of Athletic Federation) & Sports Authority of India (SAI) as applicable. Wherever such specifications are not available, CPWD specifications, relevant references, manuals etc. shall be followed as directed by Employer.

ARCHITECTURE

1. ITEM OF WORK

1. Concrete shall be with conformity to I.S.456.
2. Foundation shall be with conformity to I.S.1080.
3. C.R. Masonry shall be with conformity to I.S.1597.
5. Brick masonry shall be with conformity to I.S.2212.
6. Cement plastering shall be with conformity to I.S.9103 & 6925.
7. Mortar shall be with conformity to I.S.2250
8. White and colour washing shall be with conformity to I.S.6278.
9. CC in foundation shall be with conformity to I.S.2571.
10. Anti-Termite Treatment shall be with conformity to I.S.6313. (Part I & Part II)
11. Painting to all surfaces shall be with conformity to I.S.2395 (Part I & Part II)
12. DPC shall be with conformity to I.S.3067
13. Tar felt treatment shall be with conformity to I.S.1346
14. Steel painting shall be with conformity to I.S.1477 (Part I & Part II) I.S.1661

2. BRIEF SPECIFICATION OF ITEMS USED

It is the intent of these specifications to establish acceptable standards of quality and to provide the Contractor with complete and detailed information and subsequent instructions necessary to enable him to submit a well planned Tender, to carry out the design, where and when required, and to execute properly the work prescribed. This specification covers the general requirements for civil and architectural works comprising of masonry, flooring, skirting, dado, plastering for wall and ceilings, painting, doors, windows, ventilators, Builders hardware, ironmongery, Glass and glazing, Partition works, False ceiling works, toilet cubicles, sanitary fixtures and fittings, waterproofing, Metal sheet cladding, grills and railing works. For any items missed standard specification of Odisha Schedule of Rates (OSR) will apply and for items that are not available in OSR, Delhi Schedule of Rates may be considered.

Standards and Codes

i. The Contractor shall follow the Indian Codes and specifications for his work.

ii. All standards and codes employed or referred to shall be the latest current issue in effect at the date 28 days prior to the Tender submission date.

iii. In case of discrepancies between these Specifications and national or international standards and codes, these Specifications being only indicative in nature shall not govern, unless otherwise established by the Authority in each particular case.

Termite Treatment:

Providing and injecting chemical emulsion for pre - constructional ant termite treatment as per IS specification and creating a chemical barrier in bottom and sides of foundation trenches, top surface of plinth filling junction of walls and floors along with external perimeter of the building expansion joints surrounding the pipes and cables etc. complete using approved quality of chemical emulsion of requisite quantity prescribed by the manufacturer as directed by the Engineer-in-charge including cost of all materials and labour taxes etc. complete. (Indemnity bond for warranty for 10 years to be furnished)

Waterproofing:

Application of approved water proofing compound & continued over parapet wall as per the laying specification of the approved item, followed by a protection screed laid in requisite slope in panels of size (approximate) 2mtr x 2mtr to drain the rain water towards rain water pipe & finally filled the joint groove with Polyurethane sealant of approved make and finally finished with chequered tile all complete as per the drawing. Complete as per manufacturer specification and direction of engineer in charge. The various types of water proofing will be as per below or approved equivalent:

1. Waterproofing of sunken slab, balconies & other wet areas – Fosroc Brushbond RFX
2. Waterproofing of Overhead Water-tank – Fosroc Nitocote CM 210
3. Waterproofing of Basement area – Fosroc Proofex Engage
4. Terrace water proofing (new & old) – Fosroc Nitoproof 600 standard

Note: cost of cleaning of existing surface is inclusive and completion of job to be as per the satisfaction of the engineer in charge.

Cement Concrete Tile:

Supplying, fitting and fixing in position 25mm thick cement concrete tile of Ultra category-1/Eurocon or equivalent type of approved make, quality, colour and size in all floors at all height on 20mm thick bed of cement mortar of mix (1:4) laid in proper slope and gradient grouted with neat white cement slurry with required quantities of pigments of approved marks watering and curing for 21 days, including cost, conveyance, loading, unloading, royalties and taxes of all materials, cost of all labour, sundries, T&P required for the work complete in all respect as directed by the Engineer-in charge.

Vitrified Tile Flooring:

Providing vitrified tile flooring using double charged (either heavy duty or glazed as per the schedule of finish) vitrified tiles of premium grade of approved make having thick of 10mm conforming to IS 13756 of 800mmx800mm/ 600mmx600mm coloured / digitally printed series (homogeneous) of approved quality, colour in all floors at all height with tile adhesive on bed of cement mortar of mix (1:4) laid in proper slope and gradient with screened and washed sharp sand for mortar and grouted with epoxy grout with required quantities of pigments of approved marks to match the shades of the vitrified tile if required; watering and curing for 21 days, including cost, conveyance, loading, unloading, royalties and taxes of all materials, cost of all labour, sundries, T&P required for the work, complete in all respect as per specification and direction of Engineer-in charge. The transition with other materials like carpet/ granite etc. to be provided with standard profile systems (either aluminium or wood or stainless steel) as per the best practise in managing the level difference if any.

Vitrified Tile Skirting:

Supplying, fitting and fixing of double charged vitrified tiles in skirting of premium grade of approved make conforming to IS 13756 of 800mmx800mm /600mmx600mm coloured / digitally printed series (homogeneous) of approved quality, colour and size in skirting / dadoes in all floors at all heights using tile adhesive and minimum 12mm thick screened and washed sharp sand for mortar with grouted Epoxy grout to match the shade of the tiles including cost, conveyance, loading, unloading, royalties and taxes of all materials, cost of all labour, curing-sundries and T&P, etc. required for the work complete as per specification and direction of Engineer-in-charge.

Ceramic Floor Tile:

Providing 30cmx30cm/40cmx40cm size special plain/printed series ceramic floor tiles of premium grade of approved make having thickness 7mm to 8mm, conforming to IS 13755 for ceramic tile flooring of approved quality, colour and size in all floors at all height with tile adhesive on bed of cement mortar of mix (1:4) laid in proper slope and gradient, grouted with neat white cement slurry jointing the tile with neat white cement slurry mixed with required quantities of pigments of approved marks to match the shades of the ceramic tile if required, watering and curing for 21 days, including cost, conveyance, loading, unloading, royalties and taxes of all materials, cost of all labour, sundries, T&P required for the work, complete in all respect as directed by the Engineer-in-charge.

Ceramic Wall Tile:

Providing 30cmx45cm size special plain/printed series edge cut ceramic wall tiles of premium grade having thickness 6.5mm to 6.7mm conforming to IS 13753 of approved make & shade in Dadoes with tile adhesive over minimum 12mm thick cement plaster 1:3 (1 Cement: 3 Coarse sand) finished with modular pointing in white cement & pigment to match the shade of the tiles including cost, conveyance, loading, unloading, royalties and taxes of all materials, cost of all labour curing sundries and T & P etc. required for the work etc. complete as per specification and direction of Engineer-in-charge.

Granite Flooring:

Providing 20mm thick avg. granite flooring (as per approved sample) in staircase of approved quality, colour and size in floors, treads and risers on steps (single piece) and landings in all floors at all height on minimum 25mm thick cement mortar of mix (1:1) laid in proper slope and gradient with screened and washed sharp sand for mortar and grouted with neat white cement slurry jointing the tile with neat white cement slurry mixed with required quantities of pigments of approved marks to match the shades of the granite tile if required watering and curing for 21 days, including cost, conveyance, loading, unloading, royalties and taxes of all materials, cost of all labour, sundries, T&P required for the work including rubbing mechanically and wax polishing etc. complete in all respect as per specification and direction of Engineer-in-charge.

Sal Wood Frame:

Providing and fixing in position well dressed, naturally seasoned sal wood rebated frames of size 125mmx63mm to doors including two coats of hot bitumen applied to rear of frame in contact with masonry or concrete surface fixed with MS hold fast of 35x5mm embedded in cement concrete blocks 15x10x10cm of 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 20mm nominal size) complete with all materials, labours, T & P including cost, conveyance, loading, sundries required for the work etc. complete in all respect as directed by the Engineer-in-charge.

Flush Door:

Supplying fitting and fixing in position 35mm thick flush door including lamination of Greenply/Mayur/Century/Kitply or equivalent type of approved make with teak wood beading and 1mm thick sunmica mechanically hot pressed to both side including fixing of fixtures like Godrej make Mortise lock having model no 9168, Godrej make Door closure heavy duty type having model no 8340, 125mm aluminium hinges, handle, tower bolt, stopper including cost of all materials, labour, all taxes, transportation, loading & unloading etc. complete as per specification and direction of Engineer -in-charge.

Teak wood Shutter:

Supplying, fitting and fixing in position 38 mm thick decorative Teak wood shutter 38mm style and 22mm to 25mm thick panel well-seasoned and well-dressed fitted and fixed to sal wood choukaths in all floors at all heights including providing ornamental design as per approved drawing with necessary beadings, cutting grooves in choukaths and for lapping portion of shutter where necessary, including fitting and fixing of Godrej make Mortise lock having model no 9168, Godrej make Door closure heavy duty type having model no 8340, 125mm brass hinges, handle, tower bolt, stopper including cost of all materials, labour, all taxes, transportation, loading & unloading etc. complete as per specification and direction of Engineer - in-charge.

Aluminium Door & Window:

Providing & fixing of DOMAL - 40 or equivalent Aluminium Building Systems, made from 6063 T-6 alloy and tempered euro groove aluminium profile, in approved surface coating, mechanically mitered & joined with corrosion resistance DOMAL accessories and hardware. Glass infill, of desired thickness, shall be fixed onto using non-aging siliconized microwave treated DOMAL gaskets depending upon on the structural conditions, functions and statistical load requirements.

Structural Glazing:

Providing & Fixing Semi unitized type Structural Glazing System in fixed panels with frame work including mullions, double glazed hermetically sealed insulating glass with 6.0 mm thick Heat reflective transoms & sub frame (No aluminium section to be exposed to outside and only glass panels with silicon joint to be visible from outside) made of specially designed extruded aluminium section of Jindal / Hindalco/ OEL(Alom) make conforming to 6063 T5 or T6 as per B.S.1474, duly anodized / powder coated in approved colour & shade with mullions fixed to RCC beams/columns through adequately designed MS back up materials and Anchor fasteners of Hilti / Fischer make, having toughened glass on outer face plus 12mm air gap with perforated aluminium spacer bar and 6 mm clear float toughened glass on inner face (DGU) of Saint Gobain / AIS make (thickness and specification of glass should satisfy the detail design of the HVAC requirement with specific LT and SHGC with approved shade/tint) including providing EPDM gasket, silicon sealants etc. Glass to be fixed with structural silicone of Dow Corning/GE /JL/Alstone make & Norton tape, with weather sealant in silicone of Dow Corning/GE /JL/Alstone make & Norton tape, with weather sealant in between the joint to make leak proof glazing etc complete as per the approved drawing and direction of Engineer-in-charge.

Sensor Door:

Providing and installation of DORMA ES200 easy OPERATOR: Providing Dorma ES 200 or equivalent easy bi parting sliding door (Size - as per drawing) operator with 12mm thick toughened clear glass shutters, anchor fastener, BR soft nose seal, modular design, including internal cover with operator, microprocessor control, self learning, reversing when obstruction is encountered. Microprocessor-controlled; control unit with adjustable parameters for opening and closing speed, hold open time and opening and closing force. Class of protection 20. The system shall have constant power supply 230V, 50/60Hz, UPS supply for various opening sizes all complete as per design. ES 200 is TUV type tested, compliant EU Low voltage directives, production according to ISO 9001 certification type B. The cost including conveyance, loading, unloading, royalties and taxes of all materials, curing-sundries and T&P, etc. required for the work complete as per specification and direction of Engineer-in-charge.

Glass Partition:

Supplying and fixing of manually operated 12mm thick toughened glass partition cum door including floor spring of requisite weight (floor plate fixed flush with floor) lock (DORMA Cat. no. Agile 150 or equivalent), handles & screws etc. (DORMA or Equivalent) including all labour charges for fixing and all applicable taxes etc., and as per approved drawing of the Architect / consultant and as directed by Engineer-in-charge.

PVC Door & Frame:

Providing and fixing factory made PVC door frame of size 50x47mm with a wall thickness of 5mm rigid PVC foam sheet, mitred at corners and jointed with 2 nos of 150mm long brackets of 15x15mm MS square tube, the vertical door frame profiles to be reinforced with 19x19mm square tube of 19 gauges. The door frame to be fixed to the wall using MS screws of 65/100mm size. PVC door shutter consisting of frame made out of MS tubes of 19-gauge thickness and size of 19x19mm for style and 15x15mm for top and bottom rails. MS frame shall have a coat of steel primers of approved make and manufacture. MS frame covered with 5mm thick heat moulded PVC C channel of size 30mmthickness, 70mm width out of which 50mm shall be flat and 20mm shall be tapered in 45-degree angle on both side forming styles and 5mm thick, 95mm wide PVC sheet out of which 75mm shall be flat and 20mm shall be tapered in 45 degree on the inner side to form top and bottom rail and 115mm wide PVC sheet out of which 75mm shall be flat and 20mm shall be tapered on both sides to form lock rail. Top bottom and lock rails shall be provided with both side of panel 10mm (5mmx2) thick, 20mm wide cross PVC sheet be provided as gap insert for top rail and bottom rail. Panelling of 5mm thick of both side PVC sheet to be fitted in MS frame welded/sealed to the styles and rails with 7mm (5mm+2mm) thick x 15mm wide PVC sheet beading on inner side and joined together with solvent cement

adhesive. An additional 5mm thick PVC strip of 20 mm width is to be stock on the interior side of the channel using PVC solvent adhesive etc complete as per direction of Engineer-in-charge.

Toilet Partition:

Supplying fitting and fixing in position toilet partition & door of 18mm thick of Merino industries limited or equivalent of approved quality and as per drawing & design with all necessary SS 'U' Channel, 'F' Channel, SS coat hock, SS privacy thumb turn, SS door knob, SS hinge with cover, SS shoe box leg 18mm ,rubber lining for grove ,SS screw 304 G & P.V.C wall plugs etc including cost of all materials, labour, all taxes, transportation, loading & unloading etc. complete as per approved shop drawing specification and direction of Engineer -in-charge.

Cupboard Shutter:

Supplying of full height or low height storage (as per approved drawing) made out of 18mm pre-laminated board with two side panel & a back panel (9mm). It should be a 25-mm edge banding top. The storage should be provided with shutters mounted on to the cabinets by full overlay auto shut hinges. It should be provided internal sleeves for storage. It should be provided with proper handles. All exposed edges should be mechanically edge banded by PVC tape (Rehau & Dolkan) and hot melt glue. It should have knockdown arrangement for fitting and provided with plinth adjuster on the bottom. All hardware fittings will be of Hettich make or equivalent.

Stainless Steel Railing:

Supplying, Fitting and fixing of stainless steel of 304 grade in hand railing using 50mm dia of 2mm thick circular pipe with Balustrade of size 50mm dia of 2mm thick @ not more than 0.90mtr C/C (spaced equally as per site) and stainless pipe bracing of size 32mm dia of 2mm thick in 3 rows in stair case all in satin finish as per approved design and specification buffing polishing etc with cost conveyance taxes of all materials labour T&P etc required for the complete in all respect and as per the direction of Engineer -in-charge.

Paver Block:

Supplying and laying of M40 grade heavy duty factory made hydraulically pressed and mechanically compacted free cast interlocking TUFF STONE brand pavers of 80mm thick, coral shaped or as per approved design along with preparation of sub base with 50mm sand and levelling, laying of interlocking paver block with sand binding and final compaction with plate vibrator finishing the surface including cutting of blocks at the edges with all labour and materials etc complete as per direction of Engineer-in charge.

GRC Customized Screens casted with Power Spray methodology:

Providing and fixing Glass Reinforced Concrete (G.R.C) Screens in approved size, pattern, design, shade and thickness of 50mm on frame and design element in 30mm thick casted with layering technique Power Spray methodology have weight

approximately between 3.5 – 4 Kg per Sq. Ft. and colour of M/S UniStone make or equivalent. The above weight and thickness is considering dimensions of screens up to 2133mm in height and 1219mm in width and having at least 50% void space. The screens should be made from '53 grade' White Portland Cement manufactured by 'JK Cement' or equivalent, Fine graded Quartz & Silica Sand, Alkali Resistant Glass Fibre manufactured by 'N.E.G JAPAN' or equivalent, Super Plasticizers manufactured by 'ZPXRC' or equivalent, Polymers manufactured by 'Dow Chemicals' or equivalent and U.V resistant Synthetic inorganic pigments should be used for pigmentation manufactured by Lanxess / 'BAYFERROX (Germany)' or equivalent. The material casting should take place in FRP Moulds. The fixing of Screens should be 'Dry fixing' i.e. to be done with M.S Galvanized Clamps, fixtures and fasteners of Hilti / Fischer or self - tapping screws. All applicable taxes shall be charged extra, as per actual. All transportation cost shall be charged extra, at time of dispatch of material from plant premises.

Acoustic wall cladding:

Providing and fixing 9mm polyester fibre acoustic NSA Pet panel of size 2440 x 1220 x 9mm glued to 6mm ply fixed to GI frame. SG GI frame fabricated with 50 x 50mm sal wood spacers at 600mm, 50 x 32 x 0.55 floor and ceiling section at top and bottom edges, 48x36x34x.55 stud section at 600c/c vertically, 80 x 26..5 ceiling section at 300c/c horizontally. 16gGI wire mesh stretched and fixed to entire back face of the GI frame to hold Cine view welding in place 1000gsm/50mm wadding to be fitted in GI. 9mm polyester fibre acoustic pet panel to have 25 (A) grade fire resistance by ASTM-E4. Panel design (in colours & pattern) to be created as per approved layout/ design subjected to the approval of engineer in charge.

Gypsum wall partition:

Providing and laying gypsum panel partitions 100mm thick with water proof gypsum panels of size 666 X 500 X 100 mm, made of calcite phosphor Gypsum fixed with tongue and groove, jointed with paper tape joint and bonding plaster as per manufacturer's specifications in super-structure above plinth level up to floor V level complete with cut-outs for cables / electrical switch plates etc.. Gypsum blocks will have a minimum compressive strength of 9.3 kg/ cm2.

Backlit SS Signage's:

Design, manufacturing & installation of backlit signage's where all the letters in Signage will be illuminated by energy efficient LEDs having a lamp life of minimum 50 - 70000 hrs and will have approximately 7 times more Light output than Conventional Signage. The signage will have very strong and uniform illumination throughout the Graphics and logo with no HOT SPOTS Visible the Illumination will be Edge to Edge. LEDs for external application shall be protected by Green Compound System, Temperature 300' F, UV rays, Ozone & weatherproof. All wiring & connections will be of international standard with no joints between two points. LED light

sources (imported Interone Led Modules & Converters) are small and unobtrusive, easy to install, and can generally be fitted out of sight. The letters will be of SS 18 gauge with 3M Vinyl face using branded ISI marked L.T wire and branded fasters for wall mounting. Colour of vinyl & light will be as per approved design & sample and to be constructed after the approved shop drawing and finished to the best standard.

GRC jali:

Providing and fixing Glass Reinforced Concrete (G.R.C) Screens in approved size, pattern, design, shade and thickness of 50mm on frame and design element in 30mm thick casted with layering technique Power Spray methodology have weight approximately between 3.5 – 4 Kg per Sq. Ft. and colour of M/S UniStone make or equivalent. The above weight and thickness is considering dimensions of screens up to 2133mm in height and 1219mm in width and having at least 50% void space. The screens should be made from '53 grade' White Portland Cement manufactured by 'JK Cement' or equivalent, Fine graded Quartz & Silica Sand, Alkali Resistant Glass Fibre manufactured by 'N.E.G JAPAN' or equivalent, Super Plasticizers manufactured by 'ZPXRC' or equivalent, Polymers manufactured by 'Dow Chemicals' or equivalent and U.V resistant Synthetic inorganic pigments should be used for pigmentation manufactured by Lanxess / 'BAYFERROX (Germany)' or equivalent. The material casting should take place in FRP Moulds. The fixing of Screens should be 'Dry fixing' i.e. to be done with M.S Galvanized Clamps, fixtures and fasteners of Hilti / Fischer or self - tapping screws.

Metal Roof sheeting with under-deck Insulation:

Providing & fixing weld mesh 50 x 50 x 1.6mm to the purlins and create a bed, placing Rockloyd Rockwool Slabs of density 48kg/m3 and thickness 50mm conforming to IS: 8183 with aluminum foil lamination on the facing side over the metal mesh bed and held in position by tying GI wire crisscross through the cleats.

Providing and fixing permanently color coated profile Lloyd Standing Seam profile sheet or equivalent manufactured out of 0.55mm TCT (Total Coated Thickness) Galvalume steel (150 gsm. zinc - aluminum alloy coating total of both sides as per AS 1397: 1993) having min.300 Mpa yield strength. The color coating shall comprise of Silicon Modified Paint. The color coating shall comprise of 20 microns finish coat over a 5 micron primer coat on the exposed side and back coat of 5 microns over a primer coat of 5 micron on the reverse side. The sheet shall be standing seam profiled having max. crest height of 63mm at min.418mm pitch distance fixed over a unique concealed clip made from 1.5mm GI which is locked together by a mechanical zipping machine to give absolutely puncture less roof and prevent leakage and shall be profiled at site with suitable fasteners. The work shall be carried out as per specifications, approved drawings and instruction of the Engineer-in-charge. The Profile steel

sheets shall conform to IS: 513, 277 & 14246.The sheet & insulation to be manufactured and erected by an ISO: 9001 certified company. Taxes will be paid extra. Scaffolding charges will be paid as per the current rate.

Carpet:

Style	T655 “Pigment” Carpet Tile
Construction	Hi/Mid/Lo Loop
Pile Fiber	nexlon™ with Tuntex Approved Nylon with Anti Stain & Soil Treatment
Tufted Machine Gauge	1/12 gauge
Pile Weight	680 gm/m2
Pile Height	6.0/5.3/3.0 mm
Total Thickness	9.2 mm max
Tile size	500mm x 500mm
Total Weight	5050 gm/m2
Secondary Back	Recyclable Tuntex Commercial Duraback
Wear Warranty	Lifetime – product is warranted not to lose more than 10% pile fiber by weight in normal commercial use
Color Fastness	15 Year Warranty ASTM 16-04. Grade 4 – Little or no change
Static Electricity	Permanent Lifetime Protection – less than 3.5kv
Stain Resistance	nexlon™ Stain Shield Treatment
Soil Resistance	nexlon™ Soil Guard Treatment
Flammability	ASTM E-648 Radiant Panel Class 1
Dimensional stability	warranted not to change in size by more than 0.5mm in normal use. Will not dome or dish in normal use
Installation	Pressure Sensitive Adhesive

Sustainability All yarns used shall be Solution dyed to minimize use of water and exclude any effluent production ISO 14001 and ISO 9001

Hi-pressure laminate:

Supply and Installation of Funder Max 6mm thick Exterior grade F- Quality panels of standard size with both side decor.

Max Exterior panels are duromer high-pressure laminates (HPL) as per EN 438-6, type EDF manufactured using patented Technology (NT); Panels are double hardened including acrylic polyurethane resin which is thermally cured under high pressure.

Explanation NT: Non fading high performance acrylic polyurethane surface Technology.

Installation of FunderMax panels for Facades above 15 meters height and for wind loads above 1.2 kpa will be done by MBE Rivets (with Fixed and Sliding Points) with recommended Aluminum LT1 series, T1 section of 100x50x2 mm thick and L1 section 50x50x2mm thick held by Wall Bracket with Wind load and Dead load slot as per design, anchored by standard Hilti/Fischer or equivalent make anchor fasteners along with Thermal Separator

Installation of Max Exterior panels for facades below 15 meters and for wind loads below 1.2 kpa, and also soffits, will be done by MBE Rivets (with Fixed and Sliding Points) with minimum recommended LT2 series, Aluminium T2 section of 75x37x2.8 mm thick and L2 section 30x30x2.8mm thick held by Wall Bracket with Wind load and Dead load slot as per design, anchored by standard Hilti/Fischer or equivalent make anchor fasteners along with Thermal Separator.

Installation of FunderMax Panels will be done using Rear Ventilated Principles only, which is ensured by providing ventilation gap minimum 200 cm2/ per Meter (for free flow of air behind the façade) for the façade and using the framework with no horizontal section.

Properties	Test method	Unit of measurement	Standard values
Overall Thickness		mm	6
Apparent density	EN ISO 1183-1	g/cm³	1.35
Flexural Strength	EN ISO 178	MPa	≥ 80
Modulus of Elasticity	EN ISO 178	MPa	≥ 9000
Tensile Strength	EN ISO 527-2	MPa	≥ 60
Co-efficient of Thermal Expansion	DIN 52328	1/K	$18x10^{-6}$
Fire behaviour Europe	EN 13501 -1	MA39 VFA Vienna	B-s2, d0 for 6mm

Wooden flooring:

Vintage Laminated Wooden Flooring, 12MM Thick AC-5

Engineered Wooden Flooring Area-1900*190*14/3MM

3. SPECIFICATIONS FOR SWIMMING POOL:

3.1 Design Basis

1.1.1

RACING POOL

Size	50m x 20.5m.
Lanes	8
Depth	1.125 m
Shape	Rectangular.
Volume	110 m^3.
Type	Overflow channel on length sides
Turnover Period	4.5 hours.
Design Flow Rate	250 m3/hr
Velocity Through the Filter	40 m3/hr/m2
Residual Chlorine to be maintained	1.5 – 2.0 mg/l
pH to be maintained	7.2 – 7.6
Balancing Tank	65 m^3.
Pipe Velocities	Suction side: 1.2 – 1.5 m/sec Discharge Side: 2.5 m/sec Gravity: 0.8 m/sec

3.2 General requirement of equipment/components

3.2.1 RECIRCULATION PUMPS

Pumps shall be horizontal centrifugal with spiral volute and attached prefilter and motor, the pump shall be made in polyeprolene reinforced with fiber, selected to have the best efficiency at the specified duty point. The pumps shall be suitable for continuous operation at any point within the range of operation as stipulated in the data/specification sheets.

The pump shut off head shall not exceed 15 mts.

The pump set along with the drive motor shall run smooth without undue noise and vibration. Acceptable peak to vibration limits shall be generally guided by the Hydraulic Institute standards of USA. Acceptable limit of sound pressure level is 80 dB(A) at 1 m distance.

The pumps shall be single stage with impellers made of Noryl.

Mechanical seal shall be of Graphite/Ceramic

The impeller shall be attached to the motor shaft and dynamically balanced.

pump motor shall be asynchronous with external ventilation and short-circuited rotor. Motor shall be IP – 55 with isolation class F.

Suction and discharger flanges shall conform to DIN 2501 standards

Prefilter: Prefilter shall be in Polycarbonate with transparent lid with flanges drilled according to DIN – 2501 standards and shall be provided with polycarbonate. The lid of the prefilter shall have top opening with knobs.

Description	**Required**
Type	Horizontal Centrifugal pump With spiral volute
Quantity	3 (Three)
Capacity of each pump	125 M3/hr
Discharge head	14 meter
Total Shutoff Pressure of Pump	22 meter maximum
Material Of Construction 1. Body 2. Impeller 3. Shaft 4. Mechanical Seat	 Polyproplene Noryl AISI – 316 L stainless steel Graphite/Ceramic

Suction connection	110 mm
Discharge connection	110 mm
Motor	
Power rating	400 V 3 phase 50 Hz
Recommended Motor HP RPM	 10.5 2900
Make	AtecPool Espana/IML/Fiber Pool
Prefilter	**Polycarbonate**
Type	Basket Filter
Quantity	2 working + 1 standby
Capacity	18 Liters
Material of construction. Body & Lid Basket	 Polypropylene Polycarbonate
Screen Size	30 micron
Location	Suction of re-circulation pump

3.2.2 PRESSURE SAND FILTER

Pressure sand filter shall be of high rate and shall be Bobbin Wound Fiber Glass reinforced with Polyester resin type only. Filter shall be complete with internal PVC and PP collector heads (umbrella type) and diffusers, manual air relief valve, inlet/outlet pressure gauge, water drain, sand dump port, and top lid of 400 mm size. Each filter shall have 160 mm inlet outlet connection flanges. The bed height shall be 1.0 m and velocity through the bed shall not exceed 40 m3/hr/m2. Internal media shall be sand (0.4 – 0.8mm size) and gravel (1 – 2 mm). Head loss across the filter shall not exceed 0.5 kg/cm2.

Type	Anti – Corrosive Vertical High Flow Sand Filter
Make	AtecPool Espana/Astral/Fiber Pool
Quantity	2 (Two)
Diameter	2000 mm
Height Overall	2020 mm
Material of construction.	Bobbin wound in Fiber – Glass Filament Reinforced with Polyester resin
Flow / Unit	125 M3/hr
Total Flow	250 M3/hr
Velocity / Filtration Rate	40 M3/hr/m2
Max Working pressure	2.5 kgs/cm2
Test pressure	3.75 kgs/cm2
Max. Working Temp.	50° C
Backwash flow / unit	125 m3/hr
Backwash flow velocity	40 M3/hr/m2
Backwash time	3- 5 minutes
Type of Filtering media	Silica Quartz Sand
Size of Filter media	0.4 – 0.8 mm
Depth of Filter media	1000 mm
Quantity of filtering media per unit	4000 Kgs.
Type of Under bed	Gravel
Size of gravel	1-2 mm

Quantity of gravel / unit	1250 Kgs.
Type of Inlet distributor	Multi arm diffuser umbrella type made from unplasticised PVC and polypropylene
Type of bottom collector	Multi arm diffuser type made from unplasticised PVC and polypropylene
Total Service weight	7900 Kgs.

3.2.3 VALVE BATTERY

Valve battery shall be complete with 5 nos. PVC butterfly valves with mounting kit UPVC pipe and pipe fittings supported on zinc plated steel pipe with clamps in galvanized steel and anti vibration clamps. All valves, pipes and fittings connections shall be as per DIN standards. The valve battery shall be a package of such systems so that the connection to filter is achieved. No site assembling or fabrication will be permitted to prevent leakages.

Type of Piping and Pipe fitting	PVC- PN 10 flanged connections as per DIN / ISO standard
Quantity	5 Sets
Type of Valve	PVC Butterfly valve with zinc platted steel shaft as per DIN standard
Size of valves	160 mm
Inlet/ outlet	160 mm
Backwash Inlet	160 mm
Backwash Outlet	160 mm
Rinse	160 mm
Supports	Zinc coated steel pipe with antivibration clamps and fixing plugs.
Make	AtecPool Espana/PIMTAS/Fiber Pool/Astral

3.2.4 pH ADJUSTMENT DOSING SYSTEM

Acid/Soda ash dosing system shall be complete with membrane type dosing pump, tank and PVC stirrer. Each dosing pump shall be single phase and all parts in contact with the liquid shall be Polypropylene, Viton, Teflon, and PVC. A transparent polycarbonate cover shall protect operating panel. The pump shall have a manual regulation from 0% to 100% and shall be suitable for floor as well as wall mounting.

Each tank shall be made in transparent polyurethane with external scale so levels of liquid can be checked all the time.

Agitators shall be with steering grip in Bakelite, rod and propeller arms in PVC.

The above dosing system shall be complete with 8 mm tube and necessary foot valves

with suction prefilter.

Pump	
Type	Constant Flow Membrane Pump
Quantity	1 (One)
Capacity	15 Liters / hr.
Discharge Head	5 Kgs/ cm2 (g)
Material of construction.	All wetted parts are in Polypropylene, Viton, Teflon and PVC. Pump shall be with anti acid plastic case. Operating panel protection provided by transparent polycarbonate cover.
Flow adjustment	By adjusting stroke length from 0- 100% manually
Power rating	220 / 240 V 50 Hz
Protection	IP 55 protection
Make	AtecPool Espana/Aqua/Prominent
Tank	
Type	Cylindrical Vertical
Quantity	1 (One)
Capacity / each tank	150 liters with external scale marking
Material of construction.	Semi Transparent Polyurethane
Make	AtecPool Espana/Aqua/Prominent

PH control system

Pump	
Type	Probe type with sensor
Quantity	1 (One)

Make	AtecPool Espana/Aqua/Prominent
Capacity	0-15 pH.

3.2.5 CHLORINE DOSING SYSTEM

Chlorine dosing system shall be complete with membrane type dosing pump, tank and PVC stirrer. Each dosing pump shall be single phase and all parts in contact with the liquid shall be Polypropylene, Viton, Teflon, and PVC. A transparent polycarbonate cover shall protect operating panel. The pump shall have a manual regulation from 0% to 100% and shall be suitable for floor as well as wall mounting.

Each tank shall be made in transparent polyurethane with external scale so levels of liquid can be checked all the time.

Agitators shall be with steering grip in Bakelite, rod and propeller arms in PVC.

The above dosing system shall be complete with 8 mm tube and necessary foot valves with suction prefilter.

Pump	
Type	Constant Flow Membrane Pump
Quantity	1 (One)
Make	AtecPool Espana/Aqua/Prominent
Capacity	15 Liters / hr.
Discharge Head	5 Kgs/ cm2 (g)
MATERIAL OF CONSTRUCTION.	All wetted parts are in Polypropylene, Viton, Teflon and PVC. Pump shall be with anti acid plastic case. Operating panel protection provided by transparent polycarbonate cover.
Flow adjustment	By adjusting stroke length from 0- 100% manually
Power rating	220 / 240 V 50 Hz
Protection	IP 55 protection
Tank	
Type	Cylindrical Vertical
Quantity	1 (One)
Capacity / each tank	150 liters with external scale marking

Material of construction**.**	Semi Transparent Polyurethane
Make	AtecPool Espana/Aqua/Prominent

Chlorine control system

Pump	
Type	Probe type with sensor
Quantity	1 (One)
Make	AtecPool Espana/Aqua/Prominent
Capacity	0-5 pmH.

1.1.1.1

3.2.6 SWIMMING POOL ACESSORIES

CADDY: Trolley shall be made of anodized aluminum pipe and 200 x 75 mm plastic platform and stainless steel AISI fittings and wheels to maneuver the caddy shall be suitable to house a 2.0 HP Self Priming Pump with motor and pre filter, and a cartridge filter made in PP and fiberglass fitted with manometer, manual air relief valve. The cartridge filter capacity shall be 17.0 m3/hr with a filtration surface of 75 ft2

3.2.7 VACCUM HEAD

The Vacuum head shall be double length and made of brightly polished extruded aluminum and chromium plated with 1-1/2”/2” connection and shall have facility to be connected with handle.

Quantity	One
Type	Double length 760 mm
Material of construction	Brightly polished extruded aluminum and chromium plated. To be towed with handle.
Connection	1-1/2”/2” Butterfly/clip
Make	**AtecPool Espana/Fiber Pool/Astral**

3.2.8 VACCUM HOSE

The Vacuum hose shall be 15 mts. long and shall be made from floating transparent blue copolymer and shall be complete with hose end adapter cuffs etc.

Quantity	30 meters
Material of construction.	Floating Transparent, Blue copolymer
Size	1-1/2/2”
Make	**AtecPool Espana/Fiber Pool/Astral**

3.2.9 TELESCOPIC HANDLE

Telescopic handle shall be 7.2 m long and shall be made of anodized aluminum and with clip connection and shall be suitable to mount all the accessories like nets and brushes.

DEEP BAG NET

Deep bag net shall be made from polypropylene and white polyester netting with clip connection and suitable to trap deep pool larger sediments.

Quantity	One
Material of construction	Polypropylene and white polyester netting
End connection	Butterfly nut /clip connection
Dimension	395 mm x 420 mm deep bag
Make	**AtecPool Espana/Fiber Pool/Astral**

SHALLOW NET

Shallow net shall be made from polypropylene and white polyester netting with 1 clip and suitable to trap floating debris.

Quantity	One
Material of construction	Polypropylene and white polyester netting
End connection	Butterfly nut /clip connection

Dimension	300mm x 397 mm with 1300 mm stem
Make	**AtecPool Espana/Fiber Pool/Astral**

CURVED BRUSH

shall be 18" mm long in white polypropylene with blue-black polypropylene bristles with clip .

Quantity	One
Material of construction	Polypropylene and aluminum
End connection	Butterfly/clip connection
Total length of brush	450 mm
Make	**AtecPool Espana/Fiber Pool/Astral**

STRAIGHT BRUSH

Brush shall be 330 mm long in white polypropylene with blue-black polypropylene bristles with clip connection.

Quantity	One
Material of construction	Polypropylene and aluminum
End connection	Butterfly /clip connection
Total length of brush	330 mm
Make	**AtecPool Espana/Fiber Pool/Astral**

ALGAE BRUSH

Brush shall be 165 mm long in white polypropylene with Stainless Steel bristles Fixing arrangement shall be clip type.

Quantity	One
Material of construction	Aluminum back with Stainless steel bristles
End connection	Clip connection

Total length of brush	165 mm
Make	**AtecPool Espana/Fiber Pool/Astral**

HANDLE

handle shall be 5.0 m long and shall be made of anodized aluminum and with clip connection and shall be suitable to mount algae brush.

Quantity	One
Material of construction	Reinforced Aluminum
Type	Telescopic
End connection	Clip connection
Total length of handle	5 meter
Make	**AtecPool Espana/Fiber Pool/Astral**

TEST KIT

Test kit shall be for residual chlorine and pH. Chemical reagent used shall have satisfactory long shelf life, which shall be indicated on the box. Reagent DPD and phenol red solution and shall be used and shall be housed in a blue plastic case.

Quantity	One
Type	Residual Chlorine and pH
Make	**AtecPool Espana/Fiber Pool/Prominent**

3.2.10 POOL BASIN ITEMS

MAIN DRAIN

Main drain shall be made from Stainless Steel AISI – 304 support frame and grills and shall be fixed at the deepest point in the pool bottom on the sump made in concrete. Fixing screws shall be in AISI – 304. The grill gapping shall be designed in such a way that each drain grill has a capacity of 136 m3/hr flow rate at velocity of 0.5 m/sec. Each drain grating shall be 500 mm x 500mm size. Bidder may please note that the drain shall be machine bended and welded and shall be absolutely smooth without any sharp edges. All drains shall be interconnected and shall be connected to the suction of the filtration pump.

Quantity	2(Two)
Flow per drain	424 gpm
Velocity	1.5 fps through the grille
Total flow	424 gpm
Material of construction. Frame & Grill	ABS plastic with VGB 2008 UL listed
Suction grill size	18 inch x 18 inch
Grill fixed with	SS. Screw
Make	**AtecPool Espana/Fiber Pool/CMP**

FLOOR INLETS

Each floor inlet shall be made from unalterable ABS UV resistant with 2" connection and shall be distributed evenly on the bottom floor of the pool. Each floor inlet shall have a maximum discharge capacity of 9 cum/hr with a facility to regulate the flow through each inlet. The outlet flow from each floor inlet shall be radial instead of vertical. These floor inlets shall be fixed on the bottom pipe and shall distribute the filtered water back in the pool.

Quantity	80
Flow capacity / inlet	9000 LPH max.
Material of construction.	ABS Plastic
Outside connection	63mm Glue type
Make	**AtecPool Espana/Fiber Pool/Astral**

3.2.11 POOL SIDE ITEMS

LADDERS - 2 & 3- STEP

Each ladder shall be made in S. S. AISI 316 and shall be brightly polished with 43 mm pipe and 5 - anti slip treads. Ladders shall be designed for any slippery surface and sharp edges and shall be complete with anchoring fixtures and earthling lugs. Distance between the treads shall be 250 mm and the size shall be 500 mm long and 100 mm wide for

efficient grip. All treads shall be screwed to the pipe. Ladders shall not have any welded joints and treads

Type	Ladders with handrail without welded joints and treads.
Quantity	2 Nos & 6 Nos.
Steps dimensions	500 mm x 75 mm thick
Type of step	Non –Slip step
Handrail dia	43 mm pipe
Steps	Stainless steel
Material of construction.	AISI – 316
Center to center of steps	250 mm
Type of fixing	Wall support fixing
Accessories	Fixing anchors and electrical earthing connection
Make	**AtecPool Espana/Fiber Pool/Astral**

GRATING

Anti slip design Grating provided to cover the overflow channel shall be single type and shall be manufactured in UV stabilized Polypropylene and shall be white in colour. Gratings shall be provided on two sides. Single piece shall be connected with male – female connection. Each single piece shall sit evenly on grating support profile provided on two sides of the channel throughout.

Type	Single Piece
Quantity	110mtrs
Nos. of units per meter	45 only.
Grating Width	350 mm

Height	30 mm
Fixing to Two Grating	Male – Female Connection
Material Of Construction	UV Stabilized Polypropylene
Make	AtecPool Espana/Fiber Pool/Anti

Grating Support Profile

Quantity	220 mts
Material Of Construction	UV Stabilized Polypropylene
Make	AtecPool Espana/Fiber Pool/Anti

3.2.12 UNDER WATER LIGHTING

LIGHTS

Each light shall be complete with 12 Volt, 33-Watt LED (WW) lamp, and 3.6 m STOW or HO7RN-F cables (2 Core 6mm^2), removable housing. Each light shall be designed to be used underwater in swimming pool application and shall have class III electric apparatus with very low above mentioned safety voltage (12V with alternating current). The flood lamp shall comply with IP 68 degree of protection and shall be resistant to dust, solid bodies and humidity. The flood lamp shall also comply with international standards of light, especially the EN 60598-2-18 standard. Each lightface plate shall be made in UV resistance unalterable ABS rim and niche shall be in polystyrene. Each light shall be connected to the deck box through a flexible conduit. .The entire underwater light circuit should be protected by earth leakage circuit breaker of 30mA

Type	Under water light with cable with niche. The flood lamp shall comply with IP68 degree of protection and should be resistant to dust, solid bodies and humidity.
Quantity	36 (Thirty six)
Material of construction.	White ABS

Lamp Watts	**33 LED.**
Bulb Voltage	12 V, AC Warm white
Size	280 mm x 134 mm
Make	AtecPool Espana/Fiber Pool/Astral
Accessories	
Junction Box / Deck Box	
Quantity	36
Material of construction.	ABS
Nos. of Inlet	3
Size of Inlet	¾" Threaded Capacity
Make	**AtecPool Espana/Fiber Pool/Astral**
Flexible Conduit	
Quantity	36
Length of conduit	1.8 M
End Connection	¾" Threaded End
Purpose	For Connecting light to junction box
Make	**AtecPool Espana/Fiber Pool/Astral**
Transformers	
Quantity	6
Input – Power supply	220 / 240 V
Output power supply	12 V
Current	300 VA
Protection	**IP 55**
Make	**AtecPool Espana/Fiber Pool/Astral**
Features	Transformer shall have following features: Polystyrene anti-collision box, Protection against oxidation, no external metallic components, V0ltage shall be electronically regulated; Coil & core

	vacuum saturated, electro- static protective shield between primary and secondary windings, Internal Thermal protection against overload shall be provided.

FLEXIBLE CONDUIT

Flexible conduit shall be made in flexible PVC and 1.8 m in length with ¾" and PG 16 threaded connections and shall connect the light to the junction box (deck box).

DECK BOX

Each deck box shall be made in ABS and shall consist of 3 inlets or outlets of ¾" or PG 16 threaded coupling and the lid/cover of the deck box shall water as well as dust proof.

TRANSFORMER

Each transformer shall be complete with voltage regulation and protection cover and shall be suitable for outdoor installation and shall conform to IP – 55 protections. Input power supply to the transformer shall be 220/240 volts and output shall be 12 Volts. Transformer shall have following features: Polystyrene anti-collision box, Protection against oxidation, no external metallic components, V0ltage shall be electronically regulated; Coil & core vacuum saturated, electro- static protective shield between primary and secondary windings, Internal Thermal protection against overload shall be provided.

3.2.13 COMPETITION EQUIPMENT

STARTING BLOCKS

400 mm high starting blocks sloping at 5 degrees and making an angle of 55 degrees with the ground shall be provided for each lane. Each starting block shall be made from polyester and fiberglass non-slip platform of 600 mm x 590 mm. and Hand laid Fiber platform with a facility for gripping during the backstroke event and each starting block shall be numbered individually.

FLOAT LANES

Float lanes shall be made from injected plastic or blown polyethylene balls assembled on polyester rope. Float lanes shall be supplied SS 316 float line fixing post, chromed brass float line tightner and SS 304 float line hook. Fixing post shall be anchored on the deck with the help of a 43 mm SS 316 anchor. Float lanes shall control the water turbulence and disperse the wave energy and channelize it along the length of the lane. Only those float lanes models shall be accepted which are previously been used at international events such as Olympics or World swimming championships.

Quantity	10 (Ten)
Type	Float assembled on polyester rope
Material of Construction	Injected Plastic
Type of float	110 mm diameter
Float Dimensions	11068 mm dia x 45 mm thick
Float line length	50 meter
Make	AtecPool Espana/Fiber Pool/Anti
Accessories	
Float line fixing cup with rod	
Quantity	20
Material Of Construction	Stainless Steel AISI 316
Accessories	Gaskets, Flange and SS screws.
Make	AtecPool Espana/Fiber Pool/Anti
Float line tightners	
Quantity	20
Material of construction	Chromed Brass and Stainless Steel
Make	AtecPool Espana/Fiber Pool/Anti

ROPE ROLLER

Two nos. of lane rope roller shall be provided each of 1.8 m wide so as to have lane ropes rolled on them. Each roller shall be made in SS 304 with wheels for maneuvering. Each roller shall have a capacity roll six nos. lane ropes.

FALSE START POSTS

One set of false start posts shall be provided on either side of the racing pool at a distance of 15 m from the start. False start posts shall comprise of 2 stainless steel SS 316 posts each of 48 mm dia and 1.8 m height. Of these two posts one post shall be

with pulley and quick cord fixing and loosening device and shall be complete with false start line comprising of polyester cord and a float. . Each post shall be properly anchored in a suitable anchoring socket on the deck.

Quantity	1 Set
Material of construction	Stainless steel AISI- 316
No. Of Post	Two, One of them with a pulley and quick cord fixing and loosing device
Height of Post	1.8 meter, 48mm dia pipe
Accessories False start float line with polyester cord and Float	 21 mts.
Make	AtecPool Espana/Fiber Pool/Anti

BACK STROKE TURN INDICATOR POSTS

Two sets of backstroke turn indicator post shall be placed at distance of 5 m from either side of the racing pool and shall span across the sides. Each set of back stroke turn indicator posts shall comprise of 2 stainless steel SS 316 posts each of 48 mm dia and 1.8 m height. Each post shall be properly anchored in a suitable anchoring socket on the deck.

Quantity	2 Sets
Material of construction	Stainless steel AISI- 316
No. Of Post	Four
Height of Post	1.8 meter, 48mm dia pipe
Accessories Back stroke indicator flags and Polyester Rope	 2 Nos.(21 mtrs)

Make	AtecPool Espana/Fiber Pool/Anti

PIPING AND VALVES

All piping shall be in PVC 10 or 6 kg/cm2 rating and of reputed make and shall be made from virgin material. Contractor shall use flange connections or threaded connections as required. All piping shall be permanently identified with directional arrows for flow, identification of contents, and source and destination labels.

All valves shall be Butterfly type in PVC PN 10 rating with flange connections and EPDM seat and graded disc for regulation.

U.V DIFINFECTION SYSTEM

Max. Flow Rate : 300 m3/hr UV Dosage : 60mj/cm2, UV Lamp : Number Power Consumption : 1 x 3Kw = 3 Kw with connection size for inlet & outlet : DN 250, Length of reactor in cm : 102 Max. Working pressure: PN10. Reactor: SS316L , Flange Joint, Automatic UV lamp cleaning system.

The performances of these units have been calculated at the end of the lamps ' life (after 4000h) with a transmittance of the water of 98%. Our reactors are equipped with a selective UV sensor at 254 nm. The sensor is connected either to: a LED display monitor and dry contact for communicating the information (Standard), Lamp operating indicator lights. Lamp alarm and alarm contact indicator. Digital hour counter with reset function. Selective UV sensor at 254 nm. Control monitor.

Type	Max. Flow Rate: 300 m3/hr UV Dosage: 60mj/cm2, UV Lamp: Number Power Consumption: 1 x 3Kw = 3 Kw with connection size for inlet & outlet: DN 250, Length of reactor in cm: 102 Max. working pressure: PN10. Reactor: SS316L, Flange Joint, Automatic UV lamp cleaning system.
Quantity	1 (One)
Material of construction.	SS 316

Lamp Watts	**3000 W**
Make	AtecPool Espana/Fiber Pool/Bio UV

3.2.14 SWIMMING POOL ACESSORIES:

Suction Inlets

Quantity	8
Material of construction.	ABS Plastic
Outside connection	2" BSP (M)
Make	**AtecPool Espana/Fiber Pool/Astral**

Starting Blocks

Quantity	10 Nos.
Type	Adjustable non-slip platform
Material of construction of Platform Base Steps	 Hand made Fiber Polyester and fiberglass.
Dimension of platform	600 mm x 590 mm
Height of platform	400 mm
Accessories	Anchoring fixture to be included
Make	AtecPool Espana/Fiber Pool/Anti

Float Line Roller

Quantity	4 nos.
Material of construction	White coated aluminum two wheels

Capacity	4 float lines each.
Dimensions	1.8 m wide x 1.2 m high.
Make	AtecPool Espana/Fiber Pool/Anti

Anchors for Optional Competition Equipment

Quantity	38
Material of construction	Stainless steel AISI- 316
Quantity Distribution	(16 – Starting Blocks), (2 – False Start Post), (4 – Back Stroke Indicator Post).
Size	44 mm inside, 75 mm outside and 120 mm length
Make	AtecPool Espana/Fiber Pool/Anti

Interconnecting Pipe work and Valves

Following specifications to be adopted

Pipe sizes are to be calculated on the basis of the following velocities.

- RETURN LINE PIPE VELOCITY: 2.5M/SEC
- OVERFLOW LINE PIPE VELOCITY: 0.8M/SEC
- SUCTION LINE PIPE VELOCITY: 1.2 to 1.5M/SEC

Pipes shall be of ISI mark, Prince or Finolex or Supreme OF 10KG/CM2.

All PVC / PP valves shall be of brand of minimum PN10 rating.

In cases where PVC valves of above Ø250mm are not available, Gunmetal Valves of Audco or Brand is acceptable

All standard fittings like bends, elbows, tees etc should be of similar rating of the pipes. However, in cases where special fittings are required and the same are to be fabricated on site due to non availability anywhere in the Indian market, then the contractor has to ensure that the fittings are fabricated of high grade chopped PVC fiber/ roving's and should be capable of withstanding working pressure of at least 10kg/cm2.

All pipes and fittings, including those fittings (specials) that are fabricated on site should be pressure tested to at least 3kg/cm2 or 24 hours.

All pipes shall be well supported with clamps or civil support, especially at joints.

Ø315mm; Ø250 mm; Ø200 mm; Ø180 mm; Ø160 mm; Ø140 mm; Ø125 mm; Ø110 mm; Ø90 mm; Ø75 mm; Ø63 mm; Ø50 mm

Overflow gutter to be constructed in concrete and connected directly by Ø 200 mm (04 nos pipes) to the balance tank by gravity flow.

Four surflow channels of Ø110 mm will be constructed in concrete in the floor of the pool for fresh water lines from header Ø 250mm

The Vacuum point for suction sweeper Ø63mm

The Main drain from to pool to pump suction header Ø160mm

The Main Header for the Delivery side of the Pump shall be Ø250 mm.

The Main Header for the Suction side of the Pump shall be Ø315 mm

From Balancing tank to Suction header of the Pump shall be of Ø250mm

Life Saving Equipments

Lifebelt support Inox Make : AtecPool Espana/Fiber Pool/Anti	4 No.s
Lifebelt support with base max. height 1.5m Make : AtecPool Espana/Fiber Pool/Anti	4 No.s
Life hook with aluminum handle 5m Make : AtecPool Espana/Fiber Pool/Anti	4 No.s

Electrical Works

Scope shall include -	
Installation & commissioning of all pool underwater lights and connection from Deck box to the step down transformer. All underwater lights should have equal voltage reading but not lower than 10Volts at the light point. Therefore, the contractor should ensure that the electrical cable running from the plant room to the light is correctly sized.	**1 lot**
All the electrical cables shall be conduit in Rigid PVC pipes of 10kg/cm2. Electrical cables shall be of brand	**1 lot**

and the PVC conduits shall be ISI quality	
The contractor's scope of electrical works shall include connections / electrification of all pool pumps, chemical dosing pumps and any other pool equipment that requires electrical connections, including installation of all electrical panels and necessary circuit breakers. The electrical panels shall be of ABB or Siemens make.	**1 lot**

4. SPECIFICATIONS FOR FOOT BALL FIELD:

Standard specification issued by Sports Authority of India and FIFA shall be followed while planning, designing, engineering and construction of foot ball field. The contractor has to obtain FIFA certification for the foot ball field.

Excavation

Excavation for preparation of sub base shall be done up the depth where the soil is having CBR value more than 5%.

Drainage

The drainage of football surfaces is essential as it guarantees an optimal playing performance during rainfall. The drainage network collects and removes excess water as quickly as possible from the field of play and potentially from the concrete surroundings.

Areas of low precipitation require no sub-surface drainage. In fact, some areas receive so little precipitation that even a perimeter drain is superfluous. But the Rourkela City is subjected to Monsoon and receives heavy rainfall so it require sub-surface perimeter and sub-surface drains, if permeable sub-base materials are available; the centers between successive drains will be significantly closer and will usually have additional larger drainage outlets to cope with heavier downpours.

If the water discharging from the drainage is clean, it can be collected and re-used for other operations in connection with the field such as for watering the pitch or the surroundings, and if it is filtered it may also be suitable for showering or cleaning.

Vertical drainage systems are installed in the sub-grade as a network of channels. Prior to the installation, the installer needs to check the slopes and evenness of the sub-grade.

The channels must be installed in such a way that they collect the water coming through the sub-base, and should be ideally designed in a way that minimises the distance for the collected water to flow to the peripheral drainage channels around the field. The slope of the channels is not parallel to the slope of the sub-grade. To improve efficiency and sustainability, the sub-grade between the channels can be waterproofed. Before the installation of the pipes, all

channels need to be clean. To prevent contamination from finer particles that may wash out of the sub-grade, the channels should be excavated and laid out and lined with geotextile. The top of the channels must be left open and in contact with the sub-base.

All pipes must be connected to a peripheral collector or directly to a ditch. To ensure that water discharges efficiently, ensure that the pipes connect at the top of the peripheral collector. For maintenance reasons, the diameter of the collector should not be less than 120mm and control chambers must be installed at a maximum distance of 60m for ease of inspections and cleaning.

To avoid damaging the drain (due to construction traffic, deformations, etc.) during the construction work, a base cannot be left without a water discharge solution (permanent or temporary), and all drainage installations must be designed backwards from the outlets.

The size of such ditches or pits must take the climatic conditions and the water infiltration rate of the natural ground into consideration.

To ensure a consistent drainage over the whole pitch, the thickness of the layers installed above the drainage system must be relatively even.

Installation of Drains

Drains are installed into the sub-grade immediately below the sub-base. It is important that the drainage channels are encased in geotextile to prevent contamination of the drainage aggregate and drainage pipes from finer particles that may wash out of the sub-grade and potentially the sub-base.

To ensure the drainage was installed correctly and permeability through all layers, it is mandatory to test the drain before the installation of the field.

Stabilization of sub-grade

The sub-grade layer is an essential part of the sub-base. If this layer is not fully stable, the whole instalment could be affected. If the sub-grade is not correctly prepared the first time round and a problem is found at a later stage, the layers installed above it will have to be removed before the problem can be fixed.

❖ Consolidate

- It is recommended to excavate all material until a stable layer is found, which can be seen as a layer with a California Bearing Ratio (CBR) reading of >5%.

- If the CBR reading is <2%, it is recommended that a new location be selected as the site is not sufficiently stable and will cause significant problems in the future.

- If the CBR reading is <5% and >2%, there are certain steps which may be taken in order to achieve a CBR reading of >5%.

- When deciding on how to best approach the stabilization of the sub-grade, it is first necessary to assess how unstable the area is after excavating the humus layer.

❖ To improve stability, a variety of materials can be used such as:

- Cement (only if other options fail)
- Crushed lava stone or quarry dust
- Similar materials depending on the situation

❖ The materials then need to be distributed before being compacted using a vibratory roller. Some methods of distribution are:

- Spreader
- Plough
- Laser leveling machine
- Similar machinery

The aim of these stabilization methods is to achieve a CBR of >5% which indicates that the sub-grade is sufficiently stable.

Consolidation of sub-grade

Consolidation means to bring separate parts together into one unified body. The sub-grade is the first level of the sub-base construction, and it is important that it is consolidated to ensure that there are sufficient compaction levels on which the rest of the construction can be installed.

- A vibrating roller should be used to consolidate the sub-grade, and it is advised that the roller has a minimum mass of 5,000kg. The sub-grade should be profiled using a grader and compacted and consolidated to achieve a 95% Proctor Density Level using the CBR or other similar methods.

- The first layer of the sub-grade should replicate the same slope that you aim to achieve for the final sub-base layer.

- The planarity of the final layer should be ≤20mm under a 3m straight edge.

Geotextile membrane

Geotextiles are permeable fabrics which, when used in association with soil, have the ability to separate, filter, reinforce, protect, or drain.

- A woven or non-woven geotextile should be used to increase bearing capacity and to prevent the contamination of the sub-grade into the sub-base.

- The geotextile membrane may be installed by hand or with the use of mechanical equipment, but there must be a minimum of 300mm overlap between adjacent rolls.

Sub-base aggregates, materials and gradings

The aim of the sub-base is to create a stable permeable platform onto which the football turf (Natural Grass) system can be installed. Aggregate for sub-bases is first blasted out of a layer of rock. The large pieces are then crushed into smaller pieces, which are then separated into various fractions for use.

A. First layer

The first layer generally consists of the larger fraction of quarried aggregate. Each piece of aggregate is structurally strong but because of their large size; they do not pack closely together, leaving relatively large voids between each piece of aggregate. The large voids are good for permeability but lack cohesiveness and are therefore relatively integrally weak. The thickness of the layer shall be minimum 150mm and the minimum permeability of the layer shall be 300mm/hr.

B. Second layer

The second layer consists of a medium-sized fraction of the quarried aggregate. The smaller size slots into the interstices of the larger aggregate in the first layer, helping to create a more cohesive structure. Clearly, as the voids are reduced, so the permeability decreases somewhat. The thickness of this layer shall be in between 100-150mm and the planarity of the layer shall be less than 10mm for 3m straightedge for maintain better slope.

C. Third layer

The final layer, in combination with the first two layers, achieves the required evenness and planarity requirements. The planarity should be ≤10mm under a 3m straight edge and should obtain a CBR level of 5%. The final layer uses the smallest fraction to close up the interstices whilst avoiding sealing the surface and rendering it impermeable. For this reason, it should be used only sparingly and not form a distinct separate layer which is both structurally weak and detrimental to the permeability of the finished sub-base. The third layer shall have minimum 20 mm binding layer.

Permeability

Permeable sub-bases will allow water to flow vertically and horizontally. The vertical flow passes through the drainage hole in the turf through the interties of the sub-base into the drains installed in the sub-grade before flowing out of the field into the drains located outside of the field. To achieve the maximum vertical drainage capacity, it has to be ensured that the permeability is ensured through all layers of the sub-base. The horizontal flow will follow the slopes of the surface to perimeter drains located around the edge of the field.

Impermeable surfaces do not allow the vertical flow of water through the sub-base. The water flows from the field along the slopes of the turf/sub-base to peripheral drains. In such a sub-base design, it is important that the surface planarity tolerance is increased to ≤6mm under a 3m straightedge to avoid “bird baths” forming.

Top Soil

Top soil shall be well sieved 90% to pass through I.S. slieve of 10mm size free from stone, rubbish like dried grass, roots & other such materials, the soil should be fresh from quarry and colour of soil will be red, soil should be measured by frama and filling fresh garden soil and manuare in excavated area including lead upto a dist of 50m etc. complete (garden & park DSR) + Supplying & speading on site river sand well sieved 90% to pass through I.S. slieve of 1mm size free from stone, rubbish like dried grass, roots & other such materials, the soil should be fresh from river and colour of soil will be gray,+Supplying & speading on site cocopeat, ratio of the mixture is 40% sieved garden soil+30% sieved river sand+30% coco peat.

Grass

The type of grass shall be Bermuda grass, American selex one 1st quality of any other approved grass by SAI

5. SPECIFICATIONS FOR 8 LANE 400M ATHLATIC TRACK:

Material / Dtex: PE8000

Structure: Fibrillated*Pile Height (mm): 13

Stitch Rate (Per 10cm): 34

Gauge (inch): 3/16

Stitches /m2: 71400

Roll (Mtr) Width x Length: Width: 2m or 4m

Backing:-PP + polyester fiber short-staple +Mesh scrim inlay

High wear resistance & Perfect ball roll properties

Economical System & UV Resistance

Creative Technology & Quick Construction

Natural & Beautiful appearance, Good performance

Reinforced Playability

Earth work

i. Earth work in excavation by mechanical means (Hydraulic excavator/manual means in foundation trenches or drains (upto 300mm depth) including dressing of sides and

ramming of bottoms, for all lift and lead, including getting out the excavated soil and disposal of surplus excavated soils as directed, within all lead and lift. All kinds of soil.

ii. Excavating trenches of required width for pipes, cables, etc including excavation for sockets, and dressing of sides, remaining of bottoms, depth upto 1.5 m including getting out the excavated soil, and then returning the soil as required, in layers not exceeding 20cm in depth including consolidating each deposited layer by ramming, watering, etc. and disposing of surplus excavated soil as directed, within all lead and lift. All kinds of soil Pipes, cables etc. exceeding 80mm dia, but not exceeding 300mm dia.

iii. Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth: consolidating each deposited layer by ramming and watering, within all lead and lift.

Concrete work

i. 1:2:4 (1: Cement: 2: coarse sand: 4 graded stone aggregate 20 mm nominal size) for Drain Wall, Toe Wall, Drains & Pipe Jamming in Trenches
ii. 1:3:6 (1: Cement; 3 : coarse sand: 6 graded stone aggregate 40 mm nominal size)
iii. 1:4:8 (1: cement: 4:coarse sand: 8 graded stone aggregate 40 mm nominal size)
iv. Centering and Shuttering including strutting propping and removal of formwork for Retaking walls, return wall, walls (any thickness) including attached pillars, buttresses; plinth and string courses fillers etc.

Drainage

i. Providing and laying non - pressure NP2 class (light duty) R.C.C. S & S jointed with stiff mixture of cement mortar in the proportion of 1:2 (1 cement : 2 fine sand) including testing of joints etc. complete:
ii. 300 mm dia R.C.C. pipe
iii. 450 mm dia R.C.C. pipe
iv. Providing and laying of 100mm thick, perforated/slit, heavy duty (M-30), steel fiber reinforced cement concrete drain covers of approved (KK , Himalaya or equivalent) make and design, all complete as per the specifications and direction of engineer in charge.

SUB HEAD - BRICK WORK

Brick work with F.P.S bricks of class designation 75 in Drain & Toe Wall in Cement mortar 1:6 (1 cement : 6 coarse sand)

SUB HEAD - FINISHING

i. 12MM cement plaster of mix : 1:4 (1 cement : 4 coarse sand)
ii. Neat cement punning
iii. Consolidation of sub grade with power road roller of 8 to 10 ton capacity to required slope including making good the undulations etc. with earth or quarry spoils etc. and rerolling the sub grade.
iv. Providing, laying, spreading and compacting specified grade Granular sub base coarse using specified stone dust, gravel or any other coarse granular materials of approved materials in sub base coarse including laying and compacting up to 150mm thick including spreading in uniform layers with Motor grader on prepared surface, mixing by

mix in place method with rotavator at OMC, watering and compacting with vibratory roller to achieve the density as directed by the Engineer- In-Charge at site of work.

v. Providing, laying, spreading and compacting graded stone aggregate wet mix macadam up to 150mm thick specification including premixing the material with water at OMC in mechanical mix plant carriage of mixed material by tipper to site, laying in uniform layers in sub-base / base course on well prepared surface and compacting with static roller to achieve the desired density and as per standard specifications.

vi. Providing and applying tack coat using cold bitumen emulsion including spraying the bitumen with mechanically operated spray unit fitted on bitumen with preparing the existing road surface as per specification:
   a. On W. M. M. @ 0.5kg/sqmt. – primer
   b. On bituminous surface @ 0.30 Kg/sqmt

vii. Providing and laying Bituminous macadam on prepared surface with specified graded crushed stone aggregate for profile corrective base/binder course including loading of aggregate with FE loader and hot mixing of stone aggregates and bitumen in hot mix plant, transporting the mixed material by tipper to paver and laying the mixed material with paver finisher fitted with electronic sensing device to the required level and grade and rolling by road roller as per standard specifications, to achieve the desired density and compaction, but excluding the cost of primer / tack coat. 50/75mm average compacted thickness with bitumen of 60/70 grade@ 3.5% (percentage by weight of total mix)

viii. Providing and laying Dense bituminous concrete on the prepared surface with specified graded crushed stone aggregate for wearing course including loading of aggregate with FE loader and hot mixing of stone aggregate, filler and bitumen in hot mix plant, transporting the mixed material by tipper to paver and laying the mixed material with paver finisher fitted with electronic sensing device to the required level and grade and rolling by road roller as per MORTH specifications, to achieve the desired density, but excluding the cost of primer / tack coat. 40 / 50 mm compacted thickness with bitumen of grade 60/70 @ 5.5 %. (percentage by weight of total mix)

ix. Providing & laying minimum 15cm thick cement concrete slab over the existing sub base with a nominal mix of 1:1:5:3(1 cement: 1.5 coarse sand:3 Graded stone aggregate 20mm nominal size) for fixing throwing circles for Discus/ Hammer / Shot-put in required diameter/size including cost of cutting the base and sub-base wherever necessary cost of fixing the required throwing circle rings for Discuss/Hammer/Shot-put with necessary fixing arrangements as per direction of Engineer-in-Charge. The finished surface of concrete base slab shall have required non skid/ non slippery finish and gradient as per requirements / specifications laid down by IAAF and as per directions of Engineer-in-Charge (the cost of throwing circle rings is not included in this item and shall be paid as part of completion equipment

x. Providing and fixing at or near ground level factory made cement concrete kerb stones of M-20 grade of approved make of specified size including setting in position in kerbs edging etc. to the required line level and curvature jointed with cement mortar 1:3 (1 cement : 3 coarse sand) making joints with or without grooves (thickness of joints except at sharp curves shall not be more than 5mm) including making drainage opening wherever required including the cost of centering shuttering (if required) and including the painting of kerb stone with synthetic enamel/ water proof paint etc. all complete as per direction of Engineer-in charge.

xi. Providing and laying Sandwich Synthetic Athletics Track Surface including markings on the surface and including required competition equipment all complete as per requirements / specifications laid down by IAAF and as per direction of the Engineer- in-Charge.
Normal Stress Area with a minimum thickness of 13 mm of finished track surface

6. Schedule of finishes – main building

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
MAIN BUILDING										
1	**GROUND FLOOR**									
i	Lobby, Waiting and Reception area for canteen and office	Kota stone	550X550	Kota stone	Acrylic Emulsion Paint	Up to CEILLING	MS Door with fire rating 2hr	Aluminium sliding window	600X 600 gypsum ceiling	
ii	Canteen and kitchen	DO	DO	DO	DO	DO	-	-	600 X 600 metal ceiling	
iii	Public Staircase	Kota stone	As per Riser and Tread	-	-	-	-	Aluminium fix window	OBD	Anti skid groove in tread & SS railing
iii	VIP Staircase	Granite	As per Riser and Tread	-	-	-	-	Aluminium fix window	OBD	Anti skid groove in tread & SS railing
iv	Toilet area	Anti-skid heavy duty vitrified tile	600x600	Vitrified tile	Vitrified wall tile up to false ceiling high. OBD above false ceiling	450x600	PVC DOOR	Aluminium ventilator with louvers	600 X 600 metal ceiling	Fix with tile adhesive Nitotile GPX or equivalent
v	Store, AHU and electric room	Kota stone	550X550	Kota stone	Acrylic Emulsion Paint	Up to CEILLING	MS Door with fire rating 2hr	Aluminium sliding window	OBD	
v	Circulation space	Kota stone	550X550	Kota stone	Acrylic Emulsion Paint	Up to CEILLING	MS Door with fire rating 2hr	Aluminium sliding window	600X 600 gypsum ceiling	
vi	Control rm, support rm, lines rm	DO	DO	DO	DO	DO	MS Door	DO	DO	

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
vii	Conference room	Carpet Tile	500x500	DO	DO	DO	DO	DO	600 X 600 mineral fibre ceiling	
viii	Lift lobby, Waiting and Reception area for VIPs entry	Granite	22mm thk granite	100mm high granite	DO	DO	DO	DO	600X 600 gypsum ceiling	
ix	Doctors room and health facility	Vitrified tile	600x600	Vitrified tile	Acrylic Emulsion Paint	Up to CEILLING	MS Door	Aluminium louvers	DO	Fix with tile adhesive Nitotile GPX or equivalent
x	Changing Room	Vinyl Sheet	-	Kota stone	DO	DO	MS Door	Aluminium sliding	DO	
xi	Gym	Carpet Tile	500x500	Kota stone	Acrylic Emulsion Paint	Up to CEILLING	MS Door with fire rating 2hr	Aluminium sliding window	600 X 600 metal ceiling	
xii	Coach room	DO	DO	DO	DO	DO	DO	DO	600X 600 gypsum ceiling	
xiii	pantry	Anti-skid heavy duty vitrified tile	600x600	Vitrified tile	Vitrified wall tile up to false ceiling high. OBD above false ceiling	450x600	PVC DOOR	Aluminium ventilator with louvers	600 X 600 metal ceiling	Tile Fix with tile adhesive Nitotile GPX or equivalent
xiv	Office area	Vitrified tile	600x600	Vitrified tile	Acrylic Emulsion Paint	Up to CEILLING	MS Door	Aluminium louvers	600X 600 gypsum ceiling	Tile Fix with tile adhesive Nitotile GPX or equivalent
2	**FIRST FLOOR**									

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
i	Open terrace and circulation space	Kota stone	550X550	Kota stone	Acrylic Emulsion Paint	Up to CEILLING	MS Door with fire rating 2hr	Aluminium sliding window	OBD	
ii	Cafeteria	DO	DO	DO	DO	DO	DO	DO	600X 600 gypsum ceiling	
iii	AHU, electrical room	DO	DO	DO	DO	DO	DO	DO	OBD	
iv	CCTV room	DO	DO	DO	DO	DO	DO	DO	600X 600 gypsum ceiling	
v	Stall	DO	DO	DO	DO	DO	DO	DO	DO	
vi	Lift lobby,	Granite	22mm thk granite	100mm high granite	DO	DO	DO	DO	600X 600 gypsum ceiling	
vii	Toilet area	Anti-skid heavy duty vitrified tile	600x600	Vitrified tile	Vitrified wall tile up to false ceiling high. OBD above false ceiling	450x600	PVC DOOR	Aluminium ventilator with louvers	600 X 600 metal ceiling	Fix with tile adhesive Nitotile GPX or equivalent
viii	VIP staircase	Granite	As per Riser and Tread	-	-	-	-	Aluminium fix window	OBD	Anti skid groove in tread & SS railing
iii	Public Staircase	Kota stone	As per Riser and Tread	-	-	-	-	Aluminium fix window	OBD	Anti skid groove in tread & SS railing
ix	Seating	Kota stone	550X550	Kota stone	Acrylic Emulsion Paint	Up to CEILLING	MS Door with fire rating 2hr	Aluminium sliding window	-	seating chair in plastic

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
3	**SECOND FLOOR**									
i	Lobby and circulation space	Kota stone	550X550	Kota stone	Acrylic Emulsion Paint	Up to CEILLING	MS Door with fire rating 2hr	Aluminium sliding window	600X 600 gypsum ceiling	
ii	AHU, electrical room	DO	DO	DO	DO	DO	DO	DO	OBD	
iii	Lift lobby,	DO	DO	DO	DO	DO	DO	DO	600X 600 gypsum ceiling	
iv	Toilet area and pantry	Anti-skid heavy duty vitrified tile	600x600	Vitrified tile	Vitrified wall tile up to false ceiling high. OBD above false ceiling	450x600	PVC DOOR	Aluminium ventilator with louvers	600 X 600 metal ceiling	Fix with tile adhesive Nitotile GPX or equivalent
v	VIP staircase	Granite	As per Riser and Tread	-	-	-	-	Aluminium fix window	OBD	Anti skid groove in tread & SS railing
iii	Public Staircase	Kota stone	As per Riser and Tread	-	-	-	-	Aluminium fix window	OBD	Anti skid groove in tread & SS railing
vi	Seating	Kota stone	550X550	Kota stone	-	-	-	-	-	Seating chair fixed of tread as per approval
vii	VIPs seating	Carpet Tile	500x500	DO	DO	DO	DO	DO	DO	Seating chair fixed of tread as per approval

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
viii	Commentator box	Carpet Tile	500x500	DO	DO	DO	DO	DO	600 X 600 mineral fibre ceiling	Seating chair fixed of tread as per approval
ix	AV Room	Carpet Tile	500x500	DO	DO	DO	DO	DO	DO	Seating chair fixed of tread as per approval

7. Schedule of finishes – Circular Sitting

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIM	DOOR	WINDOW		
CIRCULAR SEATING										
1	**BASEMENT**									
i	Public Staircase	Kota Stone	As per Riser and Tread	-	-	-	-	-	OBD	Anti skid groove in tread & SS railing
ii	services area	Kota stone	550x550	Kota stone	Acrylic Emulsion Paint	Up to CEILLING	MS Door with fire rating 2hr	Aluminium sliding window	OBD	
2	**GROUND FLOOR**									
i	Ramp	kota Stone	550x550	-	-	-	-	-	-	Anti skid groove in tread & SS railing
ii	Public Staircase	DO	DO	-	-	-	-	-	-	Anti skid groove in tread & SS railing

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIM	DOOR	WINDOW		
iii	Toilet area	Anti-skid heavy duty vitrified tile	600x600	Vitrified tile	Vitrified wall tile up to false ceiling high. OBD above false ceiling	450x600	PVC DOOR	Aluminium ventilator with louvers	600 X 600 metal ceiling	Fix with tile adhesive Nitotile GPX or equivalent
iv	Store, electric room, Pump room, Plant room	Kota stone	550x550	Kota stone	Acrylic Emulsion Paint	Up to CEILLING	MS Door with fire rating 2hr	Aluminium sliding window	OBD	
3	**FIRST FLOOR**									
i	Staircase	Kota Stone	As per Riser and Tread	-	-	-	-	-	OBD	Anti skid groove in tread & SS railing
ii	Seating	Kota stone	550x550	Kota stone	Acrylic Emulsion Paint	Up to CEILLING	MS Door with fire rating 2hr	Aluminium sliding window	-	Seating chair fixed of tread as per approval

8. Schedule of finishes – Swimming Pool

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
SWIMMING POOL										
1	**BASEMENT**									

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
i	Staircase	Granite	As per Riser and Tread	-	-	-	-	Aluminium ventilator with louvers	OBD	Anti skid groove in tread & SS railing
ii	Service room, electrical room	Kota stone	550X550	Kota stone	Acrylic Emulsion Paint	Up to CEILLING	MS Door with fire rating 2hr	Aluminium ventilator with louvers	DO	
ii	lobby	DO	DO	DO	DO	DO	DO	DO	600X 600 gypsum ceiling	
2	**GROUND FLOOR**									
i	Staircase	Kota stone	As per Riser and Tread	-	-	-	-	Aluminium fix window	OBD	Anti skid groove in tread & SS railing
ii	Service room, electrical room	Kota stone	550X550	Kota stone	Acrylic Emulsion Paint	Up to CEILLING	MS Door with fire rating 2hr	Aluminium sliding window	DO	
ii	lobby	DO	DO	DO	DO	DO	DO	DO	600X 600 gypsum ceiling	
iii	Circulation area	DO	DO	DO	DO	DO	DO	DO	DO	
iv	Toilet area	Anti-skid heavy duty vitrified tile	600X600	Vitrified tile	Vitrified wall tile up to false ceiling high. OBD above false	450X600	PVC DOOR	Aluminium ventilator with louvers	600 X 600 metal ceiling	

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
					ceiling					
iv	Office area	Vitrified tile	600X600	Vitrified tile	Acrylic Emulsion Paint	Up to CEILLING	MS Door	Aluminium fix window	600X 600 gypsum ceiling	
	Deck	Deck Tile	600X600	Vitrified tile	Combination of ms sheet & translucent multi-cell polycarbonate sheet	Up to CEILLING	MS Door	-	-	
3	**FIRST FLOOR**									
i	Staircase	Granite	As per Riser and Tread	-	-	-	-	Aluminium fix window	OBD	Anti skid groove in tread & SS railing
ii	Service room, electrical room	Kota stone	550X550	Kota stone	Acrylic Emulsion Paint	Up to CEILLING	MS Door with fire rating 2hr	Aluminium sliding window	DO	
ii	Lobby	DO	DO	DO	DO	DO	DO	DO	600X 600 gypsum ceiling	
iii	Toilet area	Anti-skid heavy duty vitrified tile	600X600	Vitrified tile	Vitrified wall tile up to false ceiling high. OBD above false ceiling	450X600	PVC DOOR	Aluminium ventilator with louvers	600 X 600 metal ceiling	

SI NO	FLOOR DETAIL DESCRIPTION	FLOORING		SKIRTING	CLADDING / WALL FINISH		DOOR / WINDOW		CEILING	REMARK
		TILE / SLAB	DIMENSION		PAINT / SLAB	DIMENSION	DOOR	WINDOW		
iv	Seating area	Kota stone	550X550	Kota stone	Acrylic Emulsion Paint	Up to CEILLING	MS Door with fire rating 2hr	Aluminium sliding window	-	Seating chair fixed of tread as per approval

9. List of Approved Make

Following list of approved vendors are provided for different materials. However contractor may procure from other equivalent vendors after approval from employer.

SR. NO.	PRODUCT	BRAND, AGENCY
1.	AAC / flyash blocks	Charbuja, Aerocon, Siporex, Ecolite, CEEFpro, BLIT, First Build
2.	Waterproofing Treatment	Pidilite, BASF
3.	GRC	Unistone, Birla White
4.	Concrete, Stone Sealar	Degussa, Wacker, Hytek, Aquamix, Laticrete, Kerakoll
5.	Fire Check Wood, Steel Doors	Signum, Godrej, Guardian, Navair, Shakti Hormann, Promat, Alhada,
6.	Flush Doors	Tata Conswood, Greenwood, Garnet, Merino, Century
7.	Door seals [dust / fire]	Lorient, Enviroseals, Pemko, Assorted
8.	Structural, Weather Sealant	Dow Corning, GE, Dupont
9.	Glazed, Ceramic & Vitrified Tiles	Euro, Naveen, Kajaria, Nitco, Jhonson, RAK
10.	Pigmented Joint fillers	Laticrete, Pidilite
11.	Tensile Roof	Unique, Ecostructures
12.	Cement Putty	Birla White, J K white
13.	Paint	Nerolac, Asian Paints, Dulux, Jenson & Nicholson, Berger, ICI, Oikos, Akzonobel, MRF
14.	Glass	Saint Gobain, AIS, Pilkington, Emirates
15.	Glazing Systems	Hydro, Domal, Kawneer
16.	Fire rated glass	Schott, Saint Gobain
17.	Doors, Window Fittings And Fixtures	Dorma, Giesse, Dline, Union, Yale, Assa Abloy brands
18.	Toughening Agencies	Sejal, GSC, Gold Plus, Impact
19.	Lamination Films	Garware, Dupont
20.	Polycarbonate sheet	Lexan, Danpalon, GE, Tuflite, Plaram
21.	Gypsum & Mineral Fibre boards, systems, access panels & accessories	Saint Gobain, India Gypsum, Rondo, Armstromg, AMF, Knauf, Rehau, Lafarge, Gypsemma, USG
22.	False Floor	Unitile, Solidfeel
23.	Handrails	Technorails, Dline, Dorma, Carlf India,

SR. NO.	PRODUCT	BRAND, AGENCY
24.	Polypyopylene Rungs	Pranali, Mase Safety Works, StepX
25.	Paver Blocks	Basant Beton, Vyara
26.	Thermoplastic Road Marking Paint	Asian Paint PPG-Apcomark, Automark Technologies (India) Pvt. Ltd.
27.	Fire Stop Mortar & Foam	Firestop, Hilti, Promat, Newkem
28.	Expansion Joints	CS expansion joints, BASF Eabco, Excel Tech
29.	Cast in Channels	Halfen Deha, Jordhal
30.	Sanitary wares	Hindware, Parryware, Cera, HR Jhonson
31.	Concealed flush tanks / valves	Gebrit, Jaquar, Schell, Commander, Viega, Parryware
32.	Faucets /sanitary fittings	Jaquar, Grohe, Schell,
33.	HDPE drain boards	Doerken, Green global, Pidilite
34.	CPVC plumbing pipes & adhesives	Flowgaurd, Astral ,Ashirwad, Prince
35.	Manhole covers	Neco, Municast,
36.	Light Fittings	Corvi, Bajaj, Philips, Trilux, Schreder,
37.	Gate automation & control	Gandhi automation, Boon Edam
38.	AAC / flyash blocks	Charbuja, Aerocon, Siporex, Ecolite, CEEFpro, BLIT
39.	Waterproofing Treatment	Pidilite, BASF
40.	Anchor Fastener	Fischer, Hilti
41.	Entry Mat	Euronics, 3M

TECHNICAL SPECIFICATION OF CIVIL WORKS

1. TECHNICAL SPECIFICATIONS FOR CONCRETE WORK

1.1 EARTHWORK

1.1.1 SCOPE OF WORK

The work covered by this section of the specifications consists of furnishing all plant, labor, equipment, appliances and materials and in performing all operations in connection with earthworks of all underground supplies and services and for all structural units, stock piling, of specifications and applicable drawings, and subject to terms and conditions of the contract. The scope of this section of specifications is also covered with detailed specifications as laid down herein.

1.1.2 GENERAL

The Contractor shall acquaint himself with the nature of the ground, existing structures, foundations and subsoil which might be encountered during excavation of earthworks. The Employer does not guarantee or warrant in any way that the material to be found in the excavation will be similar in nature to that of any samples which may have been exhibited or indicated in the report, drawings or in any other contract documents or to material obtained from boring or trail holes. The contractor shall be deemed to have made local and independent inquiries and shall take the whole risk of the nature of the ground subsoil or material to be excavated or penetrated and the Contractor shall not be entitled to receive any extra or additional payment nor to be relieved from any of his obligations by reasons of the nature of such ground subsoil or material.

All excavations, cutting, and fills shall be constructed to the lines, levels and gradients specified with any necessary allowance for consolidation, settlement and drainage so that at the end of the period of maintenance the ground shall be at the required lines, levels and gradients.

During the course of the Contract and during the period of maintenance any damage or defects in cuttings and fills, structures and other works, caused by slips, falls or basins or any other ground movement due to the Contractor's negligence shall be made good by the Contractor at this own cost.

1.1.3 SITE PREPARATION

The Contractor shall construct and maintain accurate bench marks so that the lines and levels can be easily checked by the Project Engineer. The Contractor shall Construct and maintain such ditches, in addition to those shown on the plans, as will adequately drain areas under construction.

The Contractor shall perform a joint survey with the Project Engineer's representative of the area where earthwork is required, plot the ground levels on the drawings and obtain approval from him before starting the earthwork.

The Contractor shall Construct and maintain such ditches, in addition to those shown on the plans, as will adequately drain areas under construction.

The Contractor shall perform a joint survey with the Project Engineer's representative of the area where earthwork is required, plot the ground levels on the drawings and obtain approval from him before starting the earthwork.

1.1.4 EXCAVATIONS

Excavation shall include the removal of all material of every name and nature. Excavations shall be carried out in accordance with excavation plans and sections shown on the Drawings and as directed by the Project Engineer.

The major portion of excavations shall be carried out by mechanical excavators and excavated materials disposed off to stock on spoil as per drawings or as directed by the Project Engineer. The excavation which cannot be done by mechanical means including leveling, trimming and finishing to the required levels and dimensions shall be done manually. The material suitable for fill and back fill shall be stock piled within the free haulage limit of the 200m of the works.

The Contractor shall give reasonable notice that he intends to commence any excavation and he shall submit to the Project Engineer full details of his proposals. The Project Engineer may require modifications to be made if he considers the Contractor's proposals to be unsatisfactory and the Contractor shall give effect to such modifications but shall not be relieved of his responsibility with respect to such work.

For major excavations, the Contractor shall submit for the prior approval of the Project Engineer full details and drawings showing the proposed method of supporting and strutting etc. The design, provisions construction, maintenance, and removal of such works shall be the responsibility of the Contractor and all cost in these respects shall be included in the unit rates for the permanent work.

The Contractor's attention is drawn particularly to his obligations under the general conditions in respect of those works which are in close proximity to existing buildings.

The Contractor shall preserve the complete excavation from damage from slips and earth movements, ingress of water from any source what so ever and deterioration by exposure to the sun and the effects of the weather.

All excavation of every description, in whatever material encountered shall be performed to the elevations and dimensions shown on the drawings in such a manner as to avoid interruption to work in other parts of the site. The Contractor shall be responsible for injury to the permanent works caused by excavation on other parts of the works.

Excavation shall extend to sufficient distance from walls and footing to allow for placing and removal of forms, installations of services and for inspection, except where the concrete for walls and footings is authorized to be deposited directly against excavated surfaces.

All excavations in foundations shall be taken to 150mm and shall be trimmed carefully to a smooth and level surface, immediately after trimming to the final elevation a layer of building concrete shall be placed to the thickness shown on the drawings. All excavations for foundations which have been trimmed and disturbed shall be compacted and covered by concrete by the end of the day. It is specifically brought to the notice of the Contractor that any excavation taken down to the trimmed elevation which is left overnight or for any length of time thereafter, uncovered by the blinding concrete, shall be required to be trimmed to such lower elevation as directed by the Project Engineer and any extra work or any consequent increase in the quantities caused thereby shall not be paid to the Contractor.

No excavation shall be refilled nor any permanent work commenced until the foundation has been inspected by the Project Engineer and his permission to proceed given. If excavation for sub-structures is carried below the required level, as shown in the drawings or as directed by the Project Engineer, the surplus depth shall be filled in with concrete of same grade as of blinding concrete at the sole cost of the Contractor.

All excavation shall be performed in the dry. The placing of blinding concrete, placing of reinforcement and casting of the permanent works in the excavation shall be carried out in the dry and the Contractor shall have sufficient equipment for this purpose. Adequate precautions shall be taken to prevent any corrosion due to undercutting from underneath the previously constructed adjoining foundations.

Existing utility lines to be retained, as well as utility lines constructed during excavation and backfilling, and if damaged, shall be required to be repaired by the Contractor at his expense. Any existing utility lines which are not known to the Contractor in sufficient time to avoid damage, if inadvertently damaged during excavation, shall be repaired by the Contractor and adjustment in payment will be made as approved by the Project Engineer. When utility lines which are to be removed, are encountered within the area of operations the Contractor shall notify the Project Engineer in ample time for necessary measures to be taken to prevent interruption of the service.

Excavated material suitable for use as filling material shall be stock piled within the free haulage limit 200m of works as directed by the Project Engineer. This stock piled material shall be transported back to places requiring fill or backfill. Surplus or material unsuitable for use as filling shall be disposed of by the Contractor at locations approved by the Project Engineer within specified free haulage limit.

The Contractor shall make independent enquiries and perform and make independent observations to ascertain the water table in the areas of excavations during the period when the construction works are in progress. The Contractor shall take whole risk of any nature for fluctuation of the water table from his own findings. The Employer is not bound in any way and shall not be responsible for any information given by him or any information, observations or values obtained from his reports, drawings and documents.

Excavation for Recharge pits, Recharge trenches shall be taken out to the levels and dimensions as the Project Engineer may direct.

Before starting the excavations, the Contractor shall ensure the correct alignment of the recharge trenches and location of recharge pits on the ground, the depth and width of excavation of the trench and pits, all in accordance with the drawings and instructions of the Project Engineer.

The Contractor at his cost shall provide to the satisfaction of the Project Engineer all timbering, approved supports and shores and bracings to the sides of the excavated trench and foundations in such a manner to secure the sides of the trench and excavations from falling or adverse movement. All responsibility connected with such shoring shall rest with the Contractor. Adequate clearance / working space on both sides of the structure/pipe line shall be provided for which no payment shall be made.

Without the written permission of the Project Engineer no more than 50.0m the trench shall be opened in advance of the completed pipe line. The bottom of all excavations shall be carefully leveled. Any pockets of soft or loose material in the bottom of the pits and trenches shall be removed and the cavities so formed filled with lean concrete at the Contractor's expense.

The Project Engineer may require the Contractor to excavate below the elevations shown on the drawings or he may order him to step above the elevations shown depending upon the suitable foundation material encountered.
If for any reasons, the levels grades or profiles of the excavations are changed adversely, the Contractor shall at his own cost be liable to bring the excavations to the required levels and profiles as shown on the drawings or as directed by the Project Engineer.

1.1.5 EXCAVATION TOLERANCES

Excavation shall be performed within the tolerances for excavation limits indicated on the drawings. Where no tolerance limits are indicated excavation shall be performed to tolerances established by the Project Engineer as accepted for the design and type of work involved.

1.1.6 MEASUREMENT

Except otherwise specified herein or elsewhere in the Contract documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the bill of quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the bill of quantities.

Quantities of excavation shall be calculated / measured from the pre-work levels of natural ground taken jointly by the Contractor and the Project Engineer before Commencement of the work. The quantities set out for excavation and its subsequent disposal shall be deemed to be the bulk before excavating and no allowance shall be made for any subsequent variations in bulk or for any extra excavation unless otherwise shown on the drawings quantities of excavation shall be measured on the basis of vertical excavations required for the nominal concrete dimensions of the structural members of foundations. Lean concrete shall not be construed as structural concrete.

Quantities of excavation for service line trenches shall be measured for payment on the basis of vertical excavation faces for the specified width as shown on the drawings. Measurement for acceptably completed excavation works shall be made on the basis of number of cubic meter of material excavated for foundation and service trenches as shown on the drawings or as directed by the Consultant's Project Engineer.

1.1.7 PAYMENT

Payment will be made for acceptable measured quantity of excavation on the basis of unit rate per cum, quoted in the bill of quantities and shall constitute full compensation for all the works related to the item.

1.2 BACK FILLING

- After completion of foundation footing, foundation, walls, and other construction below the elevation of the final grades and prior to backfilling, forms shall be removed and the excavation shall be cleaned of trash and debris.
- The backfilling shall include filling around the foundations, trenches.

- Filling shall be approved selected material from excavation or other predominantly granular material and free from slurry, mud, organic or other unsuitable matter and capable for compaction by ordinary means.
- The excavated material if found suitable shall be stock piled within the free haulage limit of the site of the works. This material shall be used for backfilling if approved by the project engineer and shall be transported by the contractor any where required for the purpose of backfilling work in this contract.
- The contractor shall provide the approved quality fill and backfilling material as required to complete the fill/backfilling work. Filling in trenches and foundation shall be placed in 200 mm layers and compacted at optimum moisture content by mechanical means or other means as approved by the project engineer.
- Fill in around trenches and pits shall be carefully placed with fine material to cover the completely before the normal infilling is done.
- Material for back filling shall be as approved by the project engineer and shall be placed in layers of 150 mm measured as compacted material and saturated with sufficient water and compacted to produce in-situ density not less than 95% of the maximum density at optimum moisture content, achieved in test no.15 of is 1377:1975 or similar clause of relevant is code.
- All filled areas shall be left neat, smooth and well compacted with the top surface consisting of the normal site surface soil unless otherwise directed.
- Depending on the depth of fill the project engineer may instruct increased thickness of successive layer to be placed.
- Fill shall not be placed against foundation walls prior to approval by the project engineer. Fill shall be brought up evenly on each side of the walls as far as practicable. Heavy equipment for spreading and compacting the fill shall not be operated closer to the wall than a distance equal to the height of the fill above the top of footing.
- Depending on the depth of fill the project engineer may instruct increased thickness of successive layer to be placed.
- Fill shall not be placed against foundation walls prior to approval by the project engineer. Fill shall be brought up evenly on each side of the walls as far as practicable. Heavy equipment for spreading and compacting the fill shall not be operated closer to the wall than a distance equal to the height of the fill above the top of footing.
- In case the contractor is instructed to arrange for the fill material the quality of the fill material will be subject to the approval of the project engineer. The project engineer shall require the contractor to carry out various tests of the fill material. All such tests shall be made at an approved laboratory at the cost of the contractor. Once a material from a specific source has been approved, the material for the same quality and from that source only shall be used. Any fill material from borrow pits which has not been approved or the quality of which differs from the approved material shall be rejected out rightly. The project engineer reserves the right to order removal of any such materials brought to the site of works at his discretion at contractor's expense. In order to ensure satisfactory compaction, it will be necessary to carry out, depending upon the type of material, particle size distribution tests, determination of organic content

tests, maximum and minimum density tests and determination of optimum moisture content for the filling material.

- The method of compaction, namely type of compactor, type of roller, weight of roller and number of passes proposed by the contractor for any particular fill material shall be subject to the approval of the project engineer after completion of satisfactory field tests, subsequent to the laboratory analyses, using the materials and equipment proposed to be used for the earth work in conditions similar to those likely to be encountered during construction.
- the final selection of the soil moisture content, the thickness of layers, the type of compaction equipment and the number of passes shall be decided after these tests, which shall be conducted at contractor's expense.
- Having established the method of compaction to be used, no departure from this approved method shall be permitted without the prior approval of the project engineer. Adequate control of the fill and compacting operations shall be ensured by in-situ density tests and in order to obtain significant results, not less than two measurements shall be carried out per one hundred square meters of area compacted. The frequency of tests shall be determined on site and may be varied at the discretion of the project engineer. Compaction shall not be less than 95% in-situ density with respect to the maximum density, at optimum moisture content.
- The exact thickness of layers and the method of placing and compacting the fill shall be determined by the field tests, as stated above, but not withstanding the results of these trails, fill shall not be placed in layers exceeding 200mm in thickness. In order to maintain control of the thickness of layers, timber profiles shall be used wherever feasible. The travelers of such profiles for each layer of fill shall be checked by the supervisory staff of the project engineer. The contractor shall provide adequate supply of water and sufficient capacity of mechanical water carriers to ensure uniform and uninterrupted operation of compaction. The project engineer may forbid the contractor to proceed with placing and/or compaction of fill and/or order removal and re-compaction of such fill when he finds that the contractor has insufficient or defective equipment or that the fill has been improperly laid and/or compacted.
- If it is found necessary to alter the moisture content of the fill material in any way, then very strict control shall be exercised over the wetting and/or the drying process and frequent moisture content tests.
- The fill material should be well graded non-cohesive and nearly silt-free (silt content between 5 to 10 percent) salt free and free of organic materials (less than 2%). It should also be free of stones larger than 100 mm. Maximum dimension. It should be of such nature and characteristics that it can be compacted to the specified densities in reasonable length of time. It shall be free of plastic clays, of all materials subject to decay, decomposition or dissolution and or cinder or other material which corrode piping and other metals.
- TOLERANCES
  The stabilization of compacted backfill/fill surfaces shall be smooth and even and shall not vary more than 100mm in 3 meters from true profile and shall not be more than 12.5mm from true elevation.

- DISPOSAL OF SURPLUS MATERIAL

The rejected unsuitable material and surplus excavated material shall be disposed of within 200 m free haulage limit measured from boundary of the works to places or as directed by the Project Engineer.

The disposal of surplus excavated material shall include loading, unloading, transporting, stacking, spreading as directed by the Project Engineer.

- MEASUREMENT

Measurement for acceptable completed backfill/ fill works shall be made on the basis of number of cubic meter of compacted backfill/ fill in position, or as shown on the drawings or as directed by the Project Engineer.

- PAYMENT

Payment will be made for acceptable measured quantity of backfill/ fill on the basis of unit rate per cu.meter quoted in the bill of quantities and shall constitute full compensation for all the works related to the item.

1.3 PLAIN AND REINFORCED CEMENT CONCRETE

The work covered by this section of the Specifications consists of furnishing all plant, labor, equipment, appliances and materials, and in performing all operations in connection with the supply and installation of plain and reinforced concrete work, complete in strict accordance with this section of the Specifications and relevant documents, subject to the Conditions of the Contract.

1.3.1 GENERAL

Full co-operation shall be given to other trades to install embedded items and/or any associated services.

Embedded items shall have been inspected, and tests for concrete and other material or for mechanical operations shall have been completed and approved, before concrete is placed.

Formwork shop drawings shall be designed and prepared by the Contractor at his own cost. Approval of shop drawings as well as those of mock-ups /actual samples of finished concrete shall be obtained before Work is commenced.

Contractor shall prepare bar bending schedules, and get the same approved by the Project Engineer, prior to commencement of work.

1.3.2 RELATED SPECIFICATIONS

The codes and standards generally applicable to the work of this section are listed herein after.

IS 269	:	Ordinary and low heat Portland Cement
IS 8041	:	Rapid Hardening Portland Cement
IS 455	:	Portland slag cement
IS 1489	:	Portland Pozzolana Cement
IS 8112	:	High Strength Ordinary Portland Cement
IS 383	:	Coarse and fine aggregates from natural sources for concrete

IS 456	:	Code of practice for plain and reinforced concrete
IS 516	:	Method of sampling and analysis of concrete
IS 1199	:	Method of sampling and analysis of concrete
IS 1139	:	Hot rolled deformed bars
IS 23896	:	Methods of testing of aggregates for concrete (Part I to III)
IS 2751	:	Recommended Practice for welding for reinforcement bars
IS 9103	:	Admixtures for concrete
IS 10262	:	Recommended guide lines for concrete mixed design

1.3.3 MATERIALS

1.3.3.1 CEMENT

a. Cement shall conform to standards listed in section 2 of IS:456, latest edition.
b. Only one brand of each type of cement shall be used for concrete in any individual member of the structure. Cement shall be used in the sequence of receipt of shipment, unless otherwise directed.
c. There shall be sufficient cement at site to ensure that each section of Work is completed without interruption.
d. Cement reclaimed from cleaning of bags or from leaky containers shall not be used.
e. Contractor shall provide and erect, at his own cost, in a suitable place, dry, well ventilated, and water proof shed of sufficient capacity to store the cement.
f. The cement shall be used as soon as possible after delivery, and cement which the Project Engineer considers has become stale or unsuitable through absorption of moisture from the atmosphere or otherwise shall be rejected and removed immediately from the site at Contractor's expense.
g. The mixing together of different types of cement shall not be permitted.

1.3.3.2 AGGREGATES

a. The sources of supply of all fine and coarse aggregates shall be subject to the approval of Project Engineer.
b. All fine and coarse aggregates shall be clean and free from clay, loam, silt, and other deleterious matter. If required, Project Engineer reserves the right to have them washed by the Contractor at no additional expenses. Coarse and fine aggregates shall be delivered and stored separately at Site. Aggregates shall not be stored on muddy ground or where they are likely to become dirty or contaminated.
c. Fine aggregate shall be hard coarse sand, crushed stone or gravel screenings and shall conform to requirements of IS: 383 latest edition.
d. Coarse aggregate shall be gravel or broken stone or hard, durable material free from laminated structure and conforming to IS: 383 latest edition. The aggregates shall be graded as follows for use in mass concrete as in foundations:

TOTAL PASSING	PERCENT BY WEIGHT
2" B.S. Sieve (50.00 mm)	100
1-1/2" Sieve (38.10 mm)	95-100
3/4" Sieve (19.00 mm)	35- 70
3/8" Sieve (9.50 mm)	10- 30
No. 4 Sieve (4.75 mm)	0- 5

Coarse aggregate for all cast-in-place concrete other than mass concrete as for foundations shall be graded with the following limits:-

TOTAL PASSING	PERCENT BY WEIGHT
1" Sieve (25.00 mm)	100
3/4" Sieve (19.00 mm)	90-100
3/8" Sieve (9.50 mm)	20- 55
No. 4 Sieve (4.75 mm)	0- 10

1.3.3.3 Water:

Only clean potable water from the city supply, tube well installed at the Site or from other sources approved by Project Engineer shall be used. Contractor shall supply sufficient water for all purposes, including mixing the concrete, curing and cleaning plant and tools. Where doubts exist as to the suitability of the water, it shall be tested in accordance with IS: 3025. Where water can be shown to contain any sugar or an excess of acid, alkali or salt, Project Engineer may refuse to permit use. As a guide, the following concentrations represent the maximum permissible values:

a. To neutralize 200 ml sample it should not require more than 2 ml of 0.1 normal NaOH.

b. To neutralize 200 ml sample it should not require more than 10 ml of 0.1 normal HCL.

c. Percentage of solids should not exceed the following:

	PERCENT
Organic	0.02
Inorganic	0.30
Sulphates	0.05
Alkali Chlorides	0.10

In case of doubt, Project Engineer may require that concrete mixed with water proposed to be used should not have a compressive strength lower than 90 percent of the strength of concrete mixed with distilled water.

1.3.3.4 Reinforcement

a. Reinforcement for concrete shall conform to the respective IS or other standards as specified in the drawings and Contract Documents or as may be specified by Project Engineer.

b. Unless otherwise specified, all plain reinforcing bars shall comply with the requirements of IS: 432, and shall have a minimum yield stress of 248 N/sq mm.

c. Unless otherwise specified, all deformed reinforcing bars shall comply with the requirements of IS: 1786 for deformed cold worked steel bars and shall have minimum characteristic stress of 415 N/sq mm.

d. Reinforcement shall be obtained only from manufacturer's approved by Project Engineer. If and when required Contractor shall provide all necessary facilities to Project Engineer for the selection of test pieces and shall cause these to be prepared and submitted where directed for tests at Contractor's cost.

e. If the reinforcement is to be supplied by Employer, Contractor shall inform Project Engineer of his requirements much before its use in construction.

f. Reinforcement of all types is to be stored at Site in an approved manner so as to avoid damage.

g. Contractor shall report immediately on receipt of any consignment, having any deviation in the standard weights of the reinforcing bars beyond those allowed in respective standards mentioned in clause (3.3.3.4.b) and (3.3.4.4.c) herein before.

1.4 CONCRETE MIX PROPORTIONS

1.4.1 General:

The proportions of ingredients shall be such as to produce a mixture which will work readily into the corners and angles of the forms and around reinforcement by the methods of placing and consolidation employed on the Work, but without permitting the materials to segregate or excessive free water to collect on the surface. Specific approval of the Project Engineer is required to waive limitations on mixture proportions.

The proportions of ingredients shall be selected in accordance with Section 5.7 to produce the proper placebility, durability, strength and other required properties.

1.4.2 Strength

The Specified compressive strength of the concrete cube, shall be 15 N/sq mm. or 20 N/sq mm.. Samples from fresh concrete shall be taken as per IS: 1199 and cubes shall be made, cured and tested at 28 days in accordance with IS: 516.

1.4.3 Durability

Requirements of Clause 7 of IS: 456-1978 shall be followed.

1.4.4 Slump

Unless otherwise permitted or specified, the concrete shall be proportioned and produced to have a slump of 100 mm or less. A tolerance of up to 25 mm above the indicated maximum shall be allowed for individual batches provided the average for all batches or the most recent 10 batches tested, whichever is fewer, does not exceed the maximum limit.

Concrete of lower than usual slump may be used provided it is properly placed and consolidated.

Note: If S.R. Cement is used, permissible water-cement ratio may be increased by 0.05. Slump shall be determined by the "Test for slump for Portland Cement Concrete" as per relevant IS code.

1.4.5 Maximum Size of Coarse Aggregate:

The nominal maximum size of the aggregate shall be 20.mm for all portions of the structure except footings which may be 38 mm. These limitations may be waived if, in the judgment of the Project Engineer, workability and methods of consolidation are such that the concrete can be placed without honeycomb or voids.

1.4.6 Admixtures:

If required or permitted, admixtures used shall be in accordance with the manufacturer's instructions except as otherwise specified herein.

1.4.7 Methods of Obtaining Mix Design:

For concrete of normal weight, mix proportions to provide the desired characteristics shall be developed using the methods/procedure covered by the Recommended Practice for Selecting Proportions for Normal Weight Concrete ACI-211.1-77/ IS:456-1978.

Trial mixtures having proportions and consistencies suitable for the Work shall be made based on above codes, using at least three different water-cement ratios which will produce a range of strengths encompassing those required for the Work. Trial mixes shall be designed to produce the specified slump. The temperature of concrete used in trial batches shall be reported.

For each water-cement ratio, compression test of cube shall be made, cured, and tested in accordance with IS:1199 and IS:516. From the results of these tests a curve shall be plotted showing the relationship between the water-cement ratio and compressive strength. From this curve, the water-cement ratio to be used in the concrete shall be selected to produce the required design strength. The cement content and mixture proportions to be used shall be such that this water- cement ratio is not exceeded when slump is the maximum permitted. Control in the field shall be based upon maintenance of proper cement content and slump.

1.5 Ready mix concrete

1.5.1 GRADES AND STRENGTH REQUIREMENTS OF CONCRETE

General

Ready mix Concrete shall consist of the material described under site batched concrete sections, using separate coarse and fine aggregate in an appropriate combination determined in the course of the of mix design . The overall grading shall be such as to produce a concrete of the specified quality which will work readily in to position without segregation. The ready mix concrete shall conform to IS: 4926 and shall be delivered in agitating trucks. The RMC may contain flyash as per the acceptable norms.

Slump

The water shall be added to the cement and aggregate during mixing to produce concrete having a sufficient workability to enable it to be well consolidated, to be worked in to the corners of the shuttering and around the reinforcement to give the specified

surface finish, and to have the specified strength. Water cement ratio shall be maintained as per IS456-1978 when a suitable amount of water has been determined, the resulting consistency shall be maintained throughout the corresponding parts of the work and tests shall be conducted to ensure the maintenance of this consistency. The max slump at the point of the discharge should not exceed 110mm max.

Concrete Grades

Grade of concrete used in the works shall be shown on the drawings or as directed by the Architect/Project Manager. The minimum cement used for M-20 shall be 300 Kg. Per Cum, 350 Kgs for M-25 and 400Kgs for M-30.

1.5.2 TRANSPORTING CONCRETE

Concrete shall be transported in agitating trucks without contamination, loss of ingredients or segregation. In no case shall a period of more than 4 hours have elapse between the wetting of mix and discharge of the concrete at site.

1.5.3 CONCRETE PLACEMENT

- Concrete, when deposited, shall have a temperature of not less than 5oC (41oF) and not more than 32oC(90oF).
- The concrete shall be placed in the positions and sequences indicated on the drawings, in this specification and/or as directed by the Architect/Project Manager.
- Contractor shall give adequate notice to the Architect/Project Manager of his intention to concrete any section of the works.
- Except where otherwise directed, concrete shall not be placed unless the representative of the Architect/Project Manager is present and has previously examined and approved the positioning, fixing and condition of the reinforcement or any other items to be embedded and the cleanliness, positioning and suitability of the concreting surface.
- The concrete shall be deposited as nearly as possible in its final position. It shall be placed in such a manner as to avoid segregation of the concrete and displacement of the reinforcement, other embedded items, or formwork. It shall be brought up in horizontal layers not exceeding 450 mm in compacted thickness unless otherwise authorized or directed by Architect/Project Manager. Concrete shall not be placed simultaneously on each side of large horizontal specified or approved construction joints.
- Shutters for walls or thin sections of considerable height shall be provided with openings or other devices that will facilitate the cleaning of the accumulation of hardened concrete on the shutters or on the metal reinforcement above the level of theconcrete and the removal of concrete in the case of segregations.

1.5.4 Quality Control

- In order to ensure that the quality of materials and the mix proportions are suitable for the particular grade of concrete required are so maintained, sampling and testing shall be carried out regularly during the course or the works.
- Workability testing shall be carried out in accordance with IS:456. The results shall lie within the range upon which the accepted mix design is based. Testing

shall be carried out at such a frequency that the required workability is consistently achieved.

- Samples of concrete shall be taken at random in accordance with IS: 516 at the time and place of deposition of the concrete at a frequency of sampling for each grade of concrete and from each concrete mixing plant at six cubes of 150 mm nominal size per 50 cubic meters of concrete placed in the works or twice per week.
- Notwithstanding the foregoing, additional samples shall be taken by the contractor when directed by the Architect/Project Manager. The test cube procedure shall be in accordance with IS: 516 throughout.
- Compliance with the specified characteristic strength shall be assumed if:
    a. Each of the six cubes in a group has a test strength not less than the characteristic strength or,
    b. Not more than one cube has a test strength less than the specified characteristic strength but not less than 85% of the specified characteristic strength and the average strength of the group of four test results is not less than the specified characteristic strength plus the standard deviation of the group.

1.5.5 Seven day cube tests

Acceptance of concrete is based on the 28th day results. However, the contractor shall establish a relationship between 7 days and 28 days strengths by carrying out 7 days tests at the time of performing the laboratory testing and from subsequent quality control testing. This relationship shall be used in interpreting any further test results to predict the probable value of the corresponding 28 days cube strengths. The contractor shall without delay advise the Architect/Project Manager of any sample that appears likely to fail to meet the specification and the contractor shall take any necessary action to minimize the effect of such failure.

1.5.6 Acceptance Criteria

The general Acceptance Criteria of any and all of the concrete work shall be as per the relevant Clauses of IS. 456. If any of the works tests are not up to the standard, the Architect/Project Manager shall have the power to stop the work until the reason is investigated and steps taken to prevent further low results. The contractor shall not be entitled to any claims on account of such delays. Any concrete carried out from the batch that is afterwards found to be faulty, will be liable for rejection and if so directed, the contractor shall at his own expenses dismantle and replace the defective work and any work built thereon or shall take such other measures as may be deemed necessary by the Architect/Project Manager. At the discretion of the Architect/Project Manager, the contractor may be allowed to prove by means of a load test to be carried out at his own expense, that the concrete is capable of safely withstanding the loads as specified in the test.

1.5.7 Quality of Water

- Water used for both mixing and curing shall conform to IS: 456. Potable water is generally satisfactory. Water containing any excess of acid, alkali, sugar or salt shall not be used.
- The pH value of water shall not be less than 6.
- Seawater shall not be used for concrete mixing and curing.
- The proposed admixtures shall comply with requirements of specification part 11-Water sealing materials.

1.6 STEEL REINFORCEMENT

1.6.1 SCOPE OF WORK

The work to be done under this section consists of furnishing, cutting, fabricating, bending, placing and tying steel reinforcement in concrete structures or elsewhere as shown on the drawings or directed by the Project Engineer. The scope of this section of this section of specifications as laid down herein.

1.6.2 MATERIAL AND SIZE OF BARS

Reinforcement for concrete shall conform to the respective Indian or other standards as specified in the drawings and in the contract documents or as may be specified by the Project Engineer.

Unless otherwise specified, all plain mild steel reinforcing bars shall comply with the requirements of IS: 432 (Part- I) and shall have a minimum yield stress of 250 N/mm.sq.

Unless otherwise specified, all deformed reinforcing bars shall comply with the reinforcements of IS: 1786 for deformed cold twisted steel bars and shall have a minimum characteristic strength of 415 N/mm.

Reinforcement shall be obtained only from manufacturers approved by the Consultant/Project Engineer. Each consignment of reinforcement steel shall be accompanied by a manufacturer's certificate or shall refer to a previous certificate, if the consignment is from the same batch, showing that the reinforcement steel complies with the following requirement

If such certificate is not made available or if the Consultant / Project Engineer considers that the manufacturer's tests are inadequate, samples shall be taken for acceptance test from different consignments as the Project Engineer may direct and shall be tested at the Contractor's cost should the result of such that any sample does not meet with the specifications, the whole consignment shall be rejected and removed from the site at the Contractor's cost.

Reinforcement of all types is to be stored on site in approved manner so as to avoid damage.

Reinforcement shall be free from all loose or flaky rust and mill scale or coating, including ice, and other substance that would reduce or destroy the bond. Reduced section steel reinforcement shall not be used.

If such certificate is not made available or if the Consultant / Project Engineer considers that the manufacturer's tests are inadequate, samples shall be taken for acceptance test from different consignments as the Project Engineer may direct and shall be tested at

the Contractor's cost should the result of such that any sample does not meet with the specifications, the whole consignment shall be rejected and removed from the site at the Contractor's cost.

If such certificate is not made available or if the Consultant / Project Engineer considers that the manufacturer's tests are inadequate, samples shall be taken for acceptance test from different consignments as the Project Engineer may direct and shall be tested at the Contractor's cost should the result of such that any sample does not meet with the specifications, the whole consignment shall be rejected and removed from the site at the Contractor's cost.

Reinforcement of all types is to be stored on site in approved manner so as to avoid damage.

Reinforcement shall be free from all loose or flaky rust and mill scale or coating, including ice, and other substance that would reduce or destroy the bond. Reduced section steel reinforcement shall not be used.

Steel wire mesh reinforcement shall conform to requirement of relevant Indian codes or those of ASTM: A 185-64 or BS. 4483, 1969: Standard Specifications for welded steel wire fabric for concrete reinforcement. It shall be used where shown on the drawings.

1.6.3 Applicable standards

Latest editions of Indian Standards as per 4.3 or other International Standards

1.6.4 DELIVERY & STORAGE

Delivery

Steel reinforcement bars shall be delivered in bundles firmly secured and tagged. Each bars or bundle of bars shall be identified by marks stamped on hot or cold or painted on or by any other means. The identifying marks shall contain the following information:

a. Name of the producer or his trade.
b. Standard to which the bars have been manufactured.
c. The clause, type and strength respectively.
d. The diameter.
e. The number of the test certificate (if available).

Storage

The method of storage shall be approved by the Project Engineer. Reinforcing bars shall be stored in racks or platforms above the surface of ground and shall be protected free from scaling, rusting, oiling, coatings, damage, contamination and structural defects prior to placement in works. Bars of different diameters and grades of steel reinforcement shall be kept separate.

1.6.5 BAR BENDING SCHEDULES

The Contractor shall prepare bar bending schedule of all the reinforcing steel bars and these bar bending schedules will be supplied to the Consultants/Project Engineer in duplicate on the basis of which the work shall be carried out. However, the Contractor shall be responsible to satisfy himself as to the correctness and accuracy of the bar bending schedule. Any discrepancy shall immediately be notified to the Consultant / Project Engineer before commencing work.

1.6.6 MEASUREMENT & PAYMENT

Except otherwise specified herein or elsewhere in the Contract documents, no measurement and payment will be made for the under mentioned specified works related to the relevant items of the Bill of Quantities. The cost thereof shall be deemed to have been included in the quoted unit rate of the respective items of the Bill of Quantities. Providing and installing chairs, supports, hooks, spacers, binding wires, and laps not shown on drawings including wastage and rolling margin.

Measurement

Measurement for acceptably completed works of reinforcement shall be made by weight according to bar bending schedules approved by the Consultant / Project Engineer.

Payment

Payment will be made for acceptable measured quantity of reinforcement on the basis of unit rate per ton or kg quoted in the bill of quantities and shall constitute full compensation for all the works related to the item.

1.7 BRICK MASONRY

1.7.1 GENERAL

Brick Masonry shall consist of all work required in connection with constructing brick masonry at locations shown on drawings including, but not limited to, furnishing brick, Portland cement and sand for mortar and all other materials, and mixing, placing brick masonry as per bill of quantities.

1.7.2 MATERIALS

All Portland cement for mortar shall be furnished by the Contractor and shall conform to the applicable requirements specified in the section "Plain and Reinforced Concrete". All sand for mortar shall be furnished by the Contractor and shall conform to the applicable requirements for sand specified in the section "Plain and Reinforced Concrete".

All water used in the manufacture of bricks and in the preparation of mortar shall be free from objectionable quantities of silt, organic matter, alkali, salts and other impurities, and will be tested and approved by the Project Engineer as per the guidelines of IS: 456.

1.7.3 MORTAR

a. MIX: Mortar for all brick masonry, expect where otherwise directed by the Project Engineer, shall consist of one part cement to six parts of damp loose mortar sand by volume for brickwork 230mm and above. For brick piers, half brick walls, honeycombed brickwork and hollow (cavity) walls, the mortar mix shall consist of one part cement and four parts of sand. Quantity of water shall be just sufficient enough to produce proper consistency for the intended use. Where directed and approved by the Project Engineer, hydrated lime putty, shall be added to the mortar for increased workability. The putty shall, however, not exceed 25% by volume of the dry cement.

b. Methods and equipment used for mixing mortar be such as will accurately determine and control the amount of each separate ingredient entering into the mortar and shall

be subject to the approval of the Project Engineer. Mortar shall be mixed only in sufficient quantities for immediate use and all mortar not used within 30 minutes after addition of the water to the mix shall be wasted. Re-tempering of mortar will not be allowed. The mixers shall be thoroughly cleaned and washed at the end of each day's work.

1.7.4 BRICK

a. All bricks shall be of first class quality made from good brick earth, free from saline deposits and shall be sand moulded. They shall be thoroughly burnt without being vitrified, shall be regular, uniform in shape and size with sharp and square edges parallel faces and of deep red or copper colour. First class bricks shall be homogeneous in texture and emit a clear ringing sound when struck, and shall be free from flaws, cracks, chips, stones and nodules of lime. First class brick in an oven dried condition shall not absorb more than 1/5 of its weight of water when immersed for one hour in water at 21 to 27 degrees centigrade and shall show no signs of efflorescence on subsequent drying. The average compressive strength of five representative first class bricks shall be 15N/mm. sq. and shall no result shall fall below 10 N/mm sq. The bricks in general shall conform to the requirements of IS: 1077.

b. All bricks shall be manufactured by the Trench Kiln method or other standard methods approved by the Project Engineer. The earth used in manufacturing bricks shall be carefully selected and shall be free from objectionable quantities of lime, gravel coarse sand, roots, or other organic matter salts shall not exceed 0.3% and calcium carbonate shall not exceed 2.0%.

c. The moulds used in the manufacture of bricks shall be thoroughly sanded before each use and shall be sufficiently larger than the size of the bricks being manufactured to allow for shrinkage in drying and burning. The size ready for use shall be 9" by 4 3/8" by 2 3/4" (229X 112X 70mm) and shall weigh between 3.2 to 4.2 Kilograms. All bricks shall have a "Frog" 1/4" deep on one face.

1.7.5 PLACING

a. The methods and equipment used for transporting the bricks and mortar shall be such as will not damage the brick nor delay the use of mixed mortar. Brick shall not be placed during rains sufficiently heavy or prolonged to wash the mortar from the brick. Mortar which becomes diluted by rain shall be removed and replaced before continuing with the work. All bricks to be used in brick masonry shall be moistened with water for three to four hours before they are used. The chosen method of wetting shall

ensure that all bricks are thoroughly and uniformly wetted. All bricks shall be free from water adhering to their surface when they are placed in the brick masonry.

b. Bricks shall be laid "Frog" upward with mortar joints and in English bond as directed by the Project Engineer. Both bed and vertical joints shall be 6mm in thickness completely filled with cement mortar as specified herein, and each brick shall be bedded by firmly tapping with the handle of the trowel. All horizontal joints shall be parallel and all vertical joints in alternate courses shall be directly over one another. Excess mortar at the outer edges shall be removed and joints drawn straight with the edge of a trowel and a straight edge. All anchors and similar work required to be embedded in the brick masonry shall be installed as the work progresses. At the completion of the work all holes or defective mortar joints shall be cut out and repointed.

c. The exterior faces of the walls shall be finished by striking the joints as the work proceeds. The joints shall be struck by raking the green mortar after the brick work has been laid and finishing the joint with a pointing tool. Horizontal joints shall be struck to form weathered joints and vertical joints shall be struck with a V notch. Care shall be taken that the striking tools do not develop a cutting edge as the object of striking the joint is to compress the mortar into the joints.

1.7.6 CURING AND REPAIR

a. All brick masonry shall be water cured and shall be kept wet for least seven days by an approved method which will keep all surfaces continuously wet. Water used for curing shall meet the requirements of these specifications for water used in the manufacture of bricks.

b. If, after the completion of any brick masonry work, the brick are not in alignment or level or does not conform to the lines and grades shown on the drawings, or shows a defective surface, it shall be removed and replaced by the Contractor at his expense unless the Project Engineer grants permission, in writing to patch or replace the defective area.

1.7.7 TOLERANCES

The brickwork shall be erected plumb and true to line at level with the maximum variation in any storey height of any length of wall being one meter. The maximum tolerance in the length, height or width of any single masonry unit shall be +/- 3mm.

1.7.8 MEASUREMENT AND PAYMENT

GENERAL

Except otherwise specified herein or elsewhere in the contract documents, the measurement and payment will be made for the under mentioned specified works related to the relevant items of the bill of quantities.

MEASUREMENT

Measurement of acceptable completed works of brick masonry will be made on the basis of cubic meters provided and installed in position as shown on the drawing or as directed by the Project Engineer.

PAYMENT

Payment will be made for acceptable measured quantity of brick masonry on the basis of unit rate per cum quoted in the bill of quantities and shall constitute full compensation for all the works related to the items.

1.8 FINISHING

1.8.1 General

- All plaster work shall be of the best workmanship and in strict accordance with the dimensions of the drawings. All plastering shall be finished to true levels including plumbs, without imperfections, and square with adjoining work. It shall form proper foundations for finishing materials such as paint etc. Masonry and concrete surface to which plaster is to be applied shall be clean, free from efflorescence, sufficiently rough and keyed to ensure proper bond.
- All chasing, installation of conduits, boxes, etc. shall be completed before any plastering is commenced on a surface. Chasing or cutting of plaster will not be permitted. Broken corners shall be cut back less than 150 mm on both sides and patched with plaster of Paris as directed. All corners shall be rounded to a radius. Contractor shall get samples of each type of plaster work approved by the Architect/Project Manager.
- All chasing, installation of conduits, boxes, etc. shall be completed before any plastering is commenced on a surface. Chasing or cutting of plaster will not be permitted. Broken corners shall be cut back less than 150 mm on both sides and patched with plaster of Paris as directed. All corners shall be rounded to a radius. Contractor shall get samples of each type of plaster work approved by the Architect/Project Manager.
- The materials used for plastering shall be proportioned by volume by means of gauge boxes. Alternatively it may be required to proportion the materials by weight.

1.8.2 PLASTER WORK

- The joints in the brick work, concrete blocks, shall be raked to a depth of 15 mm while the masonry is green. Concrete surfaces to receive plaster shall be suitably roughened. All walls shall be washed with water and kept damp for 10 hours before plastering.
- The plaster unless specified otherwise shall be average of 12 mm thick on walls. The finished texture shall be as approved by the Architect/Project Manager. The mix for plaster unless otherwise specified, shall be one part cement and four parts sand, to walls and one part cement, 3 parts sand to ceiling.
- The interior plaster shall be applied in one coat only. The surface shall be trowelled smooth to an approved surface. All plaster work shall be kept continuously wet for seven days

- The external plaster shall be of two coats on an overall thickness of minimum 20 mm. Preparations of walls to receive plaster work shall be the same as in internal plaster. Backing coat shall be 12 to 15 mm thick with cement mortar 1:5 and finishing coat shall be with cement mortar 1:3.
- Backing coats shall be combed on wet surface to form keys for finishing coat. All external plaster shall be waterproofed with approved water proofing powder added to cement in proportion of 1.5 Kg. to 50 Kg. of cement as per the manufacturers' instruction, for both the coats. Cost of waterproofing powder per Kg. shall be paid for separately.
- For sand faced cement plaster, the finishing coat shall be in cement mortar 1:3, sand used shall be of selected color, properly graded and washed so as to give a grained texture. Finishing plaster coat shall be 8 mm thick, uniformly applied and surface finished with special rubbing by sponge pads and other tools and recommended by the Architect/Project Manager.

2. TECHNICAL SPECIFICATIONS FOR STEEL WORK

2.1 FABRICATION OF STRUCTURAL STEEL

SCOPE OF WORK

This specification covers the general requirements for supply of all steel items where specified, fabrication, inspection, testing and delivery at site of all fabricated structural steel items. This specification also covers design of all connections and substituted members, preparation of all shop fabrication drawings, inspection of fabricated items.
The scope of work also includes, but is not limited to proper stacking and storage of fabricated materials, transport from place of storage to place of erection, wherever required. All the works shall be carried as per approved QA procedures.

2.2 APPLICABLE CODES STANDARDS AND SPECIFICATIONS

The pertinent clauses of the following Indian Codes, Standards and Specification (latest editions including all applicable official amendments, reaffirmations and revisions) shall apply to the material and workmanship covered by this specification. In the event of the conflict of certain requirements between this specification and the codes referred herein, this specification shall govern.

It is not the intent to specify herein all the codes and standards required for the satisfactory completion of work. The list of codes and standards indicates certain primary codes and standards and not all the codes required for the work under the contract. It is understood that all the pertinent codes and standards shall form the part of this specification whether explicitly indicated or not.

IS 800	General Construction in Steel –Code of Practice
IS 803	Code Of Practice For Design, Fabrication And Erection Of Vertical Mild Steel Cylindrical Welded Oil Storage Tanks.

IS 806	Code Of Practice For Use Of Steel Tubes In General Building Construction
IS 808	Dimensions for Hot Rolled Steel Beam, Column, Channel and Angle Sections
IS 813	Scheme of symbols for welding
IS 814	Covered Electrodes for Manual Metal Arc Welding of Carbon And Carbon Manganese Steel-Specification
IS 816	Code of Practice for use of Metal Arc Welding for General Construction in Mild Steel
IS 822	Code of Procedure for Inspection of Welds
IS 1024	Code of practice for use of welding in bridges and structures Subjected to dynamic loading
IS 1161	Steel Tubes for structural purposes-Specification
IS 1182	Recommended Practice for Radiographic examination of Fusion Welded Butt Joints in Steel Plates.
IS 1239	Steel Tubes, Tubular and Other Wrought Steel Fittings-
IS 1239	Mild steel tubes, tubular and other wrought steel fittings-Part
IS 1363	Hexagon Head Bolts, Screws and Nuts of Product Grade 'C'
IS 1367	Technical Supply Conditions for Threaded Fasteners (All Parts)
IS 1395	Low and medium alloy steel covered electrodes for manual metal Arc welding
IS 1852	Rolling and Cutting Tolerances for Hot Rolled Steel Products(4th Rev)
IS 2062	Hot Rolled low, medium and High tensile structural steel
IS 2595	Code of Practice for Radiographic Testing
IS 3502	Steel Chequered Plates-Specification.
IS 3600:	Method of testing fusion welded joints and weld metal in steel (All parts)
IS 3658	Code of Practice for Liquid Penetrate Flaw Detection
IS 3757	Specification for High Strength Structural Bolts
IS 4000	Code of Practice High strength bolts in Steel Structures
IS 4260	Recommended practice for ultrasonic testing of butt welds in Ferritic steel.
IS 4353	Submerged arc welding of mild steel and low alloy steels – Recommendations
IS 5334	Magnetic Particle Flaw Detection of Welds-Code of Practice
IS 6639	Specification for Hexagon Bolts for Steel structures
IS 7215	Tolerances for Fabrication of Steel Structures.
IS 9595	Metal Arc Welding of Carbon and Carbon Manganese Steels-Recommendations

IS 12778	Hot rolled parallel flanged section for beams, columns
SP:6(1)	Structural Steel Sections.
AWS D1.1	Structural Welding Code: Steel

REGULATORY REQUIREMENTS:

The work covered in this specification, shall comply with all relevant government and local laws, regulations and standards. For subjects not covered by regulations, codes, standards or specifications, the materials and construction shall be based on good engineering practice, subject to approval by OWNER.

2.3 STEEL MATERIALS

Steel materials shall comply with the specifications mentioned and/or as called for on the design drawings. All materials used shall be new, unused and free from defects.

2.4 STEEL SUPPLY – BY OWNER

- The CONTRACTOR shall use steel supplied by the OWNER judiciously and to the best advantage so as to minimize splicing and wastage. All steel materials remaining after completion of the work, whether in the form of balance pieces or unutilized prime steel, shall be returned to the OWNER's stores by the CONTRACTOR at his own cost. Reconciliation of steel supplied and wastage will be as specified in the Contract.
- Structural steel materials will be issued in sizes as received from manufacturer / suppliers within the project area at the departmental stores free of cost or at the rates specified in the Contract. The CONTRACTOR shall make necessary arrangements for carriage, loading, unloading of all materials to work site at his own cost within the rates quoted and agreed for the job.
- On receiving each consignment of steel from the OWNER the CONTRACTOR shall acknowledge in writing the receipt thereof giving full particulars of sections, sizes, quantities, grade and quality. Should there be any damage or distortion of the materials in transit, the CONTRACTOR shall immediately report the matter to the ENGINEER in writing.
- The CONTRACTOR shall take proper care of the steel supplied by the OWNER and protect them from weathering and damage. Any such materials rendered unserviceable or damaged while in the CONTRACTOR's custody shall be replaced by the CONTRACTOR at his own cost as determined by the ENGINEER.
- In cases where after receipt of visibly good tested quality steel from the OWNER, defects such as laminations, seams, tears, fins etc are discovered during fabrication, the work on such sections shall be stopped immediately and the matter shall be brought to the notice of OWNER who shall arrange for replacing the affected sections, if necessary.
- CONTRACTOR shall use the materials as issued by the OWNER to fabricate the structures as required. No extra claim on account of extra welding and / or cutting resulted due to non-conformity of sizes with the drawings issued will be entertained.

- Steel required for the work will be issued to the CONTRACTOR on the basis of approved fabrication drawings and drawings released for construction.
- Steel will be issued to the CONTRACTOR on the basis of standard sectional weights and measured lengths rounded off to nearest 5mm with Unit weights given in BIS 808. For sections and weights not covered in IS: 808, unit weights as given by the manufacturers shall be considered for calculation of weight. The same unit weight shall be used in the BOM included in fabrication drawings.

2.5 STEEL SUPPLY – BY CONTRACTOR.

- All steel and other material shall be procured and supplied by the CONTRACTOR, from the reputed manufacturers as mentioned in tender document. Steel proposed to be procured from other manufacturers shall have prior approval from the OWNER before placement of procurement order. However, OWNER reserves the right to accept or reject material from other manufacturers. Materials from re-rollers will not be accepted. Steel procured shall conform to the applicable codes & standards mentioned in clause 2.0.
- CONTRACTOR shall use materials for fabrication as specified in the approved drawings. All materials supplied by the CONTRACTOR shall be in sound condition, of recent manufacture, free from defects such as mill scales, slag intrusions, laminations, pitting, flaky, rust etc. and be of full weight and thickness as specified.
- CONTRACTOR shall furnish the mill / manufacturer's test reports, along with the materials and satisfactorily demonstrates the specific grade and quality. Material test certificate shall be original.
- All materials required for the work shall be correlated with manufactures test certificates. In the absence of test certificates, CONTRACTOR shall test materials through reputed laboratory approved by ENGINEER for establishing quality, at CONTRACTOR's cost and as directed by the ENGINEER.
- Material supplied against this Test Certificates (TC) should have identification stamped or stenciled on them. All such identification markings shall be authenticated by the inspection agency, which has inspected and approved the material.
- The CONTRACTOR shall furnish to the ENGINEER duplicate copies of all purchase order copies covering the material ordered by him for the project under reference and also test reports.
- The ENGINEER shall have the right to test random samples to prove authenticity of the test certificates produced by the CONTRACTOR at the CONTRACTOR's cost. Any material found not meeting the required specification would be rejected.
- Whenever the CONTRACTOR desires to substitute structural members / shapes, plates for the sizes shown on the drawings, for want of availability of requisite materials, such substitutions shall be made only after authorization in writing by the ENGINEER. ENGINEER may also direct that substitution be made, when he considers such substitution to be necessary.

2.6 DRAWINGS.

ENGINEER'S DRAWINGS (OWNER'S DRAWING)

Engineer will issue to CONTRACTOR such drawings and data as specified in Contract which may include, depending on Contract:

a) Preliminary Drawings and Data along with Tender / Enquiry.
b) Interface particulars with other Contracts and
c) Detailed engineering design drawings in OWNER's Scope.

Design drawings will be furnished to the CONTRACTOR and all drawings so furnished shall form a part of this specification. These design drawings prepared by the ENGINEER will show all the, levels, forces on members where necessary, size and orientation of each member, location/size of openings, to enable the CONTRACTOR to prepare drawings for fabrication and erection. It shall be clearly understood that ENGINEER's drawings are design drawings and are not intended to show connection details, thickness of gussets, cuts, notches, bends and other such details.

Drawings of structures and systems engineered by ENGINEER or Others will be made available to CONTRACTOR, progressively before commencement of respective parts of works correlating with actual progress of works ensuring that there is no delay for want of drawings. CONTRACTOR shall intimate in writing, his projected date of requirement of drawings. The Schedule of release of drawings shall be mutually agreed to, based on project schedules, unless such dates of drawing release are specified in Contract.

Engineer reserves the right to make changes, revisions to drawings, even after release for preparation of shop drawings, to reflect additional data/details received and updated requirements. Revisions to drawings and any new drawings made to include additional work by the OWNER shall be considered as part of this specification and contract without additional cost implication to the OWNER. The OWNER shall not entertain any extra claims on this account.

In case of variations in drawings and specifications, the decision of the ENGINEER shall be final. Should the CONTRACTOR find discrepancies in the information furnished by the Engineer, he shall refer these to the ENGINEER before proceeding with such work.

Unless otherwise specified, the drawings and specifications are intended to include everything obviously requisite and necessary for proper and entire completion of the work and shall be carried out accordingly for completeness as required.

2.7 CONTRACTOR'S DRAWINGS (FABRICATION DRAWINGS)

Fabrication drawings shall be prepared by the CONTRACTOR or through an agency approved by ENGINEER at his own cost based on the ENGINEER's Design drawing "Released for Construction" and their subsequent revisions. All the drawings for the entire work shall be prepared in metric units. The drawings shall preferably be of one standard size and the details shown there in shall be clear and legible. Drawings shall be prepared in computer tools and the details shall be drawn to the minimum scale as specified under.

a) Marking Plan : 1:75

b) Joint Details : 1:5; 1:10; 1:15
c) Elevations: 1:20

CONTRACTOR shall not commence detailing unless ENGINEER's design drawings are officially released for preparation of shop drawings. The CONTRACTOR shall be responsible for the correctness of all fabrication drawings. Fabrication drawings shall be revised by the CONTRACTOR to reflect all revisions in design drawings as and when such revisions are made by the ENGINEER.

Key plan prepared by the CONTRACTOR shall indicate the fabrication / erection marking of each members and a table showing the corresponding fabrication drawing number where these members are detailed. Also each drawing prepared by CONTRACTOR shall indicate corresponding ENGINEER's design drawing number with revisions.

Each member shall be detailed separately unless members are identical in all respects with no deviation whatsoever. Shop detail drawings shall show all shearing, punching, drilling, bevel cutting, bending, and all welding in complete detail. All connections and splices shall be designed and detailed by the CONTRACTOR and clearly shown on the drawings. Bill of material shall show number, size, length, weight and assembly work of each erection piece. Bill of material for each drawing shall include fasteners/bolts, nuts, washers and other accessories complete with specification, size, length, numbers, etc for each erection mark and proper identification for each joint. Bill of material shall be prepared erection mark wise, showing weight of each component part and total weight of each erection mark. All revisions after initial issue of a drawing shall be clearly indicated with issue number and date of revision.

Each drawing prepared by the CONTRACTOR shall clearly indicate Names of OWNER, ENGINEER, CONTRACTOR, Project Title, Title of drawing, Scale, Notes, Details of revisions carried out etc; All titles, noting, markings and writings on the drawing shall be in English and all dimensions shall be in metric units. Before the commencement of preparation of fabrication drawings, CONTRACTOR shall discuss with the ENGINEER any specific requirement to be followed for fabrication drawing preparation.

No detailed shop drawings will be accepted by the ENGINEER unless they are complete and checked and approved by CONTRACTOR's qualified Structural ENGINEER and accompanied by an erection plan showing the location of all pieces detailed.

CONTRACTOR should check for erection clearance and ensure that detailing of connections is carefully planned to obtain ease in erection of structures including field-welded connection and bolting. Field connections/splices may be welded or bolted type as specified in design drawings.

CONTRACTOR shall submit design calculations for each and every connection detail proposed by him and also for any substitution for members, desired by him and approved by the ENGINEER. Fabrication drawings not accompanied by calculation for connection details are liable for rejection.

Each lot of drawings sent by CONTRACTOR for approval shall contain a limited number of drawings and shall be in an order and manner which follows erection sequence or as required by ENGINEER based on priorities allocated. ENGINEER will return one copy of CONTRACTOR's drawing marked with ENGINEER's approval/comments. CONTRACTOR shall furnish the ENGINEER the required number of prints of all approved drawings for field use and record purpose.

In addition to standard engineering practice in detailing the following special requirements shall be strictly followed while detailing.

a) All butt welds shall be full penetration butt weld.

b) In the case of main columns fabricated out of plates, the weld connecting flanges and web to the base plate shall be double vee butt welds.

c) At column bases, wing plates shall be connected to the column flanges by full strength single Vee butt weld.

d) In the case of column, the thickness of the continuous fillet weld between flanges and web shall be a minimum of ½ the web thickness, unless a thicker size weld is specified in the design Drawings.

e) Shop splice location for flanges and web of columns shall be staggered by at least 500 mm such that only one full strength butt weld exist in one horizontal plane. Full strength butt weld for flanges shall be of single vee type and full strength butt weld for web shall be of double vee type.

f) Where the thickness of plates changes, in the case of flange plates, outside surface shall be kept flush. The thicker plate shall be chamfered to slope of 1 horizontal to 5 vertical so that at the location of weld thickness of plate will be same on either side of weld. In the case of webs at the location where the plate thickness changes, the plates will be kept symmetrical to the vertical axis: the thicker plates shall be given a chamfer on both sides such that at the location of butt welds, thickness of plate on either side will be equal.

g) Similarly where the width of the flange plate changes, the wider plate shall be tapered with a slope 1 horizontal to 5 vertical.

h) Site splicing may be by welding or by means of high tensile bolts. In the case of welded connection, efficiency of field butt weld shall be considered as 50% and cover plate shall be designed for 50% of the tensile strength of the plates spliced.

i) In the case of framing beams, the weld between flange and web shall be calculated based on standard formula considering the shear force as the full shear capacity of the web. Continuous weld shall be provided keeping size of weld uniform for the full length of girder.However, is no case the size of weld shall be less than half the web thickness.

j) Weld between flanges and web both for column as well as beams, shall be made using automatic welding machines, with proper sequence of welds to avoid warping.

k) Connection of bracings /tie beams to column shall follow the details given in the design drawings. Where such details are not given, the connection shall be designed for 50% of the tensile strength of the member unless design drawings indicate a higher load in the member. The maximum size of the weld shall be less than or equal to the thickness of the rolled section at the location of connection.

l) Weld between flanges and web both for column as well as beams, shall be made using automatic welding machines, with proper sequence of welds to avoid warping.

m) Thickness of gusset plates shall be at least equal to the thickness of member connected and shall have adequate cross section to transfer the force at the point. If the members are connected on either side of gusset, thickness of gusset shall be more than sum of thickness of fillet weld on either side of gusset.

ENGINEER may review / approve the fabrication drawing at his option some, all or none of the fabrication drawings. Wherever such review is carried out the same shall be restricted to the following.

a) Review/ approval of the size of members, dimensions and general arrangement but shall not constitute approval of the connections between members and other details.

b) Correctness of overall dimensions, centre to centre distance, elevations. Important / typical connection details (adequacy of number of bolts / weld length for few connections only will be checked), working points for bracing members and orientation and sizes / sections of members.
c) Sequence of erection in the light of project requirements.
d) Whether the fabrication drawings broadly conform to details shown on design drawings and comply with technical specifications, general notes, any specific notes made on design drawings and generally with the requirement of good engineering practice.

It shall be clearly noted by the CONTRACTOR that even where review is done by the ENGINEER, the following shall be the sole responsibility of the CONTRACTOR.

a) Provision for erection.
b) Marking of members.
c) Cutting Lengths of members
d) Matching of Joints and holes
e) Provision kept in the member for all other interconnected members
f) Bill of materials.
g) Gusset sizes.
h) Connections

Approval by ENGINEER of any of the fabrication drawings shall not relieve the CONTRACTOR from the responsibility for correctness of engineering, design of connections, workmanship, and fit of parts, details, material, errors or omissions of any and all work shown thereon. ENGINEER's approval shall not invalidate any claim for damages of any kind for incorrectly detailed / fabricated steel, notwithstanding any approval of such drawings by ENGINEER.

On completion of fabrication and erection, the CONTRACTOR shall update his fabrication drawings, incorporating all site changes and substitutions and shall submit two (2) sets of hard copies of such "as built " drawings to OWNER for record purpose. The CONTRACTOR shall also furnish two sets of soft copies of all final approved Contractors' drawings in the form of CDs.

Time consumed by the CONTRACTOR in securing approval of drawings should not be added to the time allowed for completion of contract. A period of two (2) weeks from the dates of receipt of drawings by the ENGINEER should be anticipated for this item of procedure in the schedule.

All these fabrication drawings submitted by the CONTRACTOR will remain the property of the OWNER. OWNER reserves the right to use them in any manner whatsoever.

2.8 FABRICATION

GENERAL

Fabrication shall not be started until CONTRACTOR has received copies of such drawings upon which ENGINEER has endorsed his approval. Any work done prior to approval of CONTRACTOR's fabrication drawings will be at the CONTRACTOR's risk. The CONTRACTOR shall make such changes in the design when so directed, which are considered necessary to make the structures conform to the provisions and intent of the specifications, without any additional cost to the OWNER.

All workmanship and finish shall be of the best quality and shall conform to good engineering practice and the best-approved method of fabrication. All materials shall be finished straight and shall be machined / ground smooth, true and square where so specified.

All holes and edges shall be free of burrs. Shearing and chipping shall be neatly and accurately done and all portions of work exposed to view shall be neatly finished. Standard fabrication clearances as detailed in the American Institute of Steel Construction Manual / BIS Codes shall generally be followed unless otherwise directed / approved.

Materials at the shop shall be kept clean and protected from weather. Cutting, punching, drilling, welding and fabrication tolerances shall be generally as per relevant Codes and Standards. In addition the CONTRACTOR shall strictly adhere to the following.

a) All care should be taken to avoid undue welding distortions.
b) Complete layout shall be prepared and got approved by the ENGINEER before actual fabrications are started. If needed mock-ups may also be prepared.
c) All fit ups shall be got approved from the ENGINEER.

CONNECTIONS

All shop connections shall be welded unless otherwise specified in ENGINEER's design drawing. Field connections can be either welded or bolted and as shown in design drawings. Bolts used for erection shall conform to IS-6639 and as specified in the design drawings. Bolts used for permanent connections shall be high strength tensile bolts and shall conform to grade 'C' as per IS:1363 and property class 8.8 (minimum) as per IS:1367 or as indicated in design drawings.

All connections shall be designed for forces indicated on the design drawings or as specified elsewhere in the specification/standard drawing if not given in the design drawings. The CONTRACTOR shall be responsible for selection of standard connections from AISC Manual of Steel Construction or any other standards approved by ENGINEER.

All connections shall be designed and detailed as per guidelines given in IS800 code.

In case of bolted connections, taper washers or flat washers or spring washers shall be used with bolts as necessary. In case of high strength friction grip bolts, hardened washers are used under the nuts or the bolt heads whichever are turned to tighten the bolts. The length of the bolt shall be such that at least one thread of the bolt projects beyond the nut, except in case of high strength friction grip bolts where this projection shall be at least three times the pitch of the thread.

In all cases where bearing is critical, the unthreaded portion of bolt shall bear on the members assembled. A washer of adequate thickness may be provided to exclude the threads from the bearing thickness, if a longer grip bolt has to be used for this purpose.

Not more than one shop splice shall be provided to make up the full length of a member. Shop splices to make the full member lengths shall be of full penetration butt welded type and radio graphically tested.

Transportation or the CONTRACTOR's erection methods may require additional splices not shown on the drawings. The CONTRACTOR shall be responsible for the design and detailing of such splices or joints, and shall submit these for the ENGINEER's approval.

All bolts, nuts, screws, washers, electrodes, etc. shall be supplied / brought to site 10% in excess of the requirement in each category and size. Rates shall cover the cost of this extra quantity and no additional payment will be made for this extra quantity supplied.

All members likely to collect rain water shall have drain holes provided.

STRAIGHTENING

Rolled material, before being worked, shall be straightened, unless otherwise specified. If straightening or flattening is necessary, it shall be done by methods that will not injure the material. Long plates shall be straightened by passing through a mandrel or levelling rolls and structural shapes by the use of mechanical or hydraulic bar/section straightening machines. Heating or forging shall not be resorted to without the prior approval of the ENGINEER in writing. In case of site fabrication, CONTRACTOR shall obtain ENGINEER's approval in writing on the straightening method proposed to be adopted before commencing the work.

Checking of the straightness of the structural members like angles, channels, beams etc. shall be done by using the thread. For checking of the straightness of the column sections piano wire shall be used. The sections, which are twisted beyond repairs, shall not be used for fabrication. Heating or hammering shall not be permitted. After removal of bends structural members shall be submitted for inspection and approval of ENGINEER.

CUTTING

Cutting may be done by shearing, cropping, sawing or machine flame cutting. All re-entrant corners shall be shaped notch free to a radius of at least 12-mm. Sheared or cropped edges shall be dressed to a neat workmanlike finish and shall be free from distortion and burrs.

Hand flame cutting shall be undertaken, only if so permitted by the ENGINEER and shall only be carried out by an expert in such work. Hand flame cut edges shall be ground smooth and straight.

Edges of flange cover plates and plates used to form any sections shall be ground smooth.

PUNCHING AND DRILLING

Holes in secondary members such as Purlins, grits, lacing bars etc. may be punched full size through material not over 12 mm thick. Holes should be clean cut, without burr or ragged edges. Holes for all other connections shall be drilled accurately and the burrs removed effectively. Where several parts are to be connected to very close tolerances such parts shall be first assembled, tightly clamped together and drilled through.

Sub-punching may be permitted before assembly, provided the holes are punched 3 mm smaller in diameter than the required size and reamed after assembly to the full diameter. The thickness of material punched shall not in such cases exceed 16 mm.

When match drilling is carried out in one operation through two or more separate parts, these parts shall be separated after drilling and the burrs removed.

Holes for turned and fitted bolts shall be drilled to a slightly smaller diameter and reamed to a diameter equal to the nominal diameter of the shank or barrel subject to tolerance specified in IS: 919.

Where reamed members are taken apart for transporting or handling, the respective pieces reamed together shall be so marked that they may be reassembled in the same position in the final setting up. No interchange of reamed parts will be permitted. Poor matching, over drilling and ovality in holes shall be a cause for rejection. Burning holes with gas is strictly prohibited.

Holes may be required to be drilled by the CONTRACTOR at no extra cost at site for installing equipment or steel furnished by other agencies. The information for this will be supplied to the CONTRACTOR by the ENGINEER before or after erection of the steel. Holes should be by drilling or other machining process and not by gas cutting sets.

ROLLING AND FORMING

Plates, Channels, Rolled Steel joists etc., for circular bins, bunkers, hoppers, gantry girders, etc., shall be accurately laid off and rolled or formed to required profile/ shape as called for on the drawings. Adjacent sections shall be match-marked to facilitate accurate assembly, welding and erection in the field.

GRINDING:

Column ends bearing on each other, resting on base plates, compression joints designed for bearing, base plates coming in contact with column end and cap plate shall be ground smooth to ensure 90% contact with local gap not exceeding 0.10 mm (filler gauge shall be used to check this gap). Bottom edge of knife edge support (bearing stiffener) for crane girder and top of cap plates where the knife edge supports rest shall also be accurately ground as adobe. All ground surfaces shall be protected from dirt and mechanical damages till the assembly is completed. However the underside of base plate bearing on grout need not be machined..

WELDING

Before the start of the work, welding procedure shall be submitted to ENGINEER for approval. Welding shall be entrusted to only qualified and experienced welders who shall be periodically tested and graded as per relevant standards.

Welding procedure specification (WPS) shall be established and Qualification of weld procedure (QWP) shall be done as per approved standards. Welders employed shall also be qualified as per above standards prior to taking up fabrication. CONTRACTOR shall obtain approval from ENGINEER before the start of the work.

Following pre-qualified welding process shall be employed for fabrication, erection and repair and the same shall have the approval of ENGINEER before adopting the welding process on the job.

a) Submerged Arc Welding (SAW).
b) Shield Metal Arc Welding (SMAW).
c) Gas Metal Arc Welding (GMAW).
d) Gas Tungsten Arc Welding (GTAW)

All welds shall be free from defects like blowholes, lack of penetration, undercutting, cracks etc. All welds shall be cleaned of slag or flux and show sections, smoothness of weld metal, featheredges without overlap and freedom from porosity.

50mm on either side of the surfaces on which weld metal is to be deposited shall be smooth, uniform, free from fins, tears,burrs,cracks and absolutely free from grease, paint, loose scale, moisture or any other substance which would adversely affect quality and strength of weld.

Machining, thermal cutting or grinding may be employed for joint preparation or removal of unacceptable work or metal. The weld edges shall be smooth & regular surface, free from cracks & notches. Flame cut material above 50mm thick shall be pre-heated as per relevant standards prior to flame cutting and shall be subjected to ENGINEER's approval.

All weld fit-up shall comply with tolerances specified in the relevant standards. The parts to be joined by fillet welds shall be brought into close contact as practicable and within the tolerable limits as per relevant codes & standards. All tack welds shall be made using qualified procedure and qualified welders. Any preheat requirement specified in the welding procedure shall also apply to tack welds. All tack welds shall be examined visually for defects and if found defective, shall be removed and re-welded. Throat thickness, leg length and length of tack weld shall be as per IS: 9595.

Welding of temporary attachment/fixtures to retain fit up is permitted in case the parts have a nominal thickness of at least 10 mm. Temporary attachments are welded at the minimum distance of at least 50 mm from the weld seam. Welding of temporary attachments/fixtures into the joint slot is not allowed. All temporary fixtures shall be removed after welding, by grinding them to weaken the welded portion and hammering thereafter followed by grinding the portion of any weld remaining on the base metal. A dye check at the discretion of the quality surveyor shall be done to detect any crack/defect at the point of fixture temporary weld.

It is not allowed to turn over and carry over heavy assemblies in tacking condition in order to control the geometric dimensions to the requirements of the drawings. The work shall be positioned for flat welding wherever practicable and overhead weld shall be avoided as far as possible.

In the joints of the parts with dissimilar thickness smooth transition of one part to the other must be provided by way of the gradual decreasing of the thickness of the thicker part with the slope of the surface not exceeding 15 degree.

Welding shall not be done when the surface of the members are wet or exposed to rain or high wind velocities unless the welding operator and the work are properly protected.

In joints connected only by fillet welds, the minimum size of fillet weld to be used shall be as per IS 9595-1996.

Welds shall be defect free and surfaces shall be thoroughly cleaned to remove all visible weld defects and extra material.

For all built up sections such as Columns, Crane Girders etc welding between web and flange plates shall be carried out by SAW process. Especially for butt welds of Crane girders full penetration of weld between top of web plate and top flange shall be ensured. Welding shall be continuous and shall be on both sides of the connecting member. One side fillet weld is not acceptable.

In general all welding shall be performed as per the recommendation specified in IS: 9595-1996.

Pre-heating and Post weld Heat treatment shall be carried out as per the acceptable standards and procedure and shall have prior approval from the ENGINEER. The pre-heat and inter pass temperature shall be checked just prior to initiating the arc for each pass. The weld joint details and procedure for Pre-heating and Post heating shall be submitted by the CONTRACTOR for approval from ENGINEER.

WELDING CONSUMABLES.

Electrodes, filler wires and flux used for welding shall be from approved manufacturers/Suppliers. CONTRACTOR shall submit the list of Electrode manufacturers proposed to be procured to the ENGINEER for approval. The CONTRACTOR shall furnish certification that electrode or electrode flux combination will meet the requirements of classification. The classification and size of electrode, arc length, voltage & amperage shall be suited to type and thickness of material, type of groove, welding positions and other circumstances attending work.

Only low hydrogen electrodes shall be used for welding. All electrodes having low hydrogen covering shall conform to relevant acceptable standards. These electrodes shall be purchased in hermetically sealed containers or baked by the user as recommended by electrode manufacturer. Electrode flux coating shall be sound and unbroken. Broken or damaged coating shall cause the electrodes to be discarded. Before welding, the electrodes shall de dried in a holding oven at 120OC at least for one (1) hour or as per manufacturer's recommendations. Only limited quantity shall be issued to the welders. The electrodes shall be kept in "carry ovens" and shall not be exposed to the atmosphere.

Welding plants and accessories shall have capacity adequate for welding procedure laid down and shall satisfy appropriate standards and be of approved make and quality. CONTRACTOR shall furnish and obtain approval from ENGINEER the details of equipment he proposes to deploy for the works. All the electrical plant in connection with the welding operation shall be properly and adequately earthed and adequate means of measuring the current shall be provided. Proper safety rules shall be strictly followed.

2.9 TESTING, INSPECTION AND REPORTS

GENERAL.

On award of work, the CONTRACTOR shall submit to ENGINEER, his Field Quality Plan (FQP), outlining the types, details and extent of inspection he proposes to execute, covered in the rates quoted for various items of work.

CONTRACTOR shall give due notice to ENGINEER in advance of the materials or workmanship getting ready for inspection. All rejected material shall be promptly removed from the shop and replaced with new material for ENGINEER's approval / inspection. The fact that certain material has been accepted at CONTRACTOR's shop shall not invalidate final rejection at site by ENGINEER if it fails to conform to the requirements of these specifications, be in proper Condition.

No material shall be painted or dispatched to site without the inspection and approval by ENGINEER unless such inspection is waived in writing by the ENGINEER.

Shop inspection by ENGINEER or submission of test certificates and acceptance thereof by ENGINEER shall not relieve CONTRACTOR from the responsibility of furnishing material conforming to the requirements of these specifications, nor shall it invalidate any claim which the ENGINEER may make because of defective or unsatisfactory material or workmanship.

CONTRACTOR shall provide all the testing and inspection services and facilities for shop work except where otherwise specified. CONTRACTOR's inspection work shall be under the control of competent Chief Inspector whose primary responsibility is inspection (reporting to Management) and not to production department.

For fabrication work carried out in the field, the same standard of supervision and quality control shall be maintained as in shop fabricated work. The inspection and testing shall be conducted in a manner satisfactory to ENGINEER. The inspection and testing on structural steel members shall be as set forth below:

MATERIAL TESTING.

All materials conforming to a particular Indian or any other standard as called for shall be tested as required by such standard. Proof in the form of certified test reports or mill certificates indicating that the required tests have been carried out as per specification at the source is acceptable.

If mill test reports are not available for any steel materials, the same shall be got tested by CONTRACTOR to ENGINEER's satisfaction to demonstrate conformity with the relevant specification at his own cost.

Raw material with cracks, seams, laps, lamination and heavy pitting are not acceptable. Ultrasonic testing of plates above 50 mm thick shall be carried out for the soundness of material.

Engineer has option to specify additional inspection or testing as he deems necessary and the additional cost of such testing shall be borne by the CONTRACTOR.

The CONTRACTOR shall maintain records of all inspection and tests, which shall be made freely available to the ENGINEER and shall be submitted to the ENGINEER on completion of each stage of work.

TESTS ON WELDS

All welds shall be tested for flaws by any of the methods described under. The choice of the method adopted shall be determined by the OWNER. Following methods are generally recommended for the quality control of welded joints:

Magnetic Particle Test(MPT): All fillet welds in general structural steel work shall have their final passes fully tested by MPT. However, for fillet welds of size 10mm and above and /or critical areas, the root and final passes shall be tested using MPT. The ENGINEER shall however decide the requirements of this additional testing. For Complete penetration butt welds, the root and final passes shall be tested using MPT. All MPT shall be as per relevant acceptable standards. Defects if found, shall be repaired and retested. MPT shall be carried out using alternating current only. Direct current may be used with the permission of the ENGINEER. The cost of demagnetizing after testing is deemed to be included in the quoted rates of the CONTRACTOR.

Dye Penetrant Test (DPT): MPT may be substituted by Dye Penetrant Inspection where the former is not feasible due to configuration. The testing should be in accordance with relevant acceptable standards.

Radio-graphic Inspection (RT): All completed full penetration butt welds to a length of about 10% shall be radio-graphed as per ENGINEER's directive in accordance with the relevant acceptable standards. In case of crane girders 100 percent of the splicing shall be inspected by RT. In the case of hoppers of coal bunkers at least 10% of the circumferential as well as seam welds shall be inspected by RT.

Ultrasonic Testing (UT): Wherever built up sections for crane runway girders are fabricated, the T-joints of the sections shall be subjected to ultrasonic testing. 100 percent length of the seam as well as circumferential welds of hoppers of coal bunkers shall be inspected by UT.

Acceptance Standard: The acceptable standards for various weld tests shall be as per ASME Sec VIII- Div I or relevant acceptable standards.

INSPECTION OF WELDS.

Welding shall be carried out as per approved WPS and QWS by qualified welders.

All welds shall be inspected for flaws by any of the methods described,the choice of the method adopted shall be determined by the ENGINEER.

The correction of defective welds shall be carried out as directed by the ENGINEER without damaging the parent metal. When a crack in the weld is removed, magnetic particle inspection or any other equally positive means as prescribed by the ENGINEER shall be used to ensure that the whole of the crack and material up to 25 mm beyond each end of the crack has been removed. Cost of all such tests and operations incidental to correction shall be to the CONTRACTOR's account.

CONTRACTOR shall perform the following minimum tests on welds if not covered in any clause mentioned, with no cost implication to the OWNER. CONTRACTOR's quoted rate is deemed to have included the cost of such tests.

SL NO	Location & Type of weld	Type of Test	Extent of test	Remarks
1	All fillet welds in general other than those covered under the Sl no 2 ,3,5,7 & 8	DPT	1% of fillet weld with minimum of one test on each member / joint	
2	Fillet welds for plate thickness greater than 25 mm and fillet size more than 10 mm	MPT / DPT	10%	
3	Flame cut edges of plates more than 38 mm for fillet weld.	MPT / DPT	100%	
4	Flame cut edges of plates greater than	MPT / DPT	100%	

	25 mm for butt welds,			
5	Fillet welds between tension flanges and webs	MPT / DPT	100%	
6	Full penetration butt welds	DPT	100 %	DPT shall be carried out after back gouging
7	Fillet Weld greater than 12 mm on flame cut edges of low alloy steel	MPT	100%	
8	Fillet Welds for built up girders, columns and other heavy structures for penetration.	Mac ro etch test	One (1) test Per structure for penetration	
9	Butt welds of thickness greater than 25 mm and less than 32 mm	MPT / DPT	100%	
10	Butt welds of thickness greater than 32 mm	RT	100%	
11	Butt welds of rolled sections having depth greater than 600 mm	RT	100%	

In addition to the minimum tests to be conducted by the CONTRACTOR, ENGINEER reserves his right to direct the CONTRACTOR to conduct additional tests. The extent, type and location of test shall be decided by the ENGINEER. These additional tests shall be conducted by the CONTRACTOR or through an approved agency in presence of the ENGINEER. If the test fails, the cost of that test shall not be payable to the CONTRACTOR. The tests which when successful will be paid for at the rates specified in the schedule.

WELD DEFECTS AND ACCEPTABLE CRITERIA

Type of defect	**Acceptance Criteria**	**Remarks**
Cracks	Not acceptable	
Incomplete or lack of Fusion	Not acceptable	
Mis-alignment of butt welds	0.25 x T (maximum of 3 mm)	T: Thickness of thinner plate
Reinforcement	Max reinforcement of 2 mm for t < 10 mm 3 mm for t > 10mm < 15 mm. 4 mm for 15 mm and greater	
Undercut	0.25 mm deep max	
Sharp edges	Min radius of 2 mm	

WELD REPAIRS

Whenever weld repair is required, CONTRACTOR shall give prior intimation to the ENGINEER and obtain permission before the repair is taken up. When a defect is detected in a weld, it shall be removed by cutting / grinding and smooth blending of the area with parent metal without sharp edges, corners. If welding is required, the same shall be done using the qualified procedure / welder and stage inspection as per the original weld. Correction of defect in
the same portion of the weld shall not be allowed more than two (2) times. Portion of the welding seams, which have been subjected to repair, must be indicated in the weld inspection reports.

2.10 INSPECTION AND TESTS ON STRUCTURAL STEEL FABRICATED MEMBERS

Inspection and tests on Structural Steel Fabricated Members shall be as set forth below:

All the fabricated parts of Structural Steel members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment and surface finish are in accordance with the requirements shown on the approved CONTRACTOR's shop drawings and/or ENGINEER's drawings.

Fit ups shall be examined by the quality surveyor as per the approved QA plan prior to welding the joint. All welds shall be inspected for flaws by the method described under the Clause 7.4 (Inspection Of welds).

The dimensions of the fit ups shall be maintained as specified in the fabrication drawings.

Dimensions of all the assemblies and sub-assemblies shall be as per fabrication drawings within the tolerances specified in IS 7215.

TOLERANCES

The dimensional and weight tolerance for rolled shapes shall be in accordance with IS:1852 for indigenous steel and equivalent applicable codes for imported steel. The tolerances for fabrication of structural steel shall be as per IS:7215.

2.11 TEST FAILURE

In the event of any failure of welding, structural steel members to meet inspection or test requirements, the CONTRACTOR shall notify the ENGINEER or his authorised representative. A design concession request has to be made and got approved from the ENGINEER or his representative before repair is undertaken. The quality control procedures to be followed to ensure satisfactory repair shall be subject to approval by ENGINEER.

CONTRACTOR shall maintain records of all inspection and testing which shall be made available to the ENGINEER or his authorised representative, for three years from the date of completion of the contract.

The ENGINEER has the right to specify additional testing as he deems necessary, and the additional cost of such testing shall be borne by the OWNER only in case of successful testing.

2.12 SHOP MATCHING

For structures like bunkers, tanks, etc. shop assembly is essential. For other steel work, such as columns along with the tie beams/bracings may have to be shop assembled to ensure satisfactory fabrication, obtaining of adequate bearing areas etc. if so desired by the ENGINEER. All these shop assemblies shall be carried out by CONTRACTOR at no extra cost to the OWNER.

2.13 DRILLING HOLES FOR OTHER WORKS

As a part of this Contract, holes in members required for installing equipment or steel furnished by other manufacturers or other CONTRACTORs shall be drilled by the CONTRACTOR at no extra cost to the OWNER. The information for such extra holes will be supplied by the ENGINEER.

2.14 MARKING OF MEMBERS

After checking and inspection, all members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approved erection drawings and shall be legibly painted and stamped on it. The erection mark shall be stamped with a metal dye with figures at least 20 mm high and to such optimum depth as to be clearly visible.

All erection marks shall be on the outer surface of all sections and near one end, but clear of bolt holes. The marking shall be so stamped that they are easily discernible when sorting out members. The stamped marking shall be encircled boldly by a distinguishable paint to facilitate easy location.

Erection marks on like pieces shall be in identical locations. Members having lengths of 7.0 m or more shall have the erection mark at both ends.

2.15 ERRORS

Any error in shop fabrication which prevents proper assembling and fitting up of parts in the field by moderate use of drift pins or moderate amount of reaming will be classified by the ENGINEER as defective workmanship. In case ENGINEER rejects such material or defective workmanship, the same shall be replaced by the materials and workmanship conforming to the

ENGINEER's requirements by CONTRACTOR free of cost at site.

2.16 QUALITY SURVEILLANCE

GENERAL.

The ENGINEER shall subject all works and materials covered by this specification to Inspection.

The CONTRACTOR shall provide free access in his shop during working hours for the inspection staff, designated by the Engineer, at all phases of the work and assist them where necessary in conducting the inspection. The CONTRACTOR shall expeditiously furnish all gauges, instruments and other necessary measuring equipment required for inspection of the work in the shop. The shop inspection by the inspector is intended to ensure that the material and workmanship are in accordance with this specification, but it will not relieve the CONTRACTOR of any of his responsibilities for the product. The inspector's inspection will include, but not be limited to, the following:

MATERIAL

The inspector will ascertain that only materials conforming to the requirements of this specification are used.

DIMENSION AND TOLERANCES

The ENGINEER will ensure and check that the structural members conform to the dimensions and tolerances as set out on the drawings and as required by the specification.

WELDING PROCEDURE

ENGINEER will witness the welding and testing of any procedure qualification tests that are by this specification. The ENGINEER will also check that welding procedure (including the electrode, flux, current, arc voltage, speed of travel) used are in accordance with the approved welding procedures.

WELDING EQUIPMENT

The ENGINEER will check the welding equipment to be used for the work to ensure that it is such condition as to enable qualified welders to follow the procedures.

WELDER AND WELDING OPERATOR QUALIFICATIONS

The ENGINEER will permit welding to be performed only by welders and welding operators who are qualified by tests in accordance with relevant standards

When the quality of a welder or welding operators' work, appears to be below the requirements, the ENGINEER may require testing of his qualifications by necessary tests.

WELDS

The ENGINEER will ascertain that the sizes, length and the location of all welds conform to the requirements of this specification and the approved fabrication drawings. Temporary welds used for the works shall be removed and ground flush with the original surface.

The ENGINEER will identify with a distinguishing mark of all parts of the joints that he has inspected and accepted.

The CONTRACTOR shall comply with all the demands of the ENGINEER to correct improper workmanship and to remove and replace, or correct as instructed, all welds found defective or deficient.

In the event of faulty welding or its removal for rewelding results in damage to the base metal in the judgment of the Engineer, or its retention is not in accordance with the intent of the plans and specification, the CONTRACTOR shall remove and replace the damaged materials at his own cost.

2.17 METHOD OF MEASUREMENT

For the purpose of payment, the weight of the actual completed structures shall be calculated from the approved drawings for different items of work. The CONTRACTOR shall submit to the OWNER relevant material list containing weight of each item.

No allowances will be permitted for bolts, nuts, washers, studs, screws etc, galvanizing, welding or for rolling margins. One tonne for the purpose of payment shall mean ONE METRIC TONNE i.e. 1000 Kg. Permanent bolts, however, will be considered for payment against the relevant item under schedule of items..

The weight of a member made out of standard rolled section such as beams, channels, angles, etc. shall be based on the standard IS:808 without deductions for holes, notches, bevel cuts, etc. Where a component consists of a cut rolled sections, the full weight of the rolled section shall be considered only if more than half the depth of the original section is used. Otherwise, only half the section unit weight shall be considered for calculation of the weight of the components. Deductions shall be made in the weight of gussets/plates for cuts and notches of 900 sq. cm. or larger.

For gussets/plates used in trusses, bracings, columns, beams, etc, the area shall be that of the minimum circumscribing rectangle. The weight of any built-up members shall be based on the weight of each component.

3. ERECTION OF STRUCTURAL STEEL

3.1 SCOPE

This specification covers the general requirements for erection of structural steel. In addition to provision of erection and transport equipment, the scope of work includes supply of tools and tackles, consumables, materials, labor and supervision and shall cover the following:

- Storing and staking of all fabricated structural components/units/assemblies at site storage yards till the time of erection.
- Transportation of structures from storage yard to site of erection, including multiple handling, if required.
- All minor rectifications/ modifications such as:-

  i. Removal of bends, kinks, twists etc for parts damaged during transportation and handling

  ii. Reaming of holes which do not fit properly or which are damaged, for use of next higher size bolt.

  iii. Plug-welding and re-drilling of holes which do not register and which cannot be reamed for use of next higher size bolt.

  iv. Drilling of holes which are either not drilled at all or are drilled in incorrect position during fabrication.
- Fabrication of minor missing items as directed by the OWNER.
- Verification of the position of embedded anchor bolts and inserts w.r.t lines and levels, installed by others based on Geodetic Scheme /Bench Mark/Reference co-ordinates to be furnished by OWNER.
- Verification of actual dimensions of structures (erected by others) which would have bearing on the cutting lengths, end connections etc of those members which are to be erected under this scope of work.

- Assembly at site of steel structural components wherever required, including temporary supports and staging
- Making arrangements for providing all facilities for
    i. Conducting Ultrasonic Testing (UT) by reputed testing laboratories approved by OWNER.
    ii. Making available test films / graphs, with reports / interpretation.
- Rectifying at site damaged portions of shop primer by cleaning and application touch-up paint.
- Erection of structures including making connections by bolts/ High strength Friction Grip bolts / welding as per drawing.
- Alignment of all structures true to line, plumb and dimensions within specified limits of tolerance.
- Application at site after erection, required number of coats of primer and finishing paint as per specification.
- Rectification of structures as per preliminary acceptance report and Final acceptance report.

All necessary items of work required for satisfactory completion of job on schedule.

3.2 APPLICABLE CODES STANDARDS & SPECIFICATIONS

The pertinent clauses of the following Indian Codes, Standards and Specification (latest editions including all applicable official amendments, reaffirmations and revisions) shall apply to the material and workmanship covered by this specification. In the event of the conflict of certain requirements between this specification and the codes referred herein, this specification shall govern. It is not the intent to specify herein all the codes and standards required for the satisfactory completion of work. The list of codes and standards indicates certain primary codes & standards and not all the codes required for the work under the contract. It is understood that all the pertinent codes and standards shall form the part of this specification whether explicitly indicated or not.

Reference codes and standards:

IS 800	General Constructions in Steel –Code of Practice.
IS 806	Code Of Practice For Use Of Steel Tubes In General Building Construction.
IS 822	Code of Procedure for Inspection of Welds.
IS:1363	Hexagonal Head Bolts, screw nad nut of Product grade C
IS:1367	Technical Supply Conditions for threaded fastener (all parts)
IS 4000	Code of Practice High strength bolts in Steel Structures.
IS 7205	Safety code for erection of structural steel
IS 7969	Safety code for handling and storage of building Materials
IS:9595	Metal Arc Welding of Carbon and Carbon manganese steel.
IS 12843	Tolerances for erection of steel structures.
SP:6(1)	Structural Steel Sections.

AWS D1.1 Structural Welding Code: Steel

3.3 REGULATORY REQUIREMENTS

The work covered in this specification, shall comply with all relevant government and local laws, regulations and standards. For subjects not covered by regulations, codes, standards or specifications, the materials and construction shall be based on good engineering practice, subject to approval by OWNER.

3.4 ERECTION SCHEME

CONTRACTOR after the award of work shall submit a detailed erection scheme covering the period of completion of all the works covered under the specification for ENGINEER's approval. The erection scheme shall include but not limited to the following.

i. Methods proposed to be employed for transporting his equipments, tools, tackles, gas cylinders, electrodes and all that is necessary to site.
ii. Type, capacity and quantity of equipment that the CONTRACTOR proposes to bring to site for unloading, transporting within the site, handling, assembling, hoisting and erecting of the structural steel components for all these operations.
iii. Strength and trade wise composition of the work force and supervisory personnel that will be deployed by the CONTRACTOR for the various operations.
iv. Any special specific scheme being adopted for erection of special / complicated structural elements such as roof trusses etc.

A brief write-up covering the above activities shall be submitted along with the bid document by the Bidder during submission of his bid.

ENGINEER reserves the right to direct the CONTRACTOR either at the start or during the contract period , to mobilize additional resources in terms of labour, material ,equipment, tools and plant etc at no cost to the OWNER if in his opinion that the resources employed by the CONTRACTOR does not meet the schedule of completion.

3.5 ERECTION PROGRAMME

Within two (2) weeks of acceptance of bid the CONTRACTOR shall submit a detailed erection programme with dates and estimated completion time for various parts of the work for ENGINEER's approval. This programme shall broadly comprise the following:

i. Layout plan identifying the areas proposed for unloading, main storage,
Subsidiary storage and assembly
ii. Transportation of fabricated material between the storage and work areas.
iii. Layout to indicate the points at which proposed erection begins, direction in which it is proposed to progress, the deployment of equipment, access route for cranes to reach work areas, etc.
iv. The locations and extent of site offices and stores, labor quarters if any. v. Layout of electrical cables and water pipes from the tap-off points.

vi. Details of the method of handling, transport, hoisting and erection including false work/staging, temporary bracing, guying, etc. along with complete details of the quantity and capacity of the various items of erection equipment that will be used.
vii. Site organization chart showing the number of supervisory personnel, and the number and composition of the various gangs.
viii. Safety measures to be adopted at site of erection and organization chart showing safety personnel.

Any modifications to the erection programme directed by ENGINEER for the reasons of inadequacy of

i. The quantity and/or capacity of the erection equipment.
ii. Erection personnel and supervisors, temporary bracing, guying etc.,
iii. Safety of the erection methods, or stability of the erected portions of structures, or unsuitability of the erection sequence due to interference with the work of other agencies.
iv. Any other unforeseen events which may delay the schedule.
v. Safety measures proposed.
Shall be incorporated by CONTRACTOR and the work shall be carried out in accordance with the revised programme. Approval by ENGINEER shall not relieve the CONTRACTOR from the responsibility for the safe, sound, accurate and timely erection of structural steel work as required by ENGINEER/OWNER. CONTRACTOR shall also make no extra claims for bringing additional equipment to site for erection, if so directed by ENGINEER.
CONTRACTOR shall be deemed to have visualized all erection problems while bidding for the work and no additional compensation shall be claimed on this account.

3.6 SITE OPERATIONS

CONTRACTOR shall employ an experienced and qualified graduate Engineer who shall be in full time charge of the job and responsible for all site activities.

CONTRACTOR shall complete all preliminary works at site well before the arrival of structural steel, such as establishment of a well equipped and adequately staffed site office, stores, unloading gantry, unloading and preassembly yard, labour quarters if any, electrical and water connections, electrical winches, derricks, cranes, compressors, all tools and tackles, rivet guns, welding sets, torque wrenches, spud wrenches, staging, etc. as well as experienced erection and supervisory personnel as part of this contract and any other work that may be necessary so as to start erection immediately after the arrival of the first batch of steel at site.

CONTRACTOR shall furnish at his own expense, the necessary non inflammable staging and hoisting materials or equipment required for the erection work and shall remove and take them away after completion of the job.

CONTRACTOR shall also provide necessary passageways, fences, safety belts, helmets, lights and other fittings to the satisfaction of OWNER / ENGINEER and to meet the rules of local authorities and for protection to his men and materials. A licensed electrician shall be kept on the job for the entire duration of the work to maintain CONTRACTOR's electrical equipment and connections.

CONTRACTOR shall protect all existing plant, structures, piping, conduits, equipment and facilities against damage during erection. Any damage caused by CONTRACTOR shall be rectified entirely at CONTRACTOR's cost, to the satisfaction of OWNER / ENGINEER. If work

has to be carried out adjacent to existing switch yards or electrical installations which are live, CONTRACTOR must ensure suitable safety precautions in consultation with ENGINEER.

If a portion of the work of the project area cannot be made available to CONTRACTOR for his activities due to operations being carried out by other agencies, he shall suitably modify his sequence of operations so as to continue work without interruption. CONTRACTOR shall work in coordination with other agencies working on the project site and plan his work suitably so as not to hinder the progress of construction at site.

The Suitability and capacity of all plant and equipment used for erection shall be to the satisfaction of the OWNER/ENGINEER.

3.7 ACCEPTANCE, HANDLING AND STORAGE

The fabricated material received at erection site shall be verified with respect of marking on the key plan / marking plan or shipping list.

Any material found damaged or defective shall be stacked separately and the damaged or defective material shall be painted in distinct colour for identification and the same shall be brought to the notice of ENGINEER.

No dragging of steel shall be permitted. All fabricated items shall be stored 300mm above ground on suitable packing to avoid damage. It shall be stored in the order required for erection, with erection marks visible. All storage areas shall be prepared and maintained by CONTRACTOR. Steel shall not be stored in the vicinity of areas where excavation or grading will be done and, if so stored temporarily, this shall be removed by CONTRACTOR well before such excavation and/or grading commences to a safe distance to avoid burial under debris.

Scratched or abraded steel shall be given a coat of primer in accordance with TCE specification M4-405-04 (painting of structural steel) after unloading and handling prior to erection. All milled and machined surfaces shall be properly protected from rust/corrosion by suitable coating and also from getting damaged.

3.8 ANCHOR BOLTS, EMBEDDED PARTS AND FOUNDATIONS

CONTRACTOR shall carefully check the location, level and layout of anchor bolts embedded in foundations constructed by others, to ensure that the structures can be properly erected as shown on the drawings. Any discrepancy in the anchor bolts/foundation shall be reported to ENGINEER.

CONTRACTOR shall carefully check the actual dimensions of structures and also the location, level and sizes of embedded parts a) in the RC beam /column and/ or b) cleats / plates provided in steel beam /column constructed by others to receive structures covered under this scope of work. CONTRACTOR shall take note of discrepancies if any, shall be reported to ENGINEER and fabricate the structures covered under this contract suitably before the commencement of erection.

Levelling of column bases to the required elevation may be done either by providing shims or three nuts on the upper threaded portion of the anchor bolt. All shim stock required for keeping the specified thickness of grout and in connection with erection of structures on foundations,

crane brackets or at any other locations shall be of good M.S. plates and shall be supplied by CONTRACTOR at his cost.

A certain amount of chipping/cleaning of foundations and preparing the area is considered normal and shall be carried out by CONTRACTOR at no extra cost.

Where beams bear in pockets or on walls, bearing plates shall be set and levelled as part of the work. All grouting under column base plates or beam bearing plates will be carried out by CONTRACTOR, unless the grouting is specifically excluded from the CONTRACTOR's scope.

3.9 ASSEMBLY AND CONNECTIONS

Field connections may be effected either by bolting, welding or by use of high strength friction grip bolts as shown in the design and erection drawings.

All bolts, nuts, washers, rivets, electrodes required for field connections shall be supplied by CONTRACTOR free of cost. The materials shall have prior approval from the OWNER /ENGINEER and necessary test certificates shall be furnished to ENGINEER's approval. Materials shall be procured from the reputed manufacturers with prior approval from OWNER /ENGINEER

All assembling shall be carried out on a level platform.

Drifts shall be used only for drawing the work to proper position and must not be used to such an extent as to damage the holes. Size of drifts larger than the nominal diameter of hole shall not be used. Any damaged holes or burrs must be rectified to the satisfaction of ENGINEER.

Corrections of minor misfits and reasonable amount of reaming shall be considered as a part of erection. Any error in the shop, which prevents proper fit on a moderate amount of reaming and slight chipping or cutting, shall be immediately reported to ENGINEER.

3.10 ERECTION

Erection work shall be taken up after receipt of clearance from the ENGINEER.

All structural steel shall be erected as per approved Design / fabrication drawings.

For safety requirements during erection, provisions of IS: 7205,IS:7969, IS800 and other relevant codes shall be strictly followed.

Erection shall be carried out with the help of maximum mechanization possible.

Prior to commencement of erection, all the erection equipment, tools, tackles, ropes etc shall be tested for their load carrying capacity. Such tests may be repeated at intermediate stages also if considered necessary. Frequent visual inspection shall be done of all vulnerable areas and components to detect damages or distress in the erection equipments, if any.

Temporary bracing, whenever required, shall be provided to sustain forces due to erection loads and equipment etc. Erected parts of the structure shall remain stable during all stages of erection when subjected to action of wind, dead weight and erection forces etc. Such bracings shall be left in place as long as may be required for safety and stability. Specified sequence of erection of vertical and horizontal structural members shall be followed

Erected members shall be held securely in place by bolts to take care of dead load, wind / seismic load and erection load.

All structural members shall be erected with erection marks in the same relative position as shown in the appropriate erection and shop drawings.

All connections shall achieve free expansion and contraction of structures wherever provided.

No final bolting or welding of joints shall be done until the structure has been properly aligned and approved by ENGINEER.

For positioning beams, columns and other steel members, the use of steel sledges is not permitted.

Instrumental checking of correctness of initial setting out of structures and adjustment of alignment shall be carried out in sequence and at different stages as required using precision survey instruments. The final levelling and alignment shall be carried out immediately after completion of each section of a building.

The CONTRACTOR shall design, manufacture, erect and provide false work, staging temporary support etc,. Required for safe and accurate erection of structural steelwork and fully responsible for the adequacy of the same.

The CONTRACTOR shall also provide facilities such as adequate temporary access ladders, gangways, tools & tackles, instruments etc. to OWNER for his inspection at any stage during erection.

Proper size steel cable slings, etc., shall be used for hoisting. Guys shall not be anchored to existing structures, foundations, etc. unless so permitted by ENGINEER in writing. Care shall be taken to see that ropes in use are always in good condition.

Steel columns in the basement, if any, are to be lowered and erected carefully with the help of a crane and/or derrick without damaging the basement walls steel or floor.

Structural steel frames shall be erected plumb and true. Frames shall be lifted at such points that they are not liable to buckle and deform. Trusses shall be lifted only at node points. Trusses which are very slender in the lateral direction shall be provided with temporary lateral supports till the horizontal bracings are erected. All steel columns and beams shall be checked for plumb and level individually before and after connections are made.

Chequered plates shall be fixed to supporting members by welding or by countersunk bolts as shown/specified in relevant drawings and/or as directed by ENGINEER. The edges shall be made smooth and no burrs or jagged ends shall be left. While splicing, care should be taken so that there is continuity in pattern between the two portions. Care should also be taken to avoid distortion of the plate while welding. The erection of chequered plates shall include :

a. Welding of stiffening angles/vertical stiffening ribs as per drawings
b. Cutting to size and making holes to required shape wherever necessary to allow service lines such as piping , cables etc to pass through
c. Splicing as shown in relevant drawings
d. Smoothening of edges
e. Fixing of chequered plates by welding and/or countersunk bolts
f. Providing lifting hooks for ease of lifting.

Cutting, heating or enlarging holes may be carried out only with prior written Approval from the ENGINEER.

3.11 FIELD CONNECTIONS:

Assembly by Permanent Bolts:

- The number of washers on permanent bolts shall not be more than two(2) and not less than one(1) for the nuts and one(1) for the bolt head.
- Only wooden rams or mallet shall be used in forcing members into position in order to protect the metal from injury or shock.
- Where bolting is specified on the drawing, the bolts shall be tightened to the maximum limit. The threaded portion of each bolt shall project through the nut by at least one thread. Tapered washers shall be provided for all heads and nuts to achieve uniform bearing on sloping surface.
- To prevent loosening of nuts, spring washers or lock-nuts shall be provided as specified in the design / shop drawings.
- All machine fitted bolts shall be perfectly tight and the ends shall be checked to prevent nuts from becoming loose. No unfilled holes shall be left in any part of the structure.

ASSEMBLY BY WELDING:

- All field assembly by welding shall be executed in accordance with the requirements for shop fabrication. Where the steel has been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints to be welded.
- All other requirements of welding and its acceptance standards shall be in accordance with clauses specified in TCE.M4-405-01(Supply and Fabrication of structural steel).

Assembly by High Strength Friction Grip Bolts (HSFG Bolts)

- Assembly of structures with HSFG bolts shall conform to IS:4000
- The mating surface shall be prepared in accordance with the requirements of design in order to achieve required properties to develop adequate friction between the surfaces.
- The mating surfaces shall be absolutely free from grease. Lubricant, dust, rust etc and shall be thoroughly cleaned before assembly.
- The nuts shall be tightened up to the specific torque with the help of torquewrench or by half-turn method with the help of pneumatic wrench lever.
- The direction of tightening of the nuts shall be from the middle towards the periphery of assembly.
- After desired tightening the bolt heads, nuts and edges of the mating surfaces shall be sealed with a coat of paint to obviate entry of moisture.

3.12 INSPECTION

ENGINEER/OWNER or their authorised representatives shall have free access to all parts of the job during erection and all erection shall be subjected to their approval. In case of faulty erection, all dismantling and re-erection required will be at CONTRACTOR's cost. No paint

shall be applied to rivet heads or field welds or bolts until these have been approved by ENGINEER.

3.13 TOLERANCES

Tolerances mentioned below shall be achieved after the entire structure or part thereof is in line, level and plumb. The tolerances specified below do not apply to steel structures where the deviations from true position are intimately linked with and directly influence technological process. In such cases, the tolerances on erected steel structures shall be as per recommendations of process technologists/suppliers which will be indicated in the drawings.

COLUMNS

- Deviation of column axes at foundation top level with respect to true axes

(a) In longitudinal direction: ± 5 mm
(b) In lateral direction: ± 5 mm

- Deviation in the level of bearing surface of Columns at foundation top with respect to True level ± 5 mm

Out of plumbness (verticality) of column

Axis from true vertical axis, as measured at Column top :
(a) For columns up to and including 15 Meters in height ± 1/1000 of column height in mm or±15mm whichever is less.
(b) For columns exceeding 15 meters in height ± 1/1000 of column height in mm or±20mm Whichever is less.

- Deviation in straightness in Longitudinal and transverse planes of Column at any point along the height ± 1/1000 of column height in mm or±10mm whichever is less.
- Difference in erected position of adjacent Pairs of columns along length or across Width of building prior to connecting width Of building prior to connecting Trusses/beams with respect to true distance ± 10 mm
- Deviation in any bearing or seating level With respect to true level ± 5 mm
- Deviation in differences in bearing levels of a member on adjacent pair of columns both Across and along the building ± 10 mm

- TRUSSES AND BEAMS

- Shift at the centre of span of top chord Member with respect to the vertical plane Passing through the centre of bottom chord ± 1/250 of height of truss in mm or ± 15 mm Whichever is less.

- Lateral shift of top chord of truss at the Centre of span from the vertical plane whichever 15 support of the truss mm whichever is less — ± 1/1500 of span of truss in mm or ± passing through the centre of
- Lateral shift in location of truss from its true Vertical position — ± 10 mm
- Lateral shift in location of purlin true Position — ± 5 mm
- Deviation in difference of bearing levels of Trusses or beams from the true difference — i) ±20 mm for trusses
ii) For beams:
Depth < 1800mm: ±6mm
Depth > 1800mm: ±10 mm
- Deviation in sag in chords and diagonals of Truss between node points — 1/1500 of length in mm or 10mm whichever is smaller
- Deviation in sweep of trusses, beams etc in The horizontal plane — 1/1000 of span in mm subject to a maximum of 10 mm

CRANE GIRDERS & RAILS

- Shift in the centre line of crane rail with respect to centre line of web of crane girder — ± 5 mm
- Shift in plan of alignment of crane rail with respect to true axis of crane rail at any point — ± 5 mm
- Difference in alignment of crane rail in plan measured between any two points 2 meters apart along rail — ± 1 mm
- Deviation in crane track with respect to time gauge
  (a) For track gauges up to and including 15 meters — ± 5 mm
  (b) For track gauges more than 15 Meters — ± [5 + 0.25 (S-15)] where S in meters is true gauge
- Deviation in the crane rail level at any Distance point from true level — 1/1200 of the gauge or ±10mm whichever is less
- Difference in the crane rail actual levels Between any two points 2 meters apart Along the rail length — ± 2 mm
- Difference in levels between crane track

Rails at	
(a) Supports of crane girders ± 15 mm	
(b) Mid span of crane girders ± 20 mm	2 mm subject to grinding of surfaces for
• Relative shift of crane rail surfaces at a joint in plan and elevation	smooth transition.
• Relative shift in the location of crane stops end buffers) along the crane tracks with track gauge S in mm	1/1000 of track gauge S in mm subject to maximum of 20mm

3.14 PAINTING

After steel has been erected, all bare and abraded spots, field welds, bolt heads and nuts shall be spot painted. Before paint is applied, the surface shall be dry and free from dust, dirt, scale and grease.

3.15 METHOD OF MEASUREMENT

- For the purpose of payment, the weight of the actual, completed structures shall be calculated from the approved fabrication drawings for different items of work. CONTRACTOR shall submit to OWNER relevant material list containing weight of each item.
- No allowance will be permitted for weights of erection bolts, washers, screws etc. in calculating the weight of the completed structure. No allowances will be permitted for galvanizing, welding or for rolling margins. In the case of field connection with bolts, the bolts along with nuts and washer will be considered for payment against appropriate item in the schedule of prices. One tonne for the purpose of payment shall mean ONE METRIC TONNE i.e. 1000 Kg.
- The weight of a member made out of standard rolled sections such as beams, channels, angles, etc. shall be based on the weight of the member given in IS 808, without deducting for holes, notches, bevel cuts, etc. Where a component consists of a cut joist or channel, the full weight of the rolled section shall be considered only if more than half the depth of the section is used. Otherwise only half the section unit weight shall be taken. Deductions shall be made in the weight of gussets/plates including chequered plates for skew cuts, notches and openings of 900 sq.cm. or larger.
- For gussets/plates used in trusses, bracings, columns, beams etc. the area shall be that of the minimum circumscribing rectangle, except as stated in clause 15.3 above.
- The weight of any built-up member shall be separated into the weight of each component.
- Erection bolts installed by erector shall be left in position on completion of erection; however, no additional payment shall be made either for supply or use of such bolts. If erection bolts are removed after erection is complete, holes shall be plug welded and ground smooth. No extra payment shall be made for such plug welding.

3.16 CLEAN UP OF WORK SITE

During erection, the CONTRACTOR shall without any additional payment, at all times keep the working and storage areas used by him, free from accumulation of waste materials or rubbish. Before completion of erection, he shall remove or dispose of in a satisfactory

manner all temporary structures, waste and debris and leave the premises in a condition satisfactory to OWNER/ENGINEER.

4. PAINTING OF STRUCTURAL STEEL

4.1 SCOPE

- This specification covers the general requirements for shop and field painting for Structural Steel works using hot /cold rolled steel sections joined by using bolting and/or welding.
- Briefly the scope of works covered under this specification are; i. Supply of all primers, paints and all other materials required for painting other than Owner's supply.
  ii. Furnishing of all labor, materials, tools & equipment and the performance of all operations and incidentals necessary for surface preparation, painting, handling, storing, transporting, scaffolding etc.
  iii. Testing of paints as per the relevant codes in the Standard Laboratory identified by the Owner and furnishing of required test certificates for Owner's approval.
  iv. Repair work of damaged / pre-erection / fabrication shop primer and weld joints at field.
  v. Inspection of painting system after its application to conform to the specification requirement.
  vi. Any other requirement as required for satisfactory completion of specified work.
- Reference shall be made to Data Sheet-A for Paint system and Data Sheet-B for the structures covered in the scope of works.

4.2 EXCLUSIONS

This specification excludes paintings of the following structures /equipment.

Mechanical & electrical equipment and parts.
i. Buried & Overhead piping works
ii. Storage tanks
iii. Insulated parts
iii. Any other items of work specifically excluded in the scope of works.

4.3 APPLICABLE CODES, STANDARDS

The pertinent clauses of the following Indian / International Codes, Standards
And Specification (latest editions including all applicable official amendments,
Reaffirmations and revisions) shall apply to the material and workmanship covered by this specification. In the event of the conflict of certain requirements between this specification and the codes referred herein, this specification shall govern.
It is not the intent to specify herein all the codes and standards required for the satisfactory completion of work. The list of codes and standards indicates certain primary codes & standards and not all the codes required for the work under the contract. It is understood that all the pertinent codes and standards shall form the part of this specification whether explicitly indicated or not.

Indian Standard Codes

1. IS:5	Colours for ready mixed paints and Enamels
2. IS:101	Methods of sampling and test for paints, varnishes and related products (all parts & all sections).
3. IS:104	Ready mixed paint, brushing, zinc chrome, priming
4. IS:158	Ready Mixed paint, Brushing, Bituminous, Black,

Lead free, Acid, Alkali and heat resisting.

5. IS:1303 Glossary of Terms relating to paints
6. IS:1477 Code of practice for painting of ferrous metals in Buildings.
7. IS:2932 Enamel, synthetic, exterior:(a) undercoating (b) finishing- Specification
8. IS: 9954 Pictorial Surface Preparation Standards for Painting of Steel Surfaces.
9. IS:13183 Aluminium paint, Heat resistant-specification.
10. IS:2074 Ready Mixed Paint, Air Drying, Red Oxide Zic Chrome, Priming -Specification.

International Standard Codes

i. SSPC Society for Protective Coatings (USA) Volt I & II
ii. NACE National Association of Corrosion Engineers, USA(NACE)
iii. ISO 8501 Preparation of Steel Substrates before application of Paints and related products. Visual assessment of Surface cleanliness.(Part 1&2)
iv. ISO 8502 Preparation of Steel Substrates before application of Paints and related products-Tests for assessment of Surface cleanliness. (Part 1-4)
v. ISO 8503 Preparation of Steel Substrates before application of Paints and related products-Surface roughness Characteristics of blast-cleaned steel substrates. Part 1& 2

4.4 HEALTH, SAFETY AND REGULATORY REQUIREMENTS

- The work covered in this specification, shall comply with all relevant government and local laws, regulations and standards. For subjects not covered by regulations, codes, standards or specifications, the materials and construction shall be based on good engineering practice, subject to approval by Owner.
- CONTRACTOR shall ensure that all health and safety regulations are observed for the erection of scaffolding and use of the selected paint material.
- All necessary precautions shall be taken to ensure the safety of personal and property. Extreme caution shall be used when working with oil or oil-based paints, cleaning fluids etc., especially in close proximity to oxygen piping or oxygen equipment. Heavy concentrations of volatile or toxic fumes must be avoided and in confined areas, blowers or exhaust fans shall be used.
- Rags and other waste material soiled with paints, thinners or solvents shall be kept in tightly closed metal containers while on the jobsite and not in use. Legal disposal of waste materials outside plant site premises is Contractor's responsibility.
- Lead being hazards material it is recommended to use lead free paint as per requirement of clause 3.6 of IS158.

4.5 SURFACE PREPARATION OF STEEL

One or more of the following methods of surface preparation shall be followed, depending on condition of steel surface and as specified in the data sheet. ENGINEER reserve the right to instruct the type of surface preparation depending upon the condition of material. Recommended methods of surface preparation of steel briefly are as under.

a) Solvent Cleaning.
b) Manual or hand tool cleaning.
c) Mechanical or power tool cleaning.

d) Abrasive Blast cleaning.

It is necessary that the CONTRACTOR shall have to resort to any one or combination of the above method of surface preparation to achieve the required acceptable standard. Hence the rate quoted shall take into account for such preparation.

SOLVENT CLEANING

All contaminants like oil, grease removal shall be carried out either by special solvents or by degreasing agents. Application and cleaning of solvents shall be as per manufacturer's instructions and shall be in accordance with SSPCSP1.

MANUAL OR HAND TOOL CLEANING

This method of cleaning shall be used to remove all loose mill scale, loose rust, loose paint and other loose detrimental foreign matter by use of nonpowered hand tools. The minimum acceptable standards in case of manual or hand tool cleaning shall be in accordance with ISO 8501- St2 / SSPC-SP2.

MECHANICAL OR POWER TOOL CLEANING

This method of cleaning shall be used to remove all mill scale, rust, paint and other detrimental foreign matter by use of power assisted hand tools. The minimum acceptable standards in case of power tool cleaning shall be in accordance with ISO 8501- St3 / SSPC-SP3.

ABRASIVE BLAST CLEANING (SHOT BLASTING / GRIT BLASTING)

- Shot / Grit blasting shall be resorted to only after removal of grease, oil and other contaminants as per SP-1. Special care shall be taken on weld areas to remove flux and spatter. Precautions shall be taken when grit or shot blasting of light gauge steel surfaces, to ensure that buckling does not occur due to continuous impingement of grit or steel shots under high velocity. Surface anchor profiles shall be measured by Testex tape – press-o-film and the finished surfaces shall conform to the requirements of ISO 8501- Sa 2½ / SSPC-SP10.
- Blast cleaning shall not be performed where dust can contaminate surfaces undergoing such cleaning or during humid weather conditions having humidity exceeding 85%.

TESTS ON SURFACE PREPARATIONS

The following inspection and tests shall be performed on the steel surfaces subjected to surface preparation. Test / inspection reports shall be submitted to ENGINEER for his approval and acceptance.

i. Visual examination of surface preparation with comparators.

ii. Profile check of the prepared surface with suitable "profilometer "eg.TESTEX method.

4.6 PAINT MATERIAL

PROCUREMENT

All types of paints required for the work shall be as per the requirement of relevant IS codes and procured from the reputed manufacturers. Contractor shall obtain the detailed list of approved paint manufacturers from the ENGINEER before initiating the procurement action.

STORAGE

The Paint material shall be stored strictly in accordance with the instructions of the paint manufacturer. In general painting materials should be stored in dry, cool, well ventilated and frost free area.

PACKING

All paints delivered to the fabrication shop / site shall be in original sealed container, as packed by the manufacturer. Paint containers shall clearly mark with paint manufacturer's name, batch number, date of manufacture, shelf life and a clear indication of the type and colour of the product.

MIXING

Paint shall be thoroughly mixed prior to application. Mixing shall be done in a well-ventilated, clean and dust -free area. Paint shall be mixed by rotating power mixers or rolling rigs, until a uniform consistency is achieved. Multiple pack paint materials shall be mixed in accordance with and under the conditions as specified by the paint manufacturer. Pot life as specified by the Paint manufacturer shall be strictly followed.

THINNER AND SOLVENTS

Only additives, thinners, solvent etc as recommended by the paint manufacturer shall be used. A possible extension of the "pot life" by addition of thinners is prohibited.

TESTS ON PAINT

In order to ensure that the supplied paint meets the stipulations, samples of paint shall be tested in laboratories to establish quality of paint with respect to

i. Viscosity.
ii. Adhesion/ bond of paint in steel surfaces.
iii. Adhesion / simulated salt spray test.
iv. Chemical analysis (percentage of solids by weight)
v. Normal wears resistance as encountered during handling & erection
vi. Resistance against exposure to acid fumes etc.

Alternatively manufacturer's test certificates shall be furnished by the Painting CONTRACTOR in respect of above tests for ENGINEER's approval and acceptance. ENGINEER reserves the right to test the paint material either before the commencement of work or during the progress of work if in his opinion the paints supplied are of inferior quality and does not meet the codal

Requirements.

PAINT SAMPLE

Before buying the paint in bulk, it is recommended to obtain sample of paint and establish "Control Area of Painting". On control area surface preparation, painting shall be carried out in the presence of Engineer and the Manufacturer of paint.

6.8. FINISHING PAINT

Colour /Shade of the finishing paint shall be as per the choice of the Owner and Contractor shall obtain prior approval before procurement action is initiated.

PAINT APPLICATION

Painting shall be carried out by any one or the combination of the following method of application to suit the site condition and the type of paint being used. Manufacturer's recommended method of application shall be strictly followed.

i. Brush Application.
ii. Roller Application.
iii. Spray Application.

BRUSH APPLICATION

Brush application of paint shall be in accordance with the following.

i. Brushes shall be of a style and quality that will enable proper application of paint
ii. Round, Oval or Wide flat brushes shall be used depending upon the surface irregularity, rough or pitted steel, large flat painting areas etc
iii. There shall be a minimum of brush marks left in the applied paint.
iv. Surfaces not accessible to brushes shall be painted by spray.

ROLLER APPLICATION

Suitable rollers of different nap length to suit varying surface roughness shall be used. Rollers are not generally recommended for application of primers. Roller application shall only be used if the first or priming coat of paint has been applied by brush or other means. Manufacturer's recommendation shall be strictly followed for roller applied paints.

SPRAY APPLICATION

- Airless or pneumatic spray application shall be in accordance with the following
  i. Airless spray application shall be as per steel structure paint Manual Vol 1& Vol 2 SSPC, USA.
  ii. Spraying shall be carried out keeping the spray gun at the minimum suitable distance from the work piece and consistently at 90 0 to the surface being painted.
  iii. Correct spray tips, air pressures etc as recommended by the equipment supplier shall be adopted.
- Air spray application shall be in accordance with the following:
  i. The equipment used shall be suitable for the intended purpose, shall be capable of properly atomizing the paint to be applied, and shall be equipped with suitable pressure regulators and gauges.
  ii. Appropriate pressure and nozzles shall be those recommended by the manufacturer of the equipment for the material being sprayed. The equipment shall be kept in satisfactory condition to permit proper paint application.
  iii. Correct combination of air volume, air pressure and fluid flow to give good atomization shall be ensured to get a defect free painted surface.
  iv. Traps or separators shall be provided to remove oil and condensed water from the air. These traps or separators must be of adequate size and must be drained periodically during operations. The air from the spray gun impinging against the surface shall show no condensed water or oil.
  v. Ingredients shall be kept properly mixed in the spray pots or containers during application by continuous mechanical agitation.
  vi. Spray equipment shall be kept sufficiently clean so that dirt, dried paint and other foreign materials are not deposited in the paint film. Any solvents left in the equipment shall be completely removed before applying paint to the surface being painted.

- Selection of type of spray application shall depend upon the type of paint coating being used. At all time paint manufacturer's recommendation shall be strictly followed.

4.7 COATING PROCEDURE

COMPATIBILITY

- General Compatibility between primer, intermediate and top coats, as applicable for individual painting system shall be established through the paint manufacturer supplying the paints. Primer and finishing paint for the entire project shall preferably be procured from the same manufacturer. Mixing of material from different manufacturers is strictly prohibited
- Surface shall not be coated in rain, wind, when steel surface temperature is less than 50 C, or when the relative humidity is greater than 85%.
- Applied paint system shall be allowed to cure at ambient and surface temperatures between 10 ° C and 60 ° C with relative humidity below 85%. All paint shall be air curing.
- 6.8.4. A suitable test area (approx 0.5 m2) shall be painted with agreed paint system. The test area shall be fully coated with all coats of the agreed coating system using the tools and equipment to be used for the actual coating work. The painted test area shall be maintained for the duration of the project. Painting on test piece shall be carried out such that all the coats shall be made visible for reference at all time.
- Structural steel shall be preferably prime coated at shop and subsequent finish coats shall be carried out at site after the alignment and erection is complete. Portions of structural steel members to be embedded into the concrete shall not be painted.
- Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly.
- Surfaces inaccessible after erection, including top surfaces of floor beams supporting grating / chequered plate /RC Slabs shall receive one additional coat of finish paint over and above the number of coats specified prior to erection.
- Each coat of paint material shall be applied as continuous film uniform thickness free of pores. Any spot or areas missed in application shall be recoated and permitted to dry before the next coat is applied. Applied paint should have the desired wet film thickness.
- Each coat shall be in proper state of cure or dryness before the application of succeeding coat. Material shall be considered dry for recoating when an additional coat can be applied without development of any detrimental film irregularities, such as lifting or loss of adhesion of the under coat. Manufacturer's instruction shall be strictly followed for intercoat intervals.
- No paint shall be force dried under conditions which will cause checking, wrinkling, blistering formation of pores or detrimentally affect the condition of the paint.
- No drier shall be added to paint on the job unless specifically called for in the manufacturer's specification for the paint.
- Paint shall be protected from rain, condensation, contamination, snow and freezing until dried to the fullest extent practicable.
- Blast cleaned surface shall be coated with one coat of primer before surface degradation occurs but in no case later than 3hrs. Irrespective of the method of surface preparation, the first coat of primer shall be applied not later than 2- 3 hours after preparation and on dry surface.
- When the successive coat of the same colour is specified, alternate coat shall be tinted as far as practicable; sufficient to produce enough contrast to indicate complete coverage of the surface. The tinting material shall be compatible with the material and not detrimental to its service life.

- All field welded areas on shop painted item shall be mechanically cleaned (including the weld area proper, adjacent areas contaminated by weld spatter or fumes and areas where existing primer, intermediate / finishing paint is burnt). Subsequently, new primer and finishing coats of paint shall be applied as per painting specification.
- Care shall be taken to protect adjacent equipment, piping, structures etc., from spillage and spatter during field painting by use of adequate temporary covers. If surfaces are accidentally spattered or sprayed, the paint shall be immediately and thoroughly removed. For cleaning of spillages an inert absorbent material shall be used.
- All structures shall receive appropriate number of primer, intermediate and finishing coats in order to achieve overall DFT as per the drawings / specifications/ data sheets.

4.8 PAINTING SYSTEM

The recommended painting system of all Structural Steel Works covering surface preparation, application of Primer coats, Intermediate coats (if specified) and Final coats to develop required minimum DFT shall be as per painting guide.

4.9 REPAIR OF COATED SURFACE

- Wherever shop primer painting is scratched, abraded or damaged, the surfaces shall be thoroughly cleaned using emery paper and power driven wire brush wherever warranted, and touched up with corresponding primer. Touching up paint shall be matched and blended to eliminate conspicuous marks.
- If more than 30% area of the painted surface of an item requires repair, the entire surface shall be repainted. In such an event no extra payment will be permitted.

4.10 TEST ON PAINTING SYSTEM

Following inspection and tests shall be performed during and after the application of paint system.

i. Wet film thickness (WFT) spot checks shall be carried out during the course of painting operation to ensure that film thickness is being maintained.
ii. Dry film thickness (DFT) check of intermediate and final coating layers in accordance with the specification and /or paint manufacturer's recommendation.
iii. Quality of adhesion between the coating system and the steel substrate and of the adhesion between the coatings layers shall not be less than those specified in the Codes / Standards.
iv. Porosity Check: Holiday detection test shall be carried out and all indications shall be repaired as per approved repair procedures.

4.11 FINAL INSPECTION

- As part of the Quality Assurance, a final inspection in the presence of the representatives of OWNER and CONTRACTOR shall be conducted prior to the final acceptance of the paintwork. Part of this final inspection checks shall be

i. Visual check of the appearance.

ii. Checks on DFT's of the total applied coating system.
iii. Shade verification.
iv. Holiday Testing.
v. Scratch Test.

vi. Adhesion test.

- As part of acceptance procedure, a report shall be prepared that shall include:

i. General:

- Names of the Painting Contractor and the responsible personal
- Scope of work
- Dates when the work was carried out.
- Copy of the work and quality plan
- Deviations from this Specification and/or the quality plan.

ii. Inspection equipment

- Type and calibration of instruments used.

iii. Surface Preparation

- Condition of surface before preparation
- Checks on the requirements as specified for cleaned surface.

iv. Coating application

- Information on coating systems being applied (i.e. product names, DFT's)
- Checks on requirements as specified for coating application
- Check on dry film thicknesses of the total coating system applied

v. Conditions

- Checks on humidity, dew point and substrate temperature.

vi. Inspection reports

- Copy of the inspection reports of the Contractor
- Inspection from an independent third party

4.12 DOCUMENTATION

Contractor shall keep records and furnish the following documents to the Owner

i. A written quality plan with procedure for qualification trials and for the actual work.

ii. Daily progress report with details of weather conditions, particular of applications, number of coats and type of material applied, anomalies, progress of work versus program.

iii. Results of measurement of temperatures, relative humidity, surface profile, film thickness, holiday detection, adhesion tests with signature of appropriate authority.

iv. Particulars of surface preparation and paint application during trials and during the work.

v. Details of non-compliance, rejects and repairs.

vi. Type of testing equipments and calibration.

vii. Code and batch numbers of paint materials used including shelf life.

viii. Visual examination of surface preparation compared with the standards.

ix. Profile check of the prepared surface with suitable "profilometer.

x. Dry film thickness check of intermediate and final coating layers, in accordance with the specification and/or paint manufacturer's recommendation.

xi. Checks/ tests carried out as per clauses above.

4.13 GUARANTEE

- The paint system shall provide sufficient protection of the underlying steel surface against the attack of the environment, other than mechanical damage, chemical spillage as result of operational activities or other unusual occurrences from the outside caused by others.
- The CONTRACTOR is fully responsible for the quality of the work and for all related QA/QC activities as indicated in the specification.
- The CONTRACTOR shall guarantee quality of their coating works for the period specified in Data Sheet-B and for the coating condition as specified below.

- The guarantee period starts from the date of acceptance of CONTRACTOR's paint work.
- Initial acceptance of any new coating work by OWNER will not release the CONTRACTOR of his obligation under this section until final inspection has been carried out and acceptance of the completed work has been agreed in writing.
- These guarantee clauses regarding coating specifications are prevailing and supersede the warrantee requirements in General Conditions of Contract.

4.14 MEASUREMENT

- Painting work shall not be measured separately, if primer painting and/or primer and finish painting are already included in the scope of item of structural steel works which include supply, fabrication, painting and erection of structural steel and work is measured on the weight basis for payment.
- In cases where primer and/or finish painting work as specified is carried out on erected structural steel executed by a different agency, the method of measurement for painting shall be on the basis of tonnage of the steel erected. For this purpose, the tonnage of erected steel as certified for payment to the different agency shall be considered as the basis and no measurement will be carried out separately.

DATA SHEET A
PAINT SYSTEM

Paint System	Surface Preparation	Primer Coat (µm)	Intermediate Coat (µm)	Top Coat (µm)	Dft (µm)
PS-1	St-2	Inorganic Zinc Phosphate		Synthetic Enamel	
		2x35=70		2x25=50	120
PS-2	Sa 2 ½	Inorganic Zinc Silicate		HB Epoxy Polyamide (pigmented)	
		1x75 =75		1x75=75	150
PS-3	Sa 2 ½	Inorganic Zinc Silicate	HB MIO Epoxy	Aromatic Polyurathane Acid Resistant	
		1x75 =75	1x75=75	1x50=50	200
PS-4	Sa 2 ½	Inorganic Zinc Silicate	HB MIO Epoxy	HB Epoxy Polyamide (pigmented)	
		1x75 =75	1x75=75	1x75=75	225
PS-5	Sa 2 ½	Inorganic Zinc Silicate		Aliphatic Polyurathene(UV Resistant)	
		1x75 =75		1x50=50	125
PS-6	Sa 2 ½	Inorganic Zinc Silicate	HB MIO Epoxy	HB Epoxy Polyamide (pigmented)	
		1x75 =75	1x75=75	1x75=75	225
PS-7	Sa 2 ½	Inorganic Zinc Silicate	HB MIO Epoxy	Aromatic Polyurathane Acid Resistant	
		1x75 =75	1x75=75	2x50=100	250
PS-8	Sa 2 ½	Inorganic Zinc Silicate	HB MIO Epoxy	HB Epoxy Polyamide (pigmented)	
		1x75 =75	1x75=75	2x75=150	300
PS-9	Sa 2 ½	Inorganic Zinc Silicate	HB MIO Epoxy	Aliphatic Polyurathene(UV Resistant)	
		1x75 =75	1x75=75	1x50=50	200
PS-10	Sa 2 ½	Inorganic Zinc Silicate	HB MIO Epoxy	HB Epoxy Polyamide (pigmented)	
		1x75 =75	1x75=75	2x75=150	300
PS-11	Sa 2 ½	Inorganic Zinc Silicate	HB MIO Epoxy	Aromatic Polyurathane Acid Resistant	
		1x75 =75	1x100=100	2x50=100	275
PS-12	Sa 2 ½	Inorganic Zinc Silicate	HB MIO Epoxy	HB Epoxy Polyamide (pigmented)	
		1x75 =75	2x75=150	2x75=150	375
PS-13	Sa 2 ½	Inorganic Zinc Silicate	HB MIO Epoxy	Aliphatic Polyurathene(UV Resistant)	
		1x75 =75	1x75=75	2x50=100	250
PS-14	Sa 2 ½	Inorganic Zinc Silicate or Epoxy Zinc Rich		Heat resistant -Silicon Based aluminium paint	
		1x75=75		1x40=40	115

5. TECHNICAL SPEIFICATIONS FOR THERMAL INSULATION FOR ROOF

5.1 SCOPE

OVERDECK INSULATION:

This specification covers the requirements of thermal insulation over the RCC top slab (terrace slab/ sloping roof slab) including its fixing arrangement. The insulation system is called as 'inverted roof insulation system' in which the insulation layer is placed over the waterproofing layer that has been laid on the RCC slab. It is commonly also known as 'over deck insulation'.

BENEFITS:

The inverted roof concept has other benefits, it can be installed in any weather, added without stripping the waterproof layer, easily lifted and replaced/re-used if the building is altered.

UNDERDECK INSULATION:

- This specification covers the requirements of thermal insulation under the RCC roof or top slab (terrace slab) including its fixing arrangement.
- Thermal insulation shall be engineered resin bonded fibrous insulation to offer maximum resistance to heat passage. The thickness of material should be in range of 50 to 75mm. as approved by the consultant and client. The insulation shall be provided after the sample is approved by the client and consultant.
- Thermal insulation material consisting of boards, slabs and rolls of approved manufacture, shall be of approved thermal conductivity as per manufacturer's data sheet for creating the required design conditions, and shall be provided as specified in item of works and as shown in the drawings. The insulation shall be provided after the sample is approved by the client and consultant

5.2 OVERDECK INSULATION (RCC SLOPING ROOF AND FLAT ROOF)

APPLICABLE CODES & STANDARDS

- ASHRAE/IESNA Standard 90.1-2004, Appendix G - Energy Standard for Buildings except Low-Rise Residential Buildings
- ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
- IGBC Abridged Versions

MATERIALS

XPS Board

- Thermal insulation shall be engineered extruded polystyrene (XPS) foam insulation designed to offer maximum resistance to heat passage. The board has smooth, high-density skins, with closed cellular structure. It is produced by a continuous, fully automated extrusion process. It has excellent mechanical properties like insulating characteristics (R-value of 5.0 per inch of thickness), low water absorption, uniform density distribution, dimensional stability, excellent compressive strength, aging resistance, immunity against

insects, bacteria, rodent attacks. The thickness of material should be in range of 50 to 75mm. as approved by the consultant and the client. The insulation shall be provided after the sample is approved by the client and consultant.

- Insulation material consisting of boards/ slabs of approved manufacturer, thermal conductivity as per manufacturer's data sheet for creating the required design conditions shall be provided as specified in item of works and as shown in the drawings.
- widely available sizes are width = 600 mm, length = 1250mm and thickness= 20-100mm. Edge profile is square edge, shiplap
- Adhesives
- Fixing accessories

WORKMANSHIP/ INSTALLATION

- **Roof Deck Preparation:**
  Clean the slab surface thoroughly with wire brush to make it free from dust and loose particles. Treat all the cracks (wider than hairline) and construction joints by routing out to a minimum 3/4" x 3/4" groove and filling it with a specialised sealant of approved make. Treat the honeycombs by routing out the loose concrete upto the sound concrete and grouting with specialised non-shrink cementitious compound, curing thoroughly.
- **Waterproofing Membrane**:
  Lay over the entire slab area the elastomeric membrane waterproofing system of approved make as per manufacturer's specification as approved by the consultant and supervision of manufacturer along with the site engineer. The membrane shall have elongation of 300% and UV resistance. The membrane shall be raised till 450mm height on the parapet wall along the periphery.
- **Insulation:**
  Lay extruded polystyrene sheet of 75mm. thickness and approved size with necessary lap joint, anchors, adhesives, primers as per manufacturer's specification and under his supervision along with the site engineer.

- **Protective Cover/ Separation Layer:**
  Lay the geo-textile fabric of 0.075 mm thickness with min. 75mm overlap at edges as a separation layer on top of insulation.
- **Pre-Finishing Layer:**
  - To create a slope of specified gradient, lay as per the specification average 75mm thick of screed concrete of M20 grade mixed with water-proofing admixtures and its curing. Treatment also to continue on the parapet wall up to 300 mm height along the periphery in shape of round slope and curing.
  - The u-value to be achieved as per Appendix G of ASHRAE/IESNA Standard 90.1-2004 should be in the range of 0.063 Btu/hr.ft2.ºF.
- **STORAGE, HANDLING & DELIVERY**
  - Material received at site shall be with original packing, labels, batch dates. It shall be untouched/ intact till issued for use of site.
  - Material shall be stored at properly covered dry location and shall be safe from any sort of physical damage.
  - Cartons must always be stored with designated side upwards.
- **FINISHING**
  The finishing layer over the screed can be of china mosaic helping to reduce heat island effect.
- **SUBMITTALS AND TESTING**

The submittals by the contractor shall include:

- Samples of all boards/ slabs for approval of the client and consultant.
- Literature / catalogue of product to be used including data sheet covering technical literature.
- Manufacturer's certification that product meets/ exceeds specification for the project.
- Manufacturer's certification confirming to IGBC norms.
- The contractor shall also submit the test certificates for physical, chemical and fire resistant properties of the materials.

- **MOCK-UP**
  - The contractor shall prepare and install mock-up samples as per approved shop drawings.
  - Mock-up samples shall be of full size and shall be true representation of actual works to be carried out at site. Mock-ups may be part of completed work if undisturbed.
- **MEASUREMENT**
  - Volume in cubic metre corrected up to two places of decimal shall be measured and paid for at the unit rate less deductions, if any.
  - The quoted rate shall include supply, delivery at site, cutting and fixing of all materials at place for covering the roof with thermal insulation material, including any fixing accessories adhesives, covering as stipulated in schedule of prices and quantities, finishing at all levels and elevation etc., complete upto the satisfaction of site engineer.
  - The measurement of the water-proofing would be as per water-proofing contractor.

5.3 UNDERDECK INSULATION (RCC SLOPING ROOF AND FLAT ROOF)

- **APPLICABLE CODES & STANDARDS**
  - ASHRAE/IESNA Standard 90.1-2004, Appendix G - Energy Standard for Buildings Except Low-Rise Residential Buildings
  - ECBC-2007
  - BS 476 - Fire tests on building material
  - IS: 8183 - Bonded mineral wool
  - IGBC Abridged Versions
- **MATERIALS**

  Glass wool Board
  - Thermal insulation shall be engineered resin bonded fibrous insulation to offer maximum resistance to heat passage. The thickness of material should be in range of 50 to 75mm. as approved by the consultant and client. The insulation shall be provided after the sample is approved by the client and consultant.
  - Thermal insulation material consisting of boards, slabs and rolls of approved manufacture, shall be of approved thermal conductivity as per manufacturer's data sheet for creating the required design conditions, and shall be provided as specified in item of works and as shown in the drawings. The insulation shall be provided after the sample is approved by the client and consultant.

  Adhesives

  Fixing accessories

  Gypsum boards
- **WORKMANSHIP/ INSTALLATION**
  - Clean the surface thoroughly with wire brush to make it free from dust and loose particles. Apply adhesive on the RCC surface as well as on the insulation material. Allow both surface to dry but in sticky condition. 50 mm thick (or upto 75mm as advised by the consultant) under deck insulation material conforming to IS:8183 (such as Rockloyd/

Twiga boards or approved equivalent) having a minimum density of 32 kg/m3 and faced with 0.05 mm minimum thickness aluminium foil and 24GX25 mm wire mesh netting (facing done either at factory preferably, or at site) to be installed under concrete roof including all connected works such as, but not limited, to providing slotted angle pieces with rawl plugs and coach screws for fixing the insulation to roof.

- Fix the insulation under RCC surface and press it in position.
- 14G GI tie wires in criss-cross arrangement in angle cleats and 24 SWG x 25 mm square, wire mesh netting shall be provided at the bottom to ensure intimate contact with the underside of roof. These joints shall be sealed with aluminium adhesive tape suitably as required.

- **WORKMANSHIP/ INSTALLATION FOR THERMOCOLE BOARDS**
  - Soffit of R.C. slab shall be thoroughly cleaned with wire brush and 85/25 industrial grade hot bitumen conforming to IS: 702 shall be applied uniformly over the surface at the rate of 1.5 kg/m2.
  - Thermocole boards (T.F. variety) of 50 mm thickness shall be stuck by means of the same grade of hot bitumen.
  - The boards shall be further secured with screws, washers and plugs.
  - The joints of the boards shall be sealed with bitumen.
  - The net superficial area of the insulation shall be measured and paid.
- **WORKMANSHIP/ INSTALLATION FOR FIBRE GLASS BOARDS**
  - Timber pegs 50 mm x 50 mm x 50 mm shall be fixed to the slab at 600 mm centres with 6 mm x 65 mm long wood screws. 20 gauge G.I. lacing wire shall be tied to the pegs.
  - 'Crown' 200 fibreglass boards 50 mm thick shall be stuck to the pegs with CPRX compound or any other suitable adhesive and be held in position by the 20 gauge G.I. lacing wires.
  - The insulation boards shall be covered with 20 mm – 24 gauge hexagonal G.I. chicken wire meshes, nailed to the timber pegs and 30 gauge aluminium sheets shall be fixed over the chicken wire mesh with 50 mm overlap and secured to the timber pegs by screws.
  - If the insulation is specified to rest on top of the false ceiling, it shall be properly installed and anchored to the frame work. In case additional battens are required for proper installation, Contractor shall include its cost in the rate for insulation.
  - The net superficial area of the insulation shall be measured and paid for.
- **STORAGE, HANDLING & DELIVERY**
  - Material received at site shall be with original packing, labels, batch dates. It shall be untouched/ intact till issued for use of site.
  - Material shall be stored at properly covered dry location and shall be safe from any sort of physical damage.
  - Cartons must always be stored with designated side upwards.
- **FINISHING**

  12 mm thick gypsum boards to be fixed underside of the insulation layer. The gypsum board to be painted with acrylic emulsion pain of approved shade.
- **SUBMITTALS AND TESTING**

  The submittals by the contractor shall include:
  - Samples of all types, boards, slabs or rolls, for approval of the client and consultant.
  - Literature / catalogue of product to be used including data sheet covering technical literature.
  - Manufacturer's certification that product meets/ exceeds specification for the project.
  - Manufacturer's certification confirming the IGBC norms.

- The contractor shall also submit the test certificates for physical, chemical and fire resistant properties of the materials.

- **7.3.9. MOCK-UP**
  - The contractor shall prepare and install mock-up samples as per approved shop drawings.
  - Mock-up samples shall be of full size and shall be true representation of actual works to be carried out at site. Mock-ups may be part of completed work if undisturbed.
- **MEASUREMENT**
  - Measurement shall be in cubic meter corrected up to two places of decimal.
  - The superficial area in square metre of ceiling soffit, beams, and columns above false ceiling shall be measured and paid for at the unit rate less deductions, if any.
  - The quoted rate shall include supply, delivery at site, cutting and fixing of all materials at place for covering the roof with thermal insulation material, including fixing accessories such as wood pegs, slotted angle, G.I rawl plugs, wood/coach screws, lacing wire, G.I washers, wire mesh, any covering as stipulated in schedule of prices and quantities, finishing at all levels and elevation etc., complete up to the satisfaction of site engineer.

5.4 UNDERDECK INSULATION (FOR ROOF SHEETING IN PEB)

- **APPLICABLE CODES & STANDARDS**
  - IS 8183 : 1993 - Bonded Mineral Wool.
  - BS standard BS 476 : Part 4 - Non combustible.
  - BS 476: Part 5 - Not easily ignitable/Class P.
  - BS 476: Part 6 - Fire propagation.
  - BS 476: Part 7 - Surface spread of flame (Class 1), Class 'O' as per BS 476 part 6 & 7 together.
- **MATERIALS**
  - Fibre Glass Wool Insulation: Insulation material shall comply with IS-8183 and shall be lightweight blanket of bonded fibre glass wool insulation of approved make by the consultant and client of density 24 kg/ m3 and 50 mm thickness (any other suitable density and thickness options with suitably factory laminated with one side WMP – 50 facing or any other suitable facing may be considered) Insulation material shall have thermal conductivity value of 0.033 W/mK and shall be non toxic, low smoke emitting, chemically inert and free from impurities like sulphur, chloride and metal shots. Material having steel plants slag shall not be acceptable.
  - Important Factor to be considered while selecting insulation material -
    - Material shall be inorganic, chemically inert, non-toxic and shall not use any slag i.e. steel plant wastage during manufacturing.
    - Material shall be free from any shot content, chloride, sulphur.
    - Material shall be lighter in weight as possible like e.g. 1.2 kg per sq.m.
    - Material shall have Low Thermal Conductivity value 0.033 W/ M.K @ 25 deg C mean temperature.
    - Material shall have high Noise Reducing Coefficient (NRC) value - 0.9 to 1.0
    - Material shall be non-combustible & classified as highest fire Class O as per British Standard BS
  - Adhesive double-side tapes (min. 5 cm width)
  - Adhesive repair tape with facing.

- Wire net.

- **WORKMANSHIP/ INSTALLATION**
  - . Option – I , Single Skin Application.
  - Insulation of desired density and thickness with suitable factory laminated foil to be placed over weld mesh of size 75mm x 75 mm x1.6 mm GI mesh. Facing should be on downward direction. The 50 mm facing projections/ flange to be used as overlaps to join the rolls together. Then roofing sheet to be fixed over the insulation to the purlins with the help of mechanical fasteners or with standing seam system.
  - Option II, Double Skin Application: Insulation of the desired density and thickness to be used between two metal sheets with sub guard.
- **STORAGE, HANDLING & DELIVERY**
  - The insulation should be inspected upon arrival at the job site to ensure that it is exactly as ordered. If there is anything wrong with the insulation, it should not be installed. Contact the supplier immediately.
  - Insulation should be stored in a dry, protected area. Stack height should not be more than 3 rolls. Rolls should be placed horizontal.
  - All packages should be elevated above the ground or slab, preferably on a flat surface, to prevent contact with surface water accumulation. The facing should be protected from tears and punctures to maintain continuity of the vapour retarded.
  - Poly-bags should have holes in each end to aerate the insulation. It is also suggested that the contractor open the ends of the bags to allow better air circulation around the insulation.
  - Packages can be left uncovered during the day, weather permitting, but should be protected at night with polyethylene film, canvas or other covering.
  - Whenever possible, the insulation should be used as soon as possible after it arrives at the job site. The sooner the insulation is installed, the less likely it is to get damaged in storage.
- **FINISHING**

  Preferable Facing / Backing Options given below for PEB Building :

  - Aluminium Based Facing -
    - Aluglass Facing (Aluminium Foil backed by Glass Cloth)
    - HSMAF - High Strength Mesh less Aluminum Facing
    - Aluminium Foil
  - Aesthetic facing -
    - WMP – 50 / High strength Ultimate White Facing
    - WMP VR – 30 Facing,
    - WMP VR – 10 Facing,
    - WMP VR Facing

- **SUBMITTALS AND TESTING**

  Standard Test method carried out for various parameter as per IS 3144 like density, thickness, dimensions, moisture, sulphur and shot content, incombustibility etc. whereas thermal conductivity can be tested in third party testing laboratory.
- **MOCK-UP**
  - The contractor shall prepare and install mock-up samples as per approved shop drawings.
  - Mock-up samples shall be of full size and shall be true representation of actual works to be carried out at site. Mock-ups may be part of completed work if undisturbed.
- **MEASUREMENT**

- Measurement shall be in cubic meter corrected up to two places of decimal.
- The quoted rate shall include supply, delivery at site, cutting and fixing of all materials a place for covering the roof with thermal insulation material, including its fixing accessories as stipulated in schedule of prices and quantities, finishing at all levels and elevation etc., complete up to the satisfaction of site engineer.

TECHNICAL SPECIFICATION OF FIRE FIGHTING WORKS

1.0 FIRE FIGHTING SCOPE OF WORK:-

The scope of this section consists of but is not necessarily limited to Design, supply, installation, testing and commissioning of the fire protection system. The philosophy of the system is as follows :

a. The Fire Suppression System shall comprise the Fire Hydrants System, sprinkler system, Safety fire hose reel, Hand Appliances.

Water from the RCC Fire Water Storage tanks shall be supplied for the Fire Hydrant System (Pressurized) both for the internal landing valves and the hose reels at landings.

b. The Hydrant System under normal conditions, shall be lowest pressurized by means of the electric motor driven Jockey Pump.
c. The Hydrant System shall be provided with one electric pump sets and one diesel engine driven pump .
d. The starting and stopping of the Jockey pump shall be automatic based on the pressure switches at preset low and high pressure.
e. The electric motor driven Pump starts automatically at a preset pressure by means of a pressure switch. As soon as the main electric Pump starts, the Jockey Pump Stops. If for any reason the electric motor driven main Pump does not start at the preset pressure or is unable to maintain the pressure, the diesel engine driven Pump starts at the preset pressure.
f. The main Pump, whether electric motor driven or the diesel engine driven shall be stopped only manually.
g. Contractor shall ensure Hydro Testing for the complete system.
h. The Contractor shall obtain the necessary approval of the drawings and the schemes from the local authority(Fire Noc) as called for.
i. The contractor shall design and after approval of Project Manager display near each staircase landing at floor levels, a glass covered framed floor plan clearly showing the locations of all landing valves, hose reels, hand appliances, as well as the DO's and DON'T's for the personnel and the exit direction in case of an emergency. The dimensions of the floor plan, its scale, lettering size, color scheme etc shall be as directed by the Project Manager.

2.0 APPLICABLE CODES AND STANDARDS:

All equipment, supply, erection, testing and commissioning shall comply with the requirements of Indian Standards and code of practice given below as amended up to the date of submission of Tender. All equipment and material being supplied shall meet the requirements of BIS and other relevant standard and codes.

MS Tube upto 150mm	-	IS:1239
MS Tubes above 150mm	-	IS:3589
Malleable Iron Fittings	-	IS:1239 - 1982 (Part-I&II)
Cast Iron Sluice Valves	-	IS: 780 - 1984

Check Valves	-	IS:5312 - 1984
Internal/External Fire Hydrant Valve		IS:5290 - 1993
Rubberized Fabric Lined Hose	-	IS: 636 - 1988
Couplings, Branch Pipe, Nozzles	-	IS: 903 - 1993
First Aid Fire Hose (Rubber)	-	IS:5132 - 1969
First Air Hose Reel Drum	-	IS: 884 - 1985

3.0 BASIC CONCEPT OF DESIGN

Type of the Building -- Assembly building .
Categories as per NBC -- Moderate Hazard
Max. Height of Building-- Less than 15 mtr.

Building is classified as Assembly building as per NBC with height less than 15mtr. The fire fighting arrangement shall be designed as per the requirement of local guidelines, NBC, NFPA, guideline issued by **Local fire Authority** & engineering design standard.

The entire firefighting installation shall be compliant with the most stringent codes / standard for the entire premise to ensure the highest safety standard and uniformity of system. Further, before property is opened to work, the firefighting shall be fully operated and tested under simulated conditions to demonstrate compliance with the most stringent standards, codes and guidelines. Following functional system shall be provided; strictly in compliance with the listed reference standards:

a.	Piping System	:	Piping system confirming to IS: 1239, IS: 3589 (for pipe size > 150NB) & IS 10221 M.S /GI. Heavy Class for Hydrant system (Pipe material to be verify with Fire NOC)
b.	Fire water static Storage	:	Fire water static storage has been provided in accordance to NBC requirement.
c.	Fire Pumping system	:	Pumping system comprising of independent pumps for hydrant system & jockey application has been provided.
d.	Hydrant system	:	External & internal hydrant complete with hose reel.
e.	Hand held fire Extinguishers	:	Strategically placed at designated areas.

3.1 System Description

The firefighting system shall be provided as per National Building Code of India 2016 (Part IV), as per local Chief Fire Officer guidelines/approval, guidelines of other relevant I.S codes and it shall be consisting of as follows: :-

(a) Fire main of 150 mm dia. Connected to internal and external hydrants.

(b) Wet - riser system with landing hydrant valves and fire hose cabinet.

(c) sprinkler system for multi level car parking.

3.1.1 Fire water storage

Fire water storage tank for Fire Protection System has been provided at under-ground level of 200 KL capacity.

In addition to this, as a mandatory application as mentioned in NBC-2016 guidelines, an additional static fire water tank of 5 cum capacity shall be provided Part of OH tank.

Fire department connection shall also be provided on the external wall of the property near the main entrance. These shall comprise of 4 Nos. 63 mm dia male outlets with double landing valves capable of directly feeding the ring mains through non return valves or directly filling the static fire storage tanks. These shall be mounted in specially identified boxes.

3.1.2 Fire pumping system

The fire pumping system shall comprise of electrical pump for hydrant system, diesel engine driven pump & jockey pump for hydrant system in pump room at site located as shown in site plan and another electric pump for hydrant system near OH tank.

(a)	Electric Pump(1 No.s)	Capacity 2280LPM,70 Mt head.
(b)	Diesel Engine Driven Pump	Capacity 2250LPM 70 Mt head.
(c)	Jockey Pump	Capacity 180-LPM 70- Mt head.
(d)	Electric Sprinkler Pump(1 No.s)	Capacity 2280LPM,70 Mt head.
(e)	Water transfer Pump	Capacity 900-LPM 20 Mt head.
(f)	Booster Pump	Capacity 450-LPM 35 Mt head.

Electrical pump shall provide adequate flow for catering requirement of hydrant system. Diesel engine driven fire pumps shall be provided for ensuring operation & performance of the system in case of total electrical power failure. Jockey pumps shall compensate for pressure drop and line leakage in the hydrant installation.

Individual suction lines shall be drawn from the fire suction header and connected to independent fire suction of pumps. The electric fire pumps, diesel engine driven fire pumps and the jockey pumps shall all draw from this single common suction header.

Delivery lines from various pumps shall also be connected to a common header in order to ensure that maximum standby capacity is available. The ring main shall remain pressurized at all times and Jockey pumps shall make up minor line losses. Automation required to make the system fully functional shall be provided

.4.0 QUALITY ASSURANCE AND QUALITY CONTROL:

4.1 The work shall conform to high standard of design and workmanship, shall be structurally sound and aesthetically pleasing. Quality standards prescribed shall form the backbone for the quality assurance and quality control system.

4.2 At the site, the Contractor shall arrange the materials and their stacking/ storage in appropriate manner to ensure the quality. Contractor shall provide equipment and manpower to test continuously the quality of material, assemblies etc. as directed by the Project Manager's Representative. The test shall be conducted continuously and the result of tests maintained. In addition the Contractor shall keep appropriate tools and equipment for checking alignments, levels, slopes and evenness of surface.

4.3 The Project Manager's Representative shall be free to carry out such tests as may be decided by him at this sole direction, from time to time, in addition to those specified in this Document. The Contractor shall provide the samples and labor for collecting the samples. Nothing extra shall be payable to the Contractor for samples or for the collection of the samples.

4.4 The test shall be conducted at the site laboratory that may be established by Project Manager's Representative or at any other Standard Laboratory selected by Project Manager's Representative. Contractor shall keep the necessary testing equipment such as hydraulic testing machine, smoke testing machine, gauges and other necessary equipment required.

4.5 The Project Manager's Representative shall transport the samples to the laboratory.

4.6 Testing may be witnessed by the Contractor or his Authorized Representative. Whether witnessed by the Contractor or not, the test results shall be binding on the Contractor.

4.7 Prior to shipment, complete unit shall be tested under actual load conditions for performance and proper functioning of component parts.

5.0 PIPE WORK

5.1 General Requirements

All materials shall be of the best quality conforming to the specifications and subject to the approval of the Consultants.

Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

Pipes shall be securely fixed to walls and ceilings by suitable clamps and supports (galvanised after fabrication) at intervals specified. Only approved type of anchor fasteners shall be used for RCC slabs and walls / floors etc.

Valves and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.

Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workman like manner.

Pipe accessories such as gauges, meters, control devices, etc. shall have the same working pressure rating as the associated pipe work. All pipe work shall be free from

burrs, rust and scale and shall be cleaned before installation. All personnel engaged on welding operations must possess a certificate of competence issued by an acceptable / recognized authority.

5.2 Piping

Pipes of following types are to be used:

Mild steel black pipes as per IS:1239 heavy grade(for pipes of sizes 150 mm N.B. and below) suitably lagged on the outside to prevent soil corrosion. M.S. pipes buried below ground shall also be suitably be lagged with 2 layers of PYPKOTE/COTAK polythene sheet over 2 coats of bitumen.

Steel pipelines upto 150 mm dia shall be as per IS: 1239, Part-II (heavy grade) while pipelines above 150 mm dia shall be as per I.S.:3589.

All pipe clamps and supports shall be fabricated from MS steel sections and shall be factory galvanized before use at site. Welding of galvanised clamps and supports shall not be permitted.

Pipes shall be hung by means of expandable anchor fastener of approved make and design. The hangers and clamps shall be fastened by means of galvanised nuts and bolts. The size/diameter of the anchor fastener and the clamps shall be suitable to carry the weight of water filled pipe and dead load normally encountered.

Hangers and supports shall be thoroughly galvanised after fabrication. The selection and design of the hanger & support shall be capable of carrying the sum of all concurrently acting loads. They shall be designed to provide the required supporting effects and allow pipeline movements as necessary. All guides, anchor braces, dampener, expansion joint and structural steel to be attached to the building/structure trenches etc. shall be provided. Hangers and components for all piping shall be approved by the Consultants.

The piping system shall be tested for leakages at 2 times the operating pressure or 1.5 time shut-off pressure, which ever is highest including testing for water hammer effects.

Flanged joints shall be used for connections for vessels, equipment, flanged valves and also on two straight lengths of pipelines of strategic points to facilitate erection and subsequent maintenance work.

For pipes underground installation the pipes shall be buried at least one meter below ground level and shall have 230 mm x 230 mm masonry or concrete supports at least 300 mm high at 3m intervals. Masonry work to have plain cement concrete foundation (1 cement: 4 coarse sand : 8 stone aggregate) of size 380x380x75 thick resting on firm soil.

Mains below ground level shall be supported at regular intervals not exceeding 3.0 metres and shall be laid at least 2.0 metre away from the building.

5.3 Piping Installation & Support

Tender drawings indicate schematically the size and location of pipes. The Contractor, on the award of the work, shall prepare detailed working drawings, showing the cross-sections, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air valves, and all pipe supports.

He must keep in view the specific openings in buildings and other structure through which pipes are designed to pass.

Piping shall be properly supported on , or suspended from , on stands, clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchor, clamps and hangers, and be responsible for their structural stability.

Pipe work and fittings shall be supported by hangers or brackets so as to permit free expansion and contraction. Risers shall be supported at each floor with Galvanised steel clamps. To permit free movement of common piping support shall be from a common hanger bar fabricated from Galvanised steel sections.

Pipe hangers shall be provided at the following maximum spacings:

Pipe Dia (mm)	**Hanger Rod Dia (mm)**	**Spacing between Supports (m)**
Up to 25	6	2
32 to 50	8	2.5
65 to 80	8	2.5
80 to 100	10	2.5
125 to 150	10	3.0
200 to 300	12	3.5

The end of the steel rods shall be threaded and not welded to the threaded bolt.
All pipe work shall be carried out in a proper workman like manner, causing minimum disturbance to the existing services, buildings, roads and structure. The entire piping work shall be organized in consultation with other agencies work, so that area can be carried out in one stretch.
Cut-outs in the floor slab for installing the various pipes area are indicated in the drawings. Contractor shall carefully examine the cut-outs provided and clearly point out wherever the cut-outs shown in the drawings, do not meet with the requirements.Pipe sleeves, larger diameter than pipes, shall be provided wherever pipes pass through walls and slab and annular space filled with fibreglass and finished with retainer rings.

The contractor shall make sure that the clamps, brackets, saddles and hangers provided for pipe supports are adequate or as specified / approved by Consultants. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.

All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reduces shall be used for the piping to drain freely. In other locations, concentric reduces may be used.

Automatic air valves shall be provided at all high points in the piping system for venting. All valves shall be of 15mm pipe size and shall be associated with an equal size gate

valves. All pipes shall be pitched towards drain points.Pressure gauges shall be provided as shown on the approved drawings. Care shall be taken to protect pressure gauges during pressure testing.

5.4 Pipe Fittings

Pipe fittings mean tees, elbows, couplings, unions, flanges, reducers etc and all such connecting devices that are needed to complete the piping work in its totality.

Forged steel screwed type fitting shall be used for pipes of 50 mm dia & below. Fabricated fittings shall not be permitted for pipes diameters 50mm and below. Fabricated fittings used on pipe size 65 mm & above shall be fabricated, welded in workshops. They shall be inspected by Project Manager before dispatch from the workshop. The welding procedures of the workshop should have been approved by the rules for hydrant system. For "T" connection, pipes shall be drilled and reamed. Cutting by gas or electrical welding shall not be permitted.

5.5 Procedure For Pypkote / Cotak Application

a. Surface Preparation - The pipe surface shall be cleaned by a wire brush.
b. Application of Primer - Pypkote / Coatek primer is to be applied on pipes immediately after cleaning. This is to prevent any further accumulation of rust on the pipe. This is a cold applied primer and is applied by brush.
c. Application of Pypkote / Coatek 4 mm Tape - After the primer is applied on the pipe, it is allowed to dry for about 30 min. till it becomes touch dry. Before adhering the tape to the pipe, it is advisable to gently heat the primer coated pipe by a run of LPG torch. Remove the bottom polyethylene from the tape & then heat bottom surface of the tape by LPG torch or any heat source & start wrapping the tape to the pipe by heating the primer coated pipe & by removing the bottom polyethylene from the tape before wrapping better adhesion between the tape & pipe is obtained. Overlaps are maintained with a minimum of 12.5 mm.
d. Tape coating of weld joints - The tape is applied over the weld joints after the necessary welding & testing methods of the joints is completed. The procedure for application of tape shall be the same as bare pipe procedure. Overlaps on each side of the weld joints shall be 50 mm. A final coat of White wash with water based cement paint is done immediately over the entire coated pipe.

5.6 Jointing

Welded Joints

All pipes above 65mm dia and above shall be jointed with welded joints. Joints between MS pipes and fittings shall be made with the pipes and fittings having "V" groove and welded with electrical resistance welding in an approved manner. But welding without "V" groove shall not be permitted.

Screwed Joints

All joints in the pipe line with screwed fittings shall be seal welded after testing and the weld plus the adjoining portion shall be given two coats of zinc rich primer.

Flanged joints (65 mm dia and above)

Flanged joints with flanges conforming to IS: 6392 shall be provided on

a. Straight runs at intervals not exceeding 25-30m on pipe lines of 50 mm dia and above and as directed by the Project Manager.
b. For jointing all types of valves, appurtenances, pumps, connections with other type of pipes, to water tanks and other places necessary and as required for good engineering practice and as shown/noted on the drawings.
c. Flanges shall be with GI bolts and nuts and 3mm insertion gasket of natural rubber conforming to IS: 11149.

Unions (upto 50 mm dia)

Approved type of dismountable unions shall be provided on pipe lines of 50 mm dia and smaller dia, in locations similar to those specified for flanges.

7. Air Vessel

The air vessel shall be provided to compensate for slight loss of pressure in the system and to provide an air cushion for counter-acting pressure, surges, whenever the pumping sets come into operation. Air vessel shall conform to IS:3844. It shall be normally half full of water, when the system is in normal operation. Air vessel shall be fabricated with 8 mm thick M.S. plate with dished ends and suitable supporting legs. It shall be provided with one 100 mm dia flanged connection from pump, one 25 mm drain with valve, one water level gauge and 25 mm sockets for pressure switches. The air vessel shall be tested to pressure for 12 hours at 2 times the operating pressure or 1.5 times the shut-off.

8. Fire Brigade Connection

The storage tank shall be provided with a 150 mm fire brigade pumping connection to discharge at least 2275 litres / minute into it. This connection shall not be taken directly into the side of the storage tank, but arranged to discharge not less than 150 mm above the top edge of the tank such that the water flow can be seen. The connection shall be fitted with stop valve in a position approved by the Project Manager. An overflow connection discharging to a drain point shall be provided from the storage tank.

The fire brigade connection shall be fitted with four numbers of 63mm instantaneous inlets in a glass fronted wall box at a suitable position at street level, so located as to make the inlets accessible from the outside of the building. The size of the wall box shall be adequate to allow hose to be connected to the inlets, even if the door cannot be opened and the glass has to be broken. Each box shall have fall of 25mm towards the front at its base and shall be gl`assed with wired glass with ”FIRE BRIGADE INLET” painted on the inner face of the glass in 50 mm size block letter. Each such box shall be provided with a steel hammer with chain for breaking the glass. In addition to the emergency fire brigade connection to the storage tank, a 150mm common connection shall be taken from the four 63mm instantaneous inlets direct to hydrant main so that the fire brigade may pump to the hydrants in the even of the hydrant pumps being out of commission. The connection shall be fitted with a sluice valve and reflux valve. Location of these valve shall be as per the approval of the Project Manager.

9. System Drainage

The system shall be provided with suitable drainage arrangement with drain valves complete with all accessories.

10. Valves

10.1 Butterfly Valve

The butterfly valve shall be suitable for waterworks and rated for PN 1.6. The body shall be of cast iron in circular shape and of high strength to take the water pressure. The disc shall be heavy duty cast iron with anti corrosive epoxy or nickel coating. The valve seat shall be of high grade elastomer or nitrile rubber. The valve is closed position shall have complete contact between the seat and the disc throughout the perimeter. The elastomer rubber shall have a long life and shall not give away on continuous applied water pressure . The shaft shall be EN 8 grade carbon steel.The valve shall be fitted between two flanges on either side of pipe flanges. The valve edge rubber shall be projected outside such that they are wedged within the pipe flanges to prevent leakages. Valve above 150mm dia shall be provided with Gear assembly . Codes for different material used in valves shall be as under:

a. General Design and Manufacture:EN593/API609

b. Valve face to face ISO 5752
c. Top flange drilling:ISO 5211
d. Valve Inspection & testing:API 598
e. Flange Standard Confirmity-ANSI 150/ANSI125/BS 10TAB D&E IS6392 NP 06/1.0/1.6

10.2 Ball Valve

The ball valve shall be made forged brass and suitable for test pressure of pipe line. The valve shall be internally threaded to receive pipe connections. The ball shall be made from brass and machined to perfect round shape and subsequently chrome plated. The seat of the valve body-bonnet gasket and gland packing shall be of Teflon. The handle shall be provided with PVC jacket. The handle shall also indicate the direction of 'open' and 'closed' situations. The gap between the ball and the teflon packing shall be sealed to prevent water seeping. The handle shall also be provided with a lug to keep the movement of the ball valve within 90°. The lever shall be operated smoothly and without application of any unnecessary force.

10.3 Non-Return Valve

All Non-Return valves used in pump's delivery shall be suitable for water works cast iron double flanged with cast iron body and gunmetal internal parts conforming to IS:5312.

MATERIAL OF CONSTRUCTION

Body Disc Cover : Cast Iron
Hinge Pin : SS AISI 316
Disc Face : SS AISI 316
End connection:BS 10 Table D, E & F

10.4 Wafer Type Check Valve

All check valve used before flow switches shall be spring loaded dual plate check valves with following specifications:
Body:CI, Plate:SS304, Stop pin:SS316, Hinge Pin:SS316, Spring:SS316, Seat:EPDM,

10.5 Suction Strainers

Flanged 'Y' strainers are suitable for water. The design is compact and full flow, with large filtration area for low pressure drop and more debris collection. It is provided with drain Ball valve for frequent blow off. Element is strengthened for rigidity and long life and fitted in machined seats. Flanges provided are as per ANSI B16.5 150#, DIN10 suitable for working pressure or upto 250 PSI (16 KG/cm2), Hydraulically tested to 30Kg/cm2.

10.6 Foot Valve

Used in suction side of pump to avoid flow reversal from pump to UG tank in case on negative suction. Manufacturing Standard : IS 4038. Pressure Rating : PN 2

MATERIAL OF CONSTRUCTION

Housing, Seat, Strainer, Door, Strainer : Cast Iron IS:210, Gr. FG 200
Door Plate : Cast Iron IS:210, Gr. FG 200 / MS IS:2062, Gr.Fe 410 WA
Hinge Pin : SS ASTM A 276, Type 410
Door Face : Natural Rubber with reinforcement of cotton canvas
End Flange:IS:1538, Table 4 & 6

11. PRESSURE SWITCH

The pressure switches shall be employed for starting and shutting down operation of pumps automatically, dictated by line pressure. The Pressure Switch shall be diaphragm

type. The housing shall be die cast aluminium, with SS 316 movement, pressure element and socket. The set pressure shall be adjustable. The Switch shall be suitable for consistent and repeated operations without change in values.

It shall be provided with IP:55 water and environment protection.

12. PRESSURE GAUGE

Pressure gauge shall be provided near all individual connections of the hydrant system with isolation valves. Pressure gauge shall be 100 mm dia gunmetal bourdon type with gunmetal isolation ball valve, tapping and connecting pipe and nipple. The gauge shall be installed at appropriate height for easy readability.

13. PAINTING

All Hydrant pipes shall be painted with post office red colour paint. All M S pipes shall first be cleaned thoroughly before application of primer coat. After application of primer coat two coats of enamel paint shall be applied. Each coat shall be given minimum 24 hours drying time. No thinners shall be used. Wherever required all pipe headers shall be worded indicating the direction of the pipe and its purpose such as "TO RISER NO.1" etc. Painting shall be expertly applied, the paint shall not over run on surfaces not requiring painting such as walls, surfaces etc. Nuts and bolts shall be painted black, while valves shall be painted blue.

14. EXCAVATION

Excavation for pipe lines shall be in open trenches to levels and grades shown on the drawings or as required at site. Pipe lines shall be burried with a minimum cover of 1 meter or as shown on drawings. Wherever required Contractor shall support all trenches or adjoining structures with adequate timber supports, shoring and strutting.On completion of testing in the presence of the Project Manager and pipe protection, trenches shall be backfilled in 150 mm layers and consolidated.Contractor shall dispose off all surplus earth as directed by the Project Manager.

15. ANCHOR / THRUST BLOCK

Contractor shall provide suitably designed anchor blocks in cement concrete/steel support to cater to the excess thrust due to work hammer and high pressure Thrust blocks shall be provided at all bends, tees and such other location as determined by the Project Manager.Exact location, design, size and mix of the concrete blocks/steel support shall be as shown on the drawings or as directed by the Project Manager prior to execution of work.

16. FIRE HYDRANTS

16.1 **External Hydrants**

Contractor shall provide external hydrants. The hydrants shall be controlled by a cast iron wheel. Hydrants shall have instantaneous type 63mm dia outlets. The hydrants shall be single outlet conforming to IS:5290 with bend and riser or required height to bring the hydrant to correct level above ground.

Contractor shall provide for each external fire hydrant two numbers of 63mm dia. 15 m long

controlled percolation hose pipe with SS male and female instantaneous type couplings machine wound with copper wire (hose to IS:636 type certification) , SS branch pipe with nozzle to IS:903. This shall be measured and paid for separately.

Each hose cabinet shall be conspicuously painted with the letters “FIRE HOSE”.

16.2 **Internal Hydrants**

Contractor shall provide on each landing and other locations as shown on the drawings double headed SS landing valve with 100 mm dia inlet as per IS:5290, with shut off valves having cast iron wheels as shown on the drawings. Landing valve shall have flanged inlet and instantaneous type outlets as shown on the drawings.

Instantaneous outlets for fire hydrants shall be standard pattern and suitable for fire hoses.

Contractor shall provide for each internal fire hydrant station two numbers of 63 mm dia. 15 m long rubberized fabric lined hose pipes with SS male and female instantaneous type coupling machine would with copper wire (hose to IS:636 type A and couplings to IS:903 with IS certification), fire hose reel, SS branch pipe with nozzle to IS:903. This shall be measured and paid for separately.

Contractor shall provide standard fire hose reels of 20mm dia high pressure rubber hose 30 m long with gunmetal nozzle, all mounted on a circular hose reel of heavy duty mild steel construction having cast iron brackets. Hose reel shall be connected directly to the wet riser with an isolating valve. Hose reel shall conform to IS:884 and shall be mounted vertically.

Each internal hydrant hose cabinet shall be provided with a drain in the bottom plate. The drain point shall be lead away to the nearest general drain.Each internal hydrant hose cabinet containing items as above shall also be provided with a nozzle spanner and a Fireman’s Axe. The cabinet shall be recessed in the wall as directed. This shall be measured and paid for separately.Each hose cabinet shall be conspicuously painted with the letters “FIRE HOSE”.

17. Hose Reel

Hose reel shall conform to IS : 884, heavy duty, 20 mm dia length shall be 30 metre long fitted with SS chromium plated nozzle, mild steel pressed reel drum which can swing upto 170 degree with wall brackets of cast iron finished with red and black enamel complete.

18 Fire Hose

All hose pipes shall be of 63 mm diameter RRL as required, conforming to IS : 636. The hose shall be provided with SS delivery coupling. The hose shall be capable of withstanding a bursting pressure of 35.7 Kg/Sq.cm without undue leakage or sweating. Hose shall be provided with instantaneous spring-lock, type couplings.

19. Branch Pipe, Nozzle

Branch pipes shall be of SS with loaded tin bronze ring at the discharge and to receive the nozzle and provided at the other with a leaded tin bronze ring to fit into the instantaneous coupling. Nozzle shall be of spray type of diameter of not less than 16 mm and not more than 25 mm. Nozzle shall be of loaded tin bronze branch pipe and nozzle shall be of instantaneous pattern conforming to Indian Standard -

20. Hose Cabinet

Hose cabinet shall be provided for all internal and external fire hydrants. External Hose cabinets shall be fabricated from 14 gauge MS powder coated sheet of fully welded construction with hinged double front door partially glazed (3 mm glass panel) with locking arrangement, stove enamelled fire red paint (shade No. 536 of IS:5) with "FIRE HOSE" written on it prominently (The word `FIRE HOSE' shall be in letters of at least 35mm in height. The words shall be painted white on red back ground). Cabinet surfaces in contact with the walls shall not be powder coated but instead given two coats of anti-corrosive bitumastic paint.

20.1 Internal Hose Cabinet

Hose cabinet shall be of glass fronted with hinged door & lock. The cabinet shall be made of hollow box section, powder caoted to shade No. 536 of IS:5. The hose cabinet shall be of size to accommodate the following and size is :

i. Landing Valves (Single headed)
ii. Hose pipe
iii. Hose reel (30 mtr.)
iv. Branch pipes, nozzles (1 sets)
v. Fire man's axe and hand appliances

20.2 External Hose Cabinet

The hose cabinet shall be of size to accommodate the following:

i. Single/Double headed yard hydrant valve
ii. Hose pipe (2 length of 15 m)
iii. Branch pipes, nozzles (1 sets)
iv. Fire man's axe

21 HAND HELD FIRE EXTINGUISHERS

21.1 Scope

Work under this section shall consist of furnishing all labour, materials, appliances and equipment necessary and required to install fire extinguishing hand appliances as per relevant specification of various authorities.

Without restricting to the generality of the foregoing, the work shall consists of the following:

Installation of fully charged and tested fire extinguishing hand appliances of A B C powder type as required and specified in the drawings and schedule of rates.

21.2 General Requirements

Hand appliances shall be installed in easily accessible locations with the brackets fixed to the wall by suitable anchor fasteners.

Each appliance shall be provided with an inspection card indicating the date of inspection, testing, change of charge and other relevant data.

All appliances shall be fixed in a true workmanlike manner truly vertical and at correct locations.

Distribution / installation of fire extinguisher to be in accordance to IS:2190.

21.3 Measurement

Fire extinguishers shall be counted in numbers and include installation of all necessary items required as given in the specifications.

21.4 ABC Type Dry Powder Extinguisher

The Extinguisher shall be filled with ABC grade 40, Mono Ammonium Phosphate 40% from any approved manufacturer.

The capacity of the extinguisher when filled with Dry Chemical Powder (First filling) as per IS 15683-2006, shall be 5 Kg +/-2% or 10 Kg +/- 3%.

The distribution of fire extinguishers to be as per IS 2190 – 1992.

It shall be operated upright, with a squeeze grip valve to control discharge. The plunger neck shall have a safety clip, fitted with a pin, to prevent accidental discharge. It shall be pressurised with Dry Nitrogen, as expellant. The Nitrogen to be charged at a pressure of 15 Kg/cm2 Body shall be of mild steel conforming to relevant IS Standards. The neck ring shall be also mild steel and welded to the body. The discharge valve body, shall be forged brass or leaded bronze, while the spindle, spring and siphon tube shall be of brass. The nozzle shall be of brass, while the hose shall be braided nylon. The body shall be cylindrical in shape, with the dish and dome welded to it. Sufficient space for Nitrogen gas shall be provided inside the body, above the powder filling.

The Neck Ring shall be externally threaded - the threading portion being 1.6 cm. The filler opening in the neck ring shall not less than 50 mm. Discharge nozzle shall be screwed to the hose. The design of the nozzle shall meet the performance requirement, so as to discharge at least 85% of contents upto a throw of 4 mtrs, continuously, at least for 15 seconds. The hose, forming part of discharge nozzle, shall be 500 mm long, with 10 mm dia internally for 5 Kg capacity and 12 mm for 10 Kg capacity. It shall have a pressure gauge fitted to the valve assembly or the cylinder to indicate pressure available inside. The extinguisher shall be treated with anti-corrosive paint, and it shall be labelled with words ABC 2.5 cm long, within a triangle of 5 cm on each face. The extinguisher body and valve assembly shall withstand internal pressure of 30 Kg/cm2 for a minimum period of 2 minutes. The pressure gauge shall be imported and suited for the purpose.

21.5 Water Type Extinguisher (Gas Pressure Type)

The Extinguishing medium shall be primarily water stored under normal pressure, the discharge being affected by release of Carbon Dioxide Gas from a 120 gms cylinder. The capacity of Extinguisher, when filled upto the indicated level, shall be 9 ltr +/- 5%. The skin thickness of the Cylinder shall be minimum 4.0 mm, fabricated from Mild Steel sheet, welded as required, with dish and dome, being of same thickness, and of size not exceeding the diameter of body. The diameter of body to be not less than 150 mm and not exceeding 200 mm. The neck shall be externally threaded upto a minimum depth of 16 mm, and leaded tin bronze. The cap shall be of leaded tin bronze, and screwed on the body upto a minimum of 1.6 cm depth, with parallel screw thread to match the neck ring. The siphon tube to be of brass or G.I. and the strainer of Brass. The cartridge holder, knob, discharge fittings and plunger to be of Brass/Leaded tin bronze, and plunger of stainless steel, spring of stainless steel. The cap to have handle fixed to it. The discharge hose shall be braided nylon, of 10 mm dia and 600 mm long, with a nozzle of brass fitted at end.

The extinguisher shall be treated for anti-corrosion internally and externally, and externally painted with Fire Red paint. The paint shall be stove enamelled/powder coated. The cartridge shall be as per IS, and have 60 gm net carbon dioxide gas for expelling. The extinguisher, body and cap shall be treated to an internal hydraulic pressure of 25 Kg/cm2. It shall have external marking with letter A, of 2.5 cm height, in block letters within a triangle of 5 cm each side. The extinguisher shall be upright in operation, with the body placed on ground and discharge tube with nozzle held in one hand to give a throw of not less than 6 mtr, and continue so for atleast 60 secs. The extinguisher body shall be clearly marked with ISI stamp (IS 15683-2006).

21.6 Carbon Dioxide Extinguisher

The Carbon Dioxide Extinguisher shall be as per IS: 15683:2006

The body shall be constructed of seamless tube conforming to IS:7285 and having a convex dome and flat base. Its dia shall be maximum 140 mm, and the overall height shall not exceed 720 mm.

The discharge mechanism shall be through a control valve conforming to IS:3224. The internal siphon tube shall be of copper aluminium conforming to relevant specifications. Hose Pipe shall be high pressure braided Rubber hose with a minimum burst pressure of 140 Kg/cm2 and shall be approximately 1.0 meter in length having internal dia of 10 mm. The discharge horn shall be of high quality unbreakable plastic with gradually expanding shape, to convert liquid carbon dioxide into gas form. The hand grip of Discharge horn shall be insulated with Rubber of appropriate thickness. The gas shall be conforming to IS:307 and shall be stored at about 85 Kg/cm2. The expansion ratio between stored liquid carbon dioxide to expanded gas shall be 1:9 times and the total discharge time (effective) shall be minimum 10 secs and maximum 25 secs. The extinguisher shall fulfill the following test pressures:

Cylinder: 236 Kg/cm2
Control Valve: 125 Kg/cm2
Burst Pressure of Hose: 140 Kg/cm2 minimum

It shall be an Upright type. The cylinder, including the control valve and high pressure Discharge Hose must comply with relevant Statutory Regulations, and be approved by Chief Controller of Explosives, Nagpur and also bear IS marking. The Extinguisher including components shall be IS marked.

21.7 Mechanical Foam Type Extinguisher

The capacity of Extinguisher, when filled upto the indicated level, shall be 9 ltr +/- 5%. The skin thickness of the Cylinder shall be minimum 4.0 mm, fabricated from Mild Steel sheet, welded as required, with dish and dome, being of same thickness, and of size not exceeding the diameter of body. The diameter of body to be not less than 150 mm and not exceeding 200 mm. The neck shall be externally threaded upto a minimum depth of 16 mm, and leaded tin bronze. The cap shall be of leaded tin bronze, and screwed on the body upto a minimum of 1.6 cm depth, with parallel screw thread to match the neck ring. The siphon tube to be of brass or G.I. and the strainer of Brass. The cartridge holder, knob, discharge fittings and plunger to be of Brass/Leaded tin bronze, and plunger of stainless steel, spring of stainless steel. The cap to have handle fixed to it. The discharge hose shall be braided nylon, of 10 mm dia and 600 mm long, with a nozzle of brass fitted at end.

The extinguisher shall be treated for anti-corrosion internally and externally, and externally painted with Fire Red paint. The paint shall be stove enamelled/powder coated. The extinguisher, body and cap shall be treated to an internal hydraulic pressure of 25 Kg/cm2. It shall have external marking with letter C, of 2.5 cm height, in block letters within a triangle of 5 cm each side. The extinguisher shall be upright in operation, with the body placed on ground and discharge tube with nozzle held in one hand to give a throw of not less than 6 mtr, and continue so for atleast 60 secs. The extinguisher body shall be clearly marked with ISI stamp (IS 15683-2006).

22 FIRE PUMPS AND ALLIED EQUIPMENTS

22.1 Scope

Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install electrically operated and diesel driven pumps and as required by design drawings .

a. Electrically operated pumps with motors and diesel engine driven pumps with diesel engine, common base plates, coupling, coupling guard and accessories.
b. Automatic starting system with all accessories, wiring and connections and pressure switches.
c. Motor control centre.
d. Annunciation system with all accessories wiring and connections.
e. Pressure gauges with isolation valves and piping, bleed and block valves.
f. Suction strainers and accessories.
g. Vibration eliminator pads and foundation bolts.
h. Leak-off drain shall be led to the nearest floor drain.

22.2 General Requirements

Pumps shall be installed true to levels on suitable concrete foundations. Base plate shall be firmly fixed by properly grouted foundation bolts.

Pumps and motors shall be truly aligned by suitably instruments. Record of such alignment shall be furnished to the Project Manager.

All pump connections shall be standard flanged type with number of bolts as per relevant standard requirement for the working pressure. Companion flanges shall be provided with the pumps Manufacturers' instructions regarding installation, connections and commissioning shall be strictly followed.

Contractor shall provide necessary test certificates, type test certificates, performance curves and NPSH curves of the pumps from the manufacturer when called for. The contractor shall provide facilities to the Project Manager & Consultant for inspection of equipment during manufacturing and also to witness various tests at the manufacturer's works without any cost to the Project Manager or Consultant.

Seismic isolation and clamping for each pump and flexible connection on the suction as well as the discharge side shall be provided.

The contractor shall submit with this tender a list of recommended spare parts for three years of normal operation and quote the prices for the same as a separate submittal / annexure.

22.3 Electric Fire Pump

The electric fire pump shall be suitable for automatic operation complete with necessary electric motor and automatic starting gear, suitable for operation on 415 volts, 3 phase, 50 Hz. A.C. system. Both the motor and the pump shall be factory assembled on a common base plate, fabricated M.S. channel type or cast iron type.

Drive

The pump shall be direct driven by means of a flexible coupling. Coupling guard shall also be provided.

Fire Pump

The fire pump shall be horizontally mounted multistage centrifugal type. It shall have a capacity to deliver 2280 lpm as specified, and developing adequate head so as to ensure a minimum pressure of 3.5 Kg/Sq.cm at the highest and the farthest outlet.

The pump shall be capable of giving a discharge of not less than 150 per cent of the rated discharge, at a head of not less than 65 per cent of the rated head. The shut off head shall be within 120 per cent of the rated head.

The pump casing shall be of cast iron to grade FG 200 to IS: 210 and parts like impeller, shaft sleeve, wearing ring etc. shall be of non-corrosive metal like bronze/brass/gun metal. The shaft shall be of stainless steel. Provision of mechanical seal shall also be made. Bearings of the pump shall be effectively sealed to prevent loss of lubricant or entry of dust or water.

The pump shall be provided with a plate indicating the suction lift, delivery head, discharge, speed and number of stages. The pump casing shall be designed to withstand 1.5 times the working pressure.

Provision of Jockey Pump shall be made. The pump shall be vertical SS type and of detail as in schedule of quantity. Contractor shall verify that the capacity of the Jockey pump shall not be less than 3% (Minimum 180 LPM) and not more than 10% of the installed pump capacity.

Motor

The motor shall be squirrel cage A.C. induction type suitable for operation on 415 volts 3 phase 50 Hz. system. The motor shall be totally enclosed fan cooled type conforming to protection clause IP 55. The class of insulation shall be F. The synchronous speed shall be 1500 RPM as specified. The motor shall be rated for continuous duty and shall have a horse power rating necessary to drive the pump at 150 per cent of its rated discharge with at least 65 per cent rated head. The motor shall conform to I.S.325-1978.

Motor Starter

The motor starter shall be as per detail in MCC. The unit shall include suitable current transformer and ammeter of suitable range on one line to indicate the current. The starter shall not incorporate under voltage, no voltage trip overload or SPP.

The starter assembly shall be suitably integrated in the power and control panel for the wet riser system.

22.4 Diesel Fire Pump

General

The diesel pump set shall be suitable for automatic operation complete with necessary automatic starting gear, for starting on wet battery system and shall be complete with all accessories. Both engine and pump shall be assembled on a common base plate.

Drive

The pump shall be only direct driven by means of a flexible coupling. Coupling guard shall also be provided. The speed shall be 1500 RPM as specified.

Fire Pump

The fire pump shall be horizontally mounted centrifugal multi stage. It shall have a capacity to deliver as specified, and developing adequate head so as to ensure a minimum pressure of 3.5 Kg/Sq.cm at the highest and the farthest outlet. The pump shall be multi stage as specified. The pump shall be capable of giving a discharge of not less than 150% of the rated discharge at a head of not less than 65% of the rated head. The shut off head shall be within 120% of the rated head. The pump casing shall be of cast iron to grade FG 200 to IS 210 and parts like impeller, shaft sleeves, wearing-ring etc. shall be of non-corrosive metal like bronze/brass/gun metal. The shaft shall be stainless steel. Provision of mechanical seal shall also be made. The pump casing shall be designed to withstand 1.5 times the working pressure. Bearing of pump shall be effectively sealed to prevent loss of lubricant or entry of dust or water.

Diesel Engine

Engine Rating - The engine shall be cold starting type without the necessity of preliminary heating of the engine cylinders or combustion chamber (for example, by wicks, cartridge, heater, plugs etc.). The engine shall be multi cylinder/vertical 4 stroke cycle, aircooled, diesel engine, developing suitable HP at the operating speed specified to drive the fire pump. Continuous capacity available for the load shall be exclusive of the power requirement of auxiliaries of the diesel engine, and the after correction for altitude, ambient temperature and humidity for the specified environmental conditions. This shall be at least 20% greater than the maximum HP required to drive the pump at its duty point. It shall also be capable of driving the pump at 150% of the rated discharge at 65% of rated head. The engine shall be capable of continuous non-stop operation for 8 hours and major overhaul shall not be required before 3000 hours of operation. The engine shall have 10% overload capacity for one hour in any period of 12 hours continuous run. The engine shall accept full load within 15 seconds from the receipt of signal to start. The diesel engine shall conform to BS 649/IS 1601/IS 10002, all amended up to date.

a. **Engine Accessories** - The engine shall be complete with the following accessories:-

   Fly wheel dynamically balanced.
   Direct coupling for pump and coupling guard.
   Corrosion Resistor.
   Air cleaner.
   Fuel service tank support, and fuel oil filter with necessary pipe work.
   Elect. starting battery (2X24 v).
   Exhaust silencer with necessary pipe work.
   Governor.
   Instrument panel housing all the gauges, including Tachometer, hour meter and starting switch with key (for manual starting).
   Necessary safety controls.

b. **Fuel System** - The fuel shall be gravity fed from the engine fuel tank to the engine driven fuel pump. The engine fuel tank shall be mounted either over or adjacent to the engine itself or suitably wall mounted on bracket. The fuel filter shall be suitably located to permit easy servicing.

   All fuel tubing to the engine shall be with copper, with flexible hose connections where required. Plastic tubing shall not be permitted.

   The fuel tank shall be of welded steel construction (3 mm. thick) and of capacity sufficient to allow the engine to run on full load for at least 8 hours. The tank shall be complete with necessary wall mounted supports, level indicator (protected against mechanical injury) inlet, outlet, overflow connections and drain plug and piping to the engine fuel tank. The outlet shall be so located as to avoid entry of any sediments into the fuel line to the engine.

   As semi rotary hand pump for filling the daily service tank together with hose pipe 5 mtr. Long with a foot valve etc. shall also form part of the scope of supply.

c. **Lubricating Oil System**- Forced feed Lub. Oil system shall be employed for positive lubrication. Necessary Lub. oil filters shall be provided, located suitably for convenient servicing.

d. **Starting System**- The starting system shall comprise necessary batteries (2x24v), 24 volts starter motor of adequate capacity and axle type gear to match with the toothed ring on the fly wheel. Bi metallic relay protection to protect starting motor from excessively long cranking runs suitably integrated with engine protection system shall be included within the scope of the work. The capacity of the battery shall be suitable for meeting the needs of the starting system. The battery capacity shall be adequate for 10 consecutive starts without recharging with cold engine under full compression. The scope shall cover all cabling, terminals, initial charging etc.

e. **Exhaust System** - The exhaust system shall be complete with silencer suitable for indoor installation and silencer piping including bends and accessories needed for a run of 5 metre from the engine manifold.(Adjustment rates for extra lengths shall also be given). The total back pressure shall not exceed the engine manufacture's recommendation. The exhaust piping shall be suitably supported.

f. **Engine shut down mechanism-** This shall be auto/ manually operated and shall return automatically to the starting position after use.

g. **Governing System**- The engine shall be provided with an adjustable governor to control the engine speed within 5% of its rated speed under all conditions of load up to full load. The governor shall be set to maintain rated pump speed at maximum pump load.

h. **Engine Instrumentation**- Engine instrumentation shall include the following:-

i) Lub. oil pressure gauge.
ii) Lub. oil temperature gauge.
iii) Water pressure gauge.
iv) Water temperature gauge.
v) Tachometer.
vi) Hour meter.
vii) The instrumentation panel shall be suitably resident mounted on the engine.
viii) Engine Protection Devices- Following engine protection and automatic shut down facilities shall be provided:-
  i) Low lub.oil pressure.
  ii) High cooling water temp.
  iii) High lub.oil temperature.
  iv) Over speed shut down.

i. **Pipe Work** - All pipe lines with fittings and accessories required shall be provided for fuel oil, lub.oil and exhaust systems, copper piping of adequate sizes, shall be used for Lub.oil and fuel oil. M.S. piping will be permitted for exhaust.

j. **Anti Vibration Mounting**- Suitable vibration mounting duly approved by Project Manager shall be employed for mounting the unit so as to minimize transmission of vibration to the structure. The isolation efficiency achievable shall be clearly indicated.

k. Battery Charger-Necessary float and boost charger shall be incorporated in the control section of the power and control panel, to keep the battery in trim condition. Voltmeter to indicate the state of charge of the batteries shall be provided.

22.5 Pump Sets Assembly

On the main fire hydrant headers near pump sets a 150 mm dia by-pass valve located in an accessible location shall be provided along with a rate of flow rota meter calibrated in 1 pm and able to read 200% of the rated pump capacity. The delivery shall be connected to the fire tank. Each and every pump set assembly shall be provided with suction valve (only for positive suction head), discharge valve, non-return valve and 150 mm dia Bourdon type pressure gauge with isolation valve.

22.6 Flexible Connectors

On all suction and delivery lines double flanged reinforced neoprene flexible pipe connectors shall be provided. Connectors should be suitable for maximum working pressure of each pipe line on which it is mounted and tested to a test pressure of 1:5 time the operating pressure. Length of the connector shall be as per manufacturers standard.

22.7 Interlocking

The following inter-locking between the two main fire pumps (i.e. wet riser pump), the jockey pump and the diesel engine driven pump.

Only one category of pumps will work at a time i.e. either jockey pump or main fire pumps (wet riser can come up at a time) or diesel driven pump.

	JOCKEY PUMP	WET RISER PUMP	DIESEL DRIVEN PUMP
i.	ON	OFF	OFF
ii.	OFF	ON	OFF
iii.	OFF	OFF	ON
iv.	OFF	ON	ON
v.	OFF	OFF	ON
vi.	OFF	OFF	OFF
vii	OFF	ON	OFF

Pressure Switches mounted on the pressure vessel would be set as under (all figures in kg/cm^2).

Operating Conditions for the Service Pumps

Fire Service Pump	Nos.	Cut in Pressure	Cut Out Pressure	Remarks
Jockey pump	One	5 Kg/cm^2	5.6 g/cm^2	To auto start and auto stop on pressure switch on air vessel to stop.
Main pump	One	4.5 Kg/cm^2	Push button manual	To auto start on pressure switch on air vessel and manual off.
Diesel Fire Pump	One	4.0 Kg/Cm^2	Push button manual	To auto start on pressure switch on air vessel and manual off.

24.8 Annunciation Panel

One solid state electronic annunciation panel, fully wired with visual display and audible alarm unit shall be provided to indicate :

a. Flow condition in any flow switch indicating the area of distress and fire alarm.
b. Starting and stopping of each hydrant pump.
c. Starting and stopping of each jockey pump.
d. Failure of Hydrant pump to start.
e. High level in fire water storage tank compartment.
f. Low level in fire water storage tank compartment.
g. Low level in HSD day tank of the fire pump.

The panel shall be factory fabricated, wired and tested. All details shall be submitted with the tender.

The annunciation panel shall be located in the security office / reception on the ground floor or as instructed by the Project Manager.

24.9 Vibration Isolation

The pump set shall be mounted on rolled steel channels and 150 mm thick inertia block spring and ribbed neoprene vibration isolation mounting shall support the inertia block onto a 100 mm thick concrete plinths. The spring mountings shall have a maximum deflection of 15 mm. Reference shall be made to the section on “Nose and Vibration” for further technical requirements.

SECTION-II

COMMISSIONING & GUARANTEE

1. SCOPE OF WORK

Work under this section shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this section.

Contractor shall provide all tools, equipment, metering and testing devices required for the purpose.

On award of work, Contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

All tests shall be made in the presence of the Consultants or his representative or any inspecting authority.

At least five working days notice in writing shall be given to the inspecting parties before performing any test.

Water flow rates of all equipment and in pipe lines through valves shall be adjusted to design conditions.

Complete results of adjustments shall be recorded and submitted.

Contractor shall ensure proper balancing of the hydraulic system and for the pipes / valves installed in his scope of work by regulating the flow rates in the pipe line by valve operation. The contractor shall also provide permanent Tee connection (with plug) in Fire water lines for ease of installing pressure gauge, temperature gauge & rota meters. Contractor shall also supply all required pressure gauge, temperature gauge & rotameter for system commissioning and balancing. The balancing shall be to the satisfaction of Consultant / Project Manager.

Three copies of all test results shall be submitted to the Engineer in A4 size sheet paper within two weeks after completion of the tests.

2. PRECOMMISSIONNIG

On completion of the installation of all pumps, piping, valves, pipe connections, insulation etc. the Contractor shall proceed as follows:

a. Prior to start-up and hydraulic testing, the Contractor shall clean the entire installation including all fitments and pipe work and the like after installation and keep them in a new condition. All pumping systems shall be flushed and drained at least once through to get rid of contaminating materials. All pipes shall be rodded to ensure clearance of debris, cleaning and flushing shall be carried out in sections as the installation becomes completed.

b. All strainers shall be inspected and cleaned out or replaced.

c. When the entire systems are reasonably clean, a pre-treatment chemical shall be introduced and circulated for at least 8 hours. Warning signs shall be provided at all outlets during pretreatment. The pre-treatment chemical shall:Remove oil, grease and foreign residue from the pipe work and fittings; Pre-condition the metal surfaces to resist reaction with water or air. Establish an initial protective film; After pre-treatment, the system shall be drained and refilled with fresh water and left until the system is put into operation. Details and procedures of the pre-treatment shall be submitted to the Consultant/Client for approval.

d. Check all clamps, supports and hangers provided for the pipes.

e. Check all the equipment, piping and valves coming under hot water system and operate each and every valve on the system to see if the valves are functioning properly. Thereafter conduct & hydro test of the system.

f. Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specification. If any leakage is found, rectify the same and retest the pipes.

Fire Protection System

a. Check all hydrant valves by opening and closing : any valve found to be open shall be closed.
b. Check all the piping under hydro test.
c. Check that all suction and delivery connections are properly made for all pump sets.
d. Check rotation of each motor after decoupling and correct the same if required.
e. Test run each pump set.
f. All pump sets shall be run continuously for 8 hours (if required with temporary piping back to the tank).

Commissioning and Testing

a. Pressurise the fire hydrant system by running the jockey pump and after it attains the shutoff pressure of the pump , then.

b. Open bypass valve and allow the pressure to drop in the system. Check that the jockey pump cuts-in and cuts-out at the preset pressure. If necessary adjust the pressure switch for the jockey pump. Close by-pass valve.

c. Open hydrant valve and allow the water to below into the fire water tank in order to avoid wastage of water. The main fire pump shall cut-in at the preset pressure and shall not cutout automatically on reaching the normal line pressure. The main fire pump shall stop only by manual push button. However the jockey pump shall cut-out as soon as the main pump starts.

d. Switch off the main fire pump and test check the diesel engine driven pump in the same manner as the electrically driven pump.

e. When the fire pumps have been checked for satisfactory working on automatic controls, open fire hydrant valves simultaneously and allow the hose pipes to discharge water into the fire tank to avoid wastage.

f. Check each landing valve, male and female couplings and branch pipes, for compatibility with each other. Any fitting which is found to be incompatible and do not

fit into the other properly shall be replace by the Contractor. Each landing valve shall also be checked by opening and closing under pressure.

g. Check all annunciations by simulating the alarm conditions at site.

3. STATUTORY AUTHORITIES' TESTS AND INSPECTIONS

As and when notified in writing or instructed by the Consultants, the Contractor shall submit shop drawing and attend all tests and inspections carried out by Local Fire Authorities, Water Authority and other Statutory Authorities, and shall forthwith execute free of charge any rectification work ordered by the CFO as a result of such tests and inspections where these indicate non-compliance with Statutory Regulations. Some of these tests may take place after the issue of Practical Completion of the Main Contract and the Contractor shall make all allowances in this respect.

The Contractor shall be responsible for the submission of all necessary forms and shop drawings to the Statutory Authorities which shall conform in layout to the latest architectural plans submitted to and kept by these Authorities.

The submission shall comply with the requirements set forth in the current Codes of Practice and circular letters of the Statutory Authorities. The shop drawings to be submitted shall be forwarded to the Architect/Consultants for checking before submission.

The Contractor shall allow for at least two submissions of complete sets of shop drawings to the Authorities, one to be made within six months after the award of the Contract but not less than six weeks before the inspection. The Consultants may at his discretion instruct the Contractor for additional submissions to the Local Authorities whenever necessary.

The Contractor shall notify the Consultants at least seven days in advance of his application for local Authority tests and inspections. On receipt of a confirmed date for test and inspection the Contractor shall inform the Consultants without delay.

4. FINAL ACCEPTANCE TESTS

Following commissioning and inspection of the entire installation, and prior to issue of the Completion Certificate, the Contractor shall carry out final acceptance tests in accordance with a programme to be agreed with the Consultants.

Should the results of the acceptance tests show that plant, systems and/or equipment fail to perform tocthe efficiencies or other performance figures as given in this Specification, the Contractor shall adjust, modify and if necessary replace the equipment without further payment in order that the required performance is obtained.

Where acceptance tests are required by the relevant Authorities having jurisdiction, these tests shall be carried out by the Contractor prior to the issue of Completion Certificate to the acceptance of the Authorities.

5. REJECTION OF INSTALLATION / PLANT

Any item of plant or system or component which fails to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection

or on completion at site may be rejected by the Consultants either in whole or in part as he considers necessary/appropriate.

Adjustment and/or modification work as required by the Consultants so as to comply with the Authority's requirements and the intent of the Specification shall be carried out by the Contractor at his own expense and to the satisfaction of the Authority/Consultants.

After works have been accepted, the Contractor may be required to carry out assist in carrying out additional performance tests as reasonably required by the Consultants/Employer.

6. WARRANTY AND HANDOVER

The Contractor shall warrant that all plant, materials and equipment supplied and all workmanship performed by him to be free from defects of whatsoever nature before handover to the Owner.

7. HANDING OVER OF DOCUMENTS

All testing and commissioning shall be done by the Contractor to the entire satisfaction of the Owner’s site representative and all testing and commissioning documents shall be handed over to the Owner’s site representative.

The Contractor shall also hand over all maintenance and operation manuals, all certificates and all other documentation as per the terms of the contract to the Owner’s site representative.

8. CHECK LIST FOR COMMISSIONING

Fire Protection System

Check all hydrant & other valves by opening and closing. Any valve found to be open shall be closed.

Check all clamps, supports and hangers provided for the pipes.

All the pump sets shall be run continuously for 30 minutes (with temporary piping back to tank from the nearest hydrant, using canvas hose pipes).

Fire Hydrant System - Pressurise the fire hydrant system by running the jockey pump and after it attains the shutoff pressure of the pump, then Open bypass valve and allow the pressure to drop in the system. Check that the jockey pump cuts-in and cuts-out at the preset pressure. If necessary adjust the pressure switch for the jockey pump. Close by-pass valve. Open hydrant valve and allow the water to flow into the fire water tank in order to avoid wastage of water. The main fire pump shall cut-in at the preset pressure and shall not cutout automatically on reaching the normal line pressure. The main fire pump shall stop only by manual push button. However the jockey pump shall cut-out as soon as the main pump starts. Operate booster pump continuously for 30 minutes with piping back to underground tanks from the hydrant nearest to plant room.
Check each landing valve, male and female couplings and branch pipes, for compatibility with each other. Any fitting which is found to be incompatible and do not fit into the other properly shall be replaced by the Contractor. Each landing valve shall also be checked by opening and closing under pressure.

SECTION-III

TECHNICAL DATA SHEETS
FIRE PROTECTION SYSTEM
FIRE PUMPS & MOTOR

1. Electrical Driven Main Fire Pumps

Make / Manufacturer	:
Quantity	:
Liquid Handed	:
Liquid Temp deg.C	:
Special Gravity of Liquid	:
Suction	:
Rated Discharge	:
Actual Discharge	:
Model	:
Horizontal / Design	:
Speed / No. of Stages	:
Impeller Dia (Maximum)	:
Suction / Delivery Size	:
Efficiency at Rated Capacity & Head	:
KW required at rated capacity & head	:
Shut Off Head	:

Material of Construction

Pump Casing	:
Impeller	:
Pump Shaft	:
Shaft Sleeve	:
Casing Wearing Ring	:
Base Plate	:
Mechanical Seal	:
Make of Mechanical Seal	:
Wheather pumps is capable of discharging 150% of rated capacity at a head not less than 65% of rated head.	:
Whether automatic priming arrangement Included	:

Description of Motors

Make	:
Model No.	:
Type	:
Frame size	:
Speed (RPM)	:
Rated Capacity (Power)	:
Full load current	:
Enclosure	:
Coupling / Pulley	:
Class of Insulation	:
Size of Foundation	:
For complete coupled set mounted over MS base frame	:

2. Diesel Engine Driven Pump

Make / Manufacturer :
Quantity :
Liquid Handed :
Liquid Temp deg.C :
Special Gravity of Liquid :
Suction :
Rated Discharge :
Actual Discharge :
Model :
Horizontal / Design :
Speed / No. of Stages :
Impeller Dia (Maximum) :
Suction / Delivery Size :
Efficiency at Rated Capacity & Head :
KW required at rated capacity & head :
Shut Off Head :

Material of Construction

Pump Casing :
Impeller :
Pump Shaft :
Shaft Sleeve :
Casing Wearing Ring :
Base Plate :
Mechanical Seal :
Make of Mechanical Seal :
Wheather pumps is capable of discharging 150% of rated capacity at a head not less than 65% of rated head. :
Whether automatic priming arrangement Included :

Description of Engine

Make :
Model No. :
Type :
Frame size :
Speed (RPM) :
Rated Capacity (Power) :
Full load current :
Enclosure :
Coupling / Pulley :
No of Cylinder :
Fuel Pump & Water pump detail :
Engine Cooling & Oil System :
Diesel Oil tank capacity :
Fuel Oil storage shall ensure working of pump for number of hours :
Size of Foundation
For complete coupled set mounted over MS base frame :

3 Jockey Pump

(Please submit separate data sheet for each type of pump)

Liquid Handed :

Liquid Temp deg.C :
Special Gravity of Liquid :
Suction :
Rated Discharge at Low Zone Head :
Rated Discharge at High Zone Head :
Actual Discharge at Low Zone Head :
Actual Discharge at High Zone Head :
Model :
Horizontal / Design :
Speed / No. of Stages :
Impeller Dia (Maximum) :
Suction / Delivery Size :
Efficiency at Rated Capacity & Head :
KW required at rated capacity & head :
Shut Off Head : :

Material of Construction

Pump Casing :
Impeller :
Pump Shaft :
Shaft Sleeve :
Casing Wearing Ring :
Base Plate :
Mechanical Seal :
Make of Mechanical Seal :

Description of Motor

Make :
Model No. :
Type :
Frame size :
Speed (RPM) :
Rated Capacity (Power) :
Full load current :
Enclosure :
Coupling / Pulley :
Size of Foundation
For complete coupled set mounted over MS base frame :

4. **PIPING**

15 NB TO 50 NB :
15 TO 50 NB Fittings :
65 NB TO 150 NB Pipes :
65 NB TO 150 NB Fittings :
200 NB ONWARDS Pipes :
200 NB ONWARDS Fittings :
Flanges :
Gaskets :

5. **HYDRANT VALVES**

Technical Specifications :

Make :
Working Pressure :

Code for Design Mft. :
Construction Features
Type of Stem :
Type of Inlet :
Type of Outlet :
Flange Drilling :
Material of Construction
Body and Bonnet :
Stop Valve, Valve Seat :
Check nut & gland nut :

6. PRESSURE GAUGE

Technical Specifications :
Make :
Working Pressure :
Code for Design Mft. :
Scale range :
Construction Features
Case :
Pointer :
Dial Size :
Dial Lettering :
Process Connection :
Material of Construction
Case :
Movement :
Block :

7. PRESSURE SWITCHES

Technical Specifications
Make :
Working Pressure :
Scale range :
Construction Features
Protection :
Cable Entry :
Process Connection :
Repeatability :
Switch :
Type : :
No. of contacts :
Contact Rating :
Material of Construction
Enclosure :
Pressure element :
Wetted Parts :

8. ELECTRICAL ACCESSORIES

MAKE OF THE FOLLOWING
a. Motor Control Centre (Electrical Panel) :
b. Vacuum circuit breaker :

c. Air circuit breaker :
d. MCCB :
e. MCB :
f. Rotary switch :
g. Soft Starter :
h. Auto-transformer Starter :
j. Automatic Star Delta Starter :
k. Direct on line Starter :
l. Contactor :
m. Current Transformer (cast resin type) :
n. Single phase preventor :
o. Push Button :
p. Change over switch :
q. Ammeter & Voltmeter :
KWH meter
r. Relay :
s. Indication lamp :
t. Cables :
u. Wires :
v. Variable Frequancy Drive. :

SECTION-IV
LIST OF BUREAU OF INDIAN STANDARDS CODES

All equipment, supply, erection, testing and commissioning shall comply with the requirements of Indian Standards and code of practices given below as amended upto 30th April, 2002. All equipment and material being supplied by the contractor shall meet the requirements of IS, electrical inspectorate and Indian Electricity rules and other Codes / Publications as given below:

1. **Pipes and Fittings**

IS : 1239 (Part 1)	Mild steel, tubes, tubulars and other wrought steel fittings: Part 1 Mild Steel tubes.
IS : 1239 (Part 2)	Mild Steel tubes, tubulars and other wrought steel fittings: Part 2 Mild Steel tubulars and other wrought steel pipe fittings.
IS : 1879	Malleable cast iron pipe fittings.
IS : 3468	Pipe nuts.
IS : 3589	Seamless or electrically welded steel pipes for water, gas and sewage (168.3 mm to 2032 mm outside diameter).
IS : 4346	Specifications for washers for use with fittings for water services.
IS : 4711	Methods for sampling steel pipes, tubes and fittings.
IS : 6392	Steel pipe flanges
IS : 6418	Cast iron and malleable cast iron flanges for general engineering purposes.

2. **Valves**

IS : 778	Specification for copper alloy gage, globe and check valves forwater works purposes.
IS : 780	Specification for sluice valves for water works purposes (50 mm to 300 mm size).
IS : 1703	Specification copper alloy float valves (horizontal plunger type) for water supply fittings.
IS : 3950	Specification for surface boxes for sluice valves
IS : 5312 (Part 1)	Specification for swing check type reflux (non return) valves : part 2 Multi door pattern.
IS : 5312 (Part 2)	Specification for swing check type reflux (non return) valves : part 2 Multi door pattern.
IS : 13095	Butterfly valves for general purposes.

3. **Fire Fighting Equipment**

TAC Tariff Advisory Committee fire protection manual Part-I.
TAC Rules of Tariff Advisory Committee for automatic sprinkler system.
NFPA : 13 Installation of Sprinkler System
NFPA : 14 Installation of Standpipe & Hose System
NFPA : 20 Installation of Stationary pump for Fire Protection
IS : 636 Non-percolating flexible fire fighting delivery hose.
IS : 884 Specification for first aid hose reel for fire fighting.
IS : 901 Specification for couplings, double male and double female, instantaneous pattern for fire fighting.
IS : 902 Suction hose couplings for fire fighting purposes.

IS : 903 Specification for fire hose delivery couplings, branch pipe, nozzles and nozzle spanner.
IS : 904 Specification for 2-way and 3-way suction collecting heads for fire fighting purposes.
IS : 907 Specification for suction strainers, cylindrical type for fire fighting purposes.
IS : 908 Specification for fire hydrant, stand post type.
IS : 909 Specification for underground fire hydrant, sluice valve type.
IS : 910 Specification for portable chemical foam fire extinusiher.
IS : 933 Specification for portable chemical foam fire extinguisher.
IS : 1648 Code of practice for fire safety of building (general): Fire fighting equipment and its maintenance.
IS : 2171 Specification for portable fire extinguishers dry powder (catridge type)
IS : 2190 Selection, installation and maintenance of first aid fire extinguishers– Code of practice.
IS : 2871 Specification for branch pipe, universal, for fire fighting purposes.
IS : 2878 Specification for fire extinguishers, carbon dioxide type (portable and trolley mounted).
IS : 3844 Code of practice for installation and maintenance of internal fire hydrants and hose reel on premises.
IS : 5290 Specification for landing valves.
IS 5714 Specification for coupling, branch pipe, nozzle, used in hose reel tubing for fire fighting.
IS : 8423 Specification for controlled percolation type hose for fire fighting.
IS : 10658 Specification for higher capacity dry powder fire extinguisher (trolley mounted).
IS : 11460 Code of practice for fire safety of libraries and archives buildings.
IS : 13039 Ex

LIST OF APPROVED MAKES

Following list of approved vendors are provided for different materials. However contractor may procure from other equivalent vendors after approval from employer.

1. FIRE FIGHTING SYSTEM

S.NO.	DESCRIPTION	MANUFACTURER'S NAME
1	Hydrant Valves / Fire Brigade Inlet / Drawout	Newage / Safeguard / Padmini / Getech
2	Sluice Valves / Butterfly valves / Non Return Valves	AIP / Lehry / CIM / SANT
3	Ball Valves	AIP / Lehry / Leader / SANT
4	Air Release Valves	Newage / CIM / Leader / Sant
5	Strainers	Advance / Audco / SKS / AIP / Lehry
6	Fire Extinguishers	Minimax / Cease Fire / Safex / Safeguard / UFS
7	Fire Mans Axe	Newage / Safeguard / Padmini / Getech
8	Air Release Valve	CIM / Newage / Leader / Sant
9	Pressure Reducing Valve	AIP / Lehry / CIM / SANT
10	Branch Pipe and Nozzle	Newage / Safeguard / Padmini / Getech
11	Galvanized Iron Pipe / MS Pipe - IS : 1239	Jindal / Tata/ SAIL
12	G.I./ MS / M.I. Fittings	UNIK / Jainsons
13	Ductile Iron Fittings	Jainsons Industries
14	Fire Hose Pipe	Newage / Jayshree / Padmini / Safeguard / Getech / Mitras
15	Hose Reel	Newage / Safeguard / Padmini / Getech / Mitras
16	Fire Fighting Pumps	Kirloskar / Mather+Platt
17	Diesel Engine	Kirloskar / Cummins/Greaves
18	Electric Motors	Kirloskar / Crompton / Siemens
19	Pressure Switches	Danfoss / Indfoss
20	Pressure Gauge	H Guru / FIBIG
21	Flow Switches	System sensor / Honeywell
22	Sprinkler Annunciator Panel	Safeway / Agni Suraksha (ASES) / Daksh / Morley / Agni Devices
23	Sprinklers	Tyco / HD / Globe / Viking / Reliable

24	Sprinklers Flexible Hose	Tyco / HD / Globe / Viking / Padmini / Newage
25	Installation Control valve / Deluge Valve	Tyco / HD / Newage / Viking / Globe
26	Anchor Fastener / U clamp / Clevis / sprinkler hangers	Hilti / Intello Tech / Hightech / Fisher / Easy flex
27	Anti Vibration Mounting / Expansion Joint	Easyflex / Resistoflex / Kanwal / Precise
28	Paint	Asian / Berger / Nerolac / ICI
29	Any Other Itmes	On Approval of Consultant or Engineer-In-Charge
NOTE :		
The choice of the Final makes shall be made by the owner / consultant.		

2. Pump House Equipments / WTP

Pumps / Equipments	
Equipment / Material / Component	**Manufacturers Name**
Centrifugal Pumps Horizontal	Kirloskar / Mather+Platt / Wilo / Grundfos / Xylem
Submersible Pumps	Grundfos / Wilo / Xylem / KSB
Dosing Pumps	Asia LMI / Toshcon / Emec Italy
WTP	Ion Exchange / Thermax
Piping	
Equipment / Material / Component	**Manufacturers Name**
G I / MS Pipes	Jindal / TATA
GI Pipe Fittings	Unik / UNCO / R Brand
HDPE Pipes	Reliance / Duraline / Jain / Supreme
uPVC & cPVC Sch 40 & 80 Water Supply Pipe & Fittings	Astral / Supreme / Ashirwad
Butterfly Valves	Audco / Advance
NRV	DS Engg / Sant / Emerald
Strainer	CIM / Audco / Advance / AIP
Instrumentation	
Equipment / Material / Component	**Manufacturers Name**
Pressure Indicator	Manometer India / H Guru Instruments/ General Instruments/AN Instruments/ Forbes Marshall / Bells / Emerald / Japson / Waree Instruments
Level Sensor & Indicator	Toshniwal Bros./ABB/ Bells Controls / Forbes Marshal / Pune Techtrol / Level tech / Elegant
Flow Instrument System	Resemount (I) Pvt. Ltd/ABB/ E&H/ Forbes Marshall / SB Electromech /Waree Instruments/ Level tech Systems
pH meters	A-LMI/ Rosemont / Toshniwal /E&H/ Fobres Marshal / Ultraline
Bulk Water Meter	Aquamet / Kaycee / Kent

Technical Specifications for Heat, Ventilation, Air Conditioning System

Scope of Work :

The Contractor shall carry out Design, Supply, Install, Inspection, Testing and Commissioning of the Air-conditioning and Ventilation System of various building, which shall be as follows:

- Central Pavilion
- Swimming Pool Complex

Design Basis

Outside Design Conditions:

The Air conditioning & Ventilation System shall be designed considering continuous operation. The following outside design condition shall be considered for cooling load estimation:

Season	Summer	Monsoon	Winter
Dry Bulb Temperature (DBT) (^{0} C)/ (^{0} F)	43.3/ 110	30.55 / 87	12.22/ 54
Wet Bulb Temperature (WBT) (^{0} C)/ (^{0} F)	25.5 / 78	27.78 / 82	6.67 / 44
Relative Humidity (%)	24	80	41

Presently, Air-conditioning loads are estimated using tentative equipment heat load and diversity factor as per general practice.

Air Quantities for various ventilated areas shall be based on Air Changes per Hours (ACPH) which are as follows:

1	Toilet/Store	10
2	Pantry	12
3	Electrical Room /Pump /Utility Room	15

Input Data For Cooling Load Estimation:

Following Inside design conditions shall be considered for cooling load estimation:

S.No.	Location	Inside Design Conditions	
		Dry Bulb Temperature (DBT) (^{0} C)	Relative Humidity (%)
1.	Seating Area- Central Pavilion/ Swimming Pool, Media Room Room/Meeting Room, Commentary Box etc	24 ± 1	50-60
2.	Commercial areas at MLCP	25 ± 1	55-65
3.	Gym areas	25 ± 1	55-65

Noise Level Design Criteria

Office Area	50 - 55 dBA approx.

Conference Room	35 - 40 dBA approx
HVAC Unit	65 dBA at 1.5 m distance approx

Equipment Configuration For Cooling Load Estimation & Equipment Selection (TABLE- i) :

Area : Swimming Pool						
Sl. No.	**Location**	**Unit Capacity (TR)**	**Unit Qty.**	**Total Selected (TR)**	**Unit Type**	**ODU SELECTED IN HP**
Ground & First Floor						
1	RECEPTION	2.00	2	4.00	4 WAY CASSETTE	20 HP-VRF
2	CANTEEN SEATING	2.00	1	2.00	4 WAY CASSETTE	
3	JUDGE RETIRE ROOM	2.00	1	2.00	4 WAY CASSETTE	
4	OFFICE	2.00	2	4.00	4 WAY CASSETTE	
5	AV & COMMENTRY BOX	1.5	3	4.5	4 WAY CASSETTE	
2nd Floor						
6	VIP SEATING	4.0	4	16.00	4 WAY CASSETTE	20 HP-VRF
Area : Central Pavilion						
Sl. No.	**Location**	**Unit Capacity (TR)**	**Unit Qty.**	**Total Selected (TR)**	**Unit Type**	**ODU SELECTED IN HP**
Circular Seating						

1	MEDIA ROOM	3.50	2	7.00	4 WAY CASSETTE	10 HP-VRF
Rectangular Block – Ground Floor						
2	CONFERENCE HALL	2.5	2	5.00	4 WAY CASSETTE	20 HP x 1 +16 HP x2- VRF
3	DOPE TESTING, NURSING STATION,DOCTOR CABIN,COACH ROOM	1.25	6	7.5	4 WAY CASSETTE	
4	GYM	3.5	2	7.00	4 WAY CASSETTE	
5	RECEPTION	2.1	2	4.2	4 WAY CASSETTE	
6	INCHARGE, STAFF SEATING,ESTATE	1.5	3	4.5	4 WAY CASSETTE	
7	CHANGING ROOM -2 NOS	2.1	4	8.4	4 WAY CASSETTE	
8	CONTROL ROOM,SUPPORT ROOM	1.25	3	4.5	4 WAY CASSETTE	
Rectangular Block – 2nd Floor below Seating and 3rd Floor						
9	CAFETERIA	2.5	4	10	4 WAY CASSETTE	18 HP x 2 - VRF
10	VVIP,VIO SEATING	4.5	2	9	AHU	
11	AV ROOM COMMENTATOR BOX	1.25	3	3.75	4 WAY CASSETTE	
12	CCTV CONTROL ROOM	2.5	2	5	4 WAY CASSETTE	

2.

Equipment Configuration for ventilation system & equipment selection (Table II):

1	**Swimming Pool**			
	Ground Floor & Ist Floor			
1.1	Toilet Blocks	900	1	Ducted Cabinet Fan
	2nd Floor			
1.2	Toilet Blocks	800	2	Cabinet /Axial Fan
	Basement			
1.3	Pump House	2500	2	Cabinet / Axial Fan
2	**Central Pavilion**			
	Ground Floor			
2.1	Toilet Blocks	1800	4	Ducted Cabinet Fan
2.2	Kitchen	2800	1	Cabinet /Axial Fan
2.3	Electrical Room	1400	2	Cabinet /Axial Fan
	Ist Floor, 2nd Floor below Seating and 3rd Floor			
2.4	Toilet Blocks	1800	6	Ducted Cabinet Fan
2.5	Electrical Room- 3 Nos	1400	5	Cabinet /Axial Fan
2.6	Basement Ventilation for Electrical & Pumping Station in Curved Pavilion	2200	12	Cabinet /Axial Fan

Air Conditioning and Ventilation Design Approach

The Contractor is to note that air-conditioning and Ventilation load table given above is for reference only. Contractor shall work out detailed cooling load calculations based on latest Architectural drawings, actual areas, actual occupancy and equipment loads and select their equipment.

The Air-conditioning load shall be estimated based on fresh air shall be provided at the rate of 1.0 air change per hour or 12.75 CMH per person and 0.102 CMH per Sq. Ft in

line with ASHRAE-62.1 latest revision, whichever is higher, light load, wall /ceiling/floor heat gains.

Sustainable design is to be adopted for increasing the efficiency with which buildings use energy, water, & materials, and also for reducing impacts on human health and the environment for the entire lifecycle of a building.

Brief proposed system description:

Variable Refrigerant Flow (VRF) / Variable Refrigerant Volume (VRV) System has been proposed to meet the air-conditioning requirements. Air-conditioning indoor units catering the areas shall be wall mounted Hi /cassette units and ducted units like Floor Mounted / ceiling mounted AHUs shall be located inside the room. The Outdoor units shall be top discharge type and preferred to be located in a open space / terrace of each building. The Drain from all the Indoor Units shall be terminated to the nearby pantry/ toilet wash basin block/risers. The indoor and outdoor units shall be inter-connected by Refrigerant Copper Piping and Electrical Cabling. Access doors shall be provided for Volume control dampers installed in branch ducts for Service and maintenance purpose. There shall be provision of Treated Fresh Units to supply fresh as ASHRAE Guidelines.

The ODU of VRF/VRV unit shall deliver actual capacity at 39 deg C outside temperature. COP (Co-efficient of Performance) of the individual VRF/VRV Outdoor units shall be at least 3.5 at 100% Load at 39 Deg C outdoor, 27 Deg C DBT,19 Deg C WBT Inside temperature.

Multilevel Car Parking have a basement car parking, which will have ventilation through multiple two speed jet fan and axial fans for exhaust as per requirement of latest NBC standard. Similarly for all other levels for car parking, suitable number twin speed circular jet fans shall be used. The location of Jet Fans shall be finalised after CFD analysis. These fans will operate in low speed during normal working and will change to high speed in case there is fire and in case CO level is high with the help of CO sensor . Lift lobby in Multi-Level car parking shall be pressurised as per NBC- 2016. All lift shafts will be pressurized, in case of fire hazards. As per National Building Code of India (NBC 2016), lift-well will be pressurized to 50 Pa. Dedicated fans will be provided for each Lift-well. Starter panel for these fans will house contacts for receiving signals from fire alarm system. In case of fire, fire signal will close the contacts and fan will start automatically. These fans will run on emergency power supply.

For toilet areas, a common centrifugal inline fan shall have ducted suction grilles for exhaust purpose. For various ventilation applications, various types of Fans shall be used as per Table II.

The fresh air duct shall be provided with motorized fire dampers and shall be interlocked with Fire Detection system. In case of fire, all air-conditioning units and Fresh air fans will be switched off automatically through BMS. This equipment will be interfaced with fire detection and alarm system through BMS.

Insulation:

Duct Insulation

Supply and return air ducting in air conditioned areas will be thermally insulated with 19 mm thick and 9 mm thick class 'O' closed cell elastomeric rubber (UL/FM approved) respectively, while in non-conditioned areas it will be around 25 mm thick and 13 mm thick respectively. The ducts shall also be suitably acoustically insulated at the outlet of the AC indoor units to maintain noise level as mentioned. Thermal conductivity of insulation material shall not exceed 0.035 W/(m.K) at mean temperature of 0°C as per EN 12667. Density of insulation material shall be between 40 to 55 Kg/m3.The material shall have ODP (Ozone Depletion Potential) and GWP (Global Warming Potential) of Zero.

Roof Insulation

Under deck insulation will be provided for air-conditioned spaces exposed to roof above.

Air Conditioning & Ventilation Equipment Design Criteria

i. The Air cooled direct expansion type Full Inverter VRF outdoor unit shall be factory assembled, powder coated GI sheet metal cabinets, all hardware of anti rust quality, conformal coating on PCB to protect from duct & humidity, hydrophilic blue fin material for better corrosion resistance, top discharge type with Brushless DC Motor only. Outdoor Units must be Hot Air Top Discharge Type, as per site requirement.

ii. The Top Discharge type VRF ODU must have bigger condenser coil face area with higher CFM fan resulting in improved efficiency, less duration due to higher ambient temperatures.

iii. The ODU capacity must be delivering actual capacity at 39 deg C. Please note, the mentioned capacity is actual capacity. COP of the individual VRF Outdoor units shall

be at least 3.5 at 100% Load at 39 Deg C outdoor, 27 Deg C DBT 19 Deg C WBT Inside temperature.

iv. The Outdoor unit must consist of Inverter Scroll Compressor only. Each ODU shall consist of single / multiple Full Inverter Scroll compressors. There should not be any fixed compressor or Partial inverter.

v. The VRF system must compatible with R410A / Eco friendly green Refrigerant only. System must be pre-charged at Factory. If required additional, based on the site, then it will be charged additional at site.

vi. ALL Inverter VRF must be designed with the new generation Refrigerant Cooled PCB, which helps maintain the drive within allowable temperature range. It enhances the reliability of the system when it is working under very high ambient conditions.

vii. Each Indoor units must be connected (with VRF Outdoor unit) by means of individual Copper Refrigerant network or Y distribution joints only. The mentioned “Y” joint or refnet joints must factory make & tested by OEM. The individual size of refnets or “Y” joints , connecting to individual indoor units, to be calculated & supplied by OEM / Bidder / OEM approved bidder only. Bidder must submit design - drawing, showing IDU ODU location, piping layout, drain piping, with actual sizes also to be shown as per site requirement.

viii. All Inverter VRF should have emergency back operation. In-case of double compressor ODUs, it must operate or function even if there is a failure or maintenance downtime of one compressor.

ix. In modular VRF, where multiple units have been combined to run, as one larger unit, the system must operate even in case of failure or maintenance downtime or shutdown of one VRF ODU. It will help to ensure that cooling remains largely unaffected even during servicing.

x. As all the Indoor units are interconnected by the communication cable, if there is any break in any communication cable , subsequent IDUs are affected and must not function. By activating the IDU emergency operation on the Next Generation All Inverter VRF, the other IDUs must function despite of such break.

Indoor Units:

xi. **Ductable Indoor Units :** The Unit shall be Ductable type (ceiling suspended/ Floor Mounted as applicable). The unit shall include pre-filter, fan section and DX-coil section. The housing of the unit shall be powder coated/heat treated galvanized steel.

The unit shall have high static fan for ductable arrangement and it should have inbuilt drain pump for suitable arrangement for drain water.

xii. **Cassette type Indoor -** The indoor can be cassette type with drain pump facility, with pre-filter, fan section and DX coil.

xiii. **HI - Wall Split type** – The indoor can be Hi wall split type unit, with Pre- filter, fan section and DX coil.

xiv. **VRF Outdoor Unit Technical Data Sheet (to be filled during Technical Bid Submission) :**

Details of Technical Requirement	**To be filled up by Bidder**
Model	
Combination of Base Model	
Actual Cooling Capacity at 39 Deg C Outside (TR),	
Total Power Consumption at 39 Deg C Outside (KW)	
Power Supply Voltage	
Overall Dimension (w x d x h in mm)	
Net weight (kg)	
Type of Refrigerant	
Pre charged refrigerant Qty (kg)	
Number of Accumulator	
Type of Expansion Valve	
Type of Compressor	
Make & model number of individual compressor	
Compressor quantity	
Cooling capacity of each compressors (kw)	

Input Power of Compressor motor (kw)	
Type of Condenser coil	
Type of Condenser Fan	
Type of Condenser Fan- Motor	
Total Number of Fans for specified capacity ODU	
Power input of Condenser Fan - Motor (kw)	

xv. VRF Indoor Unit Technical Data sheet :

Details of Technical Requirement	**To be filled up by Bidder**
Model	
Type of VRF Indoor	
Combination of Base Model	
Nominal Cooling Capacity (KW)	
Input Power (KW)	
Overall Dimension (w x d x h in mm)	
Net weight (kg)	
Sound pressure level (db A)	
Air Flow (CFM) in high / med / Low	
External Static Pressure (Pa)	

xvi. Refrigerant piping:

viii. The Refrigerant pipe material shall be of hard seamless copper tubes with pipes material being hard drawn copper pipe. Forged copper fittings shall be used for the refrigerant piping. The refrigerant piping arrangements shall be in accordance with good engineering practice as applicable to the air-conditioning industry, and shall include charging connections, suction line insulation and all

other items normally forming part of proper refrigerant circuits except y joint/separation tubes.

ix. Before joining any copper pipe or fittings, its internals shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints. Subsequently it shall be thoroughly blown out using nitrogen gas.

x. After completion of installation of the refrigerant piping, the refrigerant piping system shall be pressure tested using nitrogen gas at a suitable pressure as specify by OEM (Original Equipment Manufacturer). Pressure shall be maintained in the system for 48 hours. The system shall then be evacuated to a vacuum of not less than 700 mm Hg and held for 24 hours.

xi. The supplier of air-conditioning system shall choose sizes as designed and erect proper interconnections of the complete refrigerant circuit the thickness of copper piping shall not be less than 18 SWG for pipes upto 19.1 mm and 16 SWG for larger dia.

xii. The suction line pipe size and the liquid line pipe sizes shall be selected according to the manufacturer's specified diameter. All refrigerant pipes shall be properly supported and anchored to the building/structure using steel hangers, fastener, brackets and supports from the building/structure.

xiii. The refrigerant piping should be laid in such a way that it should not distort the interior of the room, wherever the refrigerant pipe has to be laid across the room, it should be laid in a concealed manner by making appropriate boxing arrangement matching with the interior of the room. All associated minor Civil Engineering works (like chasing on wall, ceiling & re-plastering and repainting etc.) related with the above items are to be included .

xiv. Entire liquid and suction refrigerant pipe lines including all fittings, valves and strainer bodies etc. Shall be insulated with 19-mm/ 13 mm thick elastomeric Nitrile rubber as applicable.

xvii. Ventilation :

The Ventilation fan Catalogue, for fans shall be submitted by bidders along with the bid. Final selection or rating charts/ performance curves for fans with duty point marked, detailed working (fabrication/ construction) drawings for complete ventilation equipment/ system including ducting, final G.A drawings for fans, detailed foundation / mounting arrangement drawings for fans, static and dynamic loads for fans, wall/ roof opening requirement details, operation and

maintenance manuals etc. shall be furnished by the contractor for the Engineer's approval / reference, after award of contract. All fans shall be AMCA certified.

Drive motors for all ventilation fans shall be rated at least 15 % higher than the power requirement at duty point or 10 % higher than the maximum power requirement at selected speed, whichever is higher. Starting torque requirements of fans shall also be considered to finalize the motor ratings.

Equipment Design Parameters:

xiv. Ventilation Fans

Maximum fan outlet velocity for fan upto 450 mm dia, m/sec	9.0
Maximum fan outlet velocity for fan above 450 mm dia, m/sec	11.5
Maximum fan speed for fans upto 450 mm dia, rpm	1440
Maximum fan speed for fans above 450 mm dia, rpm	1000

xv. Air Distribution System

Max. allowable air flow velocity in ducts for Air conditioning m/sec	7.5
Max. air flow velocity in ducts for Ventilation, m/sec	10
Max. Friction, inch wg. / 100 ft duct length	0.1
Max. Outlet velocity at Grille/ Diffusers, m/sec- other area	2.5
Max. allowable air flow velocity in ducts for Air conditioning m/sec	7.5

xvi. Filtration

Re-circulated air (mixed fresh & return air) at Indoor Unit and ventilation units.	Washable synthetic type air filters having 90% efficiency down to 10microns (MERV 8)

xvii. The general layout of the ducting and location of air handling units, grilles, diffusers etc., shall conform to the arrangement shown in the drawings enclosed with the specification.

xviii. Ducting shall be fabricated at site from galvanized steel as specified.

xix. The construction of ducts shall conform to IS:655 /SMACNA as applicable. All duct seams shall be filled with bitumastic cold emulsion or equivalent vapor seal.

xx. All duct supports shall be provided at centre preferably not exceeding 2.5 Meter. The duct supports shall consist of structural steel angles and if required flats and jointed by bolting. Whenever duct support angles are to be fixed with reinforced concrete roof/floor slab, the anchoring screw shall be connected with duct support angles by means of intermediate angle plates with bolted connection, so as to facilitate early erection and dismantling.

xxi. Fire proof Canvas or equal flexible connection shall be provided at each connection between duct work and AHU so as to isolate vibration.

xxii. Damper blades shall be manufactured of minimum 20 BWG Sheet Steel.

xxiii. All ducted indoor units shall have motorised fire damper as per UL 555 for 90 minutes rating for supply/ return duct (as applicable).

xxiv. All diffusers and grilles shall be made up of extruded aluminium section finished in powder.

xxv. Coating shall be of approved colour to match interiors.

xxvi. Selection and placing of diffusers, grilles etc. shall by the contractor matching the lighting fitting and the décor of the office.

Applicable Standard

S.No.	Standard	Description
1.	NBC : 2016	National Building Code
2.	ASHRAE standard 90.1-2016	Energy standard for buildings except low rise residential buildings.
3.	ASHRAE 55	Thermal comfort
4.	AHRI -1230 Standard	Performance Rating of Variable Refrigerant Flow Units.
5.	ASHRAE Handbooks	American Society for Heating, Refrigerating and Air- Conditioning Engineers.
6.	IS: 655/SMACNA	Duct construction standards
7.	ASHRAE 52.2-2012	Air Filters

8.	IS 277	GI Sheet
9.	ASHRAE Standard 62.1-2016.	Ventilation for Acceptable Indoor Air quality
10.	ECBC 2016	Energy Conservation Building Code
11.	ISHRAE	HVAC Handbook - Air conditioning & Ventilation
12.	IS: 661	Thermal Insulation for Cold Surfaces
13.	IS 2312	Propeller type ventilation fans
14.	IS 3588	Electric axial fans
15.	IS 4894	Centrifugal fans
16.	UL 555	Fire dampers
17.	IS 12065	Permissible limits of noise level for rotating electrical machines
18.	IS 12075	Mechanical vibration of rotating electrical machines

Acceptance Requirements

Before acceptance, Air-conditioning and Ventilation system shall be completely adjusted and properly balanced to provide specified uniform space temperature. Proper damper settings shall be indicated clearly in a manner permanent for operations as required.

The Contractor to submit the Guaranteed Particulars for all the Equipment during Bidding:

Operation and Maintenance

The Contractor shall be required to operate and maintain the system designed, supplied, installed, tested and commissioned by him, for the duration of Five years. The Operation and Maintenance Contract shall be comprehensive type. The Contractor shall take full responsibility for the care of the mechanical services/ system and other allied systems during the contract period till it is handed over to the employer at the end of 5 years of O&M.

If any loss or damage occurs to the treatment works or to any other system, during the period for the contractor is responsible, the contractor shall rectify such loss or damage, at his cost, so that all the mechanical services/ system conforms to its condition when the contractor took possession of the treatment works at the commencement of the contract.

The Contractor shall be responsible for, but not limited to, the following:

- Providing the required staff, but not less than the minimum specified numbers/ level, during operation and maintenance period and additional staff as per requirement during periodic maintenance and in emergencies.
- Providing all required consumables such as spares, tools, tackles & Equipment and

consumables required for functioning of equipment.

- Establish work control procedures including preventive and corrective maintenance so that the entire mechanical services/ system shall work in automatic mode and/or semiautomatic at all times.
- Submission of monthly report.
- The Contractor shall be solely responsible for the safety and security of the goods in the store and will be responsible for any loss or damages in stores for any reason.
- Proper maintenance and housekeeping along with provision of all tools & equipment.
- Insurance: The Contractor shall, without limiting his or the Employer's obligations and responsibilities undertake the following;
- The insurance shall be at the Contractor's cost and shall cover the Employer and the Contractor against all losses or damages from whatsoever cause arising from the start of the O&M until the date of completion of O&M in respect of the facility or any section or part thereof as the case may be.
- Insurance shall cover for all the Civil, mechanical, electrical and instrumentation works together with material to the full replacement cost.
- Any amount not insured or not recovered from the insurer shall be borne by the Contractor.

Recommended Makes

Copper pipe : Nippon/ Nissan / Rajco

Fans / Blowers : Nicotra /System Air / Comefri / Green-heck / Kruger

Glasswool Insulation : Lloyds/ U P Twiga

Grilles/ Diffusers/ Fire Damper : Dynacraft/ Trox / System Air

G I Sheets : Jindal / Sail / Nippon.

Nitrile Rubber Insulation : A-flex / K Flex / Armacell.

VRF Units/Split AC : Voltas/ Blue Star/Hitachi / LG/ Samsung/ Daikin/Toshiba

Technical Specifications for ICT Works

1.0 Fire Detection Alarm System (FDAS):

3. General Requirements

The fire detection and alarm system may comprise of main fire alarm control panels, optical smoke/heat sensors, heat sensors, and optical smoke/heat sensor with integral sounder units, manual call points, electronic sounders, repeat panels, and interface units, each with its own short circuit built-in isolators. All loop cabling and any other components and accessories deemed necessary for a safe, reliable and satisfactory system will conform to the relevant and applicable requirements and recommendations. The fire alarm system shall comply with requirements of NFPA standard No. 72 for protected premises signaling systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.

Contractor will train and instruct client's personnel in the correct use, operation and supervision of the system, prior to the handing over of the project. The system will be fully programmed to accommodate at least 8 fire zones. The system will be configured to allow on site modifications with the minimum of disruption using the PC based software to facilitate future changes or alterations to the buildings.

Fire Alarm Control Panel (FACP):

Supply, Installation, Testing & Commissioning (SITC) of FACP with battery charger and with the battery back up for 8 hours normal operation and one hour alarm operation. The FACP shall be expandable up to 2 loop. The FACP shall include a full featured operator interface control and annunciation panel that shall include a backlit 160-character liquid crystal display, and a QWERTY style alphanumeric keypad for the field programming and control of the fire alarm system. System should support upto 159 detectors and 159 modules in one Loop. The panel shall be UL listed and FM approved and comply UL 864, 9th Edition requirement. The enclosure shall also be UL listed.

Multi Sensor Detector:
Supply, Installation, Testing & Commissioning (SITC) of Analogue Addressable Multi Sensor Detector with the hard addressing feature, with standard base and junction box wherever required. Detector shall be with Visible bi-color LEDs for 360^0 viewing. Complete as required as per technical specification.

Addressable Control Module

Supply, Installation, Testing & Commissioning of Analogue Addressable Control Module shall be with the facility of hard addressing, capable of providing DPDT contact rated at 24v DC, 2A.Complete as required as per technical specification.

Monitor Module:
Supply, Installation, Testing & Commissioning of Analogue Addressable Monitor Module for monitoring the field devices & shall be with the facility of hard addressing, capable of providing DPDT contact rated at 24v DC, 2A.Complete as required as per technical specification.

Control Relay Module:
Supply, Installation, Testing & Commissioning of Analogue Addressable Control Relay Module for AHU tripping and shall be with the facility of hard addressing, capable of providing DPDT contact rated at 24v DC, 2A.Complete as required as per technical specification.

Hooter:
Supply, Installation, Testing & Commissioning of Hooter / Strobe rated at 82 dBA @ 3m for Audible annunciation and 75cd flashing at 1 Hz for visual indication.Complete as required as per technical specification.

Beam Detector:

Supply, installation, testing and commissioning of Wall mounted type Beam Detector. The Beam Sensors will be safe addressed, loop powered, loop signaled with built in short circuit isolator and compact and will detect fire by obscuration of an optical beam by smoke. It will utilize a transmitter and receiver unit and be suitable for ranges of up to 100 Mts.

Certification & Quality Standards: UL & ULC Listed / FM Approved.

Preferred Make: Bosch, GE, Agni, Simplex, Notifier (Honeywell)

2.0 Closed-circuit Television (CCTV):

Items	Description of Item
IP Fixed Camera	SITC of IP Vandal Proof, weather proof, IP Vari-focal Auto Iris 2.8 to 12 mm 4.0 mega Pixel HD lens bullet cameras active pixel 2592*1520@25 fps, 1080@60fps, 4 Megapixel Internet Protocol (IP) based Vari-focal lenses Bullet Camera (2.8~12 mm),0.001 Lux, POE, Inbuilt on board analytics, company fitted Array LED 4 pcs for more clarity in Night Vision, IP 66 Certified Housing ,H.265/H.264 with multicasting capability, simultaneous I/O for alarm / Event Handling, Inbuilt 6000 V surge protection Chip, POE (IEEE 802.3af class 3) with multicasting capability, Array LED 2-4 Pcs. Electronic Sutter 1/25-1/30000s, ONVIF,CE FCC ROHS Certified. The adjustable image format, bit rate, brightness, contrast, white balance, more area intelligent OSD, 4A auto control (AWB;AGC;AES;AI) Support the privacy shelter, DWDR, 3D-MCTF Digital noise reduction, Latitude and longitude image mode Audio support one channel audio format G711A. Power consumption less than 8 watt.
Network Video Recorder	SITC of Network video Recorder & Storage System 32 Channel expendable up 36 ch with HDD Management and Recording Server with 8 TB HDD With Raid 5 For 30 Days Recording of all camera in real time full resoulation1512P.1080P/720P/960H/D1/HD1/ 2CIF/CIF/QCIF; Support dual-stream Support 4 SATA Interface and 1* E-SATA Interface Support multiple slow playback, multiple fast playback, manual single frame playback, inverted playback, Compression standard G711 A : G 711 U, Bit Rate 8 KHZ, Code rate 64 Kbps, Log query Max.1024 log on shown, Support searching log information based on the time and type Embedded LINUX System as reqd. Zone Setting Zone Setting: 396 (PAL 22×18 NTSC 22×15);CE FCC RoHS NSIC & ISO Detection Sensitivity Setting: Multiple Level of Sensitivity, Linkage Record, External Alarm.
LED TV/Monitor	SITC of 55 Inch (Screen size) UHD LED TV, Full HD (Screen resolution 4K resolution is exactly 3840 x 2160 pixels with inbuilt PVR with time shift (Record, Pause, Rewinding, Live Shows) with complete all accessories etc. as reqd.
Patch Cords	Supplying Installation Testing & commissioning of following items Cat 6 S/FTP Patch cord 3 feet & I/O box with base plate for CCTV side.& rack side
Ethernet Switch	SITC of 8 port 10/100/1000 TX port Ethernet switch with POE with 4X 10/100/1000 FX SFC+ two combo port. Standard 802.1d Spanning Tree support Fast convergence using 802.1w (Rapid Spanning Tree [RSTP]), enabled by default, 8 instances are supported Multiple Spanning Tree instances using 802.1s (MSTP) Port grouping Support for IEEE 802.3ad Link Aggregation Control Protocol (LACP), Up to 8 groups, Up to 8 ports per group with 802.3ad link aggregation, VLAN Support for up to 4096 VLANs simultaneously

Items	Description of Item
UTP/FTP Cables	SITC of category 6S/UTP/ FTP cable, non plenum slate jacket 4 pair count length box with information outlet orange for CCTV/ Rack side.
Patch Panel	SITC Of S/ FTP modular Fully loaded Patch panel one U 24 Port loaded for CCTV rack side with cable manager .With cable management bar for improved management Staggered 24 port panel in 1U.
6U Rack	SITC of 6 U Surface Mount networking rack with H/W packet and one vertical power Strip with two Fan castor wheels, partition, Front Glass Doors & Rear MS perforated Door Lock & Key as per site requirement.
22U Rack	SITC of 22 U Surface Mount networking rack with H/W packet and one vertical power Strip with two Fan castor wheels, partition, Front Glass Doors & Rear MS perforated Door Lock & Key as per site requirement.

Certification & Quality Standards: BIS, CE, UL Certified or Approved.

Preferred Make: Bosch, Honeywell, Sony, Hikvision, Delta

3.0 Public address System (PAS):

Speakers

- Flyable loudspeaker Full Size 15", 2 Way loudspeaker. The speaker cabinet must have HF Transducer of 1.25" diaphragm compression driver,
- Frequency range (-10dB) of 40 Hz – 20 kHz;
- Frequency Response (-3 dB): 55 Hz – 20 kHz, Axial Sensitivity >= 100 dB (1W/1m), delivering Max. Calculated SPL >= 133 dB with continuous passive power handling <=500W.
- The speaker should have a nominal impedance of 8 ohm.
- The speaker cabinet should have a Rotatable Coverage: 60° x 40°.Speaker must have 6 or more suspension points for permanent installation.

Power Amplifier

- Dual channel Class H/Class D power amplifier with inbuilt DSP, Max Midband Output Power >=950W @ 8 Ω; >=1800W @ 4 Ω & >=3200W @ 2 Ω,Max Bridged Output Power>=6000W @ 4 ohms,
- Frequency Response, ref. 1 KHz: 10Hz - 21 KHz (±1dB), THD:<0.05%, Max input level >= +21 dBu, input impedence:20 KΩ,
- Signal to Noise ratio > = 109 dB, Crosstalk < -80 dB with built in protection such as Audio Limiters,
- Output delay per channel, 31 band GEQ per channel, PEQ per channel,

MIXER

- 10 Channel Mixer having 2 independently controller 24/48 bit stereo digital effect devices offering 198 presets,
- Unit is equipped with 2 x 7 band graphic equalizer Aux 3 & 4 are equipped with anti feedback filter in the master , vocal voicing filter is in built in all line / Mice channels .
- Unit has 6 Mic/ Line + 4 Mic / Stereo Line inputs,
- Stereo gain -10 to + 20 dB,
- Freq response 15 Hz TO 70 kHz,
- Display - 128 x 64 pixels, OLED.
- Power requirements 100 to 240 Volt AC, 50 to 60 Hz

MICROPHONES

- Wireless digital Handheld Microphone with 18 or more channel,
- RF output 80mW or more, super cardiod pickup pattern,
- Frequency range : 1880 to 1930 MHz,
- Connectivity : RJ-45 etc /Wireless

MICROPHONE CONTROLLERS

- Supply of Freestanding Gooseneck Mic with base for podium having dual condenser back electrets microphone element,
- Selectable Omni directional/ Cardioids'/ Supercardioid/ Hyper Cardioids polar pattern, LED status display and with programmable button for Push to Talk or Push to Mute functions having ,
- Frequency response 50Hz-20kHz,
- Sensitivity 5.5mV/Pa,
- Clipping level >125dB SPL,
- Output impendence 200 ohm,
- Dynamic Range - > 100 dB.

EQUIPMENT RACK

19 "Equipment Rack Made of MS for housing of all above equipment , front lockable acrylic door, Fan for cooling, Caster wheel base , Complete with MCB including all internal wiring/ interconnection as required

UNINTRUPTED POWER SUPLLY (UPS)

- Rating: 5 KVA,
- Input Voltage : 230 V +/-10% AC, 50Hz+/-1%, Output Voltage : 230 V +/- 1% AC,
- Output Frequency: 50 Hz +/- 1%,
- Output waveform: Pure Sine wave, Air cooling,
- Type of battery: Sealed Maintenance free battery, Exide /power safe/ Amararaja-Amaron / Panasonic Make,
- Operating Voltage: 120 Volts D.C.(10 Nos. 12Volts, 65AH(min)),
- Front panel : LCD Display for input, output and DC Voltmeter,
- Protection: Over voltage, Short Circuit and overload at UPS output terminal, under voltage at Battery terminal.

Certification & Quality Standards: UL, BIS, CE, CB, CCC Certified

Preferred Make: Bose, JBL, Yamaha, Sennheiser, Bosch Electro Voice, Revolab.

4.0 Digital Signage:

The Player component of the software will function on any PC machine that meets the following minimum requirements:

Items	Specifications
Resolutions	1080p HD
Mode	Landscape and Portrait Modes
Aspect Ratio -	4:3, 16:9
Supported browsers	Internet Explorer , Safari, Firefox, Chrome
OS	Windows 7 Pro/10 Pro 32/64 Bit
RAM	4GB RAM
HDD	500 GB S
Zones	Unlimited number of zones
Schedulers	Multiple schedulers, Time and date based scheduling
Management	Web based management

Certification & Quality Standards: UL, BIS, CE, CB, CCC Certified or Approved

5.0 UPS System & Cabling:

4. **10 KVA UPS (ONLINE) WITH BATTERY BACKUP FOR 30 MINUTES:**

1.4.1.1 Application: *Power supply requirement for Fire Detection Alarm System, CCTV Camera, PA System and Digital Signage.*

Technology: On-line double conversion

Input:

- Nominal AC Input Voltage: 1 Phase 230V AC + Neutral + Earth , 50 Hz
- Line low/ High transfer: + 15%
- Frequency range: + 5%
- Power factor: >0.9

1.4.1.2

1.4.1.3 Output

- Voltage: 220VAC/ 230VAC/ 240VAC
- Voltage Regulation: + 1%
- Frequency: 50 Hz+/- 0.1%
- Output waveform: Pure sine-wave
- Harmonic distortion: < 2% (linear load) / 5 % nonlinear load
- Power factor: 0.7 to unity
- Crest factor: 3:1
- Inverter overload capacity: 110% 15 min./ 125% 10 min./ 150% 1 min./ > 150% 1 sec.
- Efficiency (AC – DC): 90%

- Bypass: Static bypass

1.4.1.4 Transfer time

- Line to battery mode: 0 ms
- Battery to line mode: 0 ms
- Line to bypass mode: <5ms synchronized with mains
- Bypass to line mode : <5ms synchronized with mains

1.4.1.5 Battery

- Battery type: SMF
- Communication interface
- Standard: RS 232 port for software interface
- Optional: SNMP

1.4.1.6 Display

- Standard: 2 line x 20 characters, Backlight LCD
- AC input voltage, AC input frequency, Battery voltage, AC output voltage , AC output frequency, AC output load %, Temperature
- UPS status(Mains fail, Individual phase fail, Battery low DC high, Overload with shut down time, Output low, Output high, Over temperature, UPS bypass)

1.4.1.7 General

- Operating temperature: 0 to 45 Deg C
- Humidity: Upto 95% RH, no condensing
- Noise level: < 60 dB @ 1 meter
- Indication: Mains ON, Inverter ON/ OFF/ Faulty, Battery level, Static bypass on, Load level, over temperature
- Audible alarm: Mains failure alarm/ Low battery alarm/ Overload and load on bypass/ DC high/ Inverter fault
- Protection: Advanced electronic protection for device safety backed with MCB's
- Parallel redundant option: Unitary/ Parallel redundant/ Redundant hot standby

5. **Power Supply Cable**

- 3CX1.5 /2.5/4 sq mm, multi strand with standard annealed electrolytic copper conductor armoured cable/flexible cable as per IS 1554.
- Primary insulation of 85º C PVC as IS-5831Type C
- Color code Red, Black and Green
- Inner and Outer Jacket : Extruded Flame retardant and 90º C PVC to IS 5831- Type ST2
- Inner and outer sheath - PVC Black
- Armouring - Galvanized Steel Wire/ flat as per IS-544 part I
- Armour coverage 95 %

6.0 OFC Cabling:

1.5.1.1 Application: Wired connections (Backbone Ring) between all ICT touch points like – CCTV camera, Digital Signage Parking & PA system within Birsa Munda Stadium at Rourkela.

6. **6 Core SM Optical Fiber Cable**

- 6 Core Single Mode Fiber Cable
- Tube - Thermoplastic Material (PBT)
- Filling jelly - Jelly to prevent Water ingress in loose tube
- Cable - 2 Embedded FRP provides tensile strength & Anti-buckling properties
- FRP - Strength member ensures mechanical protection to fiber
- Outer Sheathing - UV (Ultraviolet) Proof Black Polyethylene
- Rip Cord - Polyester Yarn below sheath for easy ripping

7. TECHNICAL SPECIFICATIONS OF ELECTRICAL WORKS

1. INTRODUCTION

The general requirement include design, manufacture, testing at works, supply and delivery at site, unloading and storing the equipment at site, installation, testing and commissioning of the equipment at site of all electrical equipments are covered under this section of the Specification.

Contractor shall supply the equipment in accordance with the specification, data sheets.

For uniformity of appearance, all switchgear and control panels shall have a common appearance and colour.

In order to reduce the spares holding to a minimum, electrical, control and instrumentation components of a similar type and purpose used throughout the Works shall be of the same Manufacturer and type / series unless it can be shown by the Contractor to be impractical.

2. COMPACT SUBSTATION

SCOPE

All scope for Design, Supply, Installation, Testing and Commissioning of the equipment and systems as specified in this contract/ specification shall be strictly as per specification, rules and regulations; and, not limited to this specifications and guidelines.

The specific scope of this specification for Compact Substation (CSS) covers the following:

Design, engineering and manufacturing; testing at Manufacturer's works, packing, forwarding and delivery to site; unloading and handling (shifting from unloading point to the storage area, storage and shifting from the place of storage to the place of installation) at site, assembly, erection, cleaning & touch up painting, testing, commissioning and performance demonstration at site of Compact Substations of various ratings as specified in this document. Each CSS shall typically consist of the following parts:-

a) Metallic Enclosure with ventilation and rain/ dust protection as appropriate.

b) 11kV VCB ICOG

c) Metering Compartment

d) 11 / 0.433kV Dry type transformer of respective rating along with required accessories.

e) LT switchgear

f) Power pack with One (1) Hr backup to take care of the DC load requirements within the CSS.

All the above components of each CSS shall conform to latest relevant standards, codes and requirements.

Civil works for the preparation of equipment foundation, cable trench, and earth pits electrodes, earth grid around CSS and chain link fencing with gate for each CSS is included in the scope of this specification. GA drawings for same shall be submitted by the Contractor.

Tariff Meter:

a) Tariff meter along with the mounting enclosure and all accessories like CTs, terminals, etc., shall be as per distribution company requirement & specifications and should be approved from Distribution Company.

b) The tariff meter shall be located inside the meter room.

c) Presently no separate earthing arrangement (electrodes) has been considered in the present scope. However, BIDDER shall confirm the need for separate earth system, if required by DISCOM, in the BID.

d) All required support & structure required for mounting of the above meter enclosure is included in the scope.

All SAFETY considerations in design and manufacturing for safe operation & maintenance by Employer personnel and safe practices during installation at site shall be in the scope of the Contractor. Cost towards accomplishing the same shall be included in the BID price and no extra claim shall be entertained later.

Equipments furnished shall be complete in every respect with all mountings, fittings, fixtures, and standard accessories normally provided with such equipment and / or needed for erection, completion and safe operation of the equipment as required by applicable codes though they may not have been specifically detailed in the Technical Specification unless included in the list of exclusions. Materials and component not specifically stated in the specification but which are necessary for commissioning and satisfactory operation unless specifically excluded shall be deemed to be included in the scope of specification and shall be supplied without any extra cost. All similar standard components/ parts of similar standard equipment provided shall be inter-changeable with one another.

The Contractor shall be responsible for the selection and design of appropriate equipment to provide the best co-ordinated performance of the entire system. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

SYSTEM DESCRIPTION

The CSS shall be located in the open space and fenced around for safety and to avoid unauthorized access.

APPLICABLE CODES AND STANDARDS

The design, manufacture and performance of equipment shall comply with latest applicable Codes of Standards IEC 694, IEC 298, IEC 129, IEC 265, IEC 420, IEC 60, IEC 1330, IEC 529, IEC 76, and IEC 439-1.

All components as well as the CSS as a whole shall be Type tested in accordance with the above standards.

CONTRACTOR shall submit the type test certificates of similar equipment within past five year along with the Bid/ after award of contract.

All equipment and material shall be designed, manufactured and tested in accordance with the latest applicable Indian Standard / IEC standard. The main components of compact substation, i.e., HV switchgear, Transformer & LV Switchgear, should be of same make.

Equipment and material confirming to any other standard which ensures equal or better quality may be accepted. In such case copies of English version of the standard adopted shall be submitted.

The electrical installation shall meet the requirement of Indian Electricity Rules as amended upto date; relevant IS code of practice and Indian electricity act.

SPECIFIC REQUIREMENT

Compact Sub-station (CSS) should be a factory-designed, prefabricated substation, tested, ready-to-install and consist of:

(a) Vacuum Circuit Breaker

(b) Distribution Transformer

(c) L.T. Switchgear

CSS can be equipped with the following additional units:

(a) HT Metering module (CT, PT unit)

(b) Automatic Power Factor Control (APFC) panel

The complete unit shall be installed on a substation plinth (base) as Indoor substation.

The Vacuum Circuit Breaker shall be used to control and isolate the Distribution transformer.

The pre-fabricated unitized substation shall be designed for:

(a) Compactness

(b) Fast installation

(c) Maintenance free operation

(d) Safety for worker/operator & public

The Switchgear and component thereof shall be capable of withstanding the mechanical and thermal stresses of short circuit listed in ratings and requirements without any damage or deterioration of the materials.

For continuous operation at specified ratings temperature rise of the various switchgear components shall be limited to permissible values stipulated in the relevant standard and / or datasheet.

SERVICE CONDITIONS:

(a) The equipment offered shall be suitable for continuous satisfactory operation in the area of Installation.

(b) The Enclosure of the Unitized substation shall be designed for normal outdoor service condition and the enclosure construction shall be such that it fully protects ingress of rain water, dust & rusting.

(c) The enclosure should take minimum space for the installation including the space required for approaching various doors & equipment inside.

EQUIPMENT SPECIFICATION

All the components of Compact Substation shall be enclosed, by either common enclosure or by an assembly of enclosure. All the components shall comply with their relevant IS/ IEC standards.

ENCLOSURE:

(a) The enclosure shall be made of 2.0 mm thickness Galvanized Sheet Steel tropicalised to meet weather conditions including all the partition sheets & doors.

(b) The base of the enclosure shall be of 4.0 mm thickness Hot Dip Galvanized Sheet Steel to ensure rigidity for easy transport & installation. The entire Compact Substation shall be Factory Assembled & Factory Fitted.

(c) The structure of the substation shall be capable of supporting the gross weight of all the equipment & the roof of the substation compartment shall be designed to support adequate loads. In case of relocation of the Compact Substation, the entire substation should be capable of getting lifted and placed as a Single Unit without dismantling of any of the major equipments inside. The lifting arrangement should be from the bottom of the enclosure & not from the top.

(d) The protection degree of the enclosure shall not be less than IP54 for LT & HT switchgear compartment & IP23 for Transformer compartment.

(e) There shall be proper / adequate ventilation inside the enclosure so that hot air inside enclosure is directed out by help of duct. Louvers and / or apertures shall be provided so that there is circulation of natural air inside the enclosure. The Compact Substation should be designed to have natural cooling & ventilation instead of forced cooling / ventilation as the same would de-rate the transformer further and shall be an additional load on the Transformer.

(f) The complete design shall be compartmentalized.

(g) The connection between transformer and LT switchgear shall be by means of suitable size of Cables / Aluminium busbars. The connection cables to consumer shall be taken out from the L.T. switchgear.

(h) Failure within the unitized substation due either to a defect, an exceptional service condition or mal-operation may initiate an internal arc. Such an event may lead to the risk of injury, if persons are present. It is desirable that the unit shall be tested for Internal Arc fault test to the tune of 25kA for 1 second adhering to the latest IS/ IEC standard.

(i) There shall be arrangement for internal lighting activated by associated switch on doors for HV & LV compartments separately.

(j) Covers & doors shall be a part of the enclosure. When they are closed, they shall provide the degree of protection specified for the enclosure. All covers, doors or roof shall be provided with locking facility or it shall not be possible to open or remove them before doors used for normal operation have been opened. The doors shall open outward at an angle of at least 90 degrees & be equipped with a device able to maintain them in an open position. Proper padlocking facility shall be provided for doors of each compartment. Transformer compartment doors must be open from both the sides & should not have access from outside.

(k) All metallic components shall be earthed to a common earthing point. It shall be terminated by an adequate terminal intended for connection to the earth system of the installation, by way of flexible jumpers/strips & Lung arrangement. The continuity of the earth system shall be ensured taking into account the thermal & mechanical stresses caused by the current it may have to carry.

(l) The components to be connected to the earth system shall include:

- The enclosure of Unitized / prefabricated substation

- The enclosure of High voltage switchgear & control gear from the terminal provided for the purpose.
- The metal screen & the high voltage cable earth conductor.
- The transformer tank or metal frame of transformer.
- The base frame
- Enclosure of low voltage switchgear,

(m) Labels for warning, manufacturer's operating instructions, local standards & regulations shall be pasted / provided inside and shall be durable & clearly legible.

(n) The paints shall be carefully selected to withstand tropical heat & rain, unless otherwise specified. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling. For this purpose powder coating shall be used. Special care shall be taken by the manufacturer to ensure against rusting of nuts, bolts and fittings during operation. All bushings and current carrying parts shall be cleaned properly after final painting. The fabrication process shall ensure that there are no sharp edges on the GI sheets used.

HV SWITCHGEAR

(a) The switchgear should be fixed type, Vacuum circuit breakers with O/C & E/F relay and corresponding auxiliary equipments and accessories.

(b) The Vacuum circuit breaker, Bus bars should be mounted inside a sealed for life, cast resin / stainless steel tank. The operating mechanism of the switches and breakers shall be outside the SF6 tank and accessible from front.

(c) The tank should be filled with SF6 gas at an adequate pressure. The degree of protection for gas tank shall be IP67. There shall be provision for filling the SF6 gas at site. Moreover the Cast Resin / Stainless Steel Gas Tank shall confirm to the sealed pressure system criteria (a system for which no handling of gas is required throughout service life of approximate 30 years) and ensure the gas leakage to 0.1 % per year as per IEC.

(d) It shall provide full insulation, making the switchgear insensitive to the environment. Thus assembled, the active parts of the switchgear unit shall be maintenance free.

(e) The tank shall be totally metal enclosed, vermin and dust proof suitable for tropical climate use as detailed in the specification. The switchgear & switchboard shall be designed so that the position of different devices is visible to the operator on the front of the switchboard & operations are visible as well. The switchboard shall be designed so as to prevent access to all live parts during operation without the use of tools. RMU should be tested for internal arc fault.

(f) Circuit Breaker:
Circuit breaker shall be Vacuum Circuit Breaker (VCB). These shall be triple pole, single throw and suitable for local / remote operation.

Circuit Breaker shall be provided with operating mechanism, self powered Static relay (Over current & Earth Fault Protection) with associated CTs for control and protection of Distribution Transformer. Relay should have facility to display the maximum loaded phase current also. Relay should also have facility to trip the breaker from remote commands without shunt trip coil.

An integral cable earthing switch with full making capacity shall also be provided with Circuit Breaker. Earthing switches shall be mechanically interlocked with the

associated breakers to prevent accidental earthing of live circuit or busbars.

Circuit Breaker shall be provided with the following accessories, unless otherwise specified:

- Mechanical ON/OFF/EARTH Indication
- Mechanical charge/discharge indicator
- Auxiliary contacts 2NO and 2NC
- Tripped on fault indicator
- "Live Cable" LED Indicators through Capacitor Voltage Dividers mounted on the bushings.

(g) Ratings of HV Circuit Breakers, Current Transformers & relay settings shall be selected considering the ambient conditions. The bus bars, Vacuum Circuit Breaker shall have adequate continuous rating as per the requirement and in accordance with relevant IS / IEC standard.

(h) The complete switchgear shall be suitable for breaking capacity as specified in the datasheet and/ or relevant standards.

(i) Busbars shall be of copper and complete with all connections to the switch or breaker. Continuous rating of Copper busbars shall be adequate considering all derating factors. The busbars should be fully encapsulated by SF6 gas inside the tank.

(j) The circuit breaker shall be fitted with static type self powered relay inside the front cover to avoid any tampering. The same shall be used in conjunction with suitable CT's and Tripping Coil for fault tripping of the Circuit Breakers. CT's shall be mounted on bushing of breaker. CT's mounted on cable inside cable compartment are also acceptable.

(k) Each Cable compartment shall be provided with three bushings of adequate sizes to terminate the incoming / outgoing, HT cables. Cable compartment shall be front access, Arc proof and interlocked with the respective earthing switches. From safety point of view, it should not be possible to open the cable box unless the earth switch is ON.

(l) There shall be enough height from the base of the mounted switchgear so that the cables can be bent and taken vertically up to the bushings. The Cable termination shall be done by Heat shrinkable Termination method so that adequate clearances shall be maintained between phases for Termination. Cable Termination boots shall be supplied by the switchgear manufacturer.

(m) The moving contacts of the earthing switch shall be visible in the closed position through transparent covers.

(n) Suitable padlocking arrangements shall be provided as stated below:

- Circuit Breaker manual operating handle in the "OFF" position.
- Each feeder Panel operating handle in 'Closed' 'Open" or 'Earth' position.
- Each isolator operating handle in 'Closed', ' Open', or 'Earth' position.

(o) VCB
For detailed specification refer respective section of VCB.

TRANSFORMER

(a) Distribution transformer shall be a part of the compact substation which will be housed

in the enclosure. The transformer shall be suitable for installation in hot, humid tropical atmosphere. All equipment accessories and wiring shall be provided with tropical finish to prevent fungus growth.

(b) The transformers shall be capable of continuous operation of rated output under the operating conditions of voltage and frequency variations as per statutory limits governed by relevant Indian Standard, Indian Electricity Rules and IEC with latest amendments in force.

(c) The distribution transformer shall be dry type suitable for compact substation housed in an enclosure.

(d) Insulating material shall be of proven design, complying with the requirements of applicable standards.

(e) The transformer shall have a continuous rating as specified at any of the specified tapping position and with the maximum temperature rise specified.

(f) The magnetic circuit shall be constructed from high grade cold-rolled non- ageing grain oriented silicon steel laminations with non-hygroscopic insulation material on both sides. HV and LV windings shall be of copper.

(g) The maximum temperature rise at the specified maximum continuous output shall not be less than that specified in applicable standards. The transformer shall be suitable for carrying load within the temperature rise.

(h) The transformer shall be provided with following fittings and accessories:

- WTI with alarm & trip contact
- Off circuit Tap changing links

(i) Distribution Transformer
For detailed specification refer respective section of Distribution transformer.

LT SWITCHGEAR

(a) LT switchgear shall be suitable to house following components:

- PVC sleeved Aluminium busbars
- Air circuit breaker (ACB) / Moulded Case Circuit Breaker (MCCB) for incoming feeder with microprocessor based over current, short circuit and earth fault release.
- MCCBs for outgoings with microprocessor based over current and Short circuit release.

(b) Bus bar:

Bus bar shall be of high conductivity aluminium supported on insulators made of non-hygroscopic, non-inflammable material with tracking index equal to or more than that defined in BIS. The main bus bars shall have uniform current ratings throughout their length as specified in data sheet. The current rating of the neutral shall be half that of the phase bus bars. Removable neutral links shall be provided on feeders to permit isolation of the neutral bus bar.

Only zinc passivated or cadmium plated high tensile strength steel bolts, nuts and double spring washers shall be used for all bus bar, joints and supports.

The hot spot temperature of bus bars including joints at design ambient temperature shall not exceed 95ºC for normal operating conditions.

The current rating of the bus bars shall be as required for design ambient temperature at site conditions and for being inside the cubicle at fully loaded condition. The vendor shall suitably de-rate the nominal rating to suit the above condition.

Interconnections between the main bus bars and individual units shall be made using vertical / horizontal aluminium bus bars of adequate rating.

(c) Air circuit breaker (ACB):

ACBs shall be fixed type with manually operated (MFO type) spring charging stored energy type mechanism fitted with the microprocessor based over current, Short circuit and Earth fault releases for suitable current rating. 'Open', 'Closed', 'Service' and 'Test' positions of the circuit breaker shall be clearly indicated.

ACBs shall be provided with the following accessories, unless otherwise specified:

- Indicating lamps to show 'Closed' 'Open', and 'Auto-trip' conditions of the circuit breaker when breaker operation is controlled by a control switch.
- Mechanically operated, red ‘trip’ push button, shrouded to prevent accidental operation.
- Minimum 2 NO and 2 NC potential free auxiliary contacts
- Locking facilities in the 'Service', 'Test', and 'Isolated', positions.
- Closing and trip coil shall operate satisfactorily under the following conditions of supply voltage variation:

  Closing coils - 85% to 110% of rated voltage
  Trip coils - 70% to 110% of rated voltage
- Trip free mechanism/ Anti-pumping protection

(d) Moulded Case Circuit Breakers (MCCBs):

MCCBs shall be of triple/ four pole construction arranged for simultaneous three/ four pole manual closing and opening. MCCBs shall be provided with microprocessor based release for incoming and outgoing feeders. Operating mechanism shall be quick-make, quick-break and trip-free type. The ON, OFF and TRIP positions of the MCCB shall be clearly indicated and visible to the operator. MCCB terminals shall be shrouded and designed to receive cable lugs for cable sizes relevant to circuit ratings.

For detailed specification refer respective section of LV Switchgear.

METERING MODULE:

Metering Module should have the following components:

(a) Potential Transformer with HT fuse on primary side and MCB on secondary side for protection.

(b) Current transformers

(c) Digital MFM

(d) Space heater with thermostat

AUTOMATIC POWER FACTOR CONTROL (APFC)

(a) Automatic Power Factor Control (APFC) unit shall be provided on LT side to maintain improve power factor of the system.

(b) The capacitor bank shall be provided with sequencing devices, timer and relays for automatic sequential switching of the capacitors in and out of circuit.

(c) APFC shall be complete with all the required accessories.

(d) For detailed specification refer respective section of APFC Panel.

TESTS

Enclosure shall be type tested for Ingress protection on each compartment.

It is mandatory to have temperature rise test on enclosure for K10 class.

Compact Substation Enclosure and HT switchgear shall be type tested for IAC 20 kA / 1 sec.

Type test reports for enclosure, switchgears, Load Break Switches, Circuit Breakers shall be furnished along with the tender and subsequently.

The switchgear, circuit breakers and all associated equipment shall be tested in accordance with relevant standards. All routine tests shall be carried out. Type tests shall also be carried out if not tested previously.

Type and routine test report shall be submitted for the EMPLOYER's approval before the equipment is dispatched. Bound copies of test reports shall be furnished along with the switchgear.

All meters and other reference devices used for testing shall have valid calibration from reputed national laboratories/institutes. Inspection by EMPLOYER/ Engineer will not be carried out unless the vendor confirms that calibrated equipment is ready for proceeding with the tests.

Equipment shall not be dispatched unless the test certificates are duly approved by the EMPLOYER/ Engineer-in-charge.

SYSTEM PARTICULARS

a) Nominal System Voltage: 11kV

b) Highest System Voltage: 12kV

c) Frequency: 50Hz ±3%

d) No. Of Phases: 3 Phase

e) Neutral Grounding: Solidly Grounded

f) Fault level: 20kA for 3 Sec

g) Internal Arc withstanding level: 20kA for 1 Sec.

h) Max Ambient Temperature for design and temperature rise shall be 50ºC.

DRAWINGS AND DATA

All Drawings, data, technical particulars, detailed literature, catalogues, type test certificates etc shall be submitted along with the bid/ after award of contract as specified in Bid Document.

3. HV PANEL

The scope of this specification design, manufacture, testing at manufacturer's works, supply, packing, forwarding and delivery from place of storage/ manufacturer's works to erection site including transit insurance, assistance for testing, installation, commissioning and performance demonstration at site of indoor type 11 kV VCB and its accessories with short time current rating of not less than 20kA for 1sec.

CODES AND STANDARDS

The design, material, construction, manufacture, inspection, testing and performance of Metal Clad VCB shall comply with all currently applicable standards, statutes, regulations and safety codes in the locality where the Equipment will be installed. The Equipment shall comply with the latest editions of the Codes and Standards.

The HV Switchgear, Instrument Transformers and other associated accessories shall conform to the latest revisions and amendments thereof, but not limited to, the following standards.

IEC 62 271-200 - General requirement for Metal Enclosed Switchgear.

IEC62271-102 - Alternating current Dis-connector (Load break isolators) and earthing switch.

IEC 62 271-100 - Specification for alternating current circuit breakers.

IEC 62 271-1 / IEC 60694 - Panel design, SF6/Vacuum Circuit Breakers.

IEC 60044-1/ IS 2705:1992- Current Transformer

IEC 60265 - High voltage switches.

IEC 376 - Filling of SF6 gas in RMU.

IEC 60273/IS :2099 - Characteristics of Indoor & Outdoor post insulators

IEC 60529/IS 13947(Part-1) - Degree of protection provided by enclosures

All codes and standards referred to in this specification shall be understood to be the latest version on the date of offer made by the Bidder unless otherwise indicated.

SYSTEM PARTICULARS

- Nominal System Voltage: 11 kV
- Highest System Voltage: 12 kV
- Frequency: 50Hz ±3%
- No. of Phases: 3 Phase
- Neutral Grounding: Solidly Grounded
- Fault level 20kA for 1 sec
- Internal Arc Tested As per IEC 61641 for 1s
- Max Ambient Temperature for design and temperature rise shall be 50ºC.
- Bus rating: 630A

- Bus bar material: EC grade Copper
- Breaker type: VCB
- Breaker rating: 20 kA for 1 sec
- Protection relay: µP based IDMT relay with 2OC (10%-200%) and 1 EF (10%-40%).

The switchgear shall be metal enclosed, indoor type with vacuum circuit breakers fully draw out type. Design and construction shall be such as to allow extension at either end. Metal enclosed switchgear and control gear cubicles shall be divided into following separate compartments with metal enclosures intended to be earthed (metal clad):

(a) Busbar compartment

(b) Circuit breaker compartment

(c) Cable compartment

(d) LV/Metering compartment

All the HV design must ensure conformity to IEC-60298 and must be Type tested for Internal Arc Test for 1 sec with AFLR category.

Multi Function Meter shall micro-processor based electronic meter and shall have facility for on line monitoring, reading display of each parameter and shall be provided with RS-485 communication port.

The cable glands shall be of double compression type brass glands. Gland plate shall be of 3mm minimum thickness. For Single core cables the Gland plate shall be of Al material.

Gaskets shall be EPDM Type. Hardware shall be stainless steel. Paint shall be two epoxy coats over 2 coats of primer. Epoxy painting may be powder epoxy coated or spray painted epoxy.

20% spare terminals and contacts to be provided for each terminal strip for each panel for future interconnection and interlocks.

Aluminium etched 11 kV Caution boards written in three languages (English, Hindi, Oriya) shall be riveted on the panel as well as on the Doors of the HT compartment. Stickers are not acceptable.

CURRENT TRANSFORMER

They shall satisfy following requirements:

Current transformers for metering & protection shall be cast resin (class of insulation B or better) suitable for operation on 11 kV, 50 Hz system. The CT ratios/protection class shall be as shown in 'Single Line Diagram'.

Rated VA burden for metering/protection CTs shall not be less than 15VA or 120% of total VA burden whichever is higher.

The accuracy class for metering CT shall be 0.2s or as per distribution company requirement/ statutory requirements whichever is more stringent.

It shall be responsibility of Contractor to ensure that CTs are suitable for correct and satisfactory operation of the instruments/relays connected across them.

Short time current rating and momentary withstand rating of CTs shall be as per breaker SC withstanding capacity.

All CTs shall have secondary rating of 5A.

POTENTIAL TRANSFORMER

They shall satisfy following requirements:

Potential transformers for metering/protection shall be suitable for operation on 11 kV kV, 50 Hz system.

Rated VA burden for metering/protection PTs shall not be less than 50VA or 120% of total VA burden whichever is higher.

The accuracy class for metering PT shall be 0.2 or as per distribution company requirement / statutory requirements whichever is more stringent.

It shall be responsibility of Contractor to ensure that PTs are suitable for correct and satisfactory operation of the instruments connected across them.

MPCB on primary side shall have rupturing capacity equal to the switchgear rating.

For PT's MCB shall be provided on secondary. MCB trip contact to be wired up for annunciation

4. DRY TYPE DISTRIBUTION TRANSFORMER

GENERAL CONSTRUCTIONAL FEATURES

The transformer shall be compact and suitable for easy installation at site. It shall be of modular design; i.e. windings can be individually mounted and replaced on site.

The transformer shall be provided with 4 Nos. Bi-directional cast iron rollers fitted on cross channels to facilitate the movement of the transformer in both directions.

These rollers shall be suitable for being turned through an angle of 90º and locked in that position when the transformer/enclosure is jacked up.

Steel bolts and nuts shall be galvanized.

Transformer shall be suitable for tropical climate & shall be anti-fungal treated. It shall be capable of withstanding thermal effect and stresses caused by short circuit or voltage surges.

Rating and diagram plates of stainless steel shall be provided on LT box of the transformer and shall be easily accessible. Rating and diagram plate shall be riveted to the transformer enclosure at a proper height so that it is readable. The rating diagram plate shall bear details as specified in relevant standards.

Lifting eyes or lugs shall be provided on all parts of the transformer, which require independent handling, during loading, unloading, assembly or dismantling.

CORE

The magnetic circuit shall be constructed from high grade cold-rolled non-ageing grain oriented silicon steel laminations with non-hygroscopic insulation material on both sides. The

magnetic circuit shall be of “core type” Construction. The core shall be built up with ‘step-lap' configuration. The grade of laminations shall be low loss type to meet the loss figures specified in the Data Sheet. It shall be carefully interlaced step lap epoxy arranged yoke. It shall be mitered to have low noise and losses.

An adequate painting of resin coat shall cover the complete core and the clamping structure and shall protect it against corrosion.

The Final assembled core shall be free from distortion. It shall be rigidly clamped to ensure adequate mechanical strength& prevent vibration during operations.

The core shall be provided with lugs suitable for lifting the complete core & coil assembly.

The core clamping structure designed to minimise eddy current loss & bolts shall not pass through the laminations for any purpose.

The bandages for the core shall be of polyester tape/fiber glass the spacers for clamping the windings shall be of high quality rubber/fiber glass to withstand the temperature rise specified in Data Sheet and the supports shall be of porcelain.

The insulation structure for the core to bolts and core to clamp plates shall be such as to withstand a voltage of 2500V for one minute.

WINDINGS

LV WINDING

a) LV Winding shall be of Copper foil, coated with class F insulation, epoxy resin reinforced with fibre glass layers pre-impregnated and casted under vacuum, to be thermally bound to the winding.

b) The conductors shall be transposed at suitable intervals in order to minimize eddy current and to equalize the distribution of current and temperature along with windings.

c) Insulation of LV winding shall be adequate to withstand surge voltages appearing across them as result of transfer due to an impulse striking on HV terminals.

d) Adequate cooling ducts in epoxy cast shall be provided in the LV winding to obtain the required cooling in axial and radial directions.

e) The resin used for winding insulation shall be non-hygroscopic. It should be possible to energise the transformer without drying even after long period of service interruption.

f) In case of Dyn-11 transformers, neutral shall be brought out in open for solid earthing on secondary side.

g) The winding shall be designed to reduce the out of balance forces in the transformer at all voltage ratios at all operating conditions.

h) The winding shall be so designed that all coil assembly of identical voltage rating shall be interchangeable and field repairs to the windings can be made without special equipments.

HV Winding

a) HV Winding shall be of Copper wire, double layer winding, and cast under vacuum with epoxy resin. The resin shall be pure low viscosity epoxy resin, fiber glass reinforced. The resin cast winding shall be void free.

b) Insulation of HV winding shall be capable of withstanding temperature rise limited to Class 'F'.

c) Resin on winding shall be casted under vacuum and then pressure impregnated. It shall be thermally bound to the winding after initial curing. Casting shall be cured thermally in controlled autoclave with complete cycle and temperature (typically 145˚C for 4-6 hrs.) recommended by manufacturer / standards.

d) The winding shall be designed to reduce to a minimum the out of balance forces in the transformer at all voltage ratios at all operating conditions.

e) The winding shall be so designed that all coil assembly of identical voltage rating shall be interchangeable and field repairs to the windings can be made without special equipments.

f) Adequate cooling ducts in epoxy cast shall be provided in the HV winding to obtain the required cooling in radial and axial directions.

g) HV and LV winding shall be suitably braced and supported at top as well bottom to withstand short circuit stresses set up by surges and damage because of inertia.

h) The resin casting process shall be carried out under the most strict and automated controlled conditions in order to ensure optimum insulating and mechanical properties.

i) The coil finishing shall provide smooth surface eliminating dust accumulation and give effective cooling.

EARTHING

The framework and clamping arrangement of core and coil shall be suitably earthed internally to the body of enclosure. Separate 2 nos. earthing terminals shall be provided on enclosure for connection to EMPLOYER's earth grid.

Core shall be earthed to the frame. Suitable arrangement shall be provided for disconnecting the core earthing for insulation measurement.

2 Nos. separate earthing pad / terminals shall be provided on the HV cable box for armour earthing from inside and for owner's grid connection from outside.

Apart from the neutral leads for power connection, a separate neutral terminal shall be provided to facilitate termination of 2 nos. earthing conductors, which in turn will be connected to two (2) distinct earthing pits by direct connection. The connection may be by insulated cable or by bare strip. In case of cable connection, suitable cable box to terminate the cables shall be provided.

Flexible earthing braid shall be provided between all metal parts joined with gaskets.

Arrangement for supporting 2 runs of GI, up to grade level, from neutral terminal connection installed outside shall be provided.

ELECTRICAL AND PERFORMANCE REQUIREMENTS

Transformers shall operate without injurious heating at the rated KVA at any voltage within + /- 10 percent of the rated voltage of that particular tap.

Transformer shall be capable of delivering rated current at a voltage equal to 105% of rated voltage

Transformers shall be designed for 110% continuous overfluxing with stand capability.

Overloads shall be allowed within the conditions defined in the loading guide of the applicable standard. Under these conditions, no limitations by terminals, tap changers or other auxiliary equipment shall apply.

Transformer shall be self-extinguishing in the event of fire or arcing and no toxic or corrosive gases shall be released.

There shall not be any risk of cracking of the epoxy casting in the transformer.

Transformer shall have partial discharge level of less than (10pC).

The neutral terminal of windings with star connection shall be designed for the overcurrent this can flow through this winding.

Transformer shall be of low no load loss & low noise.

Transformer shall be certified for following:

a) Class F1 : - “Fire Behaviour”

b) Class C2 : - “Climatic”

c) Class E2 : - “Condensation and humidity”

Vendor to confirm the suitability of the transformer for high inductive loads (high current, short time, unbalance loads).

Transformer shall be suitable for switching with Vacuum Circuit Breakers (VCBs). Resonance frequency of the winding shall be such as to avoid resonance with the switching impulse of VCBs & overstress of the insulation.

The sound level of the transformer shall not exceed the limit indicated by IEC 60076 part-10 standard under any specified operating conditions.

The transformer is intended to operate in parallel with the standby transformer for short period. The transformer shall be designed accordingly.

FITTINGS AND ACCESSORIES

The transformer shall be provided with following fittings and accessories:

- Enclosure with Top cover
- Rating & diagram plate
- Terminal marking plate
- 2 Earthing terminals
- Cable box with HV plug-in connectors
- Bus duct termination arrangement/ cable box for LV side
- Neutral cable box for neutral earthing
- Lifting lugs
- Hauling lugs

- Base Channel
- Under carriage with 4 nos. of Rollers which can be turned 90º and bidirectional.
- High-voltage danger notices against touching of coils.
- Louvers
- Winding Temperature indicator with RTD sensor (minimum 2 per phase) - Pre set PTC sensors shall be provided and attached to each of the LV winding as close as possible to the hottest spot. The PTC sensors shall be selected in order to protect both, HV and LV windings. Contacts for alarm and trip and shall be suitable for 220V/110V/24V D.C. The Indicators shall have a suitable RS 485 port for transfer of data to plant SCADA/DCS system).
- Marshalling Box
- Off Circuit Tap Changing Links - The tap-changing shall be performed by link mechanism. The links shall be accessible after opening the door/cover. Vendor to indicate the method of tapping from the main winding (braced joint or any other type)
- Cast resin current transformer on transformer neutral for stand-by earth fault protection, Restricted Earth fault protection, as specified in SLD.
- All necessary cable glands, cable lugs, armour earthing clamps, terminal connectors, cable sealing ends and accessories required for termination of the EMPLOYER's cables/ bus duct shall be included.

TESTS

The routine tests shall be carried out as per applicable standards and shall be deemed to be included in the VENDOR'S scope. The following additional points/tests shall also be considered as part of routine tests and included in the scope.

a) Resistance must be measured at extreme taps also in addition to principal tap.

b) Impedance must be measured at extreme steps also in addition to principal tap.

c) No load loss and exciting current shall be measured at rated frequency at 90%, 100% and 110% rated voltage. These tests shall be done after impulse tests if the latter are specified.

d) No load loss and exciting current shall be measured and recorded with 415V, 3-phase, 50 Hz. Input on LV side.

e) Magnetic circuit (Isolation) test as per CBIP.

f) Measurement of zero sequence impedance

Type tests, if required, shall be carried out, as per applicable standards and the VENDOR shall quote extra unit prices for carrying out each of the type test.

In addition, if required, special Tests as listed below shall be carried out as per applicable standards and the VENDOR shall quote extra unit prices for carrying out the same.

a) Partial Discharge test

b) Acoustic Sound Level measurement

c) Short Circuit Test

d) Thermal Shock Test

e) Environmental Test

f) Climate Test

g) Fire Behavior Test

TEST AT SITE

The following tests on dry type transformer shall be performed by the Vendor at site at the time of erection and commissioning. Typical checks to be carried out at site are listed below:

a) Preliminary checks
b) Compare nameplate details with the specifications.
c) Check for any physical damage, in particular of support insulators.
d) Check tightness of all bolts, clamps and connecting terminals.
e) Check cleanliness of support insulators, core coil assembly, marshalling panels, enclosure, etc.
f) Check for clearances.
g) Check earthing of transformer supporting structure/enclosure and neutral terminals.
h) Check that the transformer is correctly installed with reference to its phasing and properly aligned with respect to switchgear and interconnecting external bus duct.
i) Check for proper termination support of HV and control cables, and provision of cable glands for the same.
j) Check for proper alignment and connection of LV side bus bars with switchgear
k) LV bus bars.
l) Check welding/bolting to embedded parts/floor of the building.

Commissioning checks

a) Insulation resistance test of windings and polarisation index on winding.
b) Vector group test.
c) Phase sequence test.
d) Winding resistance test at all taps.
e) Insulation resistance of control wiring.
f) Core loss test at service tap.
g) Voltage/turns ratio at all the taps.
h) Magnetic current balance at full voltage.
i) Capacitance and tan delta measurement.
j) Tests on current transformers
k) Continuity test
l) Polarity test
m) IR tests
n) Magnetization characteristics
o) Ratio test
p) Secondary winding resistance measurement.
q) Measurement of mV drop across HV and LV power connections and joints.

REJECTION

EMPLOYER may reject any transformer if during tests or service any of the following conditions arise:

No load loss exceeds the guaranteed value.

Load loss exceeds the guaranteed value.

Impedance value differs from the guaranteed value by +/-10% or more.

Winding temperature rise exceeds the specified value

Transformer fails on any High voltage tests.

Transformer is proved to have been manufactured not in accordance with the agreed specification.

The EMPLOYER reserves the right to retain the rejected transformer and take it into service until the VENDOR replaces, at no extra cost to EMPLOYER, the defective transformer by a new acceptable transformer.

Alternatively VENDOR shall repair or replace the transformer within a reasonable period to the EMPLOYER's satisfaction at no extra cost to the EMPLOYER.

Also, VENDOR shall repair or replace the transformer in case of transformer failure within five (5) years from date of commissioning, due to any reason including, but not limited to high inrush current, harmonics, switching over- voltages.

SPARES

The VENDOR shall quote item wise prices for the spares recommended for 3 years trouble free operation or as per the agreement between VENDOR and EMPLOYER.

EQUIPMENT PARTICULARS

a)	Voltage Ratio:	11/0.433kV
b)	Cooling:	AN
c)	Vector Group:	DYn11
d)	Tap Changer:	+5% to -10% in steps of 2.5%
e)	Type of tap Changer:	OCTC (Rotary type tap switch)
f)	No load current:	1.5% of full load current
g)	Max flux density:	1.55T
h)	Current density:	Max 2.8A/sq mm
i)	Losses:	As per ECBC
j)	Impedance @75ºC	As per relevant IS code
k)	Clearances:	As per relevant standards

l) Current density of the HV & LV windings shall not be more than 1.4A / sq mm.

m) Noise level of transformers shall be as per NEMA standard.

5. LV SANDWICHED BUS DUCT

SCOPE

The scope shall cover design, material, constructional features, manufacture, inspection and testing at the Vendor's/his sub-vendor's work, delivery to site and performance testing of sandwiched metal enclosed bus ducts.

CODES AND STANDARDS

The design, material, construction, manufacture, inspection, testing and performance of sandwiched metal enclosed phase bus duct shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable standards. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.

GENERAL

The busbar system shall be of low impedance and sandwiched construction, i.e. no air gap shall exist between bus-bars except at plug-in opening. It shall be possible to mount the busbar in any orientation, without affecting the current rating. The length of each section will be limited to max. 3 m. It shall be totally enclosed pre-painted galvanized steel and be of the non-louvered type maintaining an overall degrees of ingress protection of IP 65(Outdoor) and IP 54 / 55 (Indoor).

BUS BARS

Busbars shall be of Aluminum with conductivity >60%. Neutral shall be 100% of cross sectional area of the phase conductor. A continuous earth busbar (Internal/External) shall be provided. Flexible connections shall be provided with Cu braided / multi leafed conductors for termination at both the ends. The busbars shall be individually insulated with by minimum 2 layers of insulating film. Bus bar conductors shall be insulated with insulation Class F material. All the insulation materials shall be halogen free and fire retardant.

HOUSING

The busbar housing shall be non-ventilated. The enclosure shall be of hot dip galvanized and pre-painted sheet steel. The housing shall be made of minimum 1.6 mm electro galvanized sheet steel, with an epoxy powder coated paint finish. It shall pass at least 1000 hours salt spray test to ensure the anticorrosion ability. The housings shall be profiled, to provide higher strength and efficient heat dissipation. The width of the housings shall be preferably the same for all ratings of busbars, in order to provide interchangeability of tap off boxes. Inspection cover shall be provided over joints to inspect the tightness of the connection.

JOINTS

The electrical joints shall be of one to four bolt type designed for even distribution of contact pressure. Bolts shall be accessible without removing covers. The joints shall be so designed as to allow removal of any length without disturbing adjacent lengths. The joints between sections shall be made so as to provide flexibility during installation and expansion / contraction of busbar during operation. The joints shall be of the Uniblock Joint. The joint construction must have the following features.

a) Shear off nut : To ensure tightness of joint at desired torque

b) Tamper proof cap over shear off nut to prevent opening of nut after achieving desired torque.

c) Heat expansion of atleast 3 mm per joint.

d) The joint insulation must be of one piece mould design and not have any cut edges which can absorb moisture.

e) Joint assembly shall be removable as separate sub-assembly so that it can be inserted or removed without disturbing the adjacent sections.

f) The busbars ends shall not have any holes or slots at the joints – the electrical continuity shall be through pressure plates, achieving a high area of joint cross section and expansion capability.

EXPANSION JOINT

Busbar expansion units shall be used in cases to reduce the stress on the system by differential expansion between the busbars and the casing; particularly for long run of the busbar. It shall consist of a flexible joint in the middle on the conductors and a sliding casing in 2 sections which can absorb the relative movements of each section of the length.

ACCESSORIES

The bus system shall be complete with all the accessories such as straight run lengths, bends/elbows / flat elbow/ edge elbow/ T sections, vertical anchors, expansion joints, flexible connections, flange ends, reducer, end covers etc. All the accessories as required to suit site conditions are deemed to be included in straight length of the bus trunk.

Flanged end boxes shall be provided to accommodate flange end for connecting the bus terminating with flanges of panels, transformers & DG sets etc. At every terminal point at flanges the connection shall be done using flexible connections.

Any other item/ accessory not specifically mentioned above but deemed necessary by the bidder for successful implementation

WALL FRAME ASSEMBLY AND SEAL OFF BUSHINGS

Wall Frame Assembly

Wherever the bus duct passes through the plant building wall, from indoors to outdoors, a wall frame assembly with seal-off bushings shall be provided to prevent any leakage of rain water, infiltration of dust and air temperature variations from indoors to outdoors. The wall frame shall be fabricated out of aluminium angles and sheet and shall be suitable for grouting in the wall.

End cable tap box

End cable tap boxes shall be applied to feed a run of bus duct with cable and conduit. The enclosure shall be designed to accommodate specified size and number of cables per phase. Conductors are separated and provided with the required number of cable lugs per phase, and necessary space for cable termination. The enclosure shall be provided with removable access covers as necessary for access to power cable terminations.

Phase Transposition

Phase transposition is normally provided within the switchgear equipment. However, when required, it can be provided within the bus run system to align phasing of terminal equipment at two ends.

BUS DUCT SUPPORTS

The supporting structure shall be fabricated from standard steel sections and shall be hot dipped galvanised after fabrication. Calculations shall be furnished to substantiate the strength of support structure shall withstand various static and dynamic loadings. The supporting structures shall include supporting members, brackets, hangers, longitudinal beams, channels, nuts, bolts, washers and all other hardware which are necessary for the erection and support of the entire bus duct installation. All the accessories and hardware of ferrous material shall be hot dip galvanised.

Indoor portion of the bus duct may be supported from the floor or ceiling beams. Outdoor portion of the bus duct shall be supported from ground below on suitable foundation in the ground & on the wall with either embedded plates or anchor bolts wherever required. The foundations and structures in outdoor area shall clear the transformers, transformer foundations, cable trenches, CSS.

EARTHING

A separately run earthing flat suitably clamped along the enclosure shall be used as the ground bus. Conductor material and size shall be calculated during detailed design engineering by the Contractor. All parts of the bus enclosure, supporting structures and equipment frames shall be bonded to above ground bus. Ground pad shall be bolted type to accommodate the required size galvanized steel flats. Complete with suitable tapped holes, bolts and washers

TESTS

All routine tests as specified in IS/IEC shall be conducted at the works and all site tests shall be conducted as per IS/IEC at site after the complete bus bar is assembled.

Certified copies of reports/certificates with final conclusions of type tests carried out as per relevant standards on similar type and rating of the equipment within last five years shall be furnished for review along with the Bid. In case the type test reports are not found to be meeting the specification requirements or older than five years, then the VENDOR shall conduct all such tests free of cost and submit the reports for approval without any cost and time implication to the PURCHASER

Type test assembly shall comprise of all the major components such as Insulations, joints, Tap-off units, etc., and shall depict the actual site installation. The components used in the type test assembly shall not be used in the bus bar sections being supplied for the project.

The busbars shall be type tested at a reputed national / International test laboratory (ASTA / KEMA or CPRI) for short circuit withstand. The test shall be for a minimum duration of one second.

Degree of ingress protection (IP rating) shall also be tested at any reputed independent laboratory. This test shall be for IP54 / IP 55 for indoor and IP 65 / IP 67 FOR OUTDOOR application.

TYPE TESTS

The Bidder shall furnish type test certificate for the following tests conducted on similar equipment as per IEC 61439

a) Temperature Rise Limits (for each rating)

b) Dielectric Properties

c) Short Circuit Strength

d) Degree of Protection

ROUTINE TESTS

Following routine tests shall be conducted on the Bus trunking.

a) Physical verification check

b) Megger Test

c) Power frequency with stand test

d) Any other tests as stipulated by the relevant standards

TECHNICAL DATASHEET

SL. NO.	ITEM	UNIT	
1.0	**General**		
1.1	Bus Bar arrangement		Sandwich
1.2	Bus Bar configuration		3phase + 100% Neutral
1.3	Phase		3
1.4	Neutral		100%
1.5	Rated operational voltage	V	1000
1.6	Rated insulation voltage	V	1000
1.7	Rated Dielectric voltage	kV in r.m.s	3.5
1.8	Rated impulse withstand voltage	kV	8
1.9	Rated frequency	Hz	50
1.10	Degree of protection		IP54/55 for Indoor IP 65/67 for outdoor

SL. NO.	ITEM	UNIT	
2.0	**Bus Bar**		
2.1	Bus Bar Ratings	A	Refer SLD / To be calculated
2.2	Short circuit rating	kA	Refer SLD / To be calculated
2.3	Bus Bar material (Phase / Neutral)		Aluminium
2.4	Bus Bar material (Internal earth bus bar)		GI
2.5	**1.7.1.1.1.1.1** Bus Bar material (External earth)		GI
2.6	Bus Bar insulation		Minimum 2 layers of insulating film Class F
2.7	Fire rating		240 min (ISO 834)
2.8	Joint type		Uni-block Joint
3.0	**Bus enclosure**		
3.1	Enclosure material		Hot dip galvanized sheet steel
3.2	Surface coating on enclosure		Epoxy powder coated paint
3.3	Paint		As per engineer-in-charge
4.0	**End Feed unit/Central Unit**		
4.1	End Feed unit Required	Yes/No	Yes
4.2	End Feed unit rating	A	As per requirement
4.3	Centre Unit Required	Yes/No	As per requirement
4.4	Centre Unit rating`	A	As per requirement
5.0	**Tap off Units**		
5.1	Tap off unit Required	Yes/No	No
5.2	Tap off unit Qty. and rating	A	Refer SLD
5.3	Tap off unit type		-
6.0	**Terminations**		
6.1	Flanged End Terminations required	Yes/No	Yes

SL. NO.	ITEM	UNIT	
6.2	Cu Flexible Connections required	Yes/No	Yes

6. L V PANELS

The scope of supply covers design, manufacture, testing and supply of LT Panels.

LT panel shall be (tested assembly - TTA) CPRI /Independent international test house tested for all the tests as per IEC61439-1 & 2 and internal arc tests as per IEC 61641 V3, 25kA (SLD) for 0.3 sec minimum at Horizontal bus bar, vertical bus bar and cable chamber.

LT Panel shall also be tested of design as per Seismic Zone II of IEC 60068-3-3.

Panel shall be rated for Impulse withstanding capability equal to or greater than the switchgears inside the panel.

The metal enclosed switchgear shall be designed to operate continuously with reference of ambient temperature of 50ºC without any de-ration.

The equipment shall be designed and manufactured in accordance with the best engineering practice and shall be such that has been proved to be suitable for the intended purpose.

Provision for interlocking of LV Incomer breaker with HV side breaker shall be provided such that if the HV breaker trips then the LV breaker will trip and it shall not be possible to close the LV breaker unless the HV side breaker is closed.

The Panel shall be indoor type having incoming sectionalisation and outgoing switchgears as specified. The design shall be cubical type. The degree of enclosure protection shall be IP 52 for indoor upto 2500A rating and IP42 above 2500A rating and IP55 for outdoor as per IS: 13947 (Part-I).

All panels shall be from same manufacturer.

LV panel manufacturer must have experience in manufacturing, supply and installation of LT panels of TTA or IEC 61439 designed during the past 7 (seven) years as a qualifying requirement.

CONSTRUCTIONAL REQUIREMENTS:

All panel boards shall be free standing, metal enclosed, single front, fabricated with 2mm CRCA sheet steel for all doors, partitions and covers and 2 mm CRCA sheet steel for load bearing sections including all ACB feeders. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panels.

The gasket shall be suitable to withstand all weathers for long tenure of service. All hardware shall be HD Galvanized or stainless steel.

Main PCC, APFC, DG panels shall conform to FORM 4B as per IS 61439 and metering, common services, street lighting panels shall conform to FORM 3B as per IS 61439.

For operator safety IP2 X (touch proof) protection to be available even after opening the feeder compartment door. The compartmentalization shall be achieved by using metal separators.

Each door & cover shall have adequate reinforcement of suitable ribs & stiffeners. All such door shall open at min 1050. All feeders and cable alleys shall have hinged type door with panel locks. All bus-bar covers and other panel covers shall be screw fixed. Cable alleys and bus-bar chamber shall have minimum width of 300mm.

All doors shall be with concealed type hinges and captive screws. Rear doors of panels requiring rear access shall be provided with removable hinged doors. Side covers of panels shall be with removable panels.

All doors shall be provided with durable and easy fitting locks with special keys to ensure opening by authorized personnel. Rubber grommets shall be provided at the cable entry.

All mounting accessories like base channels, cross angles if required, nuts, bolts etc. shall be supplied by the vendor.

All the panels shall have uniform height. The operating height of all the panels shall not be less than 300mm and not more than 1900mm. Panel height should not be more than 2450mm.

All the panel boards shall have cable entry from bottom. Split gland plate of 2mm thick shall be supplied for termination of power, control and instrumentation cables sized as per the required no. of cable mentioned in the SLDs and 20% spare space for future addition.

<u>BUS-BARS:</u>

a) Bus-bar of the panels shall be rated for Continuous current at site conditions.

b) All bus-bars shall be electrolytic grade copper or aluminium. BIDDER shall specify the purity and conductivity of the bus bar along with the BID.

c) All the bus bars shall be sleeved with heat shrinkable black colour PVC sleeve or better insulation with coloured polyester tapes for phase identification at regular intervals/ locations.

d) BIDDER shall submit all calculations & documental proof of the adequacy of the bus bar sizes to meet the continuous and short time current ratings specified for reference during procurement/ manufacturing.

e) Vertical bus-bars shall have S.C. rating same as main bus bar and shall be suitable for all connected load of vertical section.

f) BIDDER shall ensure that incoming feeder shall be suitably designed for terminating the required no. of runs of 1.1kV grade XLPE insulated armoured cables with 20% spare capacity. BIDDER shall consider the necessary arrangement (dummy panel, adapter panel, rear extension etc.) if required, for terminating the cables within the limits specified above.

g) The bus-bars shall be designed considering the following criteria:

- Current density of 0.8A/sq mm maximum for aluminium and 1.6A/Sq mm for copper.
- Sleeves made of insulating material on all bus bars.
- Bus bars carrying rated current continuously at Design Ambient Temperature shall be considered as 50ºC and temperature rise shall be considered as per latest relevant standard.
- Configuration of bus bars and Proximity effect
- Bus bars shall withstand the short time rating of the panel.

h) The span between the two insulators shall be as per the approved TYPE TEST REPORT for short time rating. Joint positions and insulators shall be properly adjusted so that they don't interfere. Bus bar bending shall be carried out on appropriate machines designated for the same rather than doing manually.

i) Neutral bus-bars of the panel boards shall be rated equal to the size of phase bus and shall be in the same chamber with phase bus bars.

j) All bus-bar shall be treated with anti-oxide paste wherever bi-metallic contact is required.

k) The material and spacing of the busbar support should be same as per the type tested assembly.

EARTHING:

a) Earth bus bars of Aluminium material shall be run all along the panel, extended out at both ends of value equal to the rated symmetrical short circuit rating of the associated switchboard/ panel. The same shall be properly supported to withstand stresses induced by the rated symmetrical short circuit current.

b) Earthing bus-bar shall be terminated at both ends of the switchgear to suit the connections to earthing conductor. The locations where the bus are protruding out of the panel boards, CONTRACTOR shall ensure that proper ingress protections are provided at all such locations.

c) All doors and detachable components inside the feeder are required to be earthed individually with green (with yellow band) colour PVC insulated multi stranded copper conductor wire of size 4 sq.mm duly crimped with ring type lugs and are to be looped & connected to horizontal earth bus.

d) Earthing bus shall be run continuously in panel drawn out suitably considering respective cable entry inside the panel.

e) Separate Al earth bus shall be provided at each cable alley for all the panels.

POWER WIRING (INSIDE THE FEEDER):

a) All power wiring for rating upto and including 63A shall be carried out with 1.1kV grade coloured HFFR/ FRLS PVC insulated, coloured for phase identification, multi stranded copper wires duly crimped with ring type lugs.

CONTROL WIRING (FOR PANEL AND FEEDERS):

a) All panel Control wiring shall be done by 1.1kV grade HFFR/FRLS PVC insulated multi-stranded copper wire. CT circuit wiring shall be done with minimum 2.5 Sq.mm size wire of above specification. Control and Potential circuits shall be wired with minimum 1.5 sq. mm size wires of above specifications. Wires shall be gray coloured with suitable crimp able copper lugs. CT's & PT's wiring shall be colour coded for multi-phase identifications (R-Y-B-N).

GENERAL REQUIREMENTS:

a) DP MCB shall be provided for all control circuits where the fault level is less than 10kA. Else the control supply shall be tapped through a control transformer of adequate capacity supplied with MCCB/ MPCB/ SFU of adequate short time rating. Independent DP MCBs shall be provided for each circuit such that tripping due to fault in one circuit should not affect other functions adversely.

b) Self explanatory Wiring diagrams with terminal and wire numbers, component numbers shall be provided on the inner face of the door of each feeder. Drawing set in the panel shall be laminated.

c) All labels for identification of feeders as well as internal and external components as per legends provided By EMPLOYER shall be on white acrylic sheet with black engraving. These labels shall be fixed by screws/rivets and shall not be pasted.

d) Aluminium etched 415V Caution boards written in two languages (English, Hindi) shall be riveted on the panel at locations where live bus bars are present and need isolation before any access to it. In case secondary covers have been provided inside the panel, then caution boards shall be also marked on these boards in addition to the external covers. Stickers are not acceptable.

e) Selector/control switches shall have an 'Off' position. The 'Off' position shall not be wired in any circuit and shall be utilised to disconnect (or bypass) power supply to control circuit for any maintenance work.

f) All electrical panels (internal components & arrangement) shall have finger touch protection, for human safety viz. working on one component shall not cause shock to the personnel due to any other live component in the panel. Also, the terminal live parts shall not be accessible by fingers (finger cannot come in contact with live parts of the terminals).

g) No openings/ holes meant for fixing hardware shall be left open. All the hardware (esp. screws, nuts, bolts, and washers) shall be in all appropriate positions & properly tightened.

h) Phase separators, shrouds, falling tool barriers shall be suitably provided. Any additional requirements as observed at any stage upto handing-over shall be provided (for safety and ease of maintenance) without any cost implication to the EMPLOYER.

i) All PVC/engineering plastic based items (including but not limited to conduits, casing-capping, trough, trunk, enclosures, covers, plugs, etc) shall be with FR properties.

j) Lifting hooks/eyes shall be provided in each shipping section of the equipment and shall be removable type. The equipment shall be given tropical and fungicidal treatment.

k) Insulation mat of suitable standard width shall be provided in front of the HV and LV panels.

l) Atleast one 230V, 1Ph, Space heater shall be provided for each vertical section of the switchboard. Each Space heater shall be provided with an isolating switch, a thermostat and dedicated MCB protection of appropriate rating. Heater shall be mounted at bottom of the panel with cover to avoid accidental contact of heater with skin.

m) 230V 1Ph, Panel illumination (11W CFL/ LED fixture with lamp, limit switch and isolation switch) along with 1 no. 5/15A 5 pin socket with switch shall be provided for each vertical section. Bare holder with open lamp is not acceptable.

n) Adequate space shall be provided for terminating the outgoing cables.

<u>EQUIPMENT REQUIREMENT:</u>

a) **MCCB:**

- All the panels shall have MCCBs upto 630Amp. All MCCBs shall be rated for 415V, 3 Ph, 50Hz.
- All MCCB shall be microprocessor based. MCCB shall have O/C, S/C Protection. Wherever MCCBs are used as incomer these shall be provided with earth fault & time delay or as specified in SLD. MCCBs of suitable Icu=Ics=100% ratings.
- There should be earth fault indication on panel door.
- Rated operational voltage will be 415V AC with +/-10% variation.
- All MCCBs shall be with Utilisation Category "A".
- All the MCCBs shall invariably be Current Limiting type, features like Double Break, Positive Isolation functions shall be Integral feature of the device and shall provide a cut off in, < 10 ms for prospective currents during faults. All MCCBs shall be provided with rotary handle

with door interlock and extension links/ spreaders with proper shrouds. No live part accessible even after opening the front cover.

b) **ACB:**

- From 800 A onwards ACBs shall normally be used. These should have 50 kA (Icu=Ics=Icw) Short Circuit Current rating with microprocessor based overload, short circuit and earth fault protection at 415 volts, 50 Hz.
- The air circuit-breakers (ACBs) used in low-voltage installations shall be designed, built and tested in compliance with the standards of the IEC 947-2 & EN 60947/ IS 19947 (Part-II) : 1993.
- Rated operational voltage Ue should be 690 V.
- The rated insulation voltage shall be equal to or greater than 1000 V.
- Overload protection shall have adjustable setting from 50% to 100% of the ACB's rating.
- The ACB release shall be self-powered, requiring no external power supply. For it to operate, it is sufficient for one phase to be loaded at 20% of the rated current of the current transformer.
- Power loss in breakers should also be watched for selection.
- Utilization category-B
- Releases are also available with LCD display which displays all three phase current & neutral current, running voltage, average voltage and maximum voltage. These releases will also display maintenance date like no. of operations, & fault history (last 10 trips and type of fault). To protect the load and cables from repetitive over temperature protection. In case of BMS connectivity through Ethernet communication, the release shall enable the user ON, OFF, Trip status communication.
- Individual fault indication LED's (OL,SC & EF) backed by lithium battery to give indications even when the CB is off and electrical fault trip (OL& SC) alarm indication on panel shall be available on trip units for easy & faster identification of cause of fault.
- ACB with microprocessor based trip release with adjustable (O/C, S/C & E/F Protection) with adjustable current & time delay & %loading bar graph for each phase.
- For Distinct Fault Indication, required voltage supply shall be derived from the existing control supply by BIDDER. No separate charges shall be asked for later during execution.
- All instrument transformers shall be cast resin type and shall have insulation of class B or better.
- Indicating lamps shall be of the Multi chip LED type with low watt consumption.
- Each incomer shall be provided with a Multi Function Meter displaying all electrical parameters like (but not limited to) current, voltage, kW, kVA, KVAr, kWH, MD, PF, Hz, (THD measurement only in main PCC incomer) etc. and shall have provision for remote communication with SCADA/ BMS..
- The switchgear shall be complete with all equipment such as CT, VT, switches etc. duly wired up to terminal blocks. Terminal blocks shall be located at suitable place for easy access. CT shorting, isolating terminals shall be provided for CTs and isolating terminals shall be provided for VT connections. Twenty (20) percent spare terminals shall be provided in each cubicle. Ring type lugs suitable for termination of 2.5 sq mm copper wires shall be used.

7. APFC PANELS

The equipment shall be complete with all necessary accessories and components as required as per IS standard.

Supply, installation, Testing and Commissioning of automatic power factor improvement (indoor) with Capacitor Banks (APP Type), type test according to IEC 61439-1&2,IEC 61921 including interconnection with LT panel with appropriate size of electric cable. The panel shall be indoor,

factory fabricated, dust and vermin proof (IP 42) type, suitable for 1100 V grade 3 phase 50 HZ AC supply, floor mounted in 12 stage with micro processor along with fully ventilated both side opening.

Fabricated out of MS CRC sheet 2mm thick & frame angle of size 50 mm X 50 mm X 6 mm having bus bar made of aluminium with 600 A capacity, three phase and one neutral fixed on insulator and bus bar insulated by coloured heats shrinkable sleeve & housed in specified compartment both side openable. Including Powder coating internally externally the entire steel surfaces All the cover shall have with suitable locking arrangements, fully internally wired with suitable size of thimbles .Incoming / outgoing internal connection with PVC insulated PVC sheathed multi stranded copper wire of suitable size all as directed.

a) The capacitor banks shall be complete with all parts that are necessary or essential for efficient operation. Such parts shall be deemed to be within the scope of supply whether specifically mentioned or not.

b) The capacitor bank may comprise of suitable number of single phase units in series parallel combination. However, the number of parallel units in each of the series racks shall be such that failure of one unit shall not create an overvoltage on the units in parallel with it, which will result in the failure of the parallel units.

c) The complete capacitor banks with its accessories shall be metal enclosed (in sheet steel cubicle), indoor floor mounting and free standing type.

d) All sheet steel work shall be thoroughly cleaned of rust, scale, oil, grease, dirt and swarf by pickling, emulsion cleaning etc. The sheet steel shall be phosphate and then painted with two coats of zinc rich primer paint. After application of primer, two coats of finishing synthetic enamel paint oven baked/stove shall be applied.

e) The assembly of the banks shall be such that it provides sufficient ventilation for each unit. Necessary louvers may be provided in the cubicle to ensure proper ventilation.

f) Each capacitor unit/bank shall be fitted with directly connected continuously rated, low loss discharge device to discharge the capacitors to reduce the voltage to 50 volts within one minute in accordance with the provisions of the latest edition of IS : 2834.

g) All panels of capacitor banks with MCCBs, Contactor, minimum 8 stage automatic power factor correction relay enclosed in IP 42 compliant CRCA Sheet Steel enclosure.

h) Capacitors shall be double layer All poly Polypropylene (APP) type having following specifications and conform to IS 13925:

i) The capacitors shall have Low Dielectric Loss of 0.5 W/ kVAR.

j) All capacitors shall be provided with 7% de-tuned filter along with all accessories and protections.

k) Any change in rated voltage level of the capacitor bank due to the filter or otherwise shall be considered by the Contractor. The indicated rating of capacitor banks are at rated voltage of 415V.

l) The banks shall be switched ON and OFF in both Auto as well as Manual mode. An “Auto/Manual” Switch at the incomer feeder shall be provided.

m) All necessary auxiliary contactors of suitable duty along with feeder accessories are included in scope. All power Contactors for capacitor switching shall be of required duty.

n) Manual operation shall be done with recess type panel mounted ON/OFF pushbutton with delay timer.

o) Minimum current rating under site conditions, of circuit breakers, Contactors, and cables shall be at least 150% of rated capacitor current.

p) Capacitors shall be mounted in such a way that heat dissipation is proper and the capacitors are accessible for maintenance and inspections.

q) Capacitor switching and automatic power factor correction panel shall be designed in such a way that power factor of 0.95 lagging shall always be maintained. Timings to cut in capacitors shall be provided in such a manner to facilitate capacitor discharging before next switching and shall also avoid hunting due to temporary fluctuations of load. The timer shall be provided in both auto and manual mode.

r) The Automatic power factor correction panel and capacitor panel are integral type, prewired including power connections. Due consideration shall be given for adding/ removal of capacitor or other components and maintenance considerations.

s) Each unit shall satisfactorily operate at 130% of rated KVAR including factors of overvoltage, harmonic currents and manufacturing tolerance. The units shall be capable of continuously withstanding satisfactorily any overvoltage up to a maximum of 10% above the rated voltage, excluding transients.

UNIT PROTECTION

Each capacitor unit shall be individually protected by a MCCB Breaker suitably rated for load current and short circuit capacity, so that a faulty capacitor unit shall be disconnected by the breaker without causing the bank to be disconnected. Thus, the breaker shall disconnect only the faulty unit and shall leave the rest of the units undisturbed.

The Inputs to the APFC system is Voltage input from two phases and current input from the third phase. Out of two phases of voltage one phase voltage is taken as Reference 0 and other phase voltage as 440 V. APFC need to be installed CT (Current Transformer) on the third phase at main incomer ACB after transformer, which will give signal to the APFC Relay. Based on this inputs the ASIC (Application Specific Integrated Circuit) OR Call it as Microprocessor internal to the APFC Relay will give output signal to relay outputs which will energize coil of the contactor so that the contactor come in line connecting the capacitor bank in circuit. However this is step correction means PF is corrected in steps. The Voltage rise due to connection of capacitor banks is marginal. There will be no frequency correction with APFC System.

APFC PANEL ACCESSORIES

a) Power capacitor and control panel shall be housed in metal enclosed cubicle. Power capacitor shall be housed in the lower compartment and capacitor control panel at top compartment.

b) The control equipment including capacitors shall be mounted in a panel of cold rolled sheet steel. The panel shall be of indoor type.

c) Bus bars shall be of aluminium conductor and high conductivity.

d) Isolating switch

e) Contactor with overload element

f) APFC Relays responsive to current/voltage/KVAR/PF as specified for automatic switching shall be of microprocessor based suitable for state board Electricity with reduced power factor.

g) Sequencing devices, timers and auxiliary relays for automatic sequential switching of the capacitors in and out of the circuit.

h) Auto-manual selector switches

i) Push button for opening and closing the power circuit.

j) Red and green cluster LED lights for capacitors ON/OFF indication

k) Protective numerical relays to protect the healthy capacitor units when one unit fails in a series connection

l) Space heater and cubicle lighting as per the requirements.

8. CABLES AND CABLE CARRIER SYSTEM

SCOPE

This specification also covers the design, material, construction features, manufacture, inspection and testing at the VENDOR's/his SUB-VENDOR's works and delivery to site of HT Cables 11 kV and LT Cables, Cabling Accessories, conduits and pipes etc.

APPLICABLE CODES & STANDARDS

The design, construction, manufacture and performance of the equipment/components shall conform to latest applicable standards as on date of submission of the bid and comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment/components will be installed. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.

Unless otherwise specified, equipment shall conform to the latest applicable standards for cables IS 1554, 7098, 8130, 5831, 3975, IEC 60183, 60227, 60502, 60885, 10418.

TECHNICAL SPECIFICATION FOR CABLES & CABLE TERMINATION

The various types of cables covered in this specification shall meet the following requirements:

XLPE Insulated HV Power Cables

The conductors shall be screened by extruded semi-conducting compound and XLPE insulated. The cores shall be screened by extruded semi-conducting compound in combination with non-magnetic metallic tape (copper tape preferred).The inner sheath over laid up cores and outer sheath over the armour shall be extruded black PVC compound type ST-2. Core identification shall be by printed numerals. The construction, performance and testing of the cable shall comply with IS 7098-Part 2 (Cross Linked Polyethylene Insulated PVC Sheathed Cables for working voltages from 3.3kV upto and including 11kV).

1100 V Grade XLPE Insulated Power Cables

The cable shall be extruded XLPE insulated. The inner sheath over laid up cores and outer sheath over the armour shall be extruded PVC compound type ST-2. Core identification shall be by printed numerals. The construction, performance and testing of the cable shall comply with IS 7098-Part1 (Cross linked polyethylene insulated PVC sheathed cables for working voltages upto and including 1100 V).

1100 V grade PVC insulated Power / control cables

The cables shall be insulated with extruded PVC compound type C, provided with inner sheath and outer sheath of extruded black PVC compound type ST-2.

The construction, performance and testing of the cable shall comply with IS 1554 - Part 1 (PVC insulated heavy duty electric cables for working voltages upto and including 1100 V).

1100 V Grade Lighting/Misc./Light duty unarmoured cables

Cables shall be insulated with extruded PVC type-C. Outer sheath shall be extruded black PVC type ST-2. The sheathed cables shall be weather proof suitable for indoor/outdoor use. Twin and multicore cables shall be laid up and filled with thermoplastic material, bound by plastic tape and provided with outer sheath.

The construction, performance and testing of the cable shall comply with IS 694 (PVC insulated cables for working voltages upto and including 1100 V).

For all LT power and control cables, double compression glands with aluminium lugs for Aluminium cables and tinned Copper lugs for Copper cables shall be used in indoor and outdoor application.

The termination shall be inclusive of miscellaneous items such as clamps, cleats, cable tags, cable markers etc.

In general cable installation works shall be carried out in accordance with IS 1255 – 1983, latest version. At road crossings, the depth of the Pipe shall be minimum 1m else proper concrete encasing shall be provided.

For Underground cables, cable marker shall project 150mm above ground and shall be spaced at an interval of 30 metres, and at every change in direction. They shall be located on both side of road and drain crossings on finished surface like foot path etc. Top of cable marker/joint marker shall be sloped, to avoid accumulation of water/dust on marker. The marking shall be accomplished with a separate colour tiles/ paver block for highlighting the route of the cable.

Cable tags shall be provided on all cables both at feeder pillar end as well as on each pole (just before entering the equipment enclosure).

Cable Glands

a) Double compression type cable glands shall be used for the termination of all the power and control cables. Cable glands shall be brass casting, machine finished and Nickel-plated to avoid corrosion and oxidation. Rubber components used in cable gland shall be of neoprene.
b) For single core cables, gland shall be with brass ring.
c) Cable glands shall be with metric threads.
d) Cable glands shall be conical (& not flange type).

Cable Lugs

a) Cable lugs shall be of tinned Copper, solder less crimping type for Cu cables & Al lugs for the Al cables.
b) The current rating of the lugs shall be same as that of the respective cable conductors.
c) Ring type cable terminations shall be used.
d) Insulated lugs are not acceptable for any cable terminations.
e) Bi-metal strip/ Bi-metallic lug shall be used whenever two different metals are to be connected together.
f) Double hole extended neck (long barrel neck) type lugs shall be used in case of cables above 185 sq. mm.
g) Fork terminals shall be used for luminaires & decorative switch/ socket. Pin terminals may be acceptable during execution only in case other terminals/ lugs cannot be accommodated.

h) Reducer / wire pin terminals shall be avoided for MCB terminations. MCB terminations shall be with 'long palm terminals.

i) All terminations in Feeder Pillars / enclosure for earthing & neutral busbars / terminals shall be with ring type terminals.

j) All earthing terminations shall be with ring type lugs only.

k) All control & interlock cable terminations shall be with ring type lugs.

l) Anticorrosion/ anti-oxidation compounds shall be used for crimping lugs [This shall especially be ensured for Al cable terminations & any bimetallic terminations (Cu cable termination using tinned Copper lugs)].

m) If termination is done with crimping tool employing crimping die then forming dies shall be used to make the sector shaped conductor into a round conductor before crimping the lugs on the conductor. The lug must not be crimped directly on the sector conductor. Before crimping the lug, the conductor shall be thoroughly cleaned and special jelly applied over it to prevent further oxidation.

The cable carrier system covers the supply of cable racks, cable trays and its supporting accessories hardware and their installation. It shall be the responsibility of the Contractor to complete the cabling system in all respects.

Cable trays shall be of Galvanised Steel and of perforated type, complete with all necessary coupler plates, elbows, tees, bends, reducers, stiffeners and other accessories and hardware as required. All hardware (i.e. bolts, nuts, screws, washers, etc.) shall be hot dip galvanised. (galvanisation thickness not less than 70 microns).

Each 2.5 metre section of all types of cable trays and all elbows, tees, crosses, etc. shall be provided with two side coupler plates and associated bolts, nuts and washers.

REQUIREMENT OF SPECIAL SHEATH FOR FRLS CABLE

Tests and Test Equipment

Cables shall be subjected to routine and acceptance tests in accordance with standards specified Test methods shall conform to IS 10810 (Methods of Test for Cables). Type tests and optional tests according to applicable standards shall be conducted on cables as specified. Contractor shall ensure use of calibrated test equipment having valid calibration test certificates from standard laboratory traceable to National Standards. Outer sheath for FRLS/FS cables shall meet the following test requirements related to flame retardance, low smoke emission, low acid and toxic gas emission. The Contractors shall have proper test apparatus to conduct all the relevant tests as per the applicable Standards mentioned herein.

Test for flame Retardance

a) Oxygen Index

The critical oxygen index value shall be minimum 29 when tested at 27 +/-2 deg.C as per ASTM-D-2863 and the temperature index value shall be minimum 250oC at oxygen index of 21 when tested as per NES 715.

b) Flammability

- Cables shall pass test under fire conditions as per IS-10810- Part-53.
- Cables shall also pass tests as per IS-10810 Part- 61 & Part-62.
- Fire survival cables in addition to tests (i) and (ii) above shall pass tests as per IEC-331.

Test for smoke generation

The cables shall satisfy the tests conducted to evaluate the percentage obscuration by smoke in an optical system placed in the path of the smoke. The maximum smoke density rating shall not be more than 60% when tested as per ASTM-D-2843.

Tests for acid gas generation

The hydrochloric acid generation when tested as per IEC 754-1 shall be less than 20% by weight.

Tests for Resistance To Ultra Violet Radiation

This test shall be carried out as per DIN 53387. The retention values of tensile strength and ultimate elongation after the tests shall be minimum 60% of tensile strength and ultimate elongation before test.

Tests for water absorption

Outer sheathes shall be subjected to tests for water absorption as per IS 10810. When additional characteristics are required, the tests shall be as agreed to between Employer and VENDOR before the placement of order.

9. INDOOR AND OUTDOOR LIGHTING & SMALL POWER SYSTEM

GENERAL REQUIREMENTS

The Lighting system includes the following items.

- Lighting fixtures complete with Lamps and accessories (lumen per watt shall be indicated)
- Lighting system equipment (ISI make)
- Light control switches, receptacle units with control switch units, lighting wires, conduits and other similar items necessary to complete lighting system.
- Lighting fixture supports, street lighting poles
- Main Lighting distribution board, lighting panels
- Multi core cables for street, boundary lighting
- PVC Conduits

Load balancing of lighting system shall be made.

DESIGN

The lighting system design shall comply with the acceptable norms and the best engineering practices. The lighting layout shall be designed to provide uniform illumination with minimum glare. The layout design shall meet all the statutory requirement, local rules etc.

The value of the ratio of spacing (S) to mounting height (H) shall be commensurate with the type of fittings selected and uniformity of illumination.

APPLICABLE CODES & STANDARDS

All standards and codes of practice referred to below shall be the latest edition including all official amendments and revisions.

- 3 pin plugs & sockets : IS 1293
- General safety requirements for luminaires : IS 1913
- Luminaires for street lighting : IS 10322(Part-5, S 3)

- Fitting for rigid steel conduits for electrical wiring : IS 2667
- Code of practice for interior illumination : IS 3646 & IS 6665
- Switches for domestic & similar purpose : IS 3854
- Electric ceiling type fans & regulator : IS 374
- Code of practice for electrical wiring installation
  1.7.1.2 (system voltage not exceeding 650Volts) : IS 732
- General lighting LED and LED Modules : IS 16101
- Self ballast LED lamps for general lighting services: IS 16102 (Part-1 & 2)
- LED modules for general lighting : IS 16103(Part-1 & 2)
- Safety of lamp control gear : IS 15885 (Part-2/sec-13)
- DC or AC supplied electronic control gear for
  1.7.1.3 LED modules : IS 16104
- Method of measurement of lumen maintenance
  1.7.1.4 of solid state light (LED) sources : IS 16105
- Method of electrical and photometric
  1.7.1.5 measurements of solid state light (LED) products : IS 16106
- Luminaries performance : IS 16107 (Part 1 &2)
- Photo biological safety of lamps and lamp system: IS 16108

LED LUMINAIRES

LED luminaires shall be used for internal & outdoor lighting. Luminaires shall be installed to permit ease of maintenance. The Contractor shall provide all equipment necessary to carry out maintenance on the lighting installation and demonstrate its operation to the satisfaction of the Engineer.

MCB (DP For single phase MCB and 4P for three phases MCB DB) and DP RCCBs for each phase shall be provided at the incomer of Lighting panels and SP MCB for outgoing feeders.

STREET LIGHTING SYSTEM

The illuminance level for road lighting in India is governed by IS 1944 (Part 1& 2): 1970/ Code of practice for lighting of public thoroughfare.

The layout for street lighting system will be planned in such a way that uniformity ratio as required by IS: 1944 is maintained.

All the Poles shall be designed to withstand the maximum wind speed as per IS 875. The top loading .i.e. area and the weight of fixtures are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BSEN 40-3:2000, pr EN-40-3-3.

All pole shafts shall be provided with the rigid flange plate of suitable thickness with provision for fixing foundation bolts. This base plate shall be fillet welded to the pole shaft at two locations .i.e. from inside and outside.

The pole shall be adequately strengthened at the location of the door to compensate for the loss in section.

Aesthetic appearance - All the grooves and carvings of the pole unit shall be free from any kind of distortion for a pleasing aesthetic appearance.

The poles and bracket shall be hot dip galvanized as per is 2629/ IS 2633/ IS 4759 standard with average coating thickness of 75 micron. The galvanizing shall be done in single dipping.

Top Mountings -The galvanized mounting bracket shall be supplied along with the Poles for Installation of the luminaries.

The pole manufacturing & galvanizing unit shall be ISO 9001: 2000 & ISO 14001 certified to ensure consistent quality & environmental protection.

Electrical connections - Four way connectors shall be provided along with Slide lock suitable for connecting 1.1 kV grade, 4 core Al cable. It shall also in house 1 no. 6A DP MCB, 2.5 mm² connectors for looping with 2.5 mm² Copper wires for connecting to the luminaries through 1.1 kV grade, 3Cx2.5 mm² PVC insulated copper conductor flexible un-armoured Cable from the terminal block to the fixture within the pole. All the cables laid through the pipe shall be without any joint.

Two nos. earth boxes shall be provided at the bottom of the pole (diagonally opposite) suitable for connecting 25x6 mm GI earth strip or 6SWG GI wire for earthing of the poles.

Two nos. 50 mm NB HDPE Sleeves of suitable length shall be provided through the foundation upto the Junction Box for entry of power cable.

The BIDDER shall carry out all the relevant tests and inspection in the presence of the EMPLOYER or Third Party Agency, as may be selected by the EMPLOYER, before the dispatch of the poles at no extra cost to the EMPLOYER.

The BIDDER shall inform the EMPLOYER at least FIFTEEN (15) days in advance, about the manufacturing programme so that arrangement can be made for inspection. EMPLOYER reserves the right to waive the inspection at any stage.

All the material/equipment/accessories shall be supplied with manufacturer's test certificates.

BIDDER shall submit the Proposed Product Catalogue, Detail Data sheet, spare parts list and drawing of Pole & Bracket along with the BID for each product quoted.

BIDDER shall arrange for all the tools and equipments.

M20 concrete foundations shall be provided for all the poles. Approx dimension of the foundation for evaluation purpose is 600X600X1700 mm. However, BIDDERs shall design as per the stability requirement and Soil bearing Capacity of each location. The Poles shall be bolted on a pre-cast foundation with minimum four foundation bolts for greater rigidity.

Solar Post Top lights shall be used for street lighting as indicated in the design intent above. These lights shall be with 180Wp – 200Wp solar PV panel along the light columns, battery of 60 – 80Ah and lumen output of 2500lumen LED fixtures.

APPLICABLE STANDARDS

Sr.No.	**Brief Title**	**IS/IEC Code**
1.1	Testing procedure of photometric testing for LED luminaires	LM 79
1.2	Testing procedure on the lifespan of LEDs	LM 80
1.3	National Lighting Code	SP72
1.4	Method of Measurement of Lumen Maintenance of Solid State Light (LED) Sources	IS:16105

Sr.No.	Brief Title	IS/IEC Code
1.5	Method of Electrical and Photometric Measurements of Solid-State Lighting (LED) Products	IS:16106
1.6	Limits of Harmonic Current Emissions	IS 14700-3-2
1.7	DC or AC supplied electronic control gear for LED modules performance requirements	IEC 62384
1.8	Lamp control gear: particular requirements for DC or AC supplied electronic control gear for LED modules	IEC 61347-2-13
1.9	Environmental Testing: Test Z- AD: composite temperature/ humidity cyclic test	IEC 60068-2-38
1.10	Electro Magnetic compatibility (EMC)- Limits for Harmonic current emission-– (equipment input current ≤ 16 A per phase)	IEC 61000-3-2
1.11	EMC Immunity requirement	IEC 61547
1.12	LED modules for general Lighting-Safety requirements	IEC 62031
1.13	Classification of degree of protections provided by enclosures (IP Codes)	IEC 60529
1.14	Fixed general purpose luminaries	IEC 60598-2-1
1.15	General Lighting - LEDs and LED modules – Terms and Definitions	IS:16101 / IEC TS 62504
1.16	LED Modules for General Lighting Part 1 Safety Requirements	IS:16103(Part1)
1.17	LED Modules for General Lighting Part 2 Performance Requirements	IS:16103(Part2)
1.18	Safety of Lamp Control Gear, Part 2 Particular Requirements Section 13 D.C. or A.C. Supplied Electronic Control gear for Led Modules	IS:15885(Part2/Sec13)

ENVIRONMENTAL CONDITION

The average atmospheric condition during the year is mentioned below. The equipment shall be designed to work in such environmental conditions:

Maximum ambient air temperature: 50° C

Max. Relative humidity: 90%

Average Rainfall: 55 inches

Atmosphere: Dusty and Heavy chemical smoke at times in certain areas.

The equipment shall be suitable to sustain and work in the humid and corrosive atmosphere of the city.

LUMINAIRE DESCRIPTION

The Luminaires shall have a sturdy and corrosion resistant high pressure Die cast Aluminium housing with weatherproof gasket for lamp and control gear accessories. The Housing shall be

Epoxy coated, without any cracks or thorough holes, made in a single piece of die-cast LM6 aluminium alloy. The luminaries shall be totally enclosed, dust tight and water proof.

Heat sink used should be aluminium extrusion having high conductivity. The dimensions of luminaries shall be optimum and adequate to permit sufficient heat dissipation, through the body itself, so as to prevent abnormal temperature rise inside the lantern and consequential damage to the cover and gasket materials, LEDs, lenses and electronic drivers. Heat sink must be thermally connected to MCPCB/ LED light source.

The Luminaries Housing shall be suitable for termination of Cable with Double Compression Cable Glands.

Housing protection: IP-66. If the LEDs and LED Driver are in different compartments, then the two compartments must be individually IP-66. For achieving IP-66, proper gaskets should be provided. Test certificate of NABL accredited laboratory is to be submitted for the luminaire model/rating offered.

Luminaires should conform to the photometric Distribution / requirements of Cut-Off / Semi Cut – off light distribution and optics as classified in IS 1944.

Suitable number of LED lamps shall be used in the luminaries. The manufacturer shall submit the proof of procurement of LEDs from OEMs at the time of testing.

The Luminaries shall be provided with high tensile heat resistant toughened glass or UV resistant polycarbonate cover fixed with stainless Steel screws.

An extruded silicon loop gasket shall be provided in the lantern body to ensure a weather proof seal between the cover and the metal housing to exclude the entry of dust, water, insects, etc. Luminaries should conform to degree of protection of IP 66 or above. Felt gasket will not be accepted.

Year of Manufacture, Batch No., Serial Number or Identification No. Luminaries Manufacturer's Name / Logo, Wattage and Frequency should be embossed on the housing.

LED luminaries, should conform to the various National / International standards for safety & performance. Manufacturer should provide test reports as per LM 79 & LM80. Lumen maintenance report as per LM 80 guidelines shall be submitted for the LEDs used along with the BID.

Luminaries should conform to the IS standards for Safety & Performance and test certificates as per IS 16107 should be provided by the manufacturer. In case of luminaries are imported, the BIDDER shall conform to test parameters as per UL or equivalent standards.

The electrical component of the LED and LED driver must be suitably enclosed in sealed unit to function in environment conditions mentioned earlier.

All the connecting wires inside the Luminaries shall be low smoke halogen free, fire retardant cable.

Adequate protection against Overloading, Short Circuit, Over Voltage, over temperature, Under Voltage, String Open shall be provided within the Luminaries.

Design of the thermal management shall be done in such a way that it shall not affect the properties of the diffuser.

The equipment should be compliant to IEC 60598-1, IEC 62031 and IEC/ PAS 62612 depending on the type of luminary.

All the material used in the luminaries shall not contain any toxic material/ metal like mercury; shall be halogen free and fire retardant confirming to relevant standards.

The Manufacturer shall have all the relevant testing facilities certified by an accredited laboratory and shall be offered for inspection to the EMPLOYER for verification of the required parameters and tests. BIDDER shall confirm the same in the BID.

The control gear shall comply to the provisions of IEC 61347-2-13, IEC 62031 and IEC 62384 as appropriate.

The lighting fixtures offered shall comply with the following requirements:

LUMINAIRE DATASHEET

Sr. No.	Parameter	Requirement / Value
1.	Type	LED Luminaries complete with all accessories
2.	Rated Voltage	230 V
3.	Expected Frequency	50 Hz +/- 3%
4.	Operating Voltage Range	140 V to 270 V but luminaires shall be tested for 100V to 300 V AC
5.	Power Factor	> 0.92
6.	Operating Temperature Range	0 Deg C to 50 Deg C
7.	Working Humidity	10% - 90% RH
8.	Driver Type	Constant Current based Electronic Driver
9.	Driver Efficiency	> 85%
10.	Driver Life	>20000 hrs.
11.	Protection required in Driver module	
a.	Short Circuit	Yes
b.	Over Voltage	Yes
c.	Over Temperature	Yes
d.	Under Voltage	Yes
e.	String Open Protection	Yes
12.	Luminaire IP Protection	Minimum IP-65 and above
13.	Minimum Surge Protection	>4 KV
14.	THD	<10%
15.	Rated Minimum LED Life (L70)	>50000 Burning Hours
16.	Rated Minimum Driver Life	20000 Burning Hours
17.	CRI	As per Standard mentioned in Design Criteria
18.	Junction temperature rise	< 85 Deg C

Sr. No.	Parameter	Requirement / Value
19.	Solder point temperature	< 70 Deg C
20.	Maximum temperature rise for Driver	<30 Deg C at 50 Deg C ambient
21.	Make of LED	Cree / Nichia/ Philips Lumiled/ Osram
22.	Make of Driver	Cree / Nichia/ Philips Lumiled/ Osram
23.	Operating Hours	Dusk to Dawn (max 12 Hrs.)
24.	Luminous Efficacy	> 135 Lumens/watt (at operating current(design) and Tj = 85 deg C)
25.	System Efficacy	>100lm/W
26.	Colour Temperature	5000K – 6000K
27.	Illumination Regulation	<5%
28.	Material used for following	
a.	Housing	Single housing, Side entry, Corrosion free High Pressure Aluminum die cast/extruded Aluminium, grey color corrosion resistant polyester powder coating, with separate optical and control gear compartments, fixing arrangement –Maintenance friendly.
b.	Heat Sink	Aluminium extrusion
c.	Clip / Fasteners	Stainless steel.
d.	Diffuser	Toughened glass/ UV stabilized Poly carbonate material
29.	Maximum temperature of Heat sink	<70 Deg C
30.	IK protection of Optic Cover	>IK07
31.	Wires used Inside Luminaries	Cu conductor, low smoke halogen free, fire retardant e-beam cable
32.	Cable gland IP protection	IP 66

TESTING OF LUMINAIRE

The Routine test on each of the offered Luminaire shall be carried out by the BIDDER before dispatch. Following tests shall be carried out as routine tests by the BIDDER for the offered Luminaries:

(a) Visual and Dimensional check
(b) Checking of documents of purchase of LED
(c) Insulation resistance test
(d) HV test
(e) Reverse polarity

The Acceptance test shall be carried out by EMPLOYER or EMPLOYER's Representative on a sample of the lot offered for Acceptance. The Lot shall be different from the lot from which the Type test samples have been drawn. The cost of the testing shall be borne by the BIDDER. Following tests shall be carried out as Acceptance tests by the BIDDER for the offered Luminaries:

(a) Visual and Dimensional check

(b) Checking of documents of purchase of LED
(c) Insulation resistance test
(d) HV test
(e) Over voltage protection
(f) Surge protection
(g) Reverse polarity
(h) Lux measurement

Following Type tests reports shall be provided by the BIDDER for the offered Luminaires along with the BID;

(a) Resistance to humidity
(b) Insulation resistance test
(c) HV test
(d) Over voltage protection
(e) Surge protection
(f) Reverse polarity
(g) Temperature rise Test
(h) Ra (Colour Rendering Index) measurement test
(i) Lux measurement
(j) Fire retardant Test
(k) Test for IP 66 protection
(l) Endurance Test,
(m) Life Test
(n) Photometric Measurements Test Report (IES LM 79)
(o) LED Lumen Maintenance Test Report (IES LM 80)
(p) Vibration test as per ANSI
(q) Drop Test

DRAWINGS AND DATA

All Drawings, data, technical particulars, calculations, detailed literature, catalogues, test certificates etc shall be submitted along with the bid/ after award of contract as specified in Bid Document.

10. EARTHING SYSTEM

SCOPE

This specification covers supply, design, installation, commissioning & testing of items required for earthing system including grounding conductors, rods, fittings, accessories and hardware to permanently and effectively ground the neutral points of transformers/ DG Sets, electrical apparatus, electrical equipment frames, conduit, cable trays and all non-current-carrying metal parts, including structural steel and fences.

The equipment shall be complete with all necessary accessories and components as required as per IS standard and PWD requirements.

GROUNDING SYSTEM

GENERAL REQUIREMENTS

The design of the equipment shall meet the following requirements:

It should provide means to dissipate the current into the earth during normal and fault conditions without exceeding the operating and substation equipment limits and connections.

The ground grid shall provide least resistance path for grounded neutral circuits.

The ground grid shall provide means of discharging current carrying parts which are to be handled by personnel.

Grounding consists of all conductors, ground rods, connectors and all other necessary items to make a complete grounding system.

The Contractor shall finalize the layout of the grounding system as required for the final equipment dimensions and locations.

The ground grid shall be designed so as to provide a maximum ground resistance of 1.0 ohm or less or as per local requirements.

Ground grid shall be installed at a minimum depth of 600 mm from ground level.

Earthing of transformers will be done separately through plate electrodes & further connected to the main collector network using connectors/ risers.

Where the ground conductor crosses the cable/ pipe trenches, the conductor shall be suitably lowered so as to cross cable trench at least 150 mm below its bottom surface.

Risers shall be brought out above the ground level for further extension and connection to equipment.

All conductors in the ground grid shall be welded together at every crossing and at every point where from risers emanate. Continuous lap welding shall be done instead of tack welding.

The risers from the grid shall be laid to avoid contact with reinforcement to guard against false grounding during resistance tests.

All non carrying current metal parts of electrical equipment and apparatus shall be earthed with two separate diametrically/ diagonally opposite connectors. The apparatus shall include:

(a) Bodies of electrical machinery, transformers etc.
(b) Frames of panels and cubicles
(c) Metallic structures of switchgear, casing of cable boxes
(d) Shielding of cables and electrical wiring conduits

DESIGN CRITERIA

Fault Current & Duration

The earthing system will be designed for fault current of 25kA for 1 sec or as per actual fault current.

Soil Resistivity

The Contractor shall undertake the soil resistivity measurements at site and select suitable type of conductors.

11. LIGHTNING PROTECTION SYSTEM

GENERAL

Supply & installation of Lightning Protection System shall be strictly in accordance with IEC: 62305-2010.

ZONE OF PROTECTION

The zone of protection of a lightning conductor defines the space within which a lightning conductor provides protection against a direct lightning stroke by diverting the stroke to itself. For a single vertical conductor, this zone is described as a cone with its apex at the highest point of the conductor and with an angle called as protective angle.

MATERIAL AND DIMENSIONS

The materials of lightning conductor, down conductors, earth termination etc. shall be copper / GI as per schedule of quantities and shall be protected against corrosion.

All air terminations and down conductors shall be of copper / GI as per schedule of quantities and shall conform to IS/IEC: 62305-2010.

Joints and Bonds

The lightning protective system shall have as few joints as far as possible. Wherever joints in the conductor are necessary they shall be mechanically and electrically effective, and shall be riveted and brazed in case of copper and by welding / bolting in case of GI in an approved manner.

Earth Terminations

Each down conductor shall have an independent earth termination. All the earth termination shall be inter-connected and shall be capable of isolation for testing.

Earth Electrode

Earthing with GI plate electrode will be used.

Down Conductor

In order to reduce probability of damage it is often necessary to have several parallel current paths. As recommended by IS/IEC: 62305-2010 equal spacing of down conductors, 20 x 3 mm GI external strip, around the building perimeter

The down conductor must be kept in constant physical contact with the structure via conductive mounting clamps.

Each down conductor shall be directly connected at the dedicated earthing pit and the dedicated Earth pit shall be connected to the other earth pits in the earthing grid.

Alternatively, steel reinforcement can be used as down conductor in line with IS/IEC: 62305-2010.

Steelwork within reinforced concrete structures is considered to be electrically continuous, provided that major part of interconnections of vertical & horizontal bars are welded, clamped or overlapped a minimum of 20 times their diameter and bound or otherwise securely connected.

While using structural reinforcement as down conductor,

- Preferably outer columns which are straight from terrace up to the ground floor shall be used as down conductor. Steel bars in this column should be welded \ bolted with proper overlapping at every floor to ensure, proper continuity throughout.
- At ground level steel bars shall be taken out & welded \ bolted to the GI tape, and the tape will be carried out till the earthing pit at ground
- Also at terrace level steel bars will be taken out & to the connected to the Air terminal.

12. DIESEL GENERATOR SET

The equipment shall be complete with all necessary accessories and components as required as per IS standard for trouble free installation & operation.

The generator shall have output rating sufficient to evacuate the output of the engine at rated power factor over complete range of site ambient conditions.

The DG set shall be supplied with acoustic enclosure conforming to relevant standards.

The generator shall be capable of satisfactory continuous operation at rated kVA and power factor at any voltage from 90% to 110% and within a frequency range of 47.5 Hz to 52.5 Hz.

The generator shall have overload capacity as per applicable standards. The generator shall be capable of withstanding a three phase short circuit at generator terminals when operating at rated kVA and power factor, 5% over voltage and with fixed excitation for 3 seconds.

EARTHING

In DG equipment 4 point earthing system are to be considered out of which 2 points are for body earthing with GI strip and 2 point is for alternator neutral earthing with Copper strip.

PIPING

All other associated piping, valves and other item necessary for completeness of equipment shall be supplied by the contractor.

UNLOADING

Genset should not be lifted from engine and alternator hooks. These are designed for lifting individual items only. Normally, provision for Genset lifting is provided on base- rails. The Genset should be unloaded from base rail by lifting with proper Genset lifting tackle or nylon sling/steel rope of suitable capacity and crane so as to ensure no damage to oil sump, air cleaner, radiator pipes etc.

Genset should be covered with polyethylene or tarpaulin during installation to ensure that water does not enter inside.

Spreader bar/ spacer plate of suitable size may be required to avoid damages to Genset components.

DG set with Acoustic enclosures shall be provided with lifting hooks.

LOCATION

DG Sets with Acoustic Enclosure

DG sets up to 1000 KVA capacity are required to be supplied with acoustic enclosure as per CPCB norms. DG Set with acoustic enclosure shall preferably be installed outside the building (including terrace subject to structural feasibility) & location should be finalized in consultation with the Architect. However, DG set should be as near to the substation as possible i.e. as near to Essential LT Panel as possible. Associated AMF panel/ Electrical panel of the DG Set can be located inside the acoustic enclosure or outside the acoustic enclosure as per manufacturer standard. In case, AMF/ Electrical panel has to be installed outside the acoustic enclosure, location of room to house AMF/ Electrical panel should be decided in consultation with the Architect so that it shall be as near to the acoustic enclosure as possible. Specially, in case of connection through bus trunking, care should be taken for aesthetics.

Nominal ratings of DG Sets

DG Sets are normally available in following standard capacities:

(Ratings in KVA)

7.5	10	12.5	15	17.5	25	30	35	40	50	62.5
75	82.5	110	125	140	200	225	250	320	350	380
415	450	500	550	600	625	700	750	1010	1250	1500

Capacity output of DG Set should be specified in tender in terms of “Prime Power Rating at 0.85 load factor” as per Clause 13.3.2 of ISO-8528 (Part-1).

Climatic Conditions

The output of DG Set shall be specified in tender documents under actual site conditions. The tenderer has to certify that the engine & alternator meets the capacity requirement after de-ration as per IS/ BIS.

DG Set upto 1000 KVA capacity should be type tested for Noise and Emission norms/standards as per CPCB.

DIESEL ENGINE

Engine Rating

The engine shall be of standard design of the original manufacturers. It should be 4 stroke cycles, water cooled, naturally aspirated/ turbo charged (as per manufacturer standard), diesel engine developing suitable BHP for giving a power rating as per ISO 8528- Part-1 in KVA at the load terminals of alternator at 1500 rpm at actual site conditions.

The engine shall be capable for delivering specified Prime Power rating at variable loads for PF of 0.8 lag with 10% overload available in excess of specified output for one hour in every 12 hours. The average load factor of the engine over period of 24 hours shall be 0.85 (85%) for prime power output.

The engine shall conform to IS: 10000/ ISO 3046/ BS:649/ BS 5514 amended up to date.

Necessary certificate indicating the compliance of the above capacity requirement for the engine model so selected along with compliance of Noise and Emission norms as per latest CPCB guidelines for DG set capacity up to 1000 KVA, should be furnished from the manufacturers along with the technical bid. However above 1000 KVA DG set, manufacturers shall furnish certificate that the Engine for the DG set complies with the CPCB Emission norms.

The engine shall be fitted with following accessories subject to the design of the manufacturer:

- Dynamically balanced Fly wheel
- Necessary flexible coupling and guard for alternator and engine (applicable only for double bearing alternator)
- Air cleaner (dry/ oil bath type) as per manufacturer standard,
- A mechanical/ electronic governor to maintain engine speed at all conditions of load.
- Daily fuel service tank of minimum capacity as per Table below, fabricated from M.S. sheet with inlet, outlet connections air vent tap, drain plug and level indicator (gauge) M.S. fuel piping from tank to engine with valves, unions, reducers, flexible hose connection and floor mounting pedestals, twin fuel filters and fuel injectors. The location of the tank shall depend on standard manufacturers design.

1.7.1.5.1.1 RECOMMENDED MINIMUM CAPACITY OF DAILY FUEL SERVICE TANK

S.No.	Capacity of DG set	Minimum Fuel Tank Capacity
(i)	Upto 25 KVA	100 Litres
(ii)	Above 25 to 62.5 KVA	120 Litres
(iii)	Above 62.5 KVA to 125 KVA	225 Litres
(iv)	Above 125 KVA to 200 KVA	285 Litres
(v)	Above 200 KVA to 380 KVA	500 Litres
(vi)	Above 380 KVA to 500 KVA	700 Litres
(vii)	Above 500 KVA to 750 KVA	900 Litres

a) Dry exhaust manifold with suitable exhaust residential grade silencer to reduce the noise level.

b) Suitable self-starter for 12 V/ 24 V DC.

c) Battery charging alternator unit and voltage regulator, suitable for starting batteries, battery racks with interconnecting leads and terminals.

d) Necessary gear driven oil pump for lubricating oil, priming of engine bearing as well as fuel systems as per manufacturer recommendations.

e) Naturally aspirated/ turbo charger (as per manufacturer standard)

f) Lubrication oil cooler

g) Lubrication oil filters with replaceable elements

h) Crank case heater as per manufacturer recommendations

i) Fuel injection: Engine should have suitable fuel injection system in order to achieve low fuel consumption

j) Fuel control solenoid

k) Fuel pump with engine speed adjustment

l) Engine Control Panel: fitted and having digital display for following:

- Start/stop key switch
- Lube oil pressure indication
- Water temp. indication
- RPM indication
- Engine Hours indications
- Battery charging indication
- Low lub. Oil trip indication
- High water temp. indication
- Over speed indication

m) All moving parts of the engine shall be mechanically guarded in such a manner that a human finger cannot touch any moving part.

n) Radiator/ Heat Exchanger System/ Remote Radiator(delete whichever is not applicable)

o) Any other item not included/ specified but is a standard design of the manufacturer

Governor

Mechanical governor of class A2 for up to and including 200 KVA capacity and Electronic governor of class A1 for capacity above 200 KVA, as per ISO 3046/ BS 5514 with actuator shall be provided as per standard design of manufacturer. Governor shall be a self contained unit capable of monitoring speed.

Frequency Variation

The engine speed shall be so maintained that frequency variation at constant load including no load shall remain within a band of 1% of rated frequency.

Fuel System

It shall be fed through engine driven fuel pump. A replaceable element of fuel filter shall be suitably located to permit easy servicing. The daily service tank shall be complete with necessary supports, gauges, connecting pipe work etc. In case of Top Mounted tanks, non return valves are must in fuel supply and return line of specified value. Pipe sealant should be used for sealing for all connections. No Teflon tape to be used. If piping length is more than 10 meters, detail engineering is required in consultation with OEM/ Manufacturers.

Lubricating Oil System

It shall be so designed that when the engine starts after a long shut down lubrication failure does not occur. Necessary priming pump for the lub. oil circuit as per recommendation of manufacturer shall be installed, to keep bearings primed. This pump shall be normally automatically operative on AC/ DC supply available with the set.

Starting System

This shall comprise of necessary set of heavy duty batteries 12V/ 24V DC (as per manufacturer standard), and suitable starter motors, axial type gear to match with the toothed ring on the fly wheel. A timer in the control panel to protect the starter motor from excessively long cranking runs shall be suitably integrated with the engine protection system and shall be included within the scope of the work. Battery capacity shall be suitable for meeting the needs of starting system (as three attempt starting), as well as the requirements of control panel, indications and auxiliaries such as priming pump as applicable etc. The scope shall cover all cabling, terminals, including initial charging etc. The system shall be capable of starting the DG set within 20-30 sec., even in winter condition with an ambient temperature down to 0°C.

Battery Charger

The battery charger shall be suitable to charge required numbers of batteries at 12V/ 24 volts complete with, transformer, rectifier, charge rate selector switch, indicating ammeter & voltmeter etc. Connections between the battery charger & batteries shall be provided with suitable copper leads with lugs etc.

Piping Work

All pipe lines and fittings and accessories requirement inside the room/ enclosure and outside for exhaust piping shall be provided by the contractor. This shall include necessary flexible pieces in the exhaust, fuel, lub. oil and water lines as are necessary in view of the vibration isolation requirement in the installation. Piping of adequate size shall be used for lub. oil of the material as per manufacturer standard. However, only M.S. pipes for the exhaust shall be used. For fuel lines within the acoustic enclosure, PVC braided pipe as per manufacturer recommendations can be used. However, for fuel lines outside the acoustics enclosure only MS pipe be used.

The pipe work shall be inclusive of all fittings and accessories required such as bends, reducers, elbows, flanges, flexible connections, necessary hardware etc. The installation shall cover clamps, supports, hangers etc. as are necessary for completing the work. However, the work shall be sectionalized with flanged connections as are necessary for easy isolation for purposes for maintenance of unit as approved by Engineer-in-charge.

Common Bed Plate

Engine and alternator shall be directly coupled or coupled by means of flexoplate/ flexible coupling as per manufacturer standard design and both units shall be mounted on a common bed plate together with all auxiliaries to ensure perfect alignment of engine and alternator with minimum vibrations. The bed plate shall be suitable for installation on suitable anti-vibration mounting system.

Exhaust System: (wherever applicable)

Exhaust Piping: All M.S. Pipes for exhaust lines shall be conforming to relevant IS. The runs forming part of factory assembly on the engine flexible connections up to exhaust silencer shall be exclusive of exhaust piping item. The work include necessary cladding of exhaust pipe work using 50 mm thick Loosely bound resin (LBR) mattress/ mineral wool/ Rockwool, density not less than 120 kg/m3 and aluminium cladding (0.6 mm thick) for the complete portion. The exhaust pipe work includes necessary supports, foundation etc. to avoid any load & stress on turbo charger / exhaust piping.The exhaust pipe shall be *run along the existing wall of the building duly clamped/*supported on independent structure for which, the design and Drawing for such structure shall be got approved from the Engineer-in-charge.

Exhaust system should create minimum back pressure.

- Number of bends should be kept minimum and smooth bends should be used to minimize back pressure.
- Pipe sleeve of larger dia. should be used while passing the pipe through concrete wall & gap should be filled with felt lining.
- Exhaust piping inside the Acoustic Enclosure/ Genset room should be lagged with asbestos rope along with aluminium sheet cladding / insulated to avoid heat input to the room.
- Exhaust flexible shall have it's free length when it is installed. For bigger engines, 2 flexible bellows can be used.
- For engines up to 500 KVA, only one bellow is required. However, if exhaust pipe length is more than 7 m then additional bellow/ provision for expansion should be provided.
- 'Schedule B' MS pipes and long bend/elbows should be used.
- The exhaust outlet should be in the direction of prevailing winds and should not allow exhaust gases to enter air inlet/ windows etc.
- When tail end is horizontal, 45 Degree downward cut should be given at the end of the pipe to avoid rain water entry into exhaust piping.
- When tail end is vertical, there should be rain trap to avoid rain water entry. If rain cap is used, the distance between exhaust pipe and rain cap should be higher than diameter of pipe. Horizontal run of exhaust piping should slope downwards away from engine to the condensate trap. Silencer should be installed with drain plug at bottom.

Optimum Silencer Location: Location of the silencer in exhaust system has very definite influence on both reduction of noise and back pressure imposed on the system. The preferred silencer locations are given in the Table below, where L is length of the total exhaust system measured from exhaust manifold in meters. Please note that locating the silencer as per optimum silencer location is not mandatory. For high rise buildings, suitable arrangements may have to be provided in consultation with acoustics engineer.

Optimum Location of Silencer (In meters)		
	In-line Engine	**'V' Engine**
Best	2L/5	(4L – 1.5) / 5
Second best	4L/5	(2L – 4.5) / 5
Worst Location of Silencer	L/5 or 3L/5 or at tail end of Exhaust piping	(3L - 10)/ 5 or at the tail end of Exhaust piping

Exhaust Stack Height: In order to dispose exhaust above building height, minimum exhaust stack height should be as follows:-

- FOR DG SET UP TO 1000 KVA :-

  $H = h + 0.2 \times \sqrt{KVA}$

  Where H = height of exhaust stack h = height of nearby building

- *FOR DG SET ABOVE 1000 KVA :-*

  30 m High or 3 m above the building height, whichever is higher.

Care should be taken to ensure that no carbon particles emitted due to exhaust leakage enters and deposits on alternator windings and on open connections.

Support to Exhaust Piping: Exhaust piping should be supported in such manner that load of exhaust piping is not exerted to turbocharger.

Air System

It is preferable to provide vacuum indicator with all engines to indicate choked filter. Maximum air intake restrictions with clean and choked filters should be within prescribed limit as per OEM/ manufacturer recommendation for the particular model of the engine. Gensets should be supplied with medium duty/ heavy duty air cleaners (specify one only). (Heavy duty air cleaner should be used for installations in dusty or polluted surroundings.)

Cooling System

System should be designed for ambient temperature of 50 Deg.C.

Water softening/ demineralizing plants should be used, if raw water quality is not acceptable.

Coolant should be used mixed with additive (in suitable proportion) as per recommendation of OEM /Manufacturer for various engine models.

Radiator fan flow should be free from any obstruction.

For radiator cooled DG Set, proper room ventilation should be planned at the time of construction of DG room.

Remote Radiator can be used in case of basement installation where fresh air may not be available. The proper location of remote radiator is very essential for the successful and efficient operation of remote radiator. In this the cooling media is ambient air. So in order to obtain maximum efficiency from remote radiator, it is necessary to get fresh air in its surrounding. The horizontal distance of remote radiator from engine should not exceed 10 Meter.

For the dusty or polluted surroundings (as radiator gets clogged) and/ or bigger capacity Gensets (say 1000 KVA and above), installation of Cooling System with Heat Exchanger system may be used.

Optional items as under may be included as per site requirement at the discretion of Technical Sanctioning authority:

- COOLING SYSTEM
  - Remote Radiator
  - Jacket Water Heater
  - Crankcase Oil Heater
  - After cooler jacket turbo charger electrical pre heat systems.
- FUEL SYSTEM
  - Fuel Water Separator
  - Auxiliary Fuel Pump
- EXHAUST SYSTEM
  - Industrial Grade Muffler
  - Residential Grade Muffler
  - Critical Grade Muffler
  - Super Critical Grade Muffler
- START SYSTEM
  - Battery Warmer Plate

- Battery Charger
- Automatic Float Equalizing
- Trickle

ALTERNATOR

Synchronous Alternator

Self excited, screen protected, self regulated, brush less alternator, Horizontal foot mounted in Single/Double bearing construction (specify one only) suitable for the following:

Rated PF.	: 0.8 (lag)
Rated voltage	: 415 volts
Rated frequency	: 50 Hz
No. of Phases	: 3
Enclosure	: SPDP
Degree of protection	: IP-23
Ventilation	: Self ventilated air cooled
Ambient Temperature	: 50° C Maximum
Insulation Class	: F/H
Temperature Rise	: Within class F/H limits at rated load
Voltage Regulation	: +/- 1%
Voltage variation	: +/- 5%
Overload duration/capacity	: 10% for one hour in every 12 hours of continuous use.
Frequency variation	: As defined by the Engine Governor (+/- 1%)
Excitation	: Self / separately excited (Self excitation upto 750 KVA and separately excited system above 750 KVA)
Type of AVR	: Electronic
Type of Bearing and Lubrication arrangement	: Anti-friction bearings with Grease lubrication
Standard	: IS 4722 & IEC:34 as amended upto date.

Alternator should be able to deliver output rating at actual site conditions.

The alternator above 500 KVA capacity shall be fitted with suitable Nos. Resistance Temperature Device (RTD) & Bearing Temperature Device (BTD) alongwith space heaters. The terminal of space heaters will be wired to terminal box and the temperature scanner shall be provided in control panel for scaling the winding and bearing temperature.

Excitation

The alternator shall be brushless type and shall be self/ separately excited, self- regulated having static excitation facility. The exciter unit be mounted on the control panel or on the alternator assembly. The rectifier shall be suitable for operation at high ambient temperature at site.

Automatic Voltage Regulators (AVR)

In order to maintain output terminal voltage constant within the regulation limits i.e.

+/- 1%, Automatic voltage regulator unit shall be provided as per standard practice of manufacturer.

Fault tripping

In the event of any fault e.g. over voltage/ high bearing temperature/ high winding temperature or an external fault, the AVR shall remove the excitation voltage to the alternator. An emergency trip shall also be provided.

Standards

The alternator shall be in accordance with the following standards as are applicable.

(i) IS 4722/ BS 2613: 1970. The performance of rotating electrical machine.

(ii) IS 4889/ BS 269 rules for method of declaring efficiency of electrical machine.

Performance

Voltage dip shall not exceed 20% of the rated voltage for any step load or transient load as per ISO 8528 (Part-1). The winding shall not develop hot spots exceeding safe limits due to imbalance of 20% between any two phases from no load to full load.

The generator shall preferably be capable of withstanding a current equal to 1.5 times the rated current for a period of not more than 15 seconds as required vide clause 14.1.1 of IS 4722:1992.

The performance characteristics of the alternator shall be as below:

- Efficiency at full load 0.8 P.F.
    - Upto 25 KVA – not less than 82%
    - Above 25 KVA and upto 62.5 KVA – not less than 86%
    - Above 62.5 KVA & upto 250 KVA – not less than 90%
    - Above 250 KVA – not less than 93.5%
- Total distortion factor Less than 3 %
- Overloading
    - 10% overload - One hour in every 12 hrs of continuous use.
    - 50% overload - 15 seconds.

Terminal Boxes

Terminal boxes shall be suitable for U.G. cables/ Bus Trunking. The terminal box shall be suitable to withstand the mechanical and thermal stresses developed due to any short circuit at the terminals.

Earth Terminals

2 Nos. earth terminals on opposite side with vibration proof connections, non-ferrous hardware etc. with galvanized plate and passivated washer of minimum size 12 mm dia. hole shall be provided.

Space Heaters

Alternators of capacity more than 500 KVA shall be provided with suitable space heaters to maintain the winding temperature automatically such that it does not absorb moisture during long idle periods. The heater terminals shall be brought to a separate terminal box suitable for 230 V AC supply and a permanent caution notice shall be displayed.

MANUAL/ AMF PANEL, BATTERIES AND ELECTRICAL SYSTEM

Battery/ Electrical System

Batteries supplied with Genset are generally dry and uncharged. First charging of uncharged batteries is very important and should be done from authorized battery charging centre. Initial charging should be done for 72-80 hours.

Batteries should be placed on stands and relatively at cool place.

Battery capacity and copper cable sizes for various engine capacity are recommended as indicated in the table below. Cable sizes shown are for maximum length of 2 m. If length is more, cable size should be selected in such a way that voltage drop does not exceed 2 V. However capacity as recommended by manufacturer may be taken.

DG Set Capacity	**Battery Capacity (AH)**	**Cable Size (Material Copper) Sq. mm**	**Electrical System (Volts)**
Above 500 KVA	360	70	24
Above 125 KVA upto 500 KVA	180	70	12
Above 82.5.KVA upto 125 KVA	180	50	12
Above 62.5 KVA upto 82.5 KVA	150	50	12
Above 25 KVA upto 62.5 KVA	120	50	12
Upto 25 KVA	88	35	12

For AMF applications, a static battery charger working on mains supply is recommended to keep the batteries charged at all times.

1.5 sq.mm copper wire should be used for wiring between junction box and Control Panel.

Cabling

Power cabling between alternator and control panel and control panel and change over switch to mains should be done with recommended cable sizes.

As far as possible, for DG Set of capacity 750 KVA & above connection between alternator to AMF panel & AMF Panel to Essential panel shall be through bus- trunking. For exposed/ outdoor bus trunking protection requirement should be IP-55.

If LT panel is part of tender of the DG Set jobs of 500 KVA & above, LT Panel specified, should be one of the reputed brands.

Overheating due to loose thimbling / undersize cables causes most of electrical failures, hence correct size of cable and thimbles should always be used, if cable is specified.

While terminating cables, avoid any tension on the bolts/ busbars (if cable is specified). While terminating R, Y& B phase notations should be maintained in the alternator and control panel for easy maintenance.

Crimped cables should be connected to alternator and control panel through cable glands, if cable is specified.

Multi-core copper cables should be used for inter connecting the engine controls with the switchgear and other equipments.

For AMF application, multicore 1.5 sq.mm flexible stranded copper cable for control cabling should be used.

It is recommended to support output cables on separate structure on ground so that weight of cables should not fall on alternator/ base rail.

External wirings, when provided for remote voltage / excitation monitoring/ droop CT etc. shall be screened sheathed type. Maximum length of such wiring shall not exceed 5 meters.

Alternator Termination Links

For proper terminations between links and switchgear terminals, the contact area must be adequate. The following situations should also be avoided as they lead to creation of heat sources at the point of termination:

Point contact arising out of improper position of links with switchgear terminals.

Gaps between busbars / links and terminals being remedied by connecting bolt/stud. In such cases the bolt will carry the load current. Normally these bolts / studs are made of MS and hence are not designed to carry currents.

Adequate clearance between busbars / links at terminals should be maintained (IS 4232 may be referred to for guidelines).

Improper termination will lead to local heat generation which may lead to failure.

FOUNDATION

Genset with Acoustic Enclosure

For DG Sets installed inside the DG Set Room - A PCC foundation (1:2:4, M-20 grade) of approximate depth 150 mm above the finished Genset Room Floor level is required so as to provide leveled surface for placement of the acoustics enclosure. The length and breadth of foundation should be at least 250 mm more on all sides than the size of the enclosure. Genset should be mounted on AVM's inside the enclosure.

For DG Sets installed outside in open area -APCC (1:2:4, M-20 grade) foundation of weight 2.5 times the operating weight of the Genset with enclosure or as recommended by the Genset manufacturer OEM/OEA, whichever is higher, is required to be provided and is included in scope of work for SITC of Genset. 300 mm of this foundation height should be above the ground level. The length and breadth of foundation should be at least 250 mm more on all sides than the size of enclosure. Genset should be mounted on AVM's inside the enclosure.

Genset without Acoustic Enclosure

Genset should not be installed on loose sand or clay.

Foundation should be designed considering safe bearing capacity of soil. Vibration isolators (AVMs) should be provided to reduce vibration transmission to the surrounding structure.

Depths of PCC (Plain Cement Concrete) for typical soil condition have been shown in the table below. However structural engineer should be consulted to verify the data depending upon soil condition.

DG Set Capacity (KVA)	**Typical Depth of PCC Foundation (For soil bearing capacity 5000 kg/sqm)**
750-2000	600 mm
625	400 mm
320-500	400 mm
200-320	400 mm
82.5 -200	400 mm
Upto 82.5	200 mm

Foundation level should be checked diagonally as well as across the length for even flatness. The foundation should be within ± 0.5 Degree (angle) of any horizontal plane.

ACOUSTIC ENCLOSURE

Installation

Acoustic enclosures are supplied with built in Anti Vibration Mountings (AVMs). As such Genset can be installed directly on the leveled surface.

Exhaust piping outlet should not be turned towards window / ventilator of home or occupied building. Provision of rain cap should be ensured.

The acoustic enclosure placement should be such that there is no restriction in front of air inlet and outlet from canopy.

Service Accessibility

Genset / Engine control panel should be visible from outside the enclosure.

Routine / periodical check on engine / alternator (filter replacement and tappet setting etc.) should be possible without dismantling acoustic enclosure.

For major repairs / overhaul, it may be required to dismantle the acoustic enclosure.

Sufficient space should be available around the Genset for inspection and service.

General Design Guidelines

To avoid re-circulation of hot air, durable sealing between radiator and canopy is must.

Ventilation fans are must for the Gensets cooled by heat-exchanger/cooling tower system.

Exhaust piping inside the enclosure must be lagged (except bellow).

Temperature rise inside the enclosure should not be more than 5°C for maximum ambient above 50°C and it should be below 10°C for ambient below 50°C.

There should be provision for oil, coolant drain and fill. Fuel tank should have provision for cleaning.

The enclosure should be designed to meet the total air requirement for the D.G. Set at full load at site conditions as recomended by the engine manufacturer.

Specifications for Acoustic Enclosure

The acoustic enclosure shall be designed and manufactured confirming to relevant standards suitable for outdoor installation exposed to weather conditions, and to limit overall noise level to 75 dB (A) at a distance of 1 mtr. from the enclosure as per CPCB norms under free field conditions.

The construction should be such that it prevents entry of rain water splashing into the enclosure and allows free & quick flow of rain water to the ground in the event of heavy rain. The detailed construction shall conform to the details as under:

The enclosure shall be fabricated out the CRCA sheet of thickness not less than

1.6 mm on the outside cover with inside cover having not less than 0.6 mm thick perforated powder coated CRCA sheet.

The hinged doors shall be made from not less than 16 SWG (1.6 mm) thick CRCA sheet and will be made air tight with neoprene rubber gasket and heavy duty locks.

All sheet metal parts should be processed through 7-tank process.

The enclosure should be powder coated.

The enclosure should accommodate the daily service fuel tank of the D.G. Set to make the system compact. There should be provision of fuel gauge, which should show the level of the fuel even when the DG Set is not running. The gauge should be calibrated. The fuel tank should be filled from the out side as in automobiles and should be with a lockable cap.

The batteries should be accommodated in the enclosure in battery rack.

The canopy should be provided with high enclosure temperature safety device.

The acoustic lining should be made up of high quality insulation material i.e. rockwool/ glass/ mineral wool/ PU foam of appropriate thickness & density for sound absorption as per standard design of manufacturer's to reduce the sound level as per CPCB norms. The insulation material shall be covered with fine glass fiber cloth and would be supported by perforated M. S. Sheet duly powder coated / GI sheet/ aluminium sheet.

The enclosure shall be provided with suitable size & No. of hinged type doors along the length of the enclosure on each side for easy access inside the acoustic enclosure for inspection, operation and maintenance purpose. Sufficient space will be provided inside the enclosure on all sides of the D.G. set for inspection, easy maintenance & repairs.

The canopy should be as compact as possible with good aesthetic look.

The complete enclosure shall be of modular construction.

The forced ventilation shall be as per manufacturer design using either engine radiator fan or additional blower fan(s). If the acoustic enclosure is to be provided with forced ventilation then suitable size of axial flow fan (with motor and auto-start arrangement) and suitable size axial flow exhaust fan to take the hot air from the enclosure complete with necessary motors and auto start arrangement should be provided. The forced ventilation arrangement should be provided with auto stop arrangement to stop after 5 minutes of the stopping of D.G sets.

The acoustic enclosure should be suitable for cable connection/connection through bus-trunking. Such arrangements on acoustic enclosure should be water proof & dust-proof conforming to IP-65 protection.

The inside of enclosure should be provided with at least two nos. 15 W-LED light luminaire controlled by a 5A switch for adequate lighting during servicing etc. of the DG Set. The power supply to this luminaire should be from the load side of the AMF Panel so that it can remain energized under all conditions.

SPECIFIC REQUIREMENTS OF DG PANEL

General operation philosophy

No volt relays provided in the Main LT panel / DG controller will monitor the grid voltage. In the event of grid supply failure Controller will trip the grid incomer breakers and also give initiating signal to DG for auto starting. For this DG Local / Remote/Test mode selector switch is in Remote mode and DG Auto/Manual selection shall be selected for Auto.

One or multiple DG sets shall start automatically as per the philosophy / sequence. After build up of voltage and speed (Voltage >80% and Engine speed reached to rated speed), incoming breaker of first DG set (Master) will close automatically on dead bus provided the lockout relay of DG breaker is reset. If DG breaker fails to close on AUTO, provision shall be made to close the same manually from DG panel. The other DG incomers (Slave) will close on Live bus synchronising as per load requirement which will be monitored by DG Controller.

Line PT's, Bus PT and Auto / Manual synchronising facility shall be provided. Outgoing breaker(s) of DG panel / incomer breakers of Main LT panel as applicable will close on auto as per the philosophy and power will be extended up to the bus of Main LT panel

On restoration of grid supply, the changeover scheme from DG supply to Grid supply shall be as per the philosophy defined in SLD.

In the AMF starting sequence, facility for minimum number of starting attempts shall be as indicated in Data Sheet. In case DG fails to start and reach rated speed within 90 seconds, it shall be disconnected and locked out automatically. A hand reset lockout relay shall be provided with suitably wired contacts such that it prevents starts in quick succession in excess of the number.

DG Controller shall perform the following function:

a) Automatic starting, load sharing and stopping of DG sets based on variation in load

b) There should be facility in panel to test the DG Sets.

Facility for remote alarm indication for “AMF set in operation”, “AMF fails to start” shall be provided through potential free contact.

The DGs will not run in parallel with State electricity board grid. There could be momentary paralleling of about 30 to 60 Seconds during changeover as per the philosophy.

Separate numerical relay for IDMT over current and earth fault i.e. 51 & 51N protection shall be provided. Relays should have RS485 port at front side. Relays and protection shall be enabled for SCADA/BMS compatibility with IEC 61850 protocol.

Generator protection relays shall be supplied with latest version software and hardware without any extra cost. It should be possible to set relay, view fault parameters, download information from relay to computer connected system.

For DG incomer(s) separate master trip relay ‘86’ (VAJHM23), trip circuit supervision relay ‘95’ (VAX31) shall be provided. These shall be separate electromechanical relays and not as element of numerical relay.

DG Set Controller shall be considered for integration with SCADA/IBMS.

DG controller shall be suitable for single genset operation as well as multi- genset operation which includes Island operation, Fixed power/ base load, AMF & ATS, peak shaving, Load takeover, AMF mode.

The DG controller shall be a part of DG panel. DG controller shall have following minimum inbuilt electrical protections:

- Reverse power (32)
- Short Circuit (50P/N)
- Overcurrent (51)
- Negative phase sequence(46)
- Unbalance Protection (47)
- Under/ Over Voltage (27/59)
- Under / Over Frequency (81R/81O)
- DG controller shall have following minimum engine side protections:
- Overspeed / Under speed shutdown
- Low/ High Battery Voltage
- Battery test alarm
- Fail to Crank shutdown
- Cranking lockout
- Incomplete start after a preset time

- Low fuel warning / shutdown
- Jacket water high temperature
- Low lube oil Pressure after the DG has attained 90% speed
- DC control supply failure
- Engine trip due to generator fault
- One Annunciator with Test, Accept, Reset & Mute push button and hooter along with following annunciations shall be provided for incomer feeder : Auxiliary voltage for the window type annunciation system shall be derived from the battery
- Engine fails to start
- DG on load test
- Engine trip due to generator fault
- High jacket water temperature
- High lube oil temperature
- High differential pressure across lube oil filter
- Bearing temp. High alarm
- Winding temp. High alarm
- Emergency DG stop
- Starting air pressure low(if applicable)
- Diesel level low indication
- Diesel level high indication
- Low lube oil pressure and trip of the engine
- High water temperature (if applicable)
- Engine over-speed and trip
- Engine / Alternator common fault
- Multifunction relay (51, 51N) operated
- Lube oil priming pump (if provided) in operation
- Voltage out of limit
- Ground fault in the system

- AC/DC control supply failure
- DG is paralleled with the main source (grid)
- Battery fully discharged
- Charger failure
- Spare (4 Nos.)

The below mentioned signals shall also be provided as potential free contacts for remote annunciation.

- DG over load
- DG trouble (group annunciation)
- Engine failed to start
- Engine ON
- Engine tripped on fault
- R, Y, B indication lamps, Local/Remote selector switch, Auto/Manual selector switch, Voltage Raise/Lower, Speed Raise/Lower selector switch, Lamp test push button, Emergency trip push button shall be considered for incomer. Trip shall be independent of local/remote.
- Incomer of panel shall be provided with analogue ammeter with ammeter selector switch, analogue voltmeter with voltmeter selector switch, analogue kW meter.
- Multifunction meters (MFM) shall be provided for all incomers/outgoing feeders.
- Looping of all RS485 ports shall be done using 3 cores twisted & shielded 1.5 sq.mm Cu cables and shall be terminated at incomer

The DG panel shall also consist of but not limited to the following:

- One (1) 45-55 Hz frequency meter (Digital type).
- DC voltmeter for battery to read battery voltage if charger is part of DG Panel
- Necessary MCBs for distribution of voltage as required for all control, interlocking and annunciation system
- Two (2) push buttons for starting and stopping the DG set.
- 1 no. temperature scanner to monitor the temperature of alternator stator winding and temperature of bearings
- Necessary MCCB for receiving 415V power supply from EMPLOYER's switchgear to the battery charger unit. if charger is part of DG Panel
- Three (3) single phase voltage transformers (VTs) 415/ 3 / 110/ 3 volts for metering & synchronisation. The VTs shall be connected in star/star with neutral earthed. The rated

VA burden of the VTs shall be minimum 50 VA for each single phase. The VT's shall be provided for each DG incomer and also for the bus.

- Necessary voltage relays
- DG Local/Remote /Test selector switch
- Auto synchroniser
- Synchronising relay for manual synchronisation
- Double volt meter and frequency meter for synchronisation
- Synchronoscope
- Synchronising mode selector switch for Auto/Manual
- Synchronising selector switches
- Auxiliary relays and timers as required for control, interlocking, annunciation system, contact multiplication shall be provided. All relays and timers shall be of reputed make
- One (1) trip relay for alternator faults and one (1) trip relay for engine faults shall be provided to trip the DG breaker on occurrence of either engine or alternator faults
- AVR shall have a motorised potentiometer with facility to control the excitation from AMF panel. Suitable equipment to facilitate operation from AMF panel shall be provided.
- Semi conductor based float cum boost charger shall be considered in DG panel.

Spare parts

The BIDDER shall furnish a list of recommended spare parts for five years operation along with unit prices.

Tests and Reports

Type test reports for the switchgear panel of similar rating for the following tests shall be submitted along with the Bid (not older than 5 years):

Temperature rise

Degree of protection

Internal arc with make of components being offered

Short circuit

The switchgear, circuit breakers and all associated equipment shall be tested in accordance with relevant standards. All routine tests shall be carried out. Type tests shall also be carried out if not tested previously.

Type and routine test report shall be submitted for the EMPLOYER's approval before the equipment is dispatched. Bound copies of test reports shall be furnished along with the switchgear.

Inspection by EMPLOYER/ Engineer will not be carried out unless the Vendor confirms that calibrated equipment are ready for proceeding with the tests

Equipment shall not be dispatched unless the test certificates are duly approved by the EMPLOYER/ ENGINEER.

Vendor shall carry out all routine tests as specified in relevant IS/ IEC standards on all major components and furnish copies of test reports for EMPLOYER's approval. Wherever required, Vendor shall conduct the necessary type tests in the presence of EMPLOYER's representative based on the unit prices available in the bid.

Vendor shall also carry out all routine and functional tests as specified in the relevant IS/IEC on the assembled switchgear panels in the presence of the EMPLOYER's representative at works before despatch and furnish copies of test reports for approval. If required stage inspection, will be carried out by the EMPLOYER

VENDOR shall furnish copies of routine test report for all bought out items for EMPLOYER's approval.

DRAWINGS AND DATA

The following shall be furnished as part of the tender:

General arrangement showing plan, elevation and typical sectional views.

Technical literature on the equipment offered

Quality Assurance Plan.

MAINTENANCE REQUIREMENTS

Easy access shall be provided for all components in the switchgear for maintenance.

As far as possible the switchgear shall be so designed that no special tools are necessary for installation and maintenance. However, if special tools are required, the Bidder shall include price of one complete set in his bid.

The Bidder shall recommend spares for three (3) years trouble free operation.

Vendor shall furnish detailed inter panel wiring diagrams, internal wiring diagrams, detailed component layout drawings to enable the EMPLOYER to carry out maintenance work.

TECHNICAL DATA SHEET

S.No.		RATING	ATTRIBUTE
1.0	DESIGNATION		DG Set
2.0	NUMBER REQUIRED		As per SLD
3.0	TAG NUMBERS		*
4.0	TYPE : MANUALLY STARTED / AUTO MAINS FAILURE (AMF)		Auto Mains Failure (AMF)

S.No.		RATING	ATTRIBUTE
5.0	FUEL AS PER IS 1460		High Speed Diesel (HSD)
6.0	SITE CONDITIONS:		
6.1	ALTITUDE - ABOVE MEAN SEA LEVEL	M	*
6.2	MAXIMUM AMBIENT TEMPERATURE	°C	50
6.3	RELATIVE HUMIDITY	%	90 (Max)
7.0	RECIPROCATING INTERNAL COMBUSTION ENGINES - BS 5514/ISO 3046 PARTS 1,3,4,5,6 &7		Yes
8.0	MACHINES FOR MISCELLANEOUS APPLICATIONS - BS 5000 PART 99		Yes
9.0	ROTATING ELECTRICAL MACHINES - IS 4722		Yes
10.0	CONTINUOUS OUTPUT AT SITE CONDITIONS	KW	*
11.0	OVERLOAD CAPABILITY FOR ONE (1) HOUR IN TWELVE (12) CONSECUTIVE HOURS OF OPERATION		10%
12.0	RATED VOLTAGE		433 V
13.0	RATED FREQUENCY		50Hz
14.0	NUMBER OF PHASES		3
15.0	POWER FACTOR (PF)		0.80
16.0	WINDING CONNECTION		Star with neutral earthed through resistor and isolator
17.0	TYPE OF INSULATION:		
17.1	ARMATURE WINDINGS		Class F
17.2	FIELD WINDINGS		Class F
17.3	COMMUTATOR		Class B
17.4	CORE CONNECTION		Class B
18.0	TYPE OF ENCLOSURE		IP 54
19.0	PERMISSIBLE VOLTAGE VARIATION AT RATED KVA, SPEED AND PF	%	+/- 10%
20.0	TRANSIENT REACTANCES:	%	
20.1	X' d:		*
20.2	X'' d:		*
21.0	PERMISSIBLE FREQUENCY VARIATION AT RATED KVA, SPEED AND PF	± %	+/- 5%
22.0	METHOD OF NEUTRAL GROUNDING: SOLIDLY EARTHED / THROUGH NGR		Solidly Earthed
23.0	LARGEST MOTOR TO BE STARTED WITH DROP IN THE GENERATOR TERMINAL VOLTAGE LESS THAN 15% WITH FULL BASE LOAD		
23.1	DOL /STAR DELTA	KW	*
23.2	REDUCED VOLTAGE	V	*
24.0	PARALLEL OPERATION		
24.1	IF MORE THAN ONE DG IS IN OPERATION,		NA

S.No.		RATING	ATTRIBUTE
	WHETHER IN ISOLATION/ IN PARALLEL		
24.2	DG IN PARALLEL WITH THE GRID CONTINUOUSLY	YES/NO	No
24.3	DG IN PARALLEL WITH THE GRID MOMENTARILY	YES/NO	No
24.4	ARE UNDERFREQUENCY LOAD SHEDDING SCHEMES REQUIRED IF YES:	YES/NO	No
24.4.1	TYPE OF UNDER FREQUENCY RELAY		
24.4.2	LOAD SHEDDING REQUIREMENTS		
24.4.3	PROTECTION REQUIREMENTS		
25.0	HARMONIC LOADING (IF ANY): CURRENT-	%THD	*
26.0	SIZE OF CONDUCTOR CABLES	C x mm^2	*
27.0	PERIOD FOR TAKING LOAD FROM 'START' IMPULSE	sec	*
28.0	COOLING WATER /MAKE-UP WATER QUALITY:		*
28.1	COOLING WATER INLET TEMPERATURE	°C	*
28.2	MAXIMUM ALLOWABLE COOLING WATER TEMPERATURE RISE	°C	*
28.3	COOLING WATER INLET PRESSURE	kg/cm2 (g)	*
28.4	MAXIMUM ALLOWABLE COOLING WATER PRESSURE DROP	kg/cm2	*
29.0	ENGINE STARTING SYSTEM : COMPRESSED AIR / ELECTRIC		Electric
30.0	BATTERY AND BATTERY CHARGER	YES/NO	Yes
31.0	EXCITATION SYSTEM : STATIC / BRUSHLESS		Brushless
32.0	MANUAL START/STOP OF ENGINE THROUGH LOCAL / REMOTE PUSH BUTTON REQUIRED	YES / NO	Yes
33.0	TRIP DEVICE ON MAIN SUPPLY RESTORATION REQUIRED	YES/NO	Yes
34.0	STOPPING OF DG SET: MANUAL/AUTO		MANUAL/AUTO
35.0	GOVERNOR CLASS : A1 / A2		A1
36.0	RESPONSE TO STEP CHANGE OF LOAD: SWITCH-IN AND/OR THROW-OFF		*
37.0	SPEEDERGEAR OPERATION ON DC VOLTAGE FOR REMOTE VARIATION OF SPEED REQUIRED	YES / NO	No
38.0	MAXIMUM TIME OF OPERATION WITHOUT COOLING WATER AVAILABILITY DURING START UP	Min	*
39.0	GENERATOR SWITCHGEAR BY		*

S.No.		RATING	ATTRIBUTE
	CONTRACTOR / EMPLOYER		
40.0	MOTORS : BY CONTRACTOR / EMPLOYER		*
41.0	ENGINE COOLING SYSTEM : WATER COOLED HEAT EXCHANGER / RADIATOR WITH ENGINE DRIVEN FAN		Radiator type
42.0	COOLING TOWER: BY CONTRACTOR/ EMPLOYER		*
43.0	COOLING WATER PUMPS: BY CONTRACTOR/ EMPLOYER		*
44.0	COUPLING AND COUPLING GUARD	YES/NO	Yes
45.0	EXHAUST PIPE/ STEEL STACK	YES/NO	*
46.0	TACHO GENERATORS	YES/NO	*
47.0	AC MOTOR DRIVEN PRIMING OIL PUMP WITH CLOCK TIMER	YES/NO	*
48.0	BATTERY VOLTMETER	YES/NO	Yes
49.0	WINDING AND BEARING RTDs FOR GENERATOR	YES/NO	*
50.0	ENGINE COUPLED WITH GENERATOR		
50.1	ONE (1) HOUR AT 50% LOAD		*
50.2	ONE (1) HOUR AT 75% LOAD		*
50.3	FOUR (4) HOURS AT FULL LOAD		*
	FOLLOWED BY ONE (1) HOUR CONTINUOUS LOAD OF 110%		
51.0	GENERATOR		
51.1	TYPE AND ROUTINE TESTS AS PER STANDARD IS 4722 / BS 5000 PART 99		Yes
52.0	EXCITER		
52.1	TYPE AND ROUTINE TESTS AS PER STANDARD IS 4722 / BS 5000 PART 99		Yes

13. ELEVATOR

SCOPE

This specification covers design, supply, installation, commissioning & testing of items required for earthing system including grounding conductors, rods, fittings, accessories of elevators.

The work shall be carried out in accordance with PWD general specification for electrical work and as per relevant IS codes of practice with regulation of local codes/Bye-laws as per the direction of Engineer-in- charge. The following codes/specifications shall be generally adhered to:

a) IS 1860: Codes of practices for installation operation and maintenance of electric passenger and goods lifts.

b) IS 3534 : Outline dimensions of electric lifts

c) IS 466 : Specification for electric passenger/good lifts

d) IS 4289 : Specification for lift cable

EXTENT OF WORK

The extent of work covered by this specification is as follows:

Design, fabrication and supply of lift complete with all devices as are necessary to complete the installation in accordance with this specification.

Complete wiring of all electrical equipment from the point of supply (provided by the PURCHASER in the lift machine room) onwards required for the safe and satisfactory operation of the lift as specified herein. The PURCHASER will provide 415 Volts, 3 Phase, 3 Wire and 240 Volts, Single Phase A.C. supplies or 415V, 3ph, 4 wire supply at one point in the machine room.

The structure/lift shaft in which the lift will be installed will be supplied and erected by the PURCHASER. VENDOR shall furnish all the information required by the PURCHASER to enable him to design the structure/lift shaft. VENDOR's supervisor shall supervise the installation of inserts in the lift shaft, and shall be responsible for the correctness of the civil work in this regard.

With each lift the Vendor shall supply a maintenance tool kit which shall be kept in machine room.

DESIGN FEATURES

All electrical devices like contactors, push buttons, indicating lamps located outside the machine room shall be housed in dust tight/water tight enclosures.

Special care and precautions shall be taken regarding the hanging of lift cable loops between the points of suspension as the loops are prone to twist/distortion.

Lift shall be provided with emergency lighting & alarm bell in each cab through car mounted dry cell rechargeable battery with minimum 5 years life expectancy & solid state battery charger, necessary changeover relays.

Provision of additional weight for interior finishes shall be kept for passenger & capsule lift as specified in the Datasheet. In case interior finishing materials in cab exceeds this provision, then the lift contractor shall clearly identify the loss of carrying capacity, if any. Recess in platform of 20 - 25 mm shall be provided in floor for receiving stone flooring in the passenger lift.

In addition car lighting will be connected on the emergency lighting UPS system. Location of light fixture to be coordinated with architects, Interior Designer. Light output shall be minimum 50 LUX at floor level.

For overhead height, pit depth, car size with respect to lift well size, lift entrance size, passenger & load carrying capacity of different types of lifts based on their application, speed criteria, machine dimensions in case of lifts with machine room refer National Building code of India (NBC) – Part 8:Building Services, Section 5:Installation of Lifts & Escalators.

For machine room less lifts which include normal & capsule lifts the specification, finishes, dimensions shall be finalised together in consultation with client, architect & lift Vendor.

For buildings having height of 15 m or more atleast one lift shall meet the requirements of fireman’s lift as given below,

The fireman's lift shall have the following minimum requirements:

a) Lift car shall have floor area of not less than 1.44 square meters. It shall also have a loading capacity of not less than 544 kg (8 persons).

b) Lift landing doors shall have a minimum of fire resistance of one hour.

c) Doors shall be of automatic operation for car and landing.

Emergency Cracking

The hoisting machines shall be provided with a set of special tools including a hand crank to allow release of hoist brake and provide for manual movement of the car in case of emergency. These tools shall be hung up on a tool board fitted to a wall in the lift machine room, with instructions for their use clearly written on the board both in English and the local language. The lift system supplier shall qualify his bid with respect to manual cranking. An automatic switch shall be provided to interrupt power to the lift mains. Upon withdrawal of crank and manual resetting of power monitor switch, power shall be restored.

In case of machine room less type lifts, emergency cranking shall be a part of lift control panel.

Speed Governor:-The car safety shall be operated by a mechanical centrifugal type car & counterweight driven speed governor located in the upper part of the lift well for both lifts with or without machine room. The governor shall actuate a switch when excessive descending speed occurs, disconnecting power to the hoist motor and applying the brake prior to deployment of the safety.

Power Conversion and Regulation Units for direct-current power for the operation of hoist machine brake, door operator, dispatch processor, signal fixtures, etc.,\ solid-state, alternating current, variable voltage \ variable frequency (ACV3F), I.G.B.T converter/inverter drives \ controllers. Units shall be design to limit current, suppress noise, and prevent transient voltage feedback into building power supply, Suppress solid-state converter noises, radio frequency interference, and eliminate regenerative transients induced into the mainline feeders or the building standby power generator

Direct drive, solid-state, digital type encoder shall be provider to update car position at each floor and automatically restore the same after power loss.

Note - All lift equipment including their supports and fastenings to building, shall be from the building structure minimize objectionable noise and vibration transmission to car, building structure, or adjacent occupied areas of building. Noise level relating to lift equipment operation shall not exceed 60 dBA.@ 1 mtr.

Lift Materials:- Lift materials shall be non-flammable except traveling cable which shall be flame resistant. All other electrical cables shall also be flame resistant and housed in metal conduit or other metal enclosures.

Guide Rails:-Steel guide rails shall be installed to guide the car and counterweight, erected plumb and securely fastened to the building structure, fitted to ensure smooth joints. The guide rail shall be minimum 16 mm, tongued and grooved type.

Buffers:-Oil or spring type buffers shall be provided in the pit in compliance with ANSI/ASME/CENEN-81 or local code if more stringent. Clearance from underside of car resting on a fully compressed buffer shall be not less than 1.20m. Buffer shall be designed for design speed + 15%. The oil buffers shall be self resetting type and shall be provided with means for

determining the oil level. Switch shall be provided on buffer to limit car speed if buffer is compressed Ladder(s) and platform(s). It shall be provided buffer access.

Car:-A car-frame fabricated from formed or structural steel members shall be provided with adequate bracing to support the platform and car enclosures. The car safety shall be integral with car-frame or shall be mounted on the bottom members of the car-frame, and shall be of the flexible guide clamp type designed to stop and hold a fully loaded car which exceeds descending speed. Safety shall conform to ANSI/ASME/CENEN-81 or local codes if more stringent. The car platform shall be of Aluminium/ Stainless steel plate as asked for in the BOQ. The entire platform shall rest on rubber pads, so that it will designed to form an isolating cushion between the car and car frame. Platform deflection shall be limited to maximum 3 mm under maximum normal operating conditions. In case of service lifts, the platform shall be provided with slip resistant Aluminium/Stainless Steel chequered plate flooring. The platform shall be arranged to accommodate one piece load of mechanical / electrical equipment, etc. For servicing the car mechanical hatch to be provided as per design of lift manufacturer.

Car Top Station:- A car top operating station shall comprise of key operated switch and constant pressure up/down buttons which shall be provided on each lift. Car shall respond to up/down command at inspection speed. The lift contractor shall provide light fixture of 36 watt enclosed fluorescent or enclosed 2 x 18 Watt compact fluorescent switched from car top station.

Counterweight:-A structural steel frame with cast iron or steel plate filler weights shall be furnished to provide proper counterbalance for smooth operation.

Counterweight:-A metal counterweight guard shall be furnished and installed at the bottom of the lift, and shall wrap around counterweight rails for a height of no less than 1.80 m in order to protect accidental contact.

Sheaves:-Sheaves shall be machined grooves, balanced and shall maintain cable /sheave ratio well within requirements. Lubrication points shall be extended to a location that is easily accessible. No deflector sheaves to protrude into lift.

Lift & Governer Ropes:-Lift ropes shall be traction steel of size, construction and number to insure proper operation of the lift and give satisfactory and safety assurance. Governor ropes shall be steel or to suit manufacturer's specifications. All ropes shall consist of at least eight strands wound about a hemp core center. All ropes shall conform to ANSI/ASME/EN-81 or more governing codes or regulations. The minimum factor of safety for ropes shall be 10.

Compensating Rope:-Compensating ropes shall be furnished and installed for all lifts with speed over 2.0 m/sec, and travel in excess of 30 m, to compensate for the shifting weight of the hoist ropes. A device shall be provided to tie the car and counterweight together to limit the jump of the car or counterweight. Compensating chain where provided shall be enclosed in a plastic flame resistant jacket to minimize noise.

Lift Operating Devices:-Redundant series wired terminal stopping devices shall be provided to slow down and stop the car automatically at the terminal landings. Resetting a tripped device shall be done manually only.

Pit Switch:-An emergency stop switch shall be located in the pit which when operated shall stop the car regardless of position in the lift.

Travelling Cables:-Travelling cable shall be secured to the cars underside. Cable shall be clear of all obstructions while car is in motion. Rubbing or chafing of cables against hoist-way or equipment within hoist-way to be avoided. Lighting & power cable shall be with Fire retardant outer sheath. Shielded wires and cables shall be provided for music, car access control, phone,

TV, etc. Twisted type, 4 pair 14/0076 music cables and 4 pair 0.5 dia. Cat 3 cable for communication system shall be used. Travelling cables shall be flexible and suspended to relieve strain on individual conductors. A minimum of 10% spare conductors shall be provided in travelling cable.

Wiring:-All wiring and electrical interconnections shall comply with governing codes. Wiring shall 1100 volt grade LSZH type and shall run in metal conduit, tubing or approved electrical raceways.

Lift entrances & Car doors

All landing lift entrance door shall have center opening horizontal sliding type doors unless otherwise specified suitable for a clear opening as indicated in Technical Data for each type of lift and shall include flush doors of hollow metal construction, extruded aluminium sill with anti slip grooving and hanger supports and hanger cover shall be provided. Exposed surfaces of doors and frames shall be finished as directed by the Interior Designer.

Sheave type two point suspension ball bearing door hangers and tracks shall be furnished for each lift opening. Sheaves shall not be less than 58 mm diameter and adjustable ball bearing rollers shall take the up thrust of the doors.

Lift Entrances to have minimum two hour fire protection. Complete entrances bearing fire labels from a nationally recognized testing laboratory approved within the governing jurisdiction.

Car doors shall, unless specifically stated, be center parting, automatic power operated, variable frequency door operator or PWM DC door operator and electronic door detector. Infrared light beams covering full height & width of entrance shall be provided to act as a safety curtain across the door entrance to monitor the door closing.

Car doors shall be hung plumb and even, to within 1 mm. with minimum number of 4 gibbs per leaf. Floor gibbs shall be well fitted so as to prevent popping noise as a car passes structural members, or car in motion in a shared shaft, etc. Lift doors shall be hung plumb and show a maximum of 6 mm joint at sides, top and bottom and 2 mm at centre joint. Narrow door frame or jamb panel shall be supplied by lift contractor. A soft chime shall ring prior to doors closing and opening.

In normal condition, Car cannot move when the car or hoist-way door is open. During emergencies, car and hoist-way doors shall be capable of being opened from outside.

Frames: 14 gauge hollow metal at all floors. Door Panels: 16 gauge steel, sandwich construction without binder angles. Leading edges of center-opening doors shall be provided with rubber astragals. Each car & lift door leaf shall be fitted with minimum of two (2) gibbs per panel, one at leading and one at trailing edge with gibbs in the sill groove entire length of door travel. Sight Guards: 14 gauge, same material and finish as lift entrance door panels. Construct without sharp edges.

Sills: Extruded aluminium.

Sill Supports: Structural or formed steel shall be designed to support door sill based upon car loading classification.

Struts and Headers: Vertical support shall be provided of entrances and related material with door open bumpers on entrances equipped with vertical struts.

Upon the car reaching landing in response to a hall or car call, a soft chime in the car shall sound. Door opening shall commence when the car is 25 mm from the leveling. Door open period shall be adjustable to within a range of + 1 second. Door-open-period on all floors except lobby floor shall be shortened to the extent that door closure will commence 2 seconds (field adjustable) following the sensor beam interruption by the last boarding or disembarking passenger. This period shall be adjustable to 1.5 seconds ± 1.0 seconds. Normal door- open-period at lobby floor shall be monitored by the car's CPU. Door closure shall override "door-open-period" where car loading has reached by pass limit, or when another car approaches the lobby floor.

An approved positive interlock shall be provided for each lift entrance which shall prevent operation of the lift unless all doors for that lift are secured and shall maintain the doors in their closed position while the lift is away from the landing. Emergency access to the hoist-way as required by governing codes shall be provided.

Car and Hoist-Way Door Operator: For each lift door, an electric VVVF door operator or PWM DC door operator shall be furnished to simultaneously open the car and hoist-way doors when the car is at a landing. The doors shall be closed simultaneously by motor power. Emergency key provision shall be made to open doors at all landing from outside of the hoist-way. In the event of interruption of electric power or failure of the door operator, it shall not be possible to open the car door manually from within the car. An electric contact for the car door shall be provided which shall prevent lift movement away from the landing unless the door is in the closed position. Each hoist- way door shall be equipped with a positive electromechanical interlock and auxiliary door closing device so that the lift can be operated only after the interlock circuit is established. The doors shall open automatically while the car is leveling at the respective landing. The doors shall automatically close after a predetermined time interval has elapsed, but the momentary pressure of the "door open" button provided in the car shall reverse the motion and reopen the doors and reset the time interval unless overridden by the electronic door monitor.

Door operation shall be consistent, smooth and quiet at all floors, regardless of door weight or varying air pressure.

Door Control Device:- Photoelectric door monitors shall be installed on each lift with full screen infrared matrix or multiple beams extending vertically along leading edge of each door panel to full height of door above finished floor. This device shall prevent doors from closing and reverse doors at normal opening speed if beams are obstructed while doors are closing, except during nudging operation. In event of device failure, provide for automatic shutdown of car at floor level with doors open. After beams of door control device are obstructed for a predetermined time interval (minimum 20.0 - 25.0 seconds), warning signal shall sound and doors shall attempt to close with a maximum of 1 kgm kinetic energy. Activation of the door open button shall override nudging operation and reopen doors. When beams are interrupted during initial door opening door shall be remain open for minimum of 3.0 seconds. When beams are interrupted after the initial 3.0 second hold open time, hold time will reduce to 1.0 -1.5 seconds and which is adjustable.

Lifts shall be designed to withstand without damage earthquake forces for the intensity of seismic acceleration .

All electrical equipments shall withstand an incoming supply voltage fluctuations of +/-10% frequency variation of +/- 5%. An inbuilt auto voltage regulator with the lift power pane shall be supplied for the same.

The lift shall be provided with automatic self-leveling feature that shall bring the lift car level to within ±3 mm of the landing floor regardless of load or direction of travel. The automatic self-leveling feature shall compensate for over travel and rope stretch.

Car speed shall be based on the travel distance and number of floors. The speed variation shall not exceed +/- 1% of the rated speed.

Acceleration / Deceleration shall be linear and smooth. Stops shall be without cable oscillations. Acceleration & Declaration shall be site adjustable.

Noise from moving equipment including door operation, car motion, fan, etc. shall not intrude into adjoining spaces by more than 20 dB and adjoining occupied areas by not more than 10 dB. (All octave bands). Noise level inside the car shall not exceed 50 dB. with out car cabin fan running. Noise level inside the car shall not exceed 55 dB. in case of door opening / closing. The noise level shall be measured at 'Zero Activity'.

Lateral quaking and vertical vibrations should not exceed 20 gal and 85 dB respectively. Contractor to demonstrate these parameters at site with performance analyzer.

For lifts hall buttons shall be provided at each terminal landing. A single micro movement push button shall be provided at top most and the lowest floor landing, two micro movement buttons on a single plate shall be provided at each intermediate floor. When a hall call is registered by momentary pressure on a landing button, that button shall become illuminated and remain illuminated until the call is answered.

LED car position indicator shall be installed above each operating panel. The position of the car in the hoist-way shall be shown by illuminating the corresponding landing at which the car is stopped or passing.

Selection for call button for passenger car shall be as per Architect selection. Freight lift call buttons shall be as per manufacturer's standard product. The catalogues of the buttons offered shall be submitted along with the tenders.

Safe landing shall be done to bring car to the nearest landing and open door at slow speed in the event of any malfunctioning and In case doors fail to open during normal stop, lift should move to immediate next floor and open doors.

The metal faceplates of the signal and operating fixtures in the cars and at the landings, along with the metal accessories in the cars, shall be hair line stainless steel or as selected by the Architect. Push button fixtures at the landings shall be of design approved by the Architect. All fixtures form and finishes, etc. shall be subject to the Architect's and interior designer's approval.

All lifts shall be equipped with automatic lift retrieval system which shall, upon signal from the central fire alarm system or manually operated key switch, because all lifts to be dispatched automatically to the ground floor. Lifts shall, open their doors and remain at the ground floor. All floor and car buttons shall be rendered ineffective until the system is manually reset. A smoke detector shall be placed in close proximity to each lift bank on the ground floor. If this device senses smoke, system shall land lifts at a preselected, alternate, landing floor. A key operated switch shall be provided at the ground floor to activate and reset the retrieval system manually.

Emergency operation shall return the lift/s to a designated floor, most commonly, the Lobby, by means of a signal from the automatic fire alarm system.

On initiation from the fire alarm system, control panel, all lifts travelling away from the lobby floors shall stop and reverse without opening their doors indicating fire mode-operation to passengers, ignoring all car and hall calls and express to the lobby or assigned floor.

Cars travelling toward ground shall express to ground ignoring all car and hall calls. Cars parked on intermediate floors shall close their doors and express to ground. Cars parked at lobby shall open their doors ignoring car and hall calls. All hall and car buttons shall extinguish and shall accept no further hall or car registration.

All lifts shall, in addition and where allowed by code, be provided with a key operated switch for use by in-house fire brigade.

The lift contractor shall coordinate and cooperate with the fire detection & alarm system supplier / installer for his system interfacing responsibilities.

Fireman Emergency

Actuation of fire mode shall put all car functions as described here under fireman control by means of a key switch.

Hall button giving car call indication shall cause the doors to close.

Applying constant pressure to the door open button shall cause door to begin to open. Releasing the button before door is fully open shall cause the door to close.

Hall buttons shall be rendered inoperative.

Car position indicator shall indicate floor when car is within door operating range, and if in motion it shall indicate nearest floor by flashing. When a car is within operating zone, the position indicator shall light uninterrupted.

All electrical door safety locks shall remain effective.

Car position, direction of travel and floor conditions shall be displayed on the car position monitor in the lobby, and at lift system monitor in engineering room.

Returning the car to the designated landing floor, deactivating the lobby switch shall render the car to original pre fire mode condition.

Resetting the Fire Alarm contacts in the car monitoring panel shall restore the system to normal condition.

A switch shall be provided in the car to permit operation of the lift from top of the car for inspection purposes, with car and hall buttons inoperative. Car shall travel at inspection speed not exceeding 0.5 m/sec. Motion of car shall require constant pressure to directional button.

A key operated switch shall be provided in the car operating station which, when actuated, shall disconnect the lift from the hall buttons and permit operation from the car buttons only.

Lift control panel (ECP) shall be vertical, totally enclosed cubicle constructed of sheet steel with hinged doors on the front and screwed panels or hinged doors on the back, giving easy access to all components inside the controller. The cubicle enclosure shall be minimum of IP 22. Panel Ventilating fans shall be provided to maintain components temperature within limits.

It will have a microprocessor with solid state switching devices sequenced and interlocked It will have monitoring points for Lift position & Emergency Stop ECP should be located such that it can be easily accessed from the last landing and shall be key locked and vandal proof.

It will provide protection but not restricted to the following:

i) No-voltage or sustained under voltage

ii) Overcurrent in any component

iii) Phase reversal of the power supply

iv) Overload

v) Single phasing

ECP shall be arranged to cut-off the power supply, apply the brake and bring the car to rest at the nearest landing in the event any of the above failures occur. Same should happen, in the event of a signal from the Fire Alarm Control Panel.

Transducers in the car platform shall monitor passenger load which shall override "pre-programmed door open period" and dispatch the loaded car from the low terminal. The load weighing device shall also function in the same manner on all intermediate and top floors and in addition shall express to the next car call and ignore all hall calls. Hall calls which are bypassed shall not be canceled. The automatic load bypass device shall be field adjusted for 50% - 75% of rated load.

Any modification in the civil works required shall be clearly brought out by the bidder. No extra claims will be entertained on this account at a later date.

The lift control system shall have a Fire Alarm signal accept facility. The 'lift recall' function shall be activated in the receipt of such a signal & lift car shall halt on the specified floor with their doors opened.

The lift control system shall have a RS 232 / RS 485 interface for connecting to the Building Automation System. Adequate number of NO / NC contacts need to be provided in the lift control system for indicating the position of lift car in a remote location.

The Elevator Panel should have the following Provisions

It shall be able to accept signal from the Fire Alarm Panel in case of fire and automatically ground the elevator on receipt of this signal.

a) Potential free contact to indicate elevator trip status.

b) Potential free contact to indicate elevator alarm status.

c) Potential free contact to indicate Emergency Activation Switch status.

FAS contractor shall provide necessary cabling up to Elevator Panel and termination shall be done by Elevator contractor.

For integration with PA System, additional cabling to be provided from lift car to the Lift machine

<u>Software Interface.</u>

The Lift microprocessor panel should be compatible with BAS and should be able to communicate with the BAS in any of the following standard protocol like MODBUS, LANWORKS, BACNET etc. In case of multiple lifts having individual microprocessor panels it should be possible to network all microprocessors panels and be connected to a master controller. BAS communication cable can be integrated directly to the master controller or in case master controller is not available it should be possible to integrate each Microprocessor controller to the BAS system. It should be possible to monitor the following data points through software integration.

1) Elevator car position.

2) Fire Emergency signal monitoring.

3) Elevator Attendant Mode.

4) Elevator Alarm Mode.

In case of fire it should be possible to control the lift through software interface. All necessary hardware including interface card and accessories necessary for integration with the BAS system has to be provided by BAS contractor.

TECHNICAL DATA SHEET

S.N.	**DESCRIPTION**	**DETAILS**
1	TYPE OF ELEVATOR	Passenger Elevators With Machine room
2	QUANTITY	4 Nos
3	CONTROL	VVVF
4	OPERATION W/WO ATTENDANT	Duplex, Full Collective
5	CAPACITY	
a.	Weight in Kgs.	As per requirement
b.	Weight for interior material of the car	150
c.	No. of persons	8

S.N.	DESCRIPTION	DETAILS
6	MACHINE	Machine room
7	SPEED (MPS) rated	1.5
8	TRAVEL	As per BOQ
9	RISE IN METERS	-3.3m to 13.8m
10	STOPS AND OPENINGS	6
a.	No. of Stops	6
b.	No. of openings	All openings on same side.
11	CAR SIZE IN (MM) (Inside Dimensions)	As per NBC
12	AVAILABLE HOIST WAY SIZE (MM) (Inside Dimensions)	As per architecture drawing
13	CAR AND HOISTWAY ENTRANCE (MM)	1000, 2 C
14	DOOR OPERATION	Automatic with electronic door detector

S.N.	DESCRIPTION	DETAILS
15	INTERIOR (CAR ENCLOSURE) With SS hand rail	Walls – Stainless steel in dot matrix (Scratch less) Floor – 19mm thick granite stone. Ceiling – False ceiling with Aluminum cladding, LED lamps and ceiling fan

The Contractor shall also carryout all tests/ operations as required by the inspector or local authority to obtain the approval of elevator installation and operation of elevator plant and to submit the same to the owner/employer. All such test, follow up action and liaison with inspector or local authority shall be deemed to be included in the prices quoted by the contractor and no extra payment on these account will be made to the Contractor. This liaison work shall be deemed to be the part of the contract.

Provision of single phase 50 Hz. AC power supply terminated with suitable sized single phase and neutral switch MCB for i) Lighting in machine room, lift wells, lift pits. ii) Lighting outlet points in the lift shaft.

Properly ventilated machine room, lift shafts and water proofed lift pits. However, if due to any reason whatsoever any water proofing is required, the same is to be done by the contractor at his own cost and nothing extra shall be paid on this account.

Lift Warranty:- 2 (Two) years warranty for free maintenance of lifts after completion of work which includes C.S.M.C. also.

Lift C.S.M.C. :- Commitment of Comprehensive Service and Maintenance of lifts for a period of 5 (five) years after expiry of two years of free maintenance period. The rate for which shall be quoted separately as per BOQ.

LIST OF TECHNICAL SPECIFICATIONS TO BE FURNISHED BY BIDDER

The Contractor shall furnish the following details as a part of technical bid. Contractor shall furnish all relevant catalogues relevant to the equipment required in the proposed building for Electrical Installation Works.

1) COMPACT SUBSTATION

	SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
	1.0	**ENCLOSURE SPECIFICATIONS**		
	1.1.	Make		
	1.2.	Applicable Standards		
	1.3.	Rated maximum power of substation	kVA	

	SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
	1.4.	Ambient Temperature	°C	
	1.5.	Type of Ventilation for		
		a) Normal Condition		
		b) Hot Condition		
	1.6.	Compartmentalized		□ Yes □ No
	1.7.	Fault level	kA, sec	
	1.8.	Rated temperature enclosure class		
	1.9.	Internal Arc withstand level		
	1.10.	Degree of protection		
		a) MV & LV compartment		
		b) Transformer compartment		
	1.11.	Enclosure material		
	1.12.	Thickness of sheet	mm	
	1.13.	Paint colour & finish		
	1.14.	Total dimensions of Compact Substation (H X W X D)	mm	
	1.15.	Weight	Kg	
	2.0	**CIRCUIT BREAKER**		
	2.1.	Type of circuit breaker		
	2.2.	Rated current	A	
	2.3.	Nominal system voltage	kV	
	2.4.	Maximum continuous voltage	kV	
R	2.5.	Power frequency withstand (one minute) voltage		
		a) Short circuit withstand	kV	
		b) Momentary withstand	kV	
	2.6.	Impulse 1.2/50micro sec withstand voltage	kV	
	2.7.	Trip coil consumption at rated voltage	Watt	
	2.8.	Type of closing mechanism		
	2.9.	Spring charging mechanism		
	2.10.	Spring charging motor power rating & voltage	Watt, Volt	
	3.0	**BUSBAR**		
	3.1.	Material		
	3.2.	Busbar cross section	Sq.mm	

	SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
	3.3.	Continuous current rating under site condition	A	
	3.4.	Busbar insulation		
	3.5.	Minimum clearance		
		c) Phase to phase	mm	
		d) Phase to earth	mm	
	4.0	**CURRENT TRANSFORMERS METERING & PROTECTION**		
	4.1.	Type (Bar/ Wound/ Any other)		
	4.2.	Make		
	4.3.	Class of insulation		
	4.4.	Ratio		
	4.5.	Rated VA burden		
	4.6.	Accuracy class		
	5.0	**VOLTAGE TRANSFORMERS**		
	5.1.	Type		
	5.2.	Make		
	5.3.	Ratio		
	5.4.	Accuracy		
	5.5.	Type of insulation		
	6.0	**INDICATING METERS**		
	6.1.	Make		
	6.2.	Type		
	6.3.	Size		
	6.4.	Mounting, flush type or other		
	6.5.	Accuracy		
	6.6.	Range		
	6.7.	VA burden for each type		
	7.0	**PROTECTION RELAYS**		□ Electromechanical □ Solid state □ Numerical
	7.1.	Make		
	7.2.	Inverse time over-current relay		
	7.3.	Instantaneous over-current relay		
	7.4.	Thermal overload protection relay		

	SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
	7.5.	Earth leakage relay for use with core balance CT		
	7.6.	Earth fault relay for use in the residual circuit of main CTs		
	8.0	**TRANSFORMER PARTICULARS**		
	8.1.	Make		
	8.2.	Type		
	8.3.	Full load rating	kVA	
	8.4.	Type of cooling		
	8.5.	Rated percentage impedance	%	
	8.6.	Winding connections		
		a) HV		
		b) LV		
		c) Vector group		
	8.7.	Tap changer		On load / off load
		a) Total tapping range	%	
		b) Tapping steps		
		c) On HV/LV winding		
	8.8.	Method of earthing - LV		
	8.9.	Windings material		
	8.10.	Type of insulation		
	8.11.	1.2/ 50 micro impulse withstand		
		a) HV	kV	
		b) LV	kV	
	8.12.	One minute power frequency withstand voltage		
		a) HV	kV	
		b) LV	kV	
	8.13.	Maximum temperature rise of windings	°C	
	8.14.	Max guaranteed load loss at rated current at max winding temperature For ONAN / ONAF / AN / AF	kW	
	8.15.	No load losses at 100% rated voltage and frequency	kW	
	8.16.	Cooling equipment power loss	kW	
⊢	8.17.	Magnetization current at rated voltage and frequency in percent of full load current	%	

	SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
	8.18.	Efficiency at max winding temperature at full load, at UPF and 0.8 PF lag at 75% load, at UPF and 0.8 PF lag at 50% load, at UPF and 0.8 PF lag	%	
	9.19.	Noise	dB	
	8.20.	Weight	Kg	
LV COMPARTMENT	**9.0**	**CIRCUIT BREAKER**		
	9.1.	Circuit Breaker Type (Air break and / MCCB)		
	9.2.	Rated voltage	V	
	9.3.	Rated current	A	
	9.4.	Rated symmetrical breaking current at rated voltage (Indicate power factor)	kA at PF	
	9.5.	Rated short time withstand rating for 1 sec (For MCCB, BIDDER to indicate the time)	kA	
	9.6.	Operating mechanism type		
	9.7.	Rated operating duty		
	9.8.	Relationship between ICU, ICS & ICW	%	
	9.9.	Have electrical and mechanical anti-pumping features been provided	Yes / No	
	11.0	**FUSE**		
	11.1.	Make		
	11.2.	Type		
	11.3.	Rated voltage	V	
	12.0	**BUSBARS**		
	12.1.	Material		
	12.2.	Busbar cross section	Sq.mm	PH : Neutral :
L	12.3.	Continuous current rating under site conditions	A	
	12.4.	Busbar insulation		
	12.5.	Minimum clearance		
		a) Phase to phase	mm	
		b) Phase to earth	mm	
	12.6.	Short time rating (One Sec.)	kA	
	12.7.	Momentary rating (Peak)	kA	
	13.0	**CURRENT TRANSFORMERS**		
	13.1.	Type		
	13.2.	Make		
	13.3.	Ratio		
	13.4.	Accuracy		

	SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
	14.0	**VOLTAGE TRANSFORMERS**		
	14.1.	Make		
	14.2.	Ratio		
	14.3.	Accuracy		
	14.4.	Output per phase	VA	
	14.5.	Class of insulation		
	15.0	**INDICATING METERS**		
	15.1.	Make		
	15.2.	Type		
	15.3.	Size		
	15.4.	Mounting, flush type or other		
	15.5.	Accuracy		
	15.6.	Range		
	15.7.	VA burden for each type		
MISCELLANEOUS	16.0	DC SYSTEM		
	17.0	AUTOMATIC POWER FACTOR CONTROL (APFC) UNIT		
	18.0	SPARES		
	19.0	COMPLIANCE WITH SPECIFICATION		

2) 415V METAL ENCLOSED SWITCHGEAR

Sr. No	Description	Unit	Technical Particulars
1	**415 V Switchgear and Bus bar Ratings**		
(a)	Rated voltage phase and frequency		
(b)	System Neutral Earthing		
(c)	Maximum system voltage		
(d)	One minute power frequency voltage		
	i) Power circuits		
	ii) Control circuits		
	iii) Aux. Circuits connected to Sec of CTS		
(e)	Continuous current rating of Bus bars		

Sr. No	Description		Unit	Technical Particulars
	under site reference Ambient Temperature and type			
(f)	Bus bar insulation			
(g)	Reference Ambient Temperature			
(h)	Maximum Temperature of Bus bars, Droppers and Contacts at Continuous			
	current rating under site ambient temperature			
(i)	Short Circuit current withstand for Bus bars and droppers (i) Short time 1 sec			
	(ii) Dynamic Rating			
2	**Switchgear Constructional Requirements**			
(a)	Type of Construction			
(b)	Thickness of sheet steel (i) Frame, Frame enclosures, doors, covers and partitions			
(d)	Colour finish shade			
(e)	Earthing bus	Material		
		Size		
	Earthing conductor	Material		
		Size		
(g)	Minimum clearances in air of live parts (i) Phase to Phase			
	(ii) Phase to Earth			
(h)	Cable entry to cubicles			
3	**Instrumentation Transformers**			
(a)	Current transformer			
	(i) Ratio			
	(ii) Burden			
	(iii) Accuracy Class			
(b)	Voltage transformer			
	(i) Ratio			
	(ii) Burden			

Sr. No	Description	Unit	Technical Particulars
	(iii) Accuracy Class		
4	**Type of Starter for MCC Panel**		

3) LV CAPACITOR PANEL

S. N.	Description		Unit	Technical Particulars
i	General			
(a)	Make			
(b)	Rated Capacity		kVAR	
(c)	Rated voltage		V	
(d)	Rated frequency and phases			
(e)	Ambient temperature		^{o} C	
(f)	Cable gland required			
(g)	Type of cable			
(h)	Size of cable			
(i)	Cable entry			
ii	Constructional Requirement			
(a)	Thickness of sheet steel			
	i) Frame, Frame enclosures, doors covers and partition		Mm	
(b)	Degree of protection			
(c)	Colour finish shade			
(d)	Earthing bus	Material		
		Size	mm x mm	
(e)	Earthing conductor	Material		
		Size	mm x mm	
iii	Design Requirement			
(a)	Insulation level		kV (rms)	
(b)	Capacitor bank connection			
(c)	Short circuit withstand for busbars			
	i) Short time (1 sec)		kA (rms)	
	ii) Dynamic		kA	

S. N.	Description	Unit	Technical Particulars
		(peak)	
(d)	Type of switching & capacitor		
(e)	Switching steps		
(f)	Rating of contactor		
(g)	Incomer switch current rating		
(h)	Busbars		

4) HV, LV POWER & CONTROL CABLES

S.N.	Description	Unit	Technical Particulars	Technical Particulars	Technical Particulars
			0.415kV power cables	11kV power cables	Control cables
1	Name of the Manufacturer				
2	Conductor(stranded/solid)				
2.1	Form circular/segmented				
2.2	Nominal diameter in mm				
2.3	Effective cross sectional area sq mm				
3	Whether cores identified by numeral for cable with five core and above.				
4	Whether incremental running lengths are marked on cable at every 1 m interval.	YES/NO			
5	Finished cable				
5.1	Diameter under armour in mm				
5.2	Diameter over armour in mm				
5.3	Overall diameter in mm				
6	Whether cables will carry ISI stamp.	YES/NO			
6.1	If not explain reasons				
7	Cable drums				
7.1	Length of cables in cable drum and tolerance				

S.N.	Description	Unit	Technical Particulars	Technical Particulars	Technical Particulars
			0.415kV power cables	11kV power cables	Control cables
7.2	Weight of cable drum without cables				
7.3	Weight of cable drum with cables				
8	Type of end sealing				
9					
9.1	Any other details the CONTRACTOR would like to furnish?				
9.2	List of deviations if any from specification, data sheet-A and applicable standard furnished				
9.3	Conductor screen				
9.4	Insulation				
9.5	Insulation screen				
9.6	Sheath				
9.7	Armour				

5) LIGHTING FIXTURES & ACCESSORIES

Sr. No.	Parameter	Technical Particulars (To be filled by BIDDER)
1.	Type	
2.	Rated Voltage	
3.	Expected Frequency	
4.	Operating Voltage Range	
5.	Power Factor	
6.	Operating Temperature Range	
7.	Working Humidity	
8.	Driver Type	
9.	Driver Efficiency	
10.	Driver Life	
11.	Protection required in Driver	

Sr. No.	Parameter	Technical Particulars (To be filled by BIDDER)
	module	
f.	Short Circuit	
g.	Over Voltage	
h.	Over Temperature	
i.	Under Voltage	
j.	String Open Protection	
12.	Luminaire IP Protection	
13.	Minimum Surge Protection	
14.	THD	
15.	Rated Minimum LED Life (L70)	
16.	Rated Minimum Driver Life	
17.	CRI	
18.	Junction temperature rise	
19.	Solder point temperature	
20.	Maximum temperature rise for Driver	
21.	Make of LED	
22.	Make of Driver	
23.	Operating Hours	
24.	Luminous Efficacy	
25.	System Efficacy	
26.	Colour Temperature	
27.	Illumination Regulation	
28.	Material used for following	
e.	Housing	
f.	Heat Sink	
g.	Clip / Fasteners	
h.	Diffuser	
29.	Maximum temperature of Heat sink	
30.	IK protection of Optic Cover	
31.	Wires used Inside Luminaries	
32.	Cable gland IP protection	
33.	Ratio of Horizontal to Vertical Illuminance	
34.	Glare index while viewing from critical observer position	

Sr. No.	Parameter	Technical Particulars (To be filled by BIDDER)		
35.	Maintenance factor			
36.	Total of LED fixture			
37.	Wattage of each fixture			
38.	Total Power Consumption			
39.	Horizontal Illumination	International Level	National Level	Practice Level
a.	Average			
b.	Uniformity (Min./Avg.)			
c.	Uniformity (Min./Max.)			
40.	Vertical Illumination			
a.	Average			
b.	Uniformity (Min./Avg.)			
c.	Uniformity (Min./Max.)			

6) LIGHTING SYSTEM EQUIPMENT

S.N.	Description	Unit	Technical Particulars
1	**LIGHTING DISTRIBUTION BOARDS AND LIGHTING PANELS**		
1.1	System Particular		
(a)	Voltage		
(i)	3 Phase, 4 wire 50 Hz system		
	Rated	V	
	Maximum	V	
	One minute withstand voltage	V	
(ii)	D.C. system		
	Rated	V	
(b)	System short-circuit level		
	(i) At 415 V, A.C.	kA (rms)	
	(ii) At 110 V.D.C.	kA (D.C.)	
(c)	Reference ambient temperature	deg C	
1.2	Indicate the type and routine tests to be carried out		
1.3	Distribution Board/Panels		
(a)	Main, floor mounted distribution boards		

S.N.	Description	Unit	Technical Particulars
(i)	Main Lighting distribution board(A.C.)		
	Make		
	Type		
	Degree of protection		
	Bus bar material		
	Bus bar current rating	A	
	Short circuit current rating	kA	
	Details of Incoming and Outgoing feeders		
	Cable entry		
	Location		
	Each complete board/panel, LxWxD		
	Dimensional drawing enclosed		
	Indicate the type and routine tests to be carried out		
(ii)	Emergency lighting panel (D.C.)		
	Make		
	Type		
	Degree of protection		
	Bus bar material		
	Bus bar current rating	A	
	Short circuit current rating	kA	
	Details of Incoming and		
	Outgoing feeders		
	Cable entry		
	Location		
	Each complete board/panel, LxWxD		
	Dimensional drawing enclosed		
	Indicate the type and routine tests to be carried out		
(iii)	Three phase DBs, wall/structure mounting		
	SLDB for indoor area		
	Make		
	Type		
	Details of Incoming and Outgoing feeders		
	Degree of Protection		
(iv)	SLDB for outdoor area		
	Make		

S.N.	Description	Unit	Technical Particulars
	Type		
	Details of Incoming and Outgoing feeders		
	Degree of Protection		
(v)	Paint Finish		
	Colour shade		
2	**MINIATURE CIRCUIT BREAKER**		
2.1	Make		
2.2	Type		
3	**EARTH LEAKAGE CIRCUIT BREAKER**		
3.1	Make		
3.2	Type		
3.3	Leakage Current I_N	mA	
4	**INSTRUMENT TRANSFORMERS**		
4.1	Make		
4.2	Type		
4.3	Output		
4.4	Accuracy Class		
5	**METERS**		
5.1	Make		
5.2	Type		
5.3	Accuracy Class		
6	**RELAYS (IF ANY PROVIDED)**		
6.1	Make		
6.2	Type		
6.3	Voltage Rating	V	
6.5	Setting Range	%	
	No. of Contacts		
	a)Normally open		
	b)Normally closed		
7	**FLAME PROOF ENCLOSURES**		
7.1	Make		
7.2	Suitable for use in hazardous area		
	a)Area classification		
	b)Gases/Vapour group		
7.3	Dimensional Drawings and Literature of each required equipment flameproof enclosure including fixing details enclosed	Yes/No	

S.N.	Description	Unit	Technical Particulars
7.4	Approval certificates of relevant statutory authorities enclosed	Yes/No	
8	**LIGHT CONTROL SWITCHES**		
8.1	Make		
9	**RECEPTACLE, PLUG AND SWITCH**		
9.1	Make		
10	**LIGHTING WIRES**		
10.1	Make		
10.2	Applicable Standard		
10.3	Voltage Grade	V	
10.4	Conductor Material	Cu/Al	
10.5	No.of Strands	mm^2	
10.6	Colour Coding		
11	**CONDUITS**		
11.1	Make		
11.2	Material		
11.3	Finish (Galvanised/Black Enamel/Any special anti-corrosive coating)		
11.4	Sizes offered and wall thicknesses		
11.5	Supply of necessary couplings, bends, tees, necessary for conduit routing included	Yes/No	
12	**JUNCTION BOXES**		
12.1	Make		
12.2	Material and Gauge		
12.3	Painted / Galvanised		
13	**CEILING FANS**		
13.1	Make		
13.2	Suspension Rod, Regulator and Switch included	Yes/No	

7) EARTHING & LIGHTNING PROTECTION SYSTEM

S. No.	Description	Material	Technical Particulars
1	**Main Earthing Grid**		
a)	Buried in earth	MS	
b)	Buried in floor slabs in buildings	MS	

S. No.	Description	Material	Technical Particulars
2	**Conductor Leads To Equipment (above ground) – Substation Equipment & Structures**		Quantity - As per requirement & Sizes – As per Fault level calculations
a)	Circuit Breaker	GS	
b)	Isolator	GS	
c)	Transformers		
	(i) Transformer neutral to bottom of tank	GS	
	(ii) From bottom of tank to earth grid	GS	
	(iii) Transformer tanks and radiator bank	GS	
	(iv) Marshalling Boxes	GS	
d)	Lightning arrester	GS	
e)	C.T. and P.T. body	GS	
f)	C.T. and P. T. secondary terminal box	GS	
g)	Towers and structures	GS	
h)	Fence posts and gates (Flex. braid)	GS	
i)	415V switchgear and capacitor panel	GS	
j)	Motors		
	(i) 415V Motors above 10 kW	GS	
	(ii)415V Motors up to 10 kW	GI wire	
	(iii)Fractional horse power motors	GI wire	
k)	Other Items		
	Capacitor panel, Battery charger panel, Main lighting D.B, Control panels and sub-lighting distribution boards	GS	
	Hand Rails	GS	
	Cable trays	GS	
	Tanks	GS	
	Junction boxes	GS	
	Lighting fixtures, receptacles, lighting conduits	GS	
	Push button stations, limit switches	GS	
	Crane rail	GS	
	Street lighting, flood lighting poles and junctions boxes	GS	
	Metallic non-current carrying structures	GS	
	Lightning Conductors	GS	
	Lightning protection down comers for building	GS	

S. No.	Description	Material	Technical Particulars
	Lightning protection horizontal roof conductor for building	GS	
	Electrodes	GS	
	Pipe electrode	GS	
	Maintenance free electrode	copper	

8) DG SET

Sr. No.	Description	Unit	Technical Particulars
1.0	GENERAL		
1.1	Name of manufacturer		
1.2	Engine model no.		
2.0	DESIGN FEATURES		
2.1	Continuous site output rating at generator terminals	**kW**	
2.2	Site output rating after auxiliary power consumption and transmission losses at switchyard/ bus bar terminals	**kW**	
2.3	Maximum site rating of engine (to be not less than 110% of the value indicated in item 2.1 above)	**kW**	
2.4	Standard engine rating (i.e., under standard atmospheric conditions as per ISO : 3046)	**kW**	
2.5	Derating factors for site conditions applicable on standard engine rating :	%	
	a) Altitude	%	
	b) Ambient temperature	%	
	c) Relative humidity at inlet temperature indicated in item (b) above	%	
	d) Cooling water temperature at the inlet of charge air cooler	%	
	e) Others	%	

Sr. No.	Description	Unit	Technical Particulars
	f) Total deration	%	
	N.B. If the derating factors are different from those indicated in ISO : 3046 the BIDDER shall furnish details in deviations there from, justifying the deratings as applicable for the offered engine. Derating charts / calculationsshall be furnished along with the Bid for various atmospheric conditions		
2.6	Operating speed	RPM	
2.7	Main effective pressure (referred to kW output)	Pa(g)	
2.8	Types of operating cycle		
2.9	Mean piston speed	m/sec	
2.10	Design fuel oil		
2.11	Design lube oil		
3.0	ENGINE PERFORMANCE		
3.1	Continuous engine rating at site at generator (with specified fuel oil) with all coupled to engine	**kW**	
3.2	10% overload operation as per ISO 3046		**Yes/No**
3.3	Fuel consumption (with design fuel)		
	a) At 100% engine load	g / KW h	
	b) At 75% engine load	g / KW h	
	c) At 50% engine load	g / KW h	
3.4	Lube oil consumption at 100% engine load	g / KW h	
3.5	Primary jacket water temperature at engine inlet	^{o}C	

Sr. No.	Description	Unit	Technical Particulars
3.6	Primary jacket water temperature engine outlet	^{o}C	
3.7	Secondary cooling water temperature at heat exchangers inlet	^{o}C	
3.8	Secondary cooling water temperature at inlet to cooling tower,	^{o}C	
3.9	Secondary cooling water flow	$m^3/hr.$	
3.10	Maximum Secondary Water pressure drop through heat exchanger at flow value indicated in 3.9 above	Pa	
3.11	Secondary cooling water pressure at heat exchanger inlet	Pa	
3.12	Lube oil temperature at lube oil cooler outlet	^{o}C	
3.13	Lube oil temperature at lube oil cooler inlet	^{o}C	
3.14	Maximum period for which engine can operate without cooling water c		
	a) During cold start of engine	Secs.	
	b) During hot start of engine	Secs.	
3.15	Flue gas analysis at 100% load for specified fuel :		
	a) SO_2		
	b) Nox		
	c) Hydro carbon		
	d) CO_2		
	e) CO		
	f) Particulate matter		
	g) Others		

Sr. No.	Description	Unit	Technical Particulars
	h) SO_2 through stack	Kg/hr	
3.16	Governing Characteristics		
3.16.1	Maximum step load that can be applied to the engine at full rated speed, no load and at normal running temperatures	% of rated load	
3.16.2	Transient speed change resulting from applications of the load indicated in item 3.16.1 above	% of rated load	
3.16.3	Permanent speed change resulting from application of the load indicated in item 3.16.1 above	% of rated load	
3.16.4	Maximum recovery time to permanent speed change of 3.16.3	Secs.	
3.16.5	Transient speed rise resulting from a full load throw-off	% of rated load	
3.16.6	Permanent speed rise resulting from a full load throw-off	% of rated load	
3.16.7	Maximum recovery time to reach permanent speed rise value indicated in item 3.16.6 above	Secs.	
3.16.8	Transient speed change resulting from a change of load, both ON and OFF, by any step of 25% of the rated full load	% of rated load	
3.16.9	Permanent speed change resulting from change of load, both ON and OFF, by any step of 25% of the rated full load	% of rated load	
3.16.10	Recovery time for attaining permanent speed change value indicated in item 3.16.9	Secs.	
3.16.11	Steady load speed band	% of rated load	
3.17	DG set starting time i.e., ready to take	Secs.	

Sr. No.	Description	Unit	Technical Particulars
	load after “start” impulse		
3.18	Maximum noise level at …….metres from equipment outline	dBA	
3.19	Maximum vibration level (peak to peak)	mm/secs.	
4.0	GENERATOR PERFORMANCE		
4.1	Generator efficiency at 100% rated load	%	
4.2	Generator efficiency at 75% rated load	%	
4.3	Generator efficiency at 50% rated load	%	
4.4	Generator efficiency at 25% rated load	%	
4.5	Voltage regulator response	%	
4.6	Excitation at full load and under specified variation of voltage and speed		
5.0	ENGINE CONSTRUCTION FEATURES		
5.1	Engine model No.		
5.2	No. of strokes		Two / Four Strokes
5.3	No. of cylinders		
5.4	Arrangement of cylinders		Inline / Vee Type
5.5	Cylinder bore	mm	
5.6	Piston stroke	mm	
5.7	Compression ratio		
5.8	Cylinder block :		
	a) Material of construction		
5.9	Crank case :		
	a) Material of construction		
5.10	Cylinder head :		

Sr. No.	Description	Unit	Technical Particulars
	a) Material of construction		
5.11	Cylinder liner :		
	a) Material of construction		
5.12	Crank shaft :		
	a) Forged / cast		
	b) Material of construction		
5.13	Crank shaft main bearings:		
	a) Nos. provided		
	b) Material of construction		
5.14	Piston :		
	a) Type		
	b) Material of construction		
5.15	Piston rings:		
	a) Material of compression rings		
	b) Material of oil rings		
5.16	Piston pin (Gudgeon pin):		
	a) Material of construction		
5.17	Connecting rod :		
	a) Material of bearings		
	b) Lining for bearing materials		
5.18	Camshaft:		
	a) Material of bearings and lining details		
	b) Mode of driving from crankshaft		
5.19	Engine valves :		Inlet Valve Exhaust Valve Starting Air Valve

Sr. No.	Description	Unit	Technical Particulars
	a) Nos. provided per cylinder		
	b) Material of valve body		
	c) Material of valve seat		
	d) Type of valve cooling		
5.20	Oil pan:		
	a) Capacity upto normal working level	m^3	
	b) Material of construction		
5.21	Gaskets – Material of construction :		
	a) Between cylinder head and cylinder block		
	b) Between cylinder block and oil pan		
	c) Between cylinder block and end corners		
5.22	Fly wheel with cover		Provided / Not provided
5.23	Fuel injection System :		
	a) Type of system		
	b) Engine driven fuel feed pump provided		Yes / No
5.24	Governing system type		
5.25	Foundation details :		
	a) No. of holding down bolts		
	b) Anti-vibration springs with visco dampers		Yes/ No
6.0	ENGINE SYSTEMS		
6.1	Fuel Oil system :		
a	Fuel Oil tanks (For each tank)		
	a) Nos. provided		
	b) Working capacity of each tank	m^3	

Sr. No.	Description	Unit	Technical Particulars
	c) Size of tank :		
	i) Rectangular tank	mxmxm	
	ii) Cylinder tank	Dia(m)xHt(m)	
	d) Material of construction		
	e) Location		
b	Motor operated transfer pumps furnished		Yes / No
	(For each pump)		
	a) Nos.		
	b) Type		
	c) Capacity	m^3/hr.	
	d) Motor Rating	KW	
c	Fuel oil filters		2 x 100 % Simplex / 1 x 100 % Duplex
d	Maximum pressure drop across filters in clogged condition		
e	Through put capacity of fuel oil treatment plant at specified viscosity of fuel oil		
f	No. of fuel oil treatment units provided.		
g	Separating temperature		
6.2	Lube oil System :		
a	Type and grade of lube oil to be used		
b	Capacity of lube oil sump below cylinder block / crane case at normal working level	m^3	
c	Lube oil tanks external to engine (For each tank)		Yes / No
d	a) Capacity	m^3	
e	b) Material of construction		

Sr. No.	Description	Unit	Technical Particulars
f	c) Location		
g	Engine driven / Motor Driven lube oil pump :		
	a) Nos.		
	b) Type		
	c) Capacity	m^3/hr.	
	d) Motor Rating	KW	
h	Lube oil cooler :		
	a) Type		
	b) Cooling fluid		
	c) Secondary Cooling Water flow / Primary Jacket Water flow	m^3/hr.	
i	Lube oil filters :		
	a) Type		2 x 100 % Simplex / 1 x 100 % Duplex
	b) Maximum allowable pressure drop across filter in clogged condition		
j	Lube oil heater :		
	a) Provided		Yes/ No
	b) Type		
	c) If electric, indicate power rating	kW	
k	AC motor driven priming pump :		
	a) Nos. provided		
	b) Type		
	c) Capacity	m^3/hr.	
	d) Head	mlc	
	e) Motor rating	kW	

Sr. No.	Description	Unit	Technical Particulars
l	Quantity of lube oil required for initial filling	m^3	
m	Through put capacity of lube oil treatment plant at specified viscosity of fuel oil		
n	No. of lube oil treatment units provided.		
o	Separating temperature		
6.3	Primary Jacket Water System		
a	Type of cooling		Radiator cooled / Secondary cooling water cooled
b	Quality of water		
c	Quantity of water required for initial filling	m^3	
d	Makeup water quantity	m^3/hr.	
e	Expansion tank :		
	a) Working capacity	m^3	
	b) Size :		
	i) Rectangular	mxmxm	
	ii) Cylindrical	Dia(m)xHt(m)	
	c) Material of construction		
	d) Inner coating details		
f	Jacket Water Pump and jacket water pre heating pump		
	a) Type		Engine driven / AC motor driven
	b) Capacity	m^3/hr.	
	c) Head	mlc	
	d) Mode of driving off engine crank		

Sr. No.	Description	Unit	Technical Particulars
	shaft		
	e) Motor Rating	KW	
g	Radiator (if required)		
	a) Type		
	b) Overall size		
	c) Materials of construction :		
	i) Tubes		
	ii) Fins		
	iii) Header		
	d) Location		
	e) Radiator fan :		
	i) Tip diameter	mm	
	ii) Max. speed	rpm	
	iii) Flow at above speed	m^3/hr.	
	f) Air temperature rise across radiator		
	g) Mode of drive from engine crank shaft		
	h) Material of construction of fan :		
	i) Blades		
	ii) Hub		
	i) Air ducting details :		
	i) Material of construction		
	ii) Inside clear dimensions	mmxmm	
	iii) Type of fixing arrangement between air duct and radiator		
	j) Fan guard provided		Yes / No
	k) Fan motor rating	KW	

Sr. No.	Description	Unit	Technical Particulars
h	Heat Exchanger :		
	a) Designation		
	b) Type		Shell & tube type / plate type
i	Jacket water heater :		
	a) Nos. provided		
	b) Type		
	c) If electric, power required	kW	
6.4	Air intake system :		
a	Intake silencer type		
b	Air cleaner :		
	a) Type		Wet/ Dry
	b) Nos. provided		
	c) Design air flow	m^3/hr.	
	d) Materials of construction:		
	i) Body and cover		
	ii) Filter element		
	e) Type of oil to be used for wet type		
	f) Frequency of oil cleaning filter element cleaning		
	g) Location		
c	Turbocharger (exhaust gas driven) :		
	a) Speed	Rpm	
	b) Air pressure at outlet	Pa(g)	
	c) Air temperature at outlet	^oC	
	d) Maximum air flow	Nm^3/hr.	
	e) Blade material		

Sr. No.	Description	Unit	Technical Particulars
	f) Casing material		
d	Supercharger (engine driven) :		
	a) Type		Roots type
	b) No. of lobes		Two / Three
	c) Speed	rpm	
	d) Air flow	$Nm^3/hr.$	
	e) Air outlet pressure	Pa(g)	
	f) Air outlet temperature	^oC	
	g) Material of construction :		
	i) Lobes		
	ii) Casing		
	iii) Shafts		
	iv) Bearings		
	v) Seals		
	vi) Timing gears		
	b) Type of drive from engine crank shaft		
e	Charge air cooler :		
	a) Type		
	b) Nos. provided		
	c) Cooling water type		
	d) Design water flow required	$m^3/hr.$	
	e) Pressure drop at above flow	mlc	
	f) Inlet water temperature	^oC	
	g) Temperature rise	^oC	
	h) Charge air temperature at cooler outlet	^oC	

Sr. No.	Description	Unit	Technical Particulars
	i) Material of construction :		
	i) Tubes		
	ii) Fins		
	iii) Cover		
	iv) End plates		
6.5	Exhaust gas system:		
6.5.1	No. of streams provided		
6.5.2	Exhaust silencer		
	a) Nos. provided per exhaust pipe		
	b) Type		
	c) Location		
6.5.3	Exhaust Duct		
	a) Size		
	b) Material		
6.5.4	Lagging details :		
	a) Lagging material		
	b) Lagging thickness		
6.6	Air starting system :		
6.6.1	Nos of compressors motor driven		
6.6.2	Nos of compressors diesel engine driven		
6.6.3	Compressor details		
	a) Manufacturer		
	b) Type		
	c) Rating		
	d) Speed	rpm	
6.6.4	Air receivers / air bottles		

Sr. No.	Description	Unit	Technical Particulars
	a) Nos. provided		
	b) Air capacity of each air receiver	m^3	
	c) Normal air pressure in air receiver	Pa(g)	
	d) No. of starts of engine from each receiver		
6.6.5	Normal air pressure for starting	Pa(g)	
6.6.6	Minimum air pressure for starting engine	Pa(g)	
6.6.7	Quantity of free air per start	Nm^3/hr.	
6.7	Common base frame for engine and generator:		
	Type		
	Material of construction		
6.8	Engine generator coupling :		
a	Type		
b	Whether fixed directly to fly wheel :		Yes / No
c	Clutch with engaging / disengaging arrangement provided?		Yes / No
d	Coupling guard material		
e	Coupling guard for clutch provided ? If 'Yes' indicate type		Yes / No
7.0	GENERATOR AND ACCESSORIES		
7.1	Name of manufacturer		
7.2	Design rating	kW	
7.3	Continuous output rating	kW	
7.4	Maximum rating	kW	
7.5	Power factor		

Sr. No.	Description	Unit	Technical Particulars
7.6	Rated voltage	Volts	
7.7	Rated current/ phase	Amps	
7.8	Speed	rpm	
7.9	Frequency	C/s	
7.10	Field current at rated output and voltage	Amps	
7.11	Insulation class :		
	a) Stator		
	b) Rotor		
7.12	Temperature rise above ambient of 45^{o}C (by thermometer):		
	a) Stator	^{o}C	
	b) Rotor	^{o}C	
	c) Cores	^{o}C	
7.13	WR^2 of rotating mass in diesel engine, generator, exciter, etc.	kgm^2	
7.14	Generator parameters :		
7.14.1	Synchronous reactance Xd:		
	a) Unsaturated	Ohms	
	b) Saturated	Ohms	
7.14.2	Transient reactance X'd:		
	a) Unsaturated	Ohms	
	b) Saturated	Ohms	
7.14.3	Sub-transient reactance X"d:		
	a) Unsaturated	Ohms	
	b) Saturated	Ohms	
7.14.4	Zero sequence reactance Xo	Ohms	
7.14.5	Negative sequence reactance X2	Ohms	

Sr. No.	Description	Unit	Technical Particulars
7.14.6	Open circuit transient time constant	secs.	
7.14.7	Open circuit synchronous time constant	secs.	
7.14.8	Open circuit field time constant T	secs.	
7.14.9	Short circuit ratio		
7.14.10	Resistance of field winding at operating temperature	Ohms	
7.14.11	Resistance of stator winding at operating temperature	Ohms	
7.15	Generator performance :		
7.15.1	Full load losses	kW	
7.15.2	Armature copper loss	kW	
7.15.3	Rotor copper loss	kW	
7.15.4	Core loss	kW	
7.15.4	Stray losses	kW	
7.15.5	Efficiency :		
	a) ¼ load	%	
	b) ½ load	%	
	c) 3/4 load	%	
	d) Full load	%	
8.0	MAIN EXCITER		
8.1	Rated voltage	Volts	
8.2	Rated current	Amps	
8.3	Ceiling voltage at zero load and rated speed	Volts	
8.4	Ceiling voltage at rated current and rated speed	Volts	
8.5	Excitation system response ratio		

Sr. No.	Description	Unit	Technical Particulars
8.6	Insulation class:		
	a) Stator		
	b) Rotor		
9.0	AUTOMATIC VOLTAGE REGULATOR		
9.1	Type		
9.2	Burden of AVR on CTs and PTs		
	a) CTs	Va	
	b) PTs	Va	
9.3	Dead band (if any)		
9.4	Field discharge resistor	Ohms	
9.5	Type and rating of field breaker		
10	TESTING		
10.1	BIDDER to indicate whether the following tests will be conducted :		
10.2	Dimensional accuracy of individual components		Yes / No
10.3	Hydro testing of all jacket water passages		Yes / No
10.4	Hydro testing of all lube oil lines		Yes / No
10.5	Hydro testing of fuel oil lines		Yes / No
10.6	Checking all lube oil passage for free flow of oil		Yes / No
10.7	Rig testing of governor assembly		Yes / No
10.8	Rig testing of individual injectors		Yes / No
10.9	Shop testing of engine with all the engine driven equipment in position		Yes / No
11	WEIGHTS		
11.1	Weight of fully assembled engine	kg	

Sr. No.	Description	Unit	Technical Particulars
11.2	Weight of generator	kg	
11.3	Weight of common base frame	kg	
11.4	Weight of fully assembled engine generator	kg	
11.4	GD2 for DG set	Kg/m^2	
11.5	Weight and name of heaviest part to be lifted during : a) Erection b) Maintenance	kg	
12	DIMENSIONS		
12.1	Overall dimension of engine		
12.2	Overall dimension of generator		
12.3	Height and name of longest part to be lifted during maintenance		

. LIST OF DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT

Following drawings, calculations & schedules shall be submitted to Employer/ DISCOM for approval before procurement, fabrication and Installation of equipments at site,

S.N.	Deliverables
1.0	Single Line Diagram of Complete Electrical System based on the design criteria.
2.0	Electrical Substation General Arrangment and sectional Layouts of substation showing locations of various Equipment including Compact substation, DG Sets , cable trenches, 11 kV VCB Switchgear Panel, LT Panels, control & relay panels and other allied equipments and associated systems.
3.0	Bill of quantities for 11/0.433kV Substation
4.0	11kV/0.433 kV Compact Substation
a)	General arrangement drawing shall indicate the overall dimensions, net weights, quantity of oil, crane requirements for assembly and dismantling of transformers, and the general constructional features.
b)	General arrangement drawing of the transformer showing plan, front elevation and side elevation complete with all accessories and fittings, detailed dimensions, cable entries, earthing terminals, foundation/floor fixing details, jacking pads, crane lift for untanking, size of lifting lugs and eyes, clearances between HV terminals, between LV terminals, between HV and LV terminals, between HV & LV terminals and ground and bill of materials etc.
c)	Valve schedule, Rating, diagram and terminal marking plates, complete with polarity and vector group.
d)	OCTC/OLTC cabinets: schematic circuit diagram and actual detailed wiring diagram giving terminal numbers.
e)	Bushings Plan, elevation, terminal details, mounting details, make and type number, current and voltage rating, creepage distances and principal characteristics.
f)	Control wiring diagram for marshalling box.
g)	QAP
5.0	DG Sets
a)	General arrangement drawing shall indicate the overall dimensions, net weights and the general constructional features.
b)	General arrangement drawing of the DG Set showing plan, front elevation and side elevation complete with all accessories and fittings, detailed dimensions, cable entries, earthing terminals, foundation/floor fixing details, and bill of materials etc.
c)	Control wiring diagram for Synchronizing Panel
6.0	Cabling system
a.	Details of Installation of Cables in Trenches, on cable trays, racks directly buried etc., at all locations as specified including cable trays.

S.N.	Deliverables
b.	11kV & 1.1kV Cable routing layout inside and outside the building.
c.	Bill of quantities of LT cables, lugs and glands & HT Termination Kits.
d.	11kV Cable termination and mounting Kit Layout drawing.
7.0	Earthing system
a)	Detail calculations of earthing network including main grid calculations.
b)	Earthing notes including detail write up and drawings of earthing conductor layout, equipment & structural earthing, joints, cable earthing, instrument earthing and special earthing.
c)	Details such as material, sizes, etc. of the earth conductor and electrode pits
d)	Earthing layout drawing showing interconnection of equipment earthing to the grid and earth pits
8.0	Lighting System
a.	Detailed Room wise Lighting Layout with type of fixture details and Circuit diagram showing phase wise load distribution and interconnection between switches, fixtures, Lighting panel, receptacles etc & Detailed lux level calculations.
b.	Conduit layout showing room wise routing of wires from lighting panel to lighting fixtures, receptacles etc.
c.	Lighting fixing arrangement, mounting structure details etc.for outdoor Football and indoor swimming pool
9.0	VCB / LBS/ LT Switchgear
a)	Design Calculations for Bus bar sizing, CT Sizing of all type etc. for each Switchboard along with a copy of relevant standard referred for the same
b)	Guaranteed Technical Parameters
c)	Equipment GA & Section drawings with dimensions, clearances, locations of components- CT, Terminals, etc. of each type of switchboard with component layouts like LV Compartment, etc with general notes
d)	Base frame and Foundation GA drawings with dimension and details
e)	Electrical Control drawing for all panels with general notes like sizes, type, Material details and other details
f)	Bill of material along with make, quantity, model no and ratings
g)	All the Type Test certificates to prove the compliance with the requirements and submit certificates before award of contract.
10.0	All civil drawings related to substation building & foundation of all the electrical items.
B)	**Calculations**
a)	Distribution Transformer , DG Sizing Calculations
b)	Fault level Calculations

S.N.	Deliverables
c)	Co-ordinated protection study with latest available version of ETAP software.
d)	HT & LT cable sizing
e)	Lightning protection Calculations
f)	Earthing Sizing Calculations
g)	Room wise Lighting Calculation
h)	Stadium lighting calculation
i)	External lighting calculation
C)	**Schedules**
a)	Cable Schedule
b)	Protection Relay Setting Schedule
c)	Interconnection schedule
d)	Junction Box Schedule

All equipment/system sizing calculations/drawings shall be submitted to the Employer for approval whether specifically mentioned or not.

2.0 Completion and Post Completion Activities

Mechanical completion is said to occur, when all erection/installation and commissioning of all electrical works and minor civil works under the scope of the Contractor are completed to the satisfaction of the Client's Representative with

a) All installation alignment checks.

b) All panels and equipment erected, grouted, with all cabling and wiring, terminations, routing, clamping, dressing, tagging, and ferruling duly completed including continuity and megger testing, and all installation checks.

At the stage of Mechanical completion, the Contractor shall ensure that all physical, aesthetic and workmanship aspects are totally completed, and the plant is fit and sound for undertaking pre-commissioning checks followed by commissioning.

Upon achieving mechanical completion, the Contractor shall notify the Client of such mechanical completion upon which the Client shall proceed with the checking of the works.

The Client may inform the Contractor regarding deficiencies for rectification by the Contractor within a jointly agreed period before the pre-commissioning checks could be undertaken. Alternately the Client, when the defects are of minor nature may undertake the pre-commissioning checks, permitting the Contractor to concurrently undertake rectification of such defects. Rectification of all defects, so notified by the Client, to his satisfaction shall be a prerequisite to issue of Taking over Certificate.

3.0 Testing and Commissioning

The Contractor shall carry out commissioning tests in the presence of the Client's representative. The evaluation of test results and decision passed by the Client's representative regarding the test results will be final and binding on the Contractor. Any additional tests or repetition of tests to establish satisfactory operation of any equipment shall be carried out by the Contractor, if so desired by the Client's representative at no extra cost.

The completion checks and commissioning tests to be carried out shall include, but not be limited to, those described in subsequent paragraphs, as applicable to the individual equipment/system.

All checks and tests shall be as per the Manufacturer's drawing manuals, relevant codes of installation and commissioning checklists described in subsequent paragraphs.

Among other commissioning tests, the following shall be carried out at site after completion of installation. Contractor shall ensure to use calibrated test equipment having valid calibration test certificates from standard laboratories traceable to National Standards / International Standards. All tests to be carried out in the presence of Client's representatives.

a) Switchboard: Power frequency high voltage test, IR test, operation tests

b) Relays: Check internal wiring, relay settings

c) Cables

- All new LT cables shall be megger tested before terminating / jointing. After terminations / joints shall be megger tested by 1000V megger.
- All HT cables shall be megger tested before terminating / jointing. After terminations / joints shall be megger tested by 5000V megger.
- Cable core shall be tested for
  - Continuity
  - Absence of cross phasing
  - Insulation resistance to earth
  - Insulation resistance between conductors

d) Earthing System

Continuity of all conductors and joints shall be checked. The Client's representatives may ask for earth continuity tests, earth resistance measurements and other tests, which in his opinion are necessary, to prove that the system is in accordance with design, specification, code of practice and CEA Regulations 2010. Earth resistance value should be not greater than one (1) ohm or as per local regulatory requirements, the stringent one to be applicable.

e) Lighting System

Commissioning tests stipulated in applicable standards and code of practice covering all lighting system equipment

The Contractor shall carry out insulation resistance tests by a megger of following rating

Control circuits up to 220 V 500 V megger

Power circuits up to 1.1 kV 1000 V megger

In general, the following checks shall be carried out on all the equipment/systems, as applicable.

a) Name plate details according to approved drawings/ specifications
b) Any physical damage or defect and cleanliness
c) Tightness of all bolts, clamps and connections
d) Oil leakages and oil level
e) Condition of accessories and their completeness
f) Clearances
g) Earthing connections
h) Correctness of installation with respect to approved drawings/specifications
i) Lubrication of moving parts
j) Alignment
k) Correctness and condition of connections

4.0 Commissioning Tests

The following commissioning tests are to be carried out on all the equipment/systems, as applicable and as desired by EMPLOYER/ STATUTORY requirements.

a) Insulation resistance measurement of equipment, accessories, cabling/wiring etc.
b) Dielectric tests on equipment, accessories, cabling/ wires etc.
c) Phase sequence and polarity
d) Voltage and current ratios
e) Vector group
f) Resistance measurement of winding, contacts etc.
g) Continuity tests
h) Calibration of indicators, meters, relays, etc.
i) Control and interlock checks
j) Settings of equipment and accessories
k) Checking of accuracy/error
l) Checking of operating characteristics, pick-up voltages and currents, etc.
m) Operational and functional tests on equipment, accessories, control schemes, alarm/trip/indication circuits, etc.
n) Operational Checks for all the equipments for Auto and Manual mode..

o) Measurement of guaranteed/approved design values including lighting levels, earth resistance measurement, etc.

p) Complete commissioning checks of the system

5.0 Specific Tests to be carried out for various Equipments are as follows;

HT Switchgear Panels

a) Check of electrical wiring.

b) Tests on auxiliary and control circuits.

c) Check of electrical operation of safety (interlocking, automatic changeover, Local / Remote operations in test as well as service position including all electrical interlocks etc).

d) Check of mechanical operations (insertion and withdrawal of removable parts, locks and interlocks system, operation of safety shutters, Anti pumping device operation etc.).

e) Protection system operation stability and sensitivity by primary injection testing method including testing of metering circuits

f) Check of setting of all protective and measurement devices (e.g. protection relays, smart devices, etc...).

g) IR values of power and control circuits

h) Panel indication, annunciation, space heater circuits

i) Spare contact for customer use

Control Circuit

a) Operational test of control circuits to be tested as per schematic drawing.

b) Indications/Alarm/Annunciation circuit to be tested as per control schematic drawing.

c) Check for panel space heater and illumination circuits.

LT Switchgear Panels

a) Check of electrical wiring.

b) IR Values of power circuits & control circuits

c) Tests on auxiliary and control circuits.

d) Check of electrical operation of safety (interlocking, automatic changeover, Remote closing / Tripping circuits etc…).

e) Check of mechanical operations (insertion and withdrawal of removable parts, locks and interlocks system, operation of safety shutters, charging - closing - tripping of breaker etc..).

f) Check of setting of all protective and measurement devices (e.g. protection relays, smart devices, Secondary injection testing of protective relays/releases, Trip circuit healthiness and tripping through relays/ release etc...).

g)

h) Indication / Annunciation / Panel space heater circuit / Space contacts for customer use

i) CT testing for polarity, ratio, IR values and magnetization for class PS characteristics

j) PT testing for ratio, IR values

k) Testing of modules for DOL/ Star-Delta/ATS/ Soft Starter starting or any other starting method as per the schematic drawings applicable.

HV & LV power cable, control cable & cable accessories

a) IR Values before Hipot

b) Hi Pot test for MV & HV cables.

c) IR Values after Hipot

Induction Motor

a) Measurement of insulation resistance on motor windings, built-in RTDs, anti-condensation heaters and bearing insulation, if any.

b) Tests on auxiliary and control circuits-Interlocks and simulation tests Auto/ Manual and local / remote operations

c) Bump start to check direction of rotation to match with driven equipment. Bump start shall be performed with motors uncoupled to prevent damage to equipment by reverse operation.

Earthing System

a) Earthing resistance of each electrode

b) Earth continuity check.

c) Overall resistance of earthing installation.

Lighting system

a) Check of electrical wiring.

b) Functional tests.

c) Lux level measurement for each area.

1. Applicable Permits

The Contractor shall obtain, as required under the Applicable Laws, the following Applicable Permits:

(a) Liasoning and approval from State Electricity Board / DISCOM to complete the work.

(b) Any other permits, clearances or approvals required under Applicable Laws.

(c) It shall be the Contractor's responsibility to arrange for inspection of all electrical equipments by the inspector or local authority. However, the actual deposited fees, if any for the inspection shall be borne by the contractor. The Contractor shall also be responsible for follow up action and obtain and deliver to the Owner/Employer the license/ permit required under the local/ provincial / national regulations/bye-laws free of cost. Nothing extra whatsoever on this account shall be paid to the contractor.

List of Vendors

Sr. No.	Material/ Equipment	Vendor
1.	Switchgear / Switchboard MV–VCB / RMU/ LBS	Siemens ABB Schneider Electric
2.	Compact Substation	Siemens ABB Schneider Electric
3.	Distribution Transformer	Schneider Electric Crompton Greaves Limited Transformers & Rectifiers India Limited Kirloskar C&S
4.	Static Power Meter & Logger (Trivector Meter)	As per DISCOM Company
5.	Sandwiched Type Bus Duct	Legrand L & T Schneider C&S Anant Powertech
6.	Protection Relays (Numeric / Electro mechanic Type)/ Auxiliary relays)	ABB Schneider Electric Siemens Alstom GE
7.	Potential & control Transformer (CT/PT)	Gilbert & Maxwell Precise Kappa Pragati Anant Powertech

Sr. No.	Material/ Equipment	Vendor
8.	Current Transformer (Cast Resin Epoxy Coated)	Gilbert & Maxwell Precise Kappa Pragati Anant Powertech
9.	Electronic Digital Meter (A/V/PF/HZ/KWH) /MFM with LCD/LED Display.	Schneider Siemens Secure Socomec L & T
10.	HRC Fuse and Fuse Fitting	ABB GE Siemens L&T
11.	ACB / MCCB/ Contactors	ABB Schneider Siemens L&T
12.	Change over switch (automatic/ manual)	HPL Hager Socomec GE
13.	Thermister relay	Alstom/ Minilec/ Siemens
14.	Push Buttons	ABB L&T Schneider Siemens

Sr. No.	Material/ Equipment	Vendor
		BCH
15.	A. Power Distribution Panels & Boards Totally Type Tested Assembly (TTA) (As Per IEC61439- 1 & 2). To be sourced directly from OEM or authorized licensed partner. To be manufactured at manufacturer's own factory.	Advance Panels & Switchgears (P) Ltd. Adlec Power Pvt Ltd Jackson C&S Electric Ltd
	B. Power Distribution Panels & Boards (Non TTA)	OEM of the following: Siemens Schneider ABB L&T C&S
16.	Switches, Time Delay Relay	Schneider Siemens Hager Legrand
17.	Indicating Lamps	Siemens Schneider ABB L&T BCH Esbee
18.	HT/ LT Power & Control Cables	Universal NICCO KEI KEC International

Sr. No.	Material/ Equipment	Vendor
		Finolex CCI LAPP India Gloster
19.	HT/ LT Jointing Kit & Termination Kit	Birla-3M Raychem M seal
20.	Termination (Lugs)/ Cable Glands(Double compression)	Commet Dowell Jainson
21.	Selector Switches	Kaycee ABB Siemens Schneider
22.	Alarm Annunciators (solid state type with LED illumination) / Facia Annunciator	Industrial Instruments & Controls Minilec Alstom ICA
23.	Cable Management Systems-Raceways/Floor Boxes/ Trunkings , Cable trays	Legrand OBO-Betterman MEM
24.	Cable tray hangers and Supports	Gripple Hilti
25.	MS Black Stove Enameled ERW Conduits/GI pipes(ISI Approved) & accessories	AKG BEC Precision
26.	UPVC Conduit/JB/flexible conduit / tees/ Bevels, elbow & accessories	AKG Plaza

Sr. No.	Material/ Equipment	Vendor
		Avon Plast Precison
27.	Copper Conductor PVC Insulated Wires/ Stranded Flexible Wires (FRLS) (including panel wiring)	Finolex RR Kabel KEI Havells LAPP India Gloster
28.	Non-insulated Copper Earthing conductors	Gupta Industrial Corporation (Vasai, Palghar) Bharat Wires & Ropes Diamond Cables
29.	Modular Switches, Socket Outlets And Wiring Accessories With Moulded Cover Plate.	Legrand Schneider MK Crabtree
30.	Metal Clad Plug & Socket (Industrial)	Legrand Schneider Neptune (Balls)
31.	MCB/RCCB/ SPD/RCBO/ MPCB	Legrand Schneider Siemens ABB
32.	Distribution Boards(MCB DBs)	Legrand Schneider Siemens ABB L & T

Sr. No.	Material/ Equipment	Vendor
33. a.	Light Fixtures-General	Wipro Philips Crompton Greaves Bajaj
b	LED / Driver	Cree Nichia Philips Lumiled Osram
34. a.	Light Fixtures-Sport lighting	Philips Bajaj Disano
35.	Exit lights	Prolite Legrand Philips Zumtobel
36.	Ceiling Fan (5 star rating)	Crompton Bajaj USHA ORIENT Havells
37.	Exhaust Fans (5 star rating)	Crompton Almonard Havells Orient
38.	Street & Landscape Lighting	Schreder Wipro BAJAJ

Sr. No.	Material/ Equipment	Vendor
		Philips Lighting technologies Keselec
39.	MS Tubular / Octagonal / Decorative Poles	Bajaj Philips Schreder Valmount K-lite Keselec
40.	Lightning Protection System	DEHN ONAY J. Propster
41.	Lightning & Surge Voltage Protection	ABB Hager OBO Betterman DEHN
42.	Fire Sealant & Fire Retardant Paint	3 M India Ltd. HILTI Promat
43.	Fire Barriers / Sealing	Brattberg Roxtec Signum Navell Multikil
44.	Water barriers/sealing system	Roxtec Rayflate (Tyco Electronics)
45.	Insulating mats	Electromat Dozz Raychem RPG

Sr. No.	Material/ Equipment	Vendor
46.	Terminal Blocks /connectors	Jainson Elmex Connect well Wago
47.	Elevator/ Escalators	Thyssenkrupp Otis Kone Mitshubishi
48.	Single Phase Preventers	Minilec Siemens Schneider Electric L&T
49.	Selector Toggle Switch	Kaycee Salzer (Larsen & Toubro) ABB
50.	Sealed Maintenance Free Batteries	Amar Raja Exide Hitachi
51.	Battery Charger	Caldyne Chhabi Electricals Amar Raja Hitachi
52.	Water barriers/sealing system	Roxtec Rayflate (Tyco Electronics)
53.	Fire Survival cables	INDIA-IMPEX(FRTEK) LEONI Bonton

Sr. No.	Material/ Equipment	Vendor
		Fusion Polymer
54.	LT DG Set (Engine, Alternator)	Caterpillar Cummins MTU Ashok Leyland (C&S)
55.	Anti Vibration Mountings	Gerb Resistoflex Kanwar
56.	Timers	Schneider Siemens L&T Legrand
57.	HSD – Storage Tank	Engineers Syndicate Multi Engineering Sermes Hydrotherm Engineering
58.	Flexible Coupling	Resistoflex Kanwal
59.	Residential Silencer	Nelson Cummins Sterling Power Catter Pillar
60.	MS Pipes for Exhaust System	Jindal Hissar Tata SAIL
61.	MS Pipes/ GI pipes for fuel system	Jindal Hissar Tata

Sr. No.	Material/ Equipment	Vendor
		SAIL
62.	Pressure/Temperature Gauges	H Guru Feibig Emerald
63.	Vibrator Eliminator	Kanwal Resistoflex Dunlop
64.	Semi Rotary type hand fuel filling pump	Rotodel Kitty Binks
65.	Polycarbonate Sockets	Clipsal MANNEKER Legrand
66.	Water Tight Polycarbonate Boxes	Hensel Legrand Phraser
67.	Astronomical Timer	The ben ABB Siemens
68.	APFC Capacitor Panels	L & T Schneider EPCOS ABB
69.	Capacitor (APP) / Series reactors / APFC relay	Schneider EPCOS ABB L & T

Note:-

1) Only one of the above makes of the materials will be acceptable. The Contractor has to comply with the approved makes given in the tender document.

2) The Bidder shall offer the equipment of makes mentioned above. Other makes are subjected to Client approval before procurement.

3) The items manufactured in India shall be permitted only if the items are ISI marked (any other definition of compliance to BIS shall not be acceptable).

4) Samples from all the approved makes shall be offered for selection.

5) For standardization, inventory, electrical system coordination, the Employer/ Employer's Representative can insist on any one make from the makes indicated above.

6) The items shall meet specifications. Mere mention of a make as approved make in the above list does not qualify for acceptance of an item.

Technical Specifications for Water Supply, Sanitary & Drainage Works

1.0 SCOPE

1. This specification covers the general requirements of providing and laying water mains and water supply piping, providing and fixing sanitary fixtures and piping and providing and laying drainage lines.

2. For specifications, mode of measurements and scope of work covered under the respective items for the work included under this contract, following documents shall be referred to in the order of precedence as given below:

   a) Description of the items and notes if any given in the Schedule of Quantities.
   b) Drawings
   c) Specifications.
   d) Additional / Special Conditions of Contract.
   e) General Conditions of Contract.
   f) Applicable Codes and Standards as specified herein with amendments/ revisions issued till date.

   In the event of any discrepancy among the documents referred above, the document in the higher order of precedence shall prevail.

3. In the event of any element of the specification not being available in any of the documents mentioned above, the instructions of the Engineer-in-Charge in writing shall be followed by the Contractor.

4. The Work shall be carried out in accordance with the drawings and designs as would be issued to the Contractor by the Engineer-in-Charge duly signed and stamped by him. The Contractor shall not take cognizance of any drawings, designs, specifications, etc. not bearing Engineer-in-Charge's signature and stamp. Similarly, the Contractor shall not take cognizance of instructions given by any other Authority except the instructions given by the Engineer-in-Charge in writing.

5. The Work shall be executed and measured as per metric dimensions are given in the Schedule of Quantities, drawings etc.

6. The Contractor shall acquaint himself fully with the partial provisions for supports that may be available in the structure and utilize them to the extent possible. In any case, the Contractor shall provide all the supports regardless of provisions that have been already made. Nothing extra shall be payable for situations where bed plates (for supports) are not available or are not useful

7. The Contractor shall incorporate seismic considerations of anchoring and isolation in the design of the systems as called for the different equipment.

8. Shop coats of paint that may be damaged during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with paint to match the finish over the adjoining shop painted surface.

9. In addition to the sectional testing carried out during the construction, the Contractor shall test the entire installation after connections to the overhead tanks or pumping

system or mains. He shall rectify all leakage and shall replace all defective materials in the system. Any consequential damage is done, on account of Contractors carelessness, open or burst pipes or failure of fittings, during testing and commissioning to the building, furniture and fixtures shall be made good by the Contractor.

2.0 GENERAL PROVISION

2.1 Scaffolding

2.1.1 Only steel tube scaffolding of approved design shall be used for all works. The scaffold structure shall comply with the requirements of IS: 4014 and IS : 3696. An independent tied scaffold (double scaffold), which has two lines of standards, shall be provided with the inner line kept at least one board clear of the finished face with extended transoms, or hop up baskets to carry an inside board. Diagonal braces shall not prevent the material being moved along the scaffold run. The scaffolding shall be suitably packed at the ends to prevent damage to the finished work.

2.2 Protection

2.2.1 Protection against damage: Care shall be taken to avoid damage from any cause at all stages. Packing pieces used for protection shall not disfigure or otherwise permanently mark the Works.

2.2.2 Surface protection shall be afforded by careful handling and the avoidance of the use of hooks, crowbars, or other implements that are likely to damage the works.

2.2.3 During installation of piping, the open end of pipe shall be protected with temporary cover to prevent du**s**t or other materials entering in it.

2.2.4 Protection during construction: Decorative surfaces shall be carefully protected during construction by a temporary cover.

2.2.5 Protection of finished work: At all stages of the Contract it is essential that all works are properly protected.

2.2.6 Suitable packing shall be used to ensure that scaffolding does not damage erected stone, marble, granite or other finished works.

2.2.7 Any disfigurement, discoloration or imperfection whatsoever due to any reason shall not be accepted and the Contractor shall either remedy the same or redo the work at no extra cost. The decision of the Engineer-in-Charge, as to whether any work either in whole or in part is acceptable or not shall be final and binding on the Contractor.

2.3 Guarantee

The Contractor shall guarantee and undertake to maintain and rectify the various components of the Plumbing work installed by him for successful performance for a period as indicated in the Datasheet-A. The Contractor shall indemnify the Engineer-in-Charge for a similar period against any damage to property and injury to persons on account of any defective work or maintenance carried out by the Contractor. The format

and text of the Guarantee and the Indemnity Bond shall be given by the Engineer-in-Charge.

3.0 APPLICABLE CODES, STANDARDS, AND PUBLICATIONS

All equipment, supply, erection, testing, and commissioning shall comply with the requirements of Indian Standards and code of practices given below as amended till date. All equipment and material being supplied by the contractor shall meet the requirements of IS, and other Codes/ Publications as given below.

SP:6(1)	Structural steel sections
IS:325	Three phase induction motors
IS:554	Dimensions for pipe threads where pressure-tight joints are required on the threads
IS:694	PVC insulated cables for working voltages up to and including 1100 V.
IS:779	Specification for water meters (domestic type)
IS:800	Code of Practice for general construction in steel
IS:1068	Electroplated coatings of nickel plus chromium and copper plus nickel plus chromium
IS:1172	Code of Basic requirements for water supply drainage and sanitation
IS:1367	(Part 1) Technical supply conditions for threaded steel fasteners: Part I Introduction and general information
IS:1367	(Part 2) Technical supply conditions for threaded steel fasteners: Part 2 Product grade sand tolerances.
IS:1554	PVC insulated (heavy duty) electric(Part 1) cables: Part 1 For working voltages up to and including 1100 V.
IS:1554 (Part 2)	PVC insulated (heavy duty) electric cables: Part 2 For working voltages from3.3 kV up to and including 11 kV.
IS:1726	Specification for cast iron manhole covers and frames
IS:1742	Code of practice for building drainage
IS:2064	Selection, installation, and maintenance of sanitary appliances - Code of practice
IS:2065	Code of practice for water supply in buildings
IS:2104	Specification for water meter boxes(domestic type)

IS:2373	Specification for water meters (bulk type)
IS:2379	Colour code for identification of pipelines.
IS:2527	Code of practice for fixing rainwater gutters and downpipes for roof drainage
IS:2629	Recommended practice for hot-dip galvanizing on iron and steel
IS:3114	Code of practice for laying of cast iron pipes
IS:4111 (Part 1)	Code of practice for ancillary structures in sewerage system: Part 1Manholes
IS:4127	Code of practice for laying glazed stoneware pipes
IS:4853	Recommended practice for radiographic inspection of fusion welded butt joints in steel pipes
IS:4985	Unplasticised PVC pipes for potable water supplies – specification.
IS:5329	Code of practice for sanitary pipework above ground for buildings
IS:5455	Cast iron steps for manholes
IS:6159	Recommended practice for design and fabrication of material prior to galvanizing
IS:7558	Code of practice for domestic hot water installations
IS:8321	Glossary of terms applicable to plumbing work
IS:9668	Maintenance of water supplies and firefighting.
IS:9842	Preformed fibrous pipe insulation
IS:9912	Coal tar based coating materials and suitable primers for protecting iron and steel pipelines
IS:10221	Code of practice for coating and wrapping of underground mild steel pipelines
IS:10234	Recommendations for general pipeline welding
IS:10446	Glossary of terms relating to water supply and sanitation
IS:11149	Rubber Gaskets
IS:11790	Code of practice for preparation of butt welding ends for pipes, valves, flanges, and fittings

IS:12183 (Part 1)	Code of practice for plumbing in multi-storeyed buildings: Part 1 Water Supply
IS:12251	Code of practice for drainage of building basements
BS:5572	Code of practice for sanitary pipework
BS:6700	Specification for design, installation, testing, and maintenance of services supplying water for domestic use within buildings and their cartilages
BS:8301	Code of practice for building drainage
BSEN274	Sanitary tapware, waste fittings for basins, bidets, and baths. General technical specifications
IS:458	Specification for precast concrete pipes(with and without reinforcement)
IS:651	Salt-glazed stoneware pipes and fittings
IS: 1239 (Part 1)	Mild steel tubes, tubular and other wrought steel fittings: Part 1 Mild steel tubes
IS:1239	Mild steel tubes, tubular and other wrought steel fittings:
IS:1536	Centrifugally cast (spun) iron pressure pipes for water, gas, and sewage
IS:1538	Cast iron fittings for pressure pipes for water, gas, and sewage
IS:1729	Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings, and accessories
IS:1879	Malleable cast iron pipe fittings
IS:1978	Line pipe
IS:1979	High test line pipe
IS:2501	Copper tubes for general engineering purposes
IS:2643 (Part 1)	Dimensions for pipe threads for fastening purposes: Part 1 Basic profile and dimensions
IS: 2643 (Part 2)	Dimensions for pipe threads for fastening purposes: Part 2 Tolerances
IS:2643 (Part 3)	Dimensions for pipe threads for fastening purposes: Part 3 Limits of sizes
IS:3468	Pipe nuts

IS:3589	Seamless or electrically welded steel pipes for water, gas, and sewage(168.3mm to 2032mm outside diameter)
IS:3989	Centrifugally cast (spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories
IS:4346	Specifications for washers for use with fittings for water services
IS:4711	Methods for sampling steel pipes, tubes, and fittings
IS:6392	Steel pipe flanges
IS:6418	Cast iron and malleable cast iron flanges for general engineering purposes.
IS:7181	Specification for horizontally cast iron double flanged pipes for water, gas, and sewage.
IS:778	Specification for copper alloy gate, globe and check valves for water works purposes
IS:780	Specification for sluice valves for water works purposes (50mm to 300mmsize)
IS:1703	Specification copper alloy float valves (horizontal plunger type) for water supply fittings.
IS:2906	Specification for sluice valves for water works purposes (350mm to 1200 mm size)
IS:3950	Specification for surface boxes for sluice valves
IS:5312 (Part 1)	Specification for swing check type reflux (nonreturn) valves: Part 1Single door pattern
IS:5312	Specification for swing check type reflux (non return) valves: Part 2 Multi door pattern
IS:12992	Safety relief valves, spring loaded: (Part 1) Part1Design
IS:13095	Butterfly valves for general purposes
IS:771(Part 1 to 3)	Specification for glazed fire-clay sanitary appliances
IS:774	Specification for flushing cistern for water closets and urinals (other than plastic cistern)
IS:775	Specification for cast iron brackets and supports for wash basins and sinks
IS:781	Specification for cast copper alloy screw down bib taps and stop valves for water services

IS:1700	Specification for drinking fountains
IS:2326	Specification for automatic flushing cisterns for
IS:2548 (Part 1)	Specification for plastic seats and covers for water closets: Part 1: Thermoset seats and covers
IS: 2548(Part 2)	Specification for plastic seats and covers for water closets: Part 2: Thermoplastic seats and covers
IS:2556(Part 1)	Specification for vitreous sanitary appliances (vitreous china): Part 1:General requirements
IS:2556(Part 2)	Specification for vitreous sanitary appliances (vitreous china) Part 2: Specific requirements of wash down water closets
IS:2556(Part 3)	Specification for vitreous sanitary appliances (vitreous china) Part 3: Specific requirements of squatting pans
IS:2556(Part 4)	Specification for vitreous sanitary appliances (vitreous china) Part 4: Specific requirements of wash basins
IS:2556 (Part 6 Sec 2)	Specification for vitreous sanitary appliances (vitreous china) Part 6: Specific requirements of urinals, Section 2 Half stall urinals
IS:2556 (Part 6 Sec 4)	Specification for vitreous sanitary appliances (vitreous china) Part 6 :Specific requirements of urinals, Section 4 Partition slabs
IS:2556 (Part 6 Sec 5)	Specification for vitreous sanitary appliances (vitreous china) Part 6 :Specific requirements of urinals, Section 5 waste fittings
IS:2556 (Part 6 Sec 6)	Specification for vitreous sanitary appliances (vitreous china) Part 6: Specific requirements of urinals, Section 6 Water spreaders for half stall urinals
IS:2556(Part 7)	Specification for vitreous sanitary appliances (vitreous china) Part 7: Specific requirements of half round channels
IS:2556(Part 8)	Specification for vitreous sanitary appliances (vitreous china) Part 8: Specific requirements of symphonic wash down water closets.
IS:2556(Part 11)	Specification for vitreous sanitary appliances (vitreous china) Part 11: Specific requirements for shower rose
IS: 2556(Part 12)	Specification for vitreous sanitary appliances (vitreous china) Part 12: Specific requirements of floor traps
IS:2556 (Part 15)	Specification for vitreous sanitary appliances (vitreous china)

	Part 15: Specific requirements of universal water closets
IS:2692	Specification for ferrule for water services
IS:2717	Glossary of terms relating to vitreous enamelware and ceramic metal systems
IS:2963	Specifications for copper alloy waste fittings for wash basins and sinks
IS:3311	Specification for waste plug and its accessories for sinks and wash basins.
IS:5961	Specification for cast iron gratings for drainage purposes.
IS:6249	Specification for flush valves and fittings for marine use
IS:6411	Specification for gel coated glass fibre reinforced polyester resin bathtubs
IS:8931	Specification for copper alloy fancy single taps, combination tap assembly and stop valves for water services
IS:9758	Specification for flush valves and fitting for water closets and urinals.
Manual for Water Supply & Treatment	CPHEEO Manual for Water Supply & Treatment -1999- MoUD, GoI
SP 7 (Part-9 Section-1) 1983	National Building Code of India
SP 35:1987	Hand book on water supply & drainage
IS 1172 :1993	Code of Basic requirements for water supply, drainage and Sanitation
IS: 8329-2000	Centrifugally Cast (spun) ductile iron pressure pipes for water, gas and sewage
IS: 5382-1985	Specification for Rubber sealing rings for gas mains, water mains and sewers.
IS: 1500	Code for Hardness test for DI pipes
IS 11906:1986	Recommendations for cement mortar lining for cast iron, Mild steel and Ductile Iron pipes and fittings for transportation of water
IS 12288:1987	Code of practice for laying of ductile iron

IS 2373:1981	Water meter (bulk type)

4.0 QUALITY ASSURANCE AND QUALITY CONTROL

1. The Work shall conform to high standards of design and workmanship, shall be structurally sound and aesthetically pleasing. Quality standards prescribed shall form the backbone for the quality assurance and quality control system.

2. At the site level, the Contractor shall arrange the materials, their stacking/ storage in an appropriate manner to ensure the quality. Contractor shall provide equipment and manpower to test continuously the quality of materials, assemblies etc. as directed by the Engineer-in-Charge. The test shall be conducted continuously and the result of tests maintained. In addition, the Contractor shall keep appropriate tools and equipment for checking alignments, levels, slopes and evenness of surface.

3. The Engineer-in-Charge shall be free to carry out tests as may be considered necessary by him at his sole discretion, from time to time, in addition to those specified in this document. The Contractor shall provide the samples and labor for collecting the samples. Nothing extra shall be payable to the Contractor for samples or for the collection of the samples.

4. The test shall be conducted at the site laboratory that may be established by Engineer-in-Charge or at any other Standard Laboratory selected by Engineer-in-Charge.

5. The Contractor shall transport the samples to the laboratory for which nothing extra shall be payable. In the event of Contractor failing to arrange transportation of the samples in proper time Engineer-in-Charge shall have them transported and recover two times the actual cost of the Contractor's bills.

6. Testing charges shall be borne by the Contractor.

7. Testing may be witnessed by the Contractor or his authorized representative. Whether witnessed by the Contractor or not, the test results shall be binding on the Contractor.

5.0 SANITARY WARE AND OTHER APPLIANCES

5.1 SCOPE OF WORK

5.1.1 Without restricting to the generality of the foregoing, sanitary and other appliances shall inter-alia include the following:-

- Sanitary appliances and fixtures for toilets
- Chromium plated brass fittings
- Stainless steel sinks
- Accessories e.g. towel rods, toilet paper holders, soap dish, liquid soap dispensers, towel rails, coat hooks etc.

- Mirrors, hand dryers, drinking water fountains, etc.

5.1.2 Whether specifically mentioned or not the Contractor shall provide for all appliances and fixtures all fixing devices, nuts, washers, Teflon tape, sealant, cement, brackets, supports, paints, connectors, cp riser pipes, adapters, bolts, screws, hangers etc as required.

5.1.3 All exposed pipes within toilets and near appliances/ fixtures shall be of chromium plated brass or copper unless otherwise specified.

5.2 GENERAL REQUIREMENTS

5.2.1 All materials shall be new and of quality conforming to specifications and subject to the approval of the Engineer-in-Charge. Wherever particular makes are mentioned, the choice of selection shall remain with the Engineer-in-Charge.

5.2.2 All appliances, fixtures, and fittings shall be provided with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Schedule of Quantities, specifications, and drawings. Accessories shall include proper fixing arrangement, brackets, nuts, bolts, washers, screws and required connection pieces.

5.2.3 Fixing screws shall be half round head chromium plated (CP) brass screws, with CP brass washers unless otherwise specified.

5.2.4 Porcelain sanitary ware shall be glazed vitreous china of first quality free from warps, cracks and glazing defects conforming to IS: 2556. The choice of the color of the Sanitaryware shall be that of the Engineer-in-Charge and nothing extra shall be payable to the Contractor for fixing of Sanitary ware of any color.

5.2.5 Sinks for kitchen shall be of stainless steel or as specified in the Schedule of Quantities.

5.2.6 Chromium plated fittings shall be cast brass chromium plated of the best quality approved by the Engineer-in-Charge.

5.2.7 If the supply of sanitary appliances, fixtures & fittings are in client's scope, no damages shall occur to the same during shifting, transportation, installation till successful handing over. If any damage occurs, the same shall be replaced by the contractor at his own cost.

5.2.8 All appliances, fittings and fixtures shall be fixed in a neat workmanlike manner true to level and to heights shown in the drawings and in accordance with the manufacturer recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling, plaster, paint, insulation or terrace shall be made good by the Contractor at his own cost.

5.2.9 All materials shall be rustproofed; materials in direct or indirect contact shall be compatible to prevent electrolytic or chemical (bimetallic) corrosion.

5.2.10 Sanitary appliances, subject to the type of appliance and specific requirements, shall be fixed in accordance with the relevant standards and the following:

a) Contractor shall, during the entire period of installation and afterward protect the appliances by providing suitable cover or any other protection in order to absolutely prevent any damage to the appliances until satisfactory handing over. (The original protective wrapping shall be left in position for as long as possible).

b) The appliance shall be placed in correct position or marked out in order that pipework can be fixed or partially fixed first.

c) The appliance shall be fixed in a manner such that it will facilitate subsequent removal if necessary.

d) All appliances shall be securely fixed. Manufacturers' brackets and fixing methods shall be used wherever possible. Compatible rust proofed fixings shall be used. Fixing shall be done in a manner that minimizes noise transmission.

e) Appliances shall not be bedded (e.g. WC pans, pedestal units) in the thick strong mortar that could crack the unit (e.g. a ceramic unit).

f) Pipe connections shall be made with de-mountable unions. Pipework shall not be fixed in a manner that it supports or partially supports an appliance.

g) Appliances shall be fixed so that waterfalls to the outlet (e.g. baths).

h) All appliances shall be secured as per the recommendations of the manufacturer.

i) Appliances shall be fixed true to level firmly fixed to anchor or supports provided by the manufacturer and additional anchors or supports where necessary.

5.2.11 Sizes of Sanitary fixtures given in the Specifications or in the Schedule of Quantities are for identification with reference to the catalogs of makes considered. Dimensions of similar models of other makes may vary within +/-10% and the same shall be provided and no claim for extra payment shall be entertained nor shall any payment be deducted on this account.

5.3 WATER CLOSET

5.3.1 WC shall be washed down or symphonic wash down type floor or wall mounted set, as shown in the drawings, designed for low volume flushing from 3-6 litres of water, flushed by means of a flushing cistern or an exposed or concealed type (as detailed in the drawings or as directed by the Engineer-in-Charge) 32mm size CP brass flush valve with regulator valve. Flush pipe/ bend shall be connected to the WC by means of a suitable rubber adaptor. Wall hung WC shall be supported by CI floor mounted chair which shall be fixed in a manner as approved by the Engineer-in-Charge.

5.3.2 Each WC set shall be provided with a solid plastic seat, rubber buffers, and chromium-plated brass hinges. The plastic seat shall be so fixed that it remains absolutely stationary in a vertical position without falling down on the WC.

5.3.3 Each WC set shall be provided with a fixed type CP brass ablution jet if called for in schedule of quantities, complete with CP/ plastic piping, concealed type CP brass angle cock etc. all of approved make and brand. The nozzle of the ablution jet and its holding

down plate shall have smooth and rounded edges and shall not be capable of causing any injury to a user or cleaner.

5.4 PAN CONNECTOR

5.4.1 The WC pan connector shall be Flexible, soft and shall be made of single body construction with integral fins, made from EVA (Ethyl Vinyl Acetate). The pan connector must conform to the BS: 5627: 1984. The pan connector must be supplied with factory fitted spring loaded seal guard.

5.4.2 The connector shall not be allowed to come in contact with mineral oil, grease, putty or any compound containing mineral oil or grease.

5.4.3 The pan connectors must be stored away from the direct sunlight and flames.

5.4.4 While fixing of the pan connector with the Soil pipe, the pipe must be reasonably clean and smooth on the inner surface; in case the soil piping is in C.I. then supplier supplied bush/adaptor shall be used. The connector socket is pushed fully home onto the pan spigot; thereafter the WC is placed in position gently pushing the fitment to ensure that the connector end fits into the Spigot of the pipe. The pan connector must be pushed in such an easy as to ensure that the seals and fins turn inward to ensure proper sealing.

5.5 URINALS

5.5.1 Urinals shall be lipped type half stall white glazed vitreous china of size as called for in the Schedule of Quantities.

5.5.2 Half stall urinals shall be provided with 15mm diameter CP spreader, 32mm diameter CP domical waste and CP cast brass bottle/"P" trap with pipe and wall flange and shall be fixed to the wall by CI brackets, CI wall clips and CP brass screws as recommended by manufacturer complete as directed by the Engineer-in-Charge.

5.5.3 Flushing for urinals shall be by means of no hand operation, PVC or ceramic flushing cistern / electronic auto flush valve with all internal fittings, mounted on a C.I. bracket, and painted with two coats of approved paint of approved shade and confirming to IS: 2326.

5.5.4 Flush pipes shall be PVC pipes concealed in wall chase but with chromium plated bends at inlet and outlet or as given in Schedule of Quantities. These shall be measured and paid for separately.

5.5.5 PVC waste pipes shall be provided for urinals. Waste pipes may be exposed on the wall or concealed in the chase as directed by the Engineer-in-Charge. These shall be measured and paid for separately.

5.6 URINAL PARTITIONS

5.6.1 Urinal partitions shall be white glazed vitreous china of size specified in the Schedule of Quantities.

5.6.2 Porcelain partitions shall be fixed at proper heights with CP brass bolts, anchor fasteners and MS clips as recommended by the manufacturer and directed by the Engineer-in-Charge.

5.7 WASH BASIN

5.7.1 Wash basins shall be white glazed vitreous china of size, shape, and type specified in the Schedule of Quantities.

5.7.2 Each basin shall be provided with painted MS angle or C.I. brackets and clips and the basin securely fixed to the wall. Placing of basins over the brackets without secure fixing shall not be accepted. The MS angle shall be provided with two coats of red oxide primer and two coats of synthetic enamel paint of make, brand, and color as approved by the Engineer-in-Charge.

5.7.3 Each basin shall be provided with 32mm diameter CP waste with overflow, pop-up waste or rubber plug, CP angle valve, CP riser pipe with connectors/adaptors and CP brass chain as specified in the Schedule of Quantities, 32mm diameter CP brass bottle trap with CP pipe to wall flange.

5.7.4 Wash basin shall be provided with hot and cold water mixing fitting or as specified in the Schedule of Quantities.

5.7.5 Basins shall be fixed at proper heights as shown on drawings. If height is not specified, the rim level shall be 790mm from finished floor level or as directed by the Engineer-in-Charge.

5.8 SINKS

5.8.1 Sinks shall be stainless steel or any other material as specified in the Schedule of Quantities.

5.8.2 Each sink shall be provided with painted MS or CI brackets and clips and securely fixed. Countertop sinks shall be fixed with suitable painted angle iron brackets or clips as recommended by the manufacturer. Each sink shall be provided with 40mm diameter CP waste, CP angle valve, CP riser pipe with connectors/adaptors and rubber plug with CP brass chain as given in the Schedule of Quantities. The MS angle shall be provided with two coats of red oxide primer and two coats of synthetic enamel paint of make, brand, and color as approved by the Engineer-in-Charge. Flow Rate = 4.5 to 6 Litres per minute @ 80 PSI

5.8.3 Supply fittings for sinks shall be deck mounted CP swivel faucets with or without hot and cold water mixing fittings as specified in the Schedule of Quantities. These shall be measured and paid for separately.

5.9 TOILETS FOR DISABLED

Where specified, in washroom facilities designed to accommodate physically disabled, accessories shall be provided as directed by the Owner's Site Representative.

Stainless steel garb brass of required size suitable for concealed or exposed mounting and opened non-slip gripping surface shall be provided in all washroom. The flushing cistern/valve shall be provided with chromium plated long handles.

5.1 MEASUREMENT AND RATES

Not used

5.2 FINAL INSTALLATION

The contractor shall install all sanitary fixtures and fittings in their final position in accordance with approved trial assemblies and as shown on drawings. The installation shall be complete with all supply and waste connections. The connection between building and piping system and the sanitary fixtures shall be through proper unions and flanges to facilitate removal/replacement of sanitary fixtures without disturbing the built-in piping system. All unions and flanges shall match in appearance with other exposed fittings.

6 SOIL, WASTE, VENT AND RAINWATER PIPES

6.1 SCOPE OF WORK

Soil, waste, vent, and rainwater disposal scope shall include Supply, Installation, testing, commissioning and successful handing over to the client as per the drawings, specifications, and schedule of quantities.

All soil, waste and storm water disposal for the portion above ground level to the public sewers shall be by gravity, whereas from the basements it shall be by pumping. Without restricting to the generality of the foregoing, the soil, waste, vent and rainwater pipes system shall inter-alia include the following:

a) Vertical and horizontal soil, waste, vent and rainwater pipes and fittings, joints, supports, paints, and connections to fixtures.

b) The connection of all pipes to sewer lines as shown in the drawings at ground level.

c) Floor and urinal traps, clean out plugs, inlet fittings, and rainwater (roof) outlets.

d) Testing of all pipes and fittings in the workshop.

e) Testing, commissioning and handing over of all pipes lines after installation.

6.2 GENERAL REQUIREMENTS

6.2.1 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

6.2.2 Pipes shall be fixed in a manner so as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

6.2.3 Pipes shall be securely fixed to walls, and ceilings with suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for fixing pipes on RCC ceilings and RCC/ masonry walls.

6.2.4 Access doors for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance.

6.2.5 Long bends shall be used on all main pipelines as far as possible. Use of elbows shall be restricted for short connections.

6.2.6 Wherever piping is going across the separation/expansion joints of buildings, the piping shall be provided with flexible connectors on both sides of such joints or on the single side depending on whether any wall is to be crossed or not.

6.3 <u>WASTE PIPE FROM APPLIANCES</u>

6.3.1 Waste pipe from appliances e.g. washbasins, baths, sinks, and urinals etc. shall be of UPVC confirming IS 4985 as given in the Schedule of Quantities.

6.3.2 The internal diameter sizes of outlet branch waste pipes for different fittings shall be as follows:

Wash basin - 32 dia

Urinals - 50 dia

Sink - 50 dia

Nahani Trap - 75 diameter, 50 mm seal

Multi Floor Trap - 75 or 100 dia. as required, with 50 mm or 75 mm seal / bolted aluminium grating in 25×25 MS angle

P Trap - 75 mm water seal as required with bolted aluminum grating in 25×25 MS angle

6.3.3 All pipes shall be fixed in gradient towards the outfalls of drains. Pipes inside a toilet room shall be in chase unless otherwise shown on drawings. Where required pipes may be run at ceiling level in suitable gradient and supported on structural clamps as directed by the Engineer-in-Charge. Spacing for the clamps shall be 3000mm for vertical runs and 2400mm for horizontal runs.

6.3.4 Pipes shall be UPVC tubes conforming to IS: 4985 and quality certificates shall be furnished. Pipes shall be provided with all required fittings conforming to IS: 4985 e.g. tees couplings, bends, elbows, unions, reducers, nipples, plugs etc. All UPVC waste pipes shall be terminated at the point of connection with the appliance with an outlet of suitable diameter. Pipes shall be painted as specified under Clause **Error! Reference source not found.**.

6.3.5 The pipes shall be of class III, 6 Kg/cm2. The pipes shall conform to IS 4985 - 2000. Fittings shall be of injection molded PVC conforming to IS 7834 (Part1) - 1975.

6.3.6 Pipe sleeves and inserts, etc. through RCC wall of buildings either external or internal or for water tanks shall be of PVC provided with water bar flanged.

6.3.7 W.C. pan connectors shall suit the requirements as per drawing, with 40 dia. vent horn for connection to the anti-siphonage pipe. Pan connector shall be of C.I. or lead.

6.3.8 Connection to the sewer or stormwater collection sumps to be perfectly watertight and as specified in the drawing.

6.3.9 Rainwater flashing shall be of 150× 100 or 230× 150 fitted on to the bell mouth of rainwater pipes inlet and then covered with cast iron grating and extension piece.

6.3.10 All rainwater pipes and fittings shall be soil type variety conforming to I.S. 1729-1964 or equivalent. This shall apply to pipe outside buildings within the building or in separate shafts.

6.3.11 Bathroom C.P. grating shall be having bolted down design out of heavy cast brass with chromium plating of the best-approved standards.

6.3.12 Cast iron grating shall be flat with a perfect edge and of the best quality procurable of the specified width and thickness and in the available length.

6.4 PIPE LAYING AND FIXING

The pipe laying and jointing shall be done in accordance with IS 7634 (Part 3) – 1975. Pipes shall be cut to size and chamfered well. Burr's if any shall be removed. Pipes and fittings shall be joined using solvent cement or rubber ring joints. The pipes and fittings shall be jointed accurately without any stress to achieve leak proof joints.

6.5 TESTING

The method which is commonly in use is filling the pipe with water, taking care to evacuate any entrapped air and slowly raising the system to the test pressure at 3Kg/cm2. The pressure testing may be followed as follows. The field test pressure to be imposed should be not less than the greatest of the following:

- One and half times of maximum sustained operating pressure.
- One and half times the maximum pipeline static pressure.
- Sum of the maximum sustained operating pressure and the maximum surge pressure.
- Sum of the maximum pipeline static pressure and the maximum surge pressure, subject to a maximum equal to the works test pressure for any pipe fittings incorporated.
- The field test pressure should wherever possible be not less than 2/3rd working pressure and should be applied and maintained for at least four hours. If the visual inspection satisfies that there is no leakage the test can be passed.
- A test register shall be maintained and all entries signed and dated by Contractor and Engineer-in-Charge. A Performa of the proposed test register shall be submitted to the Engineer-in-Charge for approval.
- All pipes in wall chase or meant to be encased or buried shall be hydro tested before the chase is plastered or the pipe encased or buried.

6.6 CUTING AND MAKING GOOD HOLES / CHASES

Pipes shall be fixed and tested as the building work proceeds. Contractor shall provide all necessary holes, cut outs and chases in structural members as the building work proceeds. Wherever holes are cut or left originally, they shall be made good with cement concrete 1:1:2 (1 cement: 1coarse sand :2 stone aggregate 20mm nominal size) or cement mortar 1:2 (1 cement :2 coarse sand) as directed by the Engineer-in-Charge and the surface restored as in original condition to the entire satisfaction of the Engineer-in-Charge at no extra cost.

6.7 DRAINAGE ACCESSORIES

a) Floor Trap / Urinal Trap Grating

Floor/ urinal traps grating shall be of stainless steel square / round of size 125 x 125 mm square/round as approved by client & shown in the drawing. Floor trap assembly shall be provided with round stainless steel strainer basket as a cockroach trap. Entire assembly shall be complete with ring, frame, outer cup, inner cup, grating, screws etc. of an approved make.

b) Floor Cleanout

Floor cleanout cover shall be of stainless steel square / round of size 125 x 125 mm square/round as approved by client & shown in the drawing. Floor cleanout assembly shall be complete with ring, outer frame, cover, screws etc. of an approved make.

c) Ceiling Cleanout

Ceiling cleanout cover shall be in nickel bronze / PVC plug type / GI flanged type of round shape matching pipe size as approved by client & shown in the drawing. Ceiling

cleanout assembly shall be threaded with key hole for opening / flanged type suitable for pipe. Threaded cover shall be used up to 100 mm size & above shall be GI flanged type with GI nuts & bolts. PVC cover shall be used for PVC drainage piping only, whereas nickel bronze & GI flanged type cover shall be used for HDPE / CI / CI LA pipe work.

d) Cockroach Traps

Floor/ urinal traps shall sealed cover provided with 100-150mm square or round stainless steel cockroach trap assembly complete with ring, outer cup, inner cup, jali etc. of an approved make.

e) Wire Balloons / Grating For Rain Water Pipes

The wire balloons and the domical gratings shall conform to IS: 1729. The wire balloons shall be of galvanised steel. The CI domical gratings for the roof outlet shall be minimum 13mm thick.

Leaf and Gravel grates along with a perforated ring shall be made out of M.S. flat/bars of a design and dimension as shown in the drawing or as directed by the Engineer-in-Charge. These shall be painted with epoxy paint with a DFT of 200 microns.

Wire balloons/gratings for rainwater pipes shall be measured by numbers for different sizes. Leaf and gravel grates along with the perforated ring shall be measured in kgs.

6.8 RAINWATER PIPES

All rainwater pipes shall be of UPVC as shown in drawing & specified in specification. UPVC piping shall conform to IS: 13592 g or as specified in the schedule of quantities.

6.9 RAIN WATER OUTLET

a) Rain water out shall be preferably scupper type drain with cast iron body & cast aluminium grating with stainless steel screws. Suitable adopter / connector shall be used to match the pipe. Wherever shafts are not available near rain water outlet, dome type rain water outlet shall be installed.

b) Rain water outlet shall be tested for water leaking, prior to waterproofing treatment. Extreme care shall be taken, while sealing gap between rain water outlet & wall / slab.

6.10 CLAMPS

Wherever MS/GI clamps are required to be anchored directly to brick walls, concrete slabs, beams or columns, nothing extra shall be payable for clamping arrangement, RCC block and making good with cement concrete 1:2:4 mix (1 cement:2 sand:4stone aggregate 20mm nominal size) as directed by the Engineer-in-Charge.

6.11 ANGELS / CHANNELS

Slotted angles/ channels shall be measured per linear metre of finished length and shall include support bolts and nuts, length embedded in the cement concrete blocks of 1:2:4 (1cement: 2 coarse sand: 4 stone aggregate 20mm nominal size) formed in the masonry

walls; nothing extra shall be paid for the cement concrete block and making good the masonry wall, anchor fasteners etc. complete.

6.12 INSTALLATION OF SOIL, WASTE & VENT PIPES

All Horizontal pipes running below the slab and along the ceiling shall be fixed on structural adjustable clamps, sturdy hangers of the design as called for in the drawings. The pipes shall be laid in uniform slope and proper levels. All vertical pipes shall be truly vertical fixed by means of stout clamps in two sections, bolted together, built into the walls, wedged and neatly jointed. The branch pipes shall be connected to the stack at the same angle as that of fittings. All connections between soil, waste and ventilating pipes and branch pipes shall be made by using pipe fittings with inspection doors for cleaning. Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts. Where the horizontal run off the pipe is long or where the pipes cross over building expansion joints etc. suitable allowance shall be provided for any movements in the pipes by means of expansion joint etc. such that any such movement does not damage the installation in any way.

Before joining, the interior of the socket and exterior of the spigots shall be thoroughly cleaned and dried. The spigot end shall be inserted into the socket right up to the back of the socket and carefully centered by two or three laps of threaded spun yarn, twisted into ropes of uniform thickness, well caulked into the back of the socket. No piece of yarn shall be shorter than the circumference of the pipe. The jointed pipe line shall be at required levels and alignment. The reminder of the socket is left for the lead caulking. Where the gasket has been tightly held, a jointing ring shall be placed round the barrel against the face of the socket. Molten Lead shall be poured to the remainder of the socket.

The joint shall not be covered till the pipeline has been tested under pressure. Rest of pipeline shall be covered so as to prevent the expansion and contraction due to variation in temperature.

Rainwater Pipes

All open terraces shall be drained by rainwater down takes.

Rainwater down takes are separate and independent of the soil and waste system and will discharge to rainwater harvesting tank and excess rainwater will be diverted to the external stormwater drain.

7 WATER SUPPLY SYSTEM

7.1 SCOPE OF WORK

The scope shall include supply, installation, testing, commissioning and satisfactory handing over of the complete water supply system to client as per drawings, specifications and schedule of quantities. The water supply system shall inter-alia include the following:

a) Distribution system from main supply or overhead tank to all fixtures and appliances for cold water.

b) Pipe protection and painting.

c) Control valves, masonry chambers and other appurtenances.

d) Connections to all plumbing fixtures, tanks, appliances and municipal mains

e) Inserts, nozzles for R.C.C. tanks

The term water supply is used as indicative of all water supply work required and necessary for the building including such external work as may be necessary to make the system functional.

The scope of this section comprises the supply, installation, testing and commissioning of piping network for water supply for internal & external services as follows:

a. Tapping from available main sourcel /Tanker water supply/

b. Domestic water supply.

c. Flushing water supply

The contractor shall make all necessary application and arrangements for his work to be inspected by the Local Authorities.

The contractor shall be solely responsible for obtaining the Authorities approval of his works prior to the handing over of the complete water supply / distribution installation to the owner.

7.2 GENERAL REQUIREMENTS

7.2.1 If necessary and if approved by the Engineer-in-Charge, where unavoidable, bends may be formed by means of a hydraulic pipe bending machine for pipes up to 20mm dia. No bending shall be done for pipes of 25mm diameter and above. After bending zinc rich paint shall be applied wherever the zinc coating is damaged.

7.2.2 Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs. Valves shall be located at a height not exceeding 1.6m above their operating floor/ platform level. Where such a provision is not possible and the valve is to be frequently operated a MS chain shall be provided for its operation.

7.3 GI PIPES, FITTINGS AND VALVES

7.3.1 All pipes inside the buildings and where specified, outside the building shall be M.S. galvanized steel tubes conforming to IS: 1239 of Class specified. When Class is not specified they shall be Heavy Class. All embedded / concealed pipes shall be of heavy duty.

7.3.2 Fittings shall be of malleable cast iron galvanized, of approved make. Each fitting shall have manufacturer's trade mark stamped on it. Fittings

for GI pipes shall include couplings, bends, tees, reducers, nipples, unions, bushes etc. Fittings etc. shall conform to IS: 1879.

7.3.3 Pipes and fittings shall be jointed with screwed joints using Teflon tape suitable for water pipes. Care shall be taken to remove burr from the end of the pipe after cutting by a round file. All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets. Necessary vents and drains shall be provided at all high and low points respectively. GI pipes inside toilets shall be fixed in wall chases well above the floor. No pipes shall be run inside a sunken floor as far as possible. Pipes may be run under the ceiling or floors and other areas as shown on drawings. All pipe joints after testing of the line shall be seal welded and the weld plus the adjoining portion shall be given two coats of zinc rich primer.

7.3.4 Bib cocks and stop cocks

All bib cocks and stop cocks shall be of C.P. brass conforming to IS: 781 of tested quality and approved make and design, of diameter as specified in schedule of quantities.

7.3.5 Clamps

GI pipes in shafts and other locations shall be supported by GI clamps of design approved by the Engineer-in-Charge. Pipes in wall chases shall be anchored by iron hooks. Pipes at ceiling level shall be supported on structural clamps fabricated from MS structural's as described in Clause **Error! Reference source not found.**. Pipes in shafts shall be supported on slotted angles/ channels as specified/ as directed.

7.3.6 Unions

Contractor shall provide adequate number of unions on all pipes to enable easy dismantling later when required. Unions shall be provided near each gunmetal valve, stop cock or check valve and on straight runs as necessary at appropriate locations as required for easy dismantling and/ or as directed by the Engineer-in-Charge.

7.3.7 Flanges

Flanged connections shall be provided on pipes as required for maintenance/ ease in dismantling or where shown on the drawings, all equipment connections as necessary and required or as directed by the Engineer-in-Charge. Connections shall be made by the correct number and size of the GI nuts/ bolts as per relevant IS Standards and made with 3mm thick insertion rubber washer/gasket. Where hot water or steam connections are made insertion gasket shall be of suitable high temperature grade and quality approved by the Engineer-in-Charge. Bolt hole dia for flanges shall conform to match the specification for CI sluice valve as per IS: 780. Gaskets shall conform to IS: 11149.

7.3.8 Trenches

All GI/PVC/HDPE pipes running below ground shall have minimum cover of 600mm.

7.3.9 Excavation to be taken to proper depth

Excavation shall be done in all conditions of soil and to such a depth that the sewers / or other pipes shall rest as described in the several clauses relating thereto and so that the inverts may be at the levels given on the section. Should the contractor excavate the trench to a greater depth than is required the extra depth shall have to be filled up with concrete at the contractor's own cost to the requirements and satisfaction of the client / consultants.

7.3.10 Back filling (IS: 12288 – 19S87)

After the sewer or other piping work has been laid and proved to be water-tight, the trench or other excavation shall be refilled. Utmost care shall be taken in doing this so that no damage is caused to the sewer and other permanent works.

7.3.11 Painting

a) All pipes above ground shall be painted with one coat of red lead and two coats of synthetic enamel paint of approved shade and quality to give an even shade, or as specified by the Engineer-in-Charge.

b) Hot water pipes in the chase:

All hot water pipes fixed in wall chase shall be properly insulated by elastomeric tape as per manufacturer's recommendation.

7.3.12 Pipe protection

Where specified, pipes below the floor or below ground shall be protected against corrosion by the application of two or more coats of solvent-based rubberized asphaltic primer to give a uniform coat covered with 'Pipe coat Hiper', a puncture resistant non woven polyester mat. The application of pipe coat primer and "Hiper" membrane shall be as specified by the manufacturer.

7.4 VALVES & FITTINGS

7.4.1 Sluice Valves

Unless otherwise specified all valves 200 mm Dia. and above shall be CI double flanged sluice valves with non rising spindle. Sluice valves shall be provided with the wheel when they are in exposed positions and with a cap top when they are located underground. Contractor shall provide suitable operating keys for sluice valves with cap tops.

Sluice valves shall be of approved makes conforming to IS: 780 of Class as specified.

7.4.2 Butterfly Valves

Where specified, Valves 80 mm Dia. and above shall be Cast steel or cast iron butterfly valve to be used for isolation and/ or flow regulation as directed by the Engineer. The valves shall be tight shutoff/ regulatory type with a resilient seat suitable for flow in either direction and seal in both directions.

Butterfly valve shall conform to IS: 13095.

7.4.3 Non-Return Valve

Where specified nonreturn valve (swing check type) shall be provided through which flow can occur in one direction only. It shall be single door swing check type of best quality conforming to IS: 5312.

7.4.4 Forged Brass Ball Valve

(a) Valves of size 50 mm Dia. and below shall be full bore quarter turn lever operated female threaded forged brass hard chrome plated ball valves conforming to IS: 554. Valve shall have PTFE body seat rings and gland packing, forged brass ball, stem and bonnet, carbon steel nut washer and lever and finished in chrome. Valves shall have the minimum working pressure of 16 bars. Valves shall be tested at manufacturer's works and the same stamped on it.

7.4.5 Air Release Valve (ARV)

(a) Pressurized water supply lines shall be provided with air release valve at the highest point to release accumulated air for piping system. Air release valve shall be automatic float operated; the diameter shall be as specified in the Schedule of Quantities. Air release valve shall be provided with ball valve for ease in Operation and Maintenance. Valve body shall be in cast iron stainless steel, brass and EPDM internal components. Valves shall have the minimum working pressure of 10 Kegs.

7.4.6 Ball float valve

Ball valves with Heavy duty float to be fixed in storage tanks as shown in the drawing and shall consist of cast brass lever arm having copper balls (26 SWG) screwed to the arm integrally. The copper ball shall have bronze welded seams. The closing/opening mechanism incorporating the piston and cylinder shall be non-corrosive metal and include washers. The size and construction of ball valves and float shall be suitable for desired working pressure operating the supply system.

7.4.7 TESTING

(a) All pipes, fittings, and valves shall be tested in accordance with IS: 2065 except as may be modified hereinunder. All pipes, fittings, and valves, after fixing at the site, shall be tested to a hydrostatic pressure of 10 kg/cm2 or 1.5 times the shut-off head of the pump whichever is greater.

(b) The test pressure shall be maintained for a period of at least thirty minutes without any drop in pressure.

(c) A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and the Engineer.

(d) After commissioning of the Water Supply System, the Contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently and effectively. Valves which do not operate efficiently and effectively

shall be replaced by new ones at no extra cost and the same shall be tested as above.

(e) All pipes in wall chase or meant to be encased or buried shall be hydro tested before the chase is plastered or the pipe encased or buried.

7.5 PRESSURE REDUCING VALVE SET

Each pressure reducing valve set shall be complete with pressure reducing or pressure regulating valve, isolating valves, pressure gauges on inlet and outlet, pressure relief valve on outlet and filter on the inlet.

Each pressure reducing valve shall contain loading neoprene diaphragm and a full floating, self-aligning, ignition resistant seat and shall be of the single stage, pressure reduction type with provision for manually adjusting the delivery pressure. The valve shall fail safe to the low pressure.

Valves shall be capable of operating at the maintaining automatically the respective delivery pressure and flow rates as indicated and shall not be liable to creep. Valves shall also be capable of maintaining the pre-set downstream pressure under static condition.

The filter on each inlet to a pressure reducing valve shall be of a replaceable porous sintered metal type.

(a) Pressure reducing valves are used to lower pipeline pressure to a predetermined set point. Pressure reducing valves protect installations against excessive pressure from the supply.

(b) Pressure reducing valves automatically controls downstream pressure, from no flow to full open flow, without regard to changes in inlet pressure. Outlet pressure control is smooth and precise since the friction and hysteresis of the valve and pilot are negligible.

(c) Because the valve will not chatter or slam under low flow conditions, it is not necessary to parallel pressure reducing valves with a second smaller size control valve to obtain accurate pressure control at low flow rates. In any size, pressure reducing valves will control pressure right down to shut off.

(d) Spring loaded pressure reducing valves operate by means of a force equalizing system. The force of a diaphragm operates against the force of an adjustment spring. If the outlet pressure and therefore diaphragm force fall because water is drawn, the then greater force of the spring causes the valve to open. The outlet pressure then increases until the forces between the diaphragm and the spring are equal again. The inlet pressure has no influence in either opening or closing of the valve. Because of this, inlet pressure fluctuation does not influence the outlet pressure, thus providing inlet pressure balancing.

7.6 PRESSURE RELIEF VALVES

Each pressure relief valve shall be of the fully enclosed type and fitted with hand easing gear.

Each pressure relief valve in a pressure reducing station shall have a flow capacity equal to that of the pressure reducing valve. PRV shall be of Brass.

Pressure relief valves in locations other than reducing stations shall have flow capacities equal to that of the associated equipment.

7.7 LEVEL CONTROLLED SOLENOID VALVES

A solenoid valve is an electromechanically operated valve. The valve is controlled by an electric current through a solenoid: in the case of a two-port valve the flow is switched on or off; in the case of a three-port valve, the outflow is switched between the two outlet ports.

Level sensor based solenoid valve will be installed at terrace level for automatic operation of the water transfer pump set.

7.8 UNDERGROUND / OVERHEAD STORAGE TANKS

7.8.1 Storage tanks for water supply shall be in RCC.

7.8.2 Each tank shall be provided with lockable type manhole cover fabricated from MS sheet or standard cast iron tank covers. Manhole covers shall be of an appropriate size as directed by the Engineer-in-Charge.

7.8.3 Each storage tank shall be provided with high and low-level annunciation by means of magnetic level switches.

7.8.4 One solid state electronic annunciation panel fully wired with a visual display and audible alarm unit shall be provided to indicate the following:

- High and low-level alarms for each water storage tank.
- On/ off status of all Pump sets namely domestic

7.8.5 All the necessary arrangements for fixing the panel shall be provided by the Contractor.

7.8.6 All the cabling from the respective level switches to the Annunciation Panel, MCC Switchgear to Annunciation Panel, including power supply from MCC shall be provided by the Contractor.

7.8.7 The number of outgoing terminals shall be equal to the number of incoming terminals from field/ MCC with 20% margin, so that necessary interconnection to BMS could be done at a later date.

7.9 TESTING

7.9.1 All pipes, fittings and valves shall be tested in accordance with IS: 2065 except as may be modified herein under. All pipes, fittings and valves, after fixing at site, shall be tested to a hydrostatic pressure of 10 kg/cm^2 or 1.5 times the shut off head of the pump whichever is greater.

7.9.2 The test pressure shall be maintained for a period of at least thirty minutes without any drop in pressure.

7.9.3 A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and the Engineer-in-Charge.

7.9.4 After commissioning of the water supply system, the Contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently and effectively. Valves which do not operate efficiently and effectively shall be replaced by new ones at no extra cost and the same shall be tested as above.

7.9.5 All pipes in wall chase or meant to be encased or buried shall be hydro tested before the chase is plastered or the pipe encased or buried.

7.10 INSULATION

7.10.1 All open hot water flow and return pipes shall be insulated with preformed fibrous pipe sections conforming to IS: 9842.

7.10.2 Insulation to pipes shall be with pre-molded pipe sections, the thickness for sections shall be:

a) Pipe 50mm diameter and below - 25mm thick

b) Pipe 65mm diameter and above - 40mm thick

7.10.3 Application:

a) All surfaces shall be thoroughly cleaned with a wire brush.

b) One layer of approved primer shall be applied and pre-molded pipe insulation sections shall be fixed.

c) One layer of aluminum foil of thickness 0.711mm (20 SWG), shall be applied as a finish layer.

7.10.4 Insulation for hot water pipes in the chase:

All hot water pipes in chase shall be insulated with 3 mm elastomeric tape as per manufacturer's recommendations.

7.11 CONNECTION TO RCC WATER TANKS (PUDDLE FLANGE)

The contractor shall provide all inlets, outlets, washouts, vents, ballcocks, overflows control valves and all such other piping connections including a level indicator to water storage tanks as called for. All pipes crossing through RCC work shall have puddle

flanges fabricated from GI pipes of required size and length and welded to 6/8 mm thick MS plate. All puddle flanges must be fixed in true alignment and level to ensure further connection in proper order.

Full way gate valves of an approved make shall be provided as near the tank as practicable on every outlet pipe from the storage tank except the overflow pipe. Overflow and vent pipes shall terminate with mosquito proof grating with the bronze screen on vent.

The overflow pipe shall be so placed to allow the discharge of water is readily seen. The overflow pipe shall be of a size as indicated. A stop valve shall also be provided in the inlet water connection to the tank. The outlet pipes shall be fixed approximately 75mm above the bottom of the tank towards which the floor of the tank is sloping to enable the tank to be emptied for cleaning.

The floor and the walls of the tank shall be tiled with glazed tiles up to the overflow level. Alternatively, food grade epoxy to be applied.

7.12 WATER METERS

Water meters of approved make and design shall be supplied for installation at locations as shown. The water meters shall meet with the approval of local supply authorities. Suitable valves and chambers or wall meter box to house the meters shall also be provided along with the meters.

The meters shall conform to Indian Standard IS: 779 and IS: 2373. Calibration certificate shall be obtained and submitted for each water meter.

Provision shall also be made to lock the water meter. The provision shall be such that the lock is conveniently operated from the top. Where the provision is designed for use in conjunction with padlocks, the hole provided for padlocks shall be a diameter not less than 4mm.

(Note: The water meters to be installed at every use of water such as Landscape irrigation, Domestic, Flushing, Firefighting etc.)

7.13 LEVEL SENSORS

Level sensor shall consist of the control unit, preamplifier and one full insulated probe-mounted vertically or two-part insulated probe mounted from tanks side wall adjustable switching system for pump control application, the same to be housed in stove enamel painted cast aluminum weatherproof suitable for black panel/wall mounting etc.,

The enclosure of probes shall be manufactured with the SS316 material. The least count of the central unit with amplifier should be +/- 0.10mm for response value of 30 seconds.

7.14 LEVEL INDICATORS

A level control system with electronic level probes is mounted on the face of the reservoir. The top two level sensors provide the ON-OFF signal for the treated water transfer pumps. A third level sensor enunciates a low-level alarm condition to the paging

system and a fourth sensor enunciates an alarm to the paging system and stops the domestic water pumps from operating.

7.15 INSULATION

The insulation for hot water pipes shall be done as specified in Bill of Quantities and accordingly following guidelines shall be followed:

7.16 PAINTING / PIPE PROTECTION / INSULATION

Unless otherwise specified painting/ pipe protection/ insulation for pipes shall be measured and paid for separately. These shall be measured per linear meter along the center line of the pipe, over the finished surface and shall include all valves and fittings for which no deduction shall be made.

7.17 AIR RELEASE VALVES

Air release valve shall be installed as per specifications provided in BOQ.

Table Commonly Adopted Size of Air Valves

Size of Main mm	Type of Valve	Size of Air Valve mm
80	Single air valve	20
100	Double air valve	40
125-200	Double air valve	50
250-350	Double air valve	80
400-500	Double air valve	100
600-900	Double air valve	150
1000-1200	Double air valve	200

a) Air release valves shall be single acting type air valves with cast iron body and bronze/gunmetal internal parts and plastic float.

b) Each air release valve shall be provided with a cast iron isolating sluice valve specification given above.

7.18 MEASUREMENT AND RATES

Not Used

7.19 PUMPS FOR WATER SUPPLY & STROM DRAINAGE SYSTEM

(a) Hydro-pneumatic Pumps for domestic and flushing water supply (transfer pumps)

Pumps shall be vertical, centrifugal, multistage directly coupled to the motor. Provision of the pump with pump head & base of cast iron, Shaft of SS-316 and other parts in SS 304 shall be made for pumps required in Hydropneumatic System. Impeller shall be hydraulically balanced and keyed to shaft. Pump shall be mounted on a concrete foundation, projecting at least 15 CM above finished floor level. The pumps base shall be set on a vibration elimination pad. The pump shall be lubricated in strict accordance with the manufacturer's instructions and shall be factory aligned prior to shipment. All motors and bases shall be painted with approved finish shop coat of paint. The pump shall be selected for the lowest operating noise level and shall be complete with flexible connections, valves, and pressure gauges. The pumps shall include the cost of foundation channel complete.

The Contractor shall supply and install pumps of the type and performance as shown in the drawings. All duties of pumps given in the Tender Drawings shall be checked and where necessary corrected before ordering. All the parts of the pumps that are in contact with water e.g. shaft, impeller etc. shall be of stainless steel construction.

Pumps shall be so selected that the design duty point is within 5% of the maximum efficiency point. The pump casing so selected shall have ample space to take an impeller one size larger than that capable of performing the design duty.

The pump shall have a speed of not more than 2900 rpm with high efficiency and low noise motor can be selected and noise data submitted for approval. All pumps and motors shall be of minimum vibration and noise level during operation. Vibration isolators shall be provided for all pump sets.

Facilities shall be provided to prevent starting of pumps when the water tank is at low water level. An indicator for this low water level alarm shall be provided.

Facilities to select which pump to be duty pump and standby pump shall be provided and will be interchangeable.

Leakage from pump gland shall be drained to the nearest floor waste.

Pump curves for all pumps offered shall be submitted. All curve indicating excessive shut-off head will not be approved.

Each pump shall be provided with a gate valve at suction and discharge, approved check valve at discharge, approved strainer at suction, flexible connections at pump suction and discharge, eccentric reducer at suction, concentric reducer at discharge, pressure gauges at suction and discharge, circulation relief valve and automatic air relief valve.

Appropriate neoprene vibration isolation mountings shall be provided for each pump sets.

(b) Vertical Multi-Stage Pumps

Multi-stage pumps shall be of a centrifugal type and arranged with shafts vertically installed. The impellers shall be of stainless steel mechanically balanced and keyed to shaft.

Pumps shall be driven by elevated in-line TEFC squirrel cage motors via extended vertical shafted complete with rigid universal couplings.

The shafts shall be stainless steel. Stainless steel diffuser shall be provided to protect the shaft in the water space and through the mechanical sealing.

The bearings shall be of the ball or roller type protected against ingress of water, dirt and other matter.

Vertical multistage pumps shall have universal flanges. Intermediate bearing, support bearing shall be provided in the pump.

The shaft seal shall be easily serviceable and shall allow for correct adjustment and loading of the seal. Pump motors above 7.5 KW shall be equipped with a spacer coupling which allows changing of shaft seals without removing the motor. The pump motors shall be of Class “F” insulation and IP55 rating and shall be provided with built-in thermostats for protection against overheating.

. The hydropneumatic pumping units shall have the following features;

System Description

The system shall be supplied as complete sets including suction and discharge common manifolds, non-return valves, isolating valves, pressure transmitter on the discharge side and flow sensor levels at the suction tank.

The closed diaphragm pressure vessel shall be of polyethylene material with a pressure gauge and isolating valve. The interior shall be of non-toxic lining suitable for use with potable water. The vessel shall be manufactured to conform to ASME pressure vessel code/standards.

The system shall be under the control of PLC.

A pressure transmitter shall detect the pressure at the delivery manifold and feedback to the microprocessor control panel via a control circuit.

(c) Vertical Submersible Pumps

Pump

a) The pump shall conform to IS 8034: 2000 amended up to date.

b) The pump shall be submersible bore well type directly coupled to submersible electric motor with built in anti thrust bearing. The pump set shall be complete with suction strainer, anti-thrust streamlined non return valve and submersible type copper conductor cable of suitable size.

c) Inlet passage of the suction casing shall be designed reduce entry losses and strainer shall be provided in suction casing to restrain large solids entering the pump. For submersible type cables, clamping arrangement and cable guard shall be provided on pump casing.

d) Each metallic impeller shall be dynamically balanced to Grade G 6.3 of IS 11723.

e) The pump characteristic shall be non overloading type to ensure trouble free operation in the entire operating range.

Electric Motor

a) The submersible motor shall conform to IS 9283. The electric motor shall be three phase squirrel cage, water filled submersible type.

b) The motor shall be suitable for operation on 415V (3 phase), 50 Hz electric supply with required RPM capable of delivering the rated output with

i) The terminal voltage differing from its rated value by not more than +6% and -15%

ii) The frequency differing from its rated value by not more than 3% or

iii) Any combination of b) and ii).

c) Motor shall be capable of running continuously at a B. H. P. (brake horse power) not less than 10% in excess of that absorbed by pump set under any operating conditions.

d) Starting current for the motor shall be limited to 6 times the full load current.

e) Motor shall have minimum starting torque of 140% FLT and maximum starting torque 200% FLT. It shall have 100% FLT during running condition.

f) Contractor shall submit the motor details including manufacturer's guarantee for efficiency and P.F. at full load, no load, 3/4 load, 1/2 load.

Material of Construction

The material of construction shall be suitable for application and site conditions. The material of construction shall be as follows:

Sr.	Component	Material of Construction
1.	Pump bowl	High graded CI
2.	Impeller	Bronze Gr LTB2 / 20% Glass filled Noryl
3.	Diffuser	20% Glass filled Noryl
4.	Stage casing	High graded CI

Sr.	Component	Material of Construction
5.	Motor casing	SS 304
6.	Pump shaft	SS 410
7.	Motor shaft	SS 410
8.	Bearing bush	Bronze IS 318 Gr LTB 2,3,4,5
9.	Base	Cast iron / Brass
10.	Fasteners	SS 304
	Strainers	SS 304

Testing

Each pump-motor set shall be factory tested at manufacturer's works as per I.S. 8034 to determine following characteristics covering the full operating range.

-Head- Discharge curve

-Efficiency curve

-Dynamic balancing of rotor, impeller

Certificates

Contractor shall furnish:

- Performance characteristic curves.
- Catalogue of pump set and details of pump and its motor.
- Manufacturing test certificate, Guarantee card and list of parts for the pump sets.
- Operation and maintenance manuals for the pump set.
- Drawings showing cross sections of pumps, mounting arrangements, list of materials and necessary curves along with their offer.
- In the event of any pump failing to meet the specified requirement of pump set it shall be modified and retested until the requirements are fulfilled. The inspections and testing of the pump set are at contractors cost.

8.0 DI PIPES AND SPECIALS

The pipes shall be of centrifugally cast (spun) Ductile Iron pipes K-7 & K-9 class with internal cement motor lining confirming to IS 8329: 2000. The pipes shall be of push on joint type (Rubber Gasket Joints). The flange connection shall be used only in case of fitting of specials or under special circumstances as directed by Engineer in Charge.

The pipes shall be coated with zinc coating and finishing layer shall be of bitumen and have factory provided internal cement mortar lining as per the provisions of IS 8329: 2000 the mortar thickness shall be minimum 5 mm as per Table 15 of the code. The tolerances

for pipes and fittings regarding dimensions, mass, ovality and deviations from straight line in case of pipes shall be as per IS 8329/IS 9523.

The pipes shall be supplied in standard length of 5.50 and 6.00 meters length with suitably rounded or chamfered ends. Each pipe of the push on joint variety shall also be supplied with a rubber EPDM/ (SBR) gasket. The flanged joints shall confirm to Clause 6.2 of IS: 8329.The pipe supply shall include one rubber gaskets for each flange. Any change in the stipulated lengths will be approved by the Engineer- in -Charge. The gaskets shall conform to IS 5382:1985. The gaskets shall also be supplied by the contractor. They shall preferably be manufactured by the manufacturer of the pipes. In case they are not, it shall be the responsibility of the contractor to have them manufactured from a suitable manufacturer under his own supervision and have it tested at his / sub contractors premises as per the instruction and to the satisfaction of the Engineer- in -Charge. The pipe contractor shall however be responsible for the compatibility and quality of the products. The flanged joints shall conform to Clause 6.2 of IS 8329.

Inspection and Testing of pipes during manufacture

Mechanical Tests

Mechanical tests shall be carried out during manufacture of pipes and fittings as specified in IS: 8329 / IS: 9523. The frequency and sampling of tests for each batch of pipes shall be in accordance with IS: 8329. The method for tensile tests and the minimum tensile strength requirement for pipes and fittings shall be as per IS: 8329/IS: 9523.

Brinell Hardness Test

For checking the Brinell hardness, the pipes used for the ring test and tensile test shall comply with the requirements specified in IS: 1500/IS: 8329.

Retests

If any test piece representing a lot fails in the first instance, two additional tests shall be made on test pieces selected from two other pipes from the same lot. If both the test results satisfy the specified requirements, the lot shall be accepted. Should either of these additional test pieces fail to pass the test, the lot shall be liable for rejection.

Hydrostatic Test

For hydrostatic test at works, the pipes and fittings shall be kept under test pressure as specified in IS: 8329 / IS: 9523 for a period of minimum 15 seconds, during which the pipes shall be struck moderately with a 700 g hammer for confirmation of satisfactory sound. They shall withstand the pressure test without showing any leakage, sweating or other defect of any kind. The hydrostatic test shall be conducted before surface coating and lining.

The pipes shall be subjected to following tests for acceptance:

- Visual and dimensional check as per Clause 13 and 15 of IS 8329

- Mechanical Test as per Clause 10 of IS 8329
- Hydrostatic Test as per Clause 11 of IS 8329
- The test report for the rubber gaskets shall be as per acceptance tests of IS 5832 and will be in accordance to Clause 3.8. The sampling shall be as per the provisions of the IS 8329.

Markings

All pipes will be marked as per Clause 18 of IS 8329 along with the requisite information as provided below:

Manufacturer name / stamp

Nominal diameter

Class reference

A white ring line showing length of insertion at spigot end

Employers mark as “” “IITGNL"

Coatings

Pipe shall be supplied internally (cement mortar lining) and externally with Zinc coating along with a finishing layer of bituminous coating as per IS 8329:2000. The materials and finishing shall be as per the relevant specifications.

Joints

General

Jointing of DI pipes and fittings shall be done as per IS 12288 and manufacturer’s recommendations. Rubber sealing rings/gaskets used for jointing shall conform to IS 638, IS 12820 and IS 5382.

Spigot and Socket joints

These shall have sockets which are integral with the pipe and incorporate an elastomeric rubber ring gasket conforming to IS 12820. The gaskets/sealant used for joints shall be suitable for water conveyance. The material of rubber gaskets for use with mechanical joints and push-on-joints shall conform to IS: 5382.

Flanged Joints

These shall be of 10 bar rating and shall comply with dimensions and drilling details as specified in IS 8329. These shall have isolation gaskets between the flanges, isolation sleeves around all bolts and isolation washers under all bolt heads and nuts. The bolts shall be of mild steel unless otherwise specified. They shall be coated with cal tar epoxy coating after tightening.

Slip on Type Couplings

Slip-on type couplings shall include the following couplings:

straight flexible couplings

stepped flexible couplings

Slip-on type couplings shall be procured from approved suppliers whose fittings meet the same Specification. The preparation of pipe ends for slip-on type couplings shall be in accordance with the requirements and the tolerances specified by the joint manufacturer. Couplings shall be installed fully in accordance with the manufacturer's recommendations.

Slip-on type couplings shall be protected if buried with Densomastic and Densotape wrapping or similar approved material applied in accordance with the manufacturer's recommendations. Flexible joints shall be harnessed or tied where shown on the Drawings. Flexible couplings shall be supplied with transit protection.

Specials and fittings

All DI specials and fittings shall be manufactured and tested in accordance with IS: 9523 or BS: 4772. All DI fittings shall be supplied with one rubber ring gasket for each socket. The rubber ring shall conform to IS: 12820 and IS: 5382. Flanged fittings shall be supplied with one rubber gasket per flange along with the required number of nuts and bolts.

Lubricant for Pipes and specials

Lubricant for the assembly of Ductile Iron pipes and specials suitable for Tyton push-on rubber ring joints shall confirm to IS 9523.

DI Pipe handling, Laying, jointing, testing and commissioning

- Laying of DI pipes shall conform to IS: 12288. All pipes, fittings and material shall be tested and approved by the Engineer- in -Charge before being laid. Polyethylene sleeves wound pipes shall be used for water logged areas as directed by the Engineer- in -Charge.
- The transportation and handling of pipes shall be made as per IS 12288.
- Cranes or chain pulley block or other suitable handling and lifting equipment shall be used for loading and un-loading of heavy pipes. However, for pipes up to 400 mm nominal bore, skid timbers and ropes may be used. When using crane hooks at sockets and spigot ends; hooks shall be broad and protected by rubber or similar material, in order to avoid damage to pipe ends and lining. Damage to lining must be repaired before pipe laying according to the instructions of the pipe manufacturer. the trench must not be refilled before laying of the pipes
- All specials like bends, tees etc. and appurtenances like sluice or butterfly valves etc. shall be laid in synchronization with the pipes. No pipe shall be laid in wet trench conditions. On gradients of 1:15 or steeper, precautions should be taken to ensure that the spigot of the pipe laid does not move into or out of the socket of the laid pipe during the jointing operations. The designed anchorage shall be provided to resist the thrusts developed by internal pressure at bends, tees, etc.

- Where a pipeline crosses a watercourse, the design and method of construction should take into account the characteristics of the watercourse to ascertain the nature of bed, scour levels, maximum velocities, high flood levels, seasonal variation, etc. which affect the design and laying of pipeline. The assembly of the pipes shall be made as recommended by the pipe manufacturer using suitable tools.

Pipe testing and commissioning

The pipeline shall be tested for tightness of barrels and joints, and stability of thrust blocks in sections. Preferably the pipeline stretches to be tested shall be between two chambers (air valve, scour valve, bifurcation, other chamber). Contractor shall test stretches not exceeding 1 km. After successful organization and execution of tests the length may be extended to more than 2 km after approval of the Engineer- in -Charge.

The water required for testing shall be arranged by the contractor himself. The Contractor shall fill the pipe and compensate the leakage during testing. Complete setting of the thrust blocks. Water used for testing should not be carelessly disposed off on land which would ultimately find its way to trenches. The testing conditions for the pipelines shall be as per the test pressures and condition laid out in IS 8329 for DI pipes.

The testing conditions for the pipelines are summarized as follows:

Maximum hydrostatic test pressure for DI K-7 / K9 pipes shall be 2.0 times of maximum design pressure in the pipeline.

Pre test and saturation period with addition of make-up water

Pressure: Test pressure

Duration: 3 hrs for DI pipes without cement mortar lining / 24 hrs for DI pipes with cement mortar lining

Pressure test with addition of make-up water

Pressure: Test pressure

Duration: 3 hrs

Test criteria for DI pipes: Q=1 litre / km per 10mm of pipe per 30 m test pressure per 24 hrs.

All pressure testing at site should be carried out hydrostatically. The pipes shall be accepted to have passed the pressure test satisfactorily, if the quantity of water required to restore the test pressure does not exceed the amount 'Q', calculated by the above formula. All pipes or joints which are proved to be in any way defective shall be replaced or remade and re-tested as often as may be necessary until a satisfactory test have been obtained.

9.0 PIPE LAYING

Excavation

The trench excavation of pipe line shall be in accordance with IS 12288. Pipe trenches shall be excavated to the lines and levels shown on the drawings or as directed by the Engineer. The depth of the excavated trench depth should be sufficient to provide a cover not less than 1000 mm or as directed by the Engineer. It may be necessary to increase the depth of pipeline to avoid land drains or in the vicinity of roads, railways or other crossings. The width of the trench at bottom between the faces of sheeting shall be such as to provide 200 mm clearance on either side of the DI / PE pipe except where rock excavation is involved. No pipe shall be laid in a trench until the section of trench in which the pipe is to be laid has been approved by the Engineer.

The bottom of the trench shall be trimmed and levelled to permit even bedding of the pipes. It should be free from all extraneous matter which may damage the pipe or the pipe coating. Additional excavation shall be made at the joints of the pipes, so that the pipe is supported along its entire length.

To protect persons from injury and to avoid damage to property, adequate barricades, construction signs, red lanterns and guards as required shall be placed and maintained during the progress of the construction work and until it is safe for the traffic to use the roadways. The relevant Indian Standards and the rules and regulations of local authorities in regards to safety provisions shall be observed.

Suitable fencing shall be provided along the sides of trenches and pits. The posts of fencing shall be of timber securely fixed in the ground not more than 3 m apart and they shall not be less than 75 mm in diameter or less than 1.2m above surface of the ground. There shall be two rails, one near the top of the post and the other about 450mm above the ground and each shall be from 50mm to 70mm in diameter and sufficiently long to run from post to post to which they shall be bound with strong rope. The method of projecting rails beyond the post and tying them together where they meet will not be allowed on any account. All along the edges of the excavation trenches a bank of earth about 1.2 m high shall be formed where required by the Engineer for further protection.

The road metal and also the rubble packing shall first be stripped off for the whole width of the trench/pit and separately deposited in such place or places as may be determined by the Engineer.

During excavation, large stones and rubble shall be separated and removed from the excavated soil and stacked separately. The material from excavation shall be deposited on either side of the trench leaving adequate clear distance from the edges of the trench and pit, or as may be necessary to prevent the sides of the trench pit to slip or fall, or at such a distance and in such a manner as to avoid covering fire hydrants, sluice valves, manholes and covers etc. so as to avoid abutting the wall or structure or causing inconvenience to the public and other service organizations or otherwise as the Engineer may direct.

Contractor shall take into account additional excavation if any as the Engineer may require for locating the position of water pipes, drains, sewers etc. or any other works which may be met with. Such service lines if met with during excavation shall be properly maintained by Contractor, by means of shoring, strutting, planking over, padding or otherwise as the Engineer may direct, and shall be protected by the Contractor from

damage during the progress of the work. All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure / pipe line of water, gas, sewage etc.

Utmost care shall be taken to see that the width of the trench at the top of pipe is not more than the minimum requirement. In case additional width is required it shall be provided only in the top portion from the ground level upto 300 mm above the top of pipe. If any extra width is provided in the area below this portion, Contractor shall have to provide remedial measures in the form of lime concrete or rubble masonry otherwise at the discretion and to the satisfaction of the Engineer. If rock is met with, it shall be removed to 15 cm below the bottom of pipes and fittings/specials and the space resulting shall be refilled with granular materials and properly consolidated. Bottom of trenches / pits shall be saturated with water well rammed wherever the Engineer may consider it necessary to do so.

Wherever a socket or collar of pipe or fitting / special occurs, a grip is to be cut in the bottom of the trench or concrete bed to a depth of at least 75 mm below the bed of the pipe so that the pipe may have a fair bearing on its shaft and does not rest upon its socket. When welding is to be carried out with the pipes and specials in the trench, additional excavation of not more than 60cm in depth and 90 cm in length shall be made at joints in order to facilitate welding. The excess excavated material shall be carried away from site of works to a place up to a distance as directed by the Engineer. This shall be done immediately so as not to cause any inconvenience to the public or traffic.

The Contractor has to ensure the following:

Safety protections as mentioned above have to be incorporated in the work process

Hindrances to the public have to be minimised

The trench must not be eroded before the pipes are laid

The trench must not be filled with water when the pipes are laid

The trench must not be refilled before laying of the pipes

Dewatering

During the excavation, if subsoil water is met with Contractor shall provide necessary equipment and labourers for dewatering the trenches. The Contractor shall also make necessary arrangement for the disposal of drained water to nearby storm water drain or in a pit if allowed by the Engineer. In no case the water shall be allowed to spread over the adjoining area. Before discharging this water into public sewer/drain, the Contractor shall take necessary permission from the local authorities.

Special Foundation in Poor Soil

Where the bottom of the trench and sub grade is found to consist of material which is unstable to such a degree that in the opinion of the Engineer, it cannot be removed and replaced with an approved material thoroughly compacted in place to support the pipe properly, suitable foundation for the pipes, consisting of piling, timbers or other materials,

in accordance with relevant drawings be prepared by the Contractor and as instructed by the Engineer shall be constructed.

Wooden Shoring

Contractor shall suitably design polling boards, waling and struts to meet different soil conditions that might be encountered in excavating trenches / pits. The horizontal and vertical spacing of struts shall be such that not only the sides of trenches shall be prevented from collapse but also easy lowering of pipe in trenches shall be ensured without creating undue obstructions for the excavation of the work. Any inconvenience and /or delay that might be caused in lowering pipes in trenches as a result of adopting improper spacing of struts by Contractor shall be his sole responsibility. No part of shoring shall at any time be removed by Contractor without obtaining permission from the Engineer. While taking out shoring planks the hollows of any form must simultaneously be filled in with soft earth well rammed with rammers and with water.

The Engineer may order portions of shoring to be left in the trenches /pits at such places, where it is found absolutely necessary to do so to avoid any damage which may be caused to buildings, cables, gas mains, water mains, sewers etc. in close proximity of the excavation, by pulling out the shoring from the excavations. The Contractor shall not claim, on any reason whatsoever, for the shoring which may have been left in by him at his own discretion.

Steel Plate Shoring

Where the subsoil conditions are expected to be of a soft and unstable character in trench / pit excavation, the normal method of timbering may prove insufficient to avoid subsidence of the adjoining road surfaces and other services. In such circumstances, the Contractor will be required to use steel trench sheeting or sheet piling adequately supported by timber struts, waling etc., as per the instructions, manner and method directed by the Engineer. Contractor shall supply pitch, drive and subsequently remove trench sheeting or piling in accordance with other items of the Employer's Requirements.

Bedding

The trench bottom shall be even and smooth so as to provide a proper support for the pipe over its entire length, and shall be free from stones, lumps, roots and other hard objects that may injure the pipe or coating. Holes shall be dug in the trench bottom to accommodate sockets so as to ensure continuous contact between the trench and the entire pipe barrel between socket holes. In case of sandy strata no separate bedding is required. However the bottom face / trench bed where pipe shall be placed shall be compacted to provide a minimum compaction corresponding to 95% of maximum dry density. In case excavation is through rock or Black Cotton Soil, bedding should be provided to give complete contact between the bottom of the trench and the pipe. The bedding material shall be well graded sand or another granular material passing 5.6 mm sieve suitably compacted/rammed. The bedding material shall be clean, well graded and free from topsoil, clay or vegetable matter and to the approval of the Engineer. The thickness of bedding shall be a minimum of 150 mm or 0.5x(Outer dia) whichever is maximum.

Boning Staves and Sight Rails

In laying the pipes and fittings/ specials the centre for each manhole / chamber or pipeline shall be marked by a peg. Contractor shall dig holes for and set up two posts (about 100 x 100 x 1800 mm) at each manhole/chamber or junction of pipelines at nearly equal distance from the peg and at sufficient distances there from to be well clear of all intended excavation, so arranged that a sight rail when fixed at a certain level against the post shall cross the centre line of the manhole/chamber or pipe lines. The sight rail shall not in any case be more than 30 m apart; intermediate rails shall be put up if directed by the Engineer.

Boning staves of 75 mm x 50 mm size shall be prepared by Contractor in various lengths, each length being of a certain whole number of metres and with a fixed tee head and fixed intermediate cross pieces, each about 300 mm long. The top-edge of the cross piece must be fixed below the top-edge of the tee-head at a distance equal to the outside diameter of the pipe or the thickness of the concrete bed to be laid as the case may be. The top of cross pieces shall indicate different levels such as excavation for pipe line, top of concrete bed, top of the pipe etc. as the case may be.

The sight rail of size 250 mm x 40 mm shall be screwed with the top edge resting against the level marks. The center line of the pipe shall be marked on the rail and this mark shall denote also the meeting point of the center lines of any converging pipes. A line drawn from the top edge of one rail to the top edge of the next rail shall be vertically parallel with the bed of the pipe, and the depth of the bed of pipe at any intermediate point may be determined by letting down the selected boning staff until the tee head comes in the line of sight from rail to rail. The post and rails shall be perfectly square and planed smooth on all sides and edges. The rails shall be painted white on both sides, and the tee-heads and cross-piece of the boning staves shall be painted black.

For the pipes converging to a manhole/chamber at various levels, there shall be a rail fixed for every different level. When a rail comes within 0.60 M of the surface of the ground, a higher sight-rail shall be fixed for use with the rail over the next point. The posts and rails shall in no case be removed until the trench is excavated, the pipes are laid and the Engineer gives permission to proceed with the backfilling.

Laying of Pipes and Fittings/Specials

All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure / pipeline of water, gas, sewage etc. After excavation of trenches, pipes shall not be lowered unless the dimensions of trenches and bedding work for pipes at the bottom of the trenches are approved and measured by Employer / Engineer. Pipes and fittings / specials shall be carefully lowered in the trenches. Special arrangements such as cranes, tripods with chain pulley block for lowering the pipes and fittings/specials shall be made by Contractor. In no case pipes and fittings/specials shall be dropped. Slings of canvas or equally non-abrasive material of suitable width or special attachment to fit the ends of pipes and fittings / specials shall be used to lift and lower the coated pipes and fittings/specials. The pipes and fittings /specials shall be inspected for defects and be rung with a light hammer preferably while suspended to detect cracks. If doubt persists, further confirmation shall be done by

pouring a little kerosene/dye on the inside of the pipe at the suspected spot. No sign of kerosene/dye should appear on the outside surface. Pipes and fittings/specials damaged during lowering or aligning shall be rejected by the Engineer.

All the pipes are to be laid perfectly true both in alignment and to gradient specified. In case of spigot and socket pipe the socket end of the pipe shall face upstream, except when the pipeline runs uphill in which case the socket ends should face the upgrade. The laying of pipes shall always proceed upgrade of a slope. After placing a pipe in the trench, the spigot end shall be centered in the socket and the pipe forced home and aligned to required gradient. The pipes shall be secured in place with approved backfill material tamped under it except at the socket. Pipes and fittings/specials which do not allow a sufficient and uniform space for joints shall be removed and replaced with pipes and fittings/specials of proper dimensions to ensure such uniform space. Precautions shall be taken to prevent dirt from entering the jointing space. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Engineer. During the period that the plug is on, the Contractor shall take proper precautions against floating of the pipe owing to entry of water into the trench. Wherever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions or where long radius curves are permitted the deflection allowed at joints shall not exceed 2 ½0. In case of pipes, with joint to be made with loose collars, the collars shall be slipped on before the next pipe is laid. The pipes shall be laid such that the marking on pipes appears at the top of the pipes. The cutting of pipe for inserting valves, fittings, or specials shall be done in a neat and workman like manner without damage to the pipe so as to leave a smooth end at right angles to the axis of the pipe. For this purpose, pipe cutting machine shall be used.

External protection

All underground pipe work having a cover less than 1.0 m shall be encased with M 15 concrete of minimum 200 mm thick all around.

Flexibility in Pipe work

The Contractor shall provide flexibility in the pipe work at joints in the main structures and shall submit proposals for the approval of the Engineer. Flexible joints or collars and cut pipes shall be allowed on all pipe work where necessary to allow for some margin of error in the building work. Wherever possible flexible joints shall be provided with tie bolts or other means to transfer longitudinal thrusts as a whole so that external anchorages may be kept to a minimum. Flexible joints shall also be provided for case of erection and future dismantling. Particular care shall be taken to ensure that pipe work thrusts are not transmitted to machinery or associated apparatus. The Contractor shall indicate on his detailed drawings what thrust blocks are required.

Puddle Flanges

Puddle flanges shall be fitted to pipes where the structure through which they pass is required to take thrust resulting form the pipe. Puddle flanges shall also be fitted where a water barrier is required. All puddle flanges shall be clearly shown on the drawing and the resultant thrust clearly indicated. Puddle flanges shall only be fitted with the Engineer prior approval.

Support of Pipe work and Accessories

All necessary supports, saddles, slings, fixing bolts and foundation bolts shall be supplied to support the pipe work and its associated equipment in an approved manner. Valve, meters, strainers, and other devices mounted in the pipe work shall be supported independently of the pipes to which they connect. All brackets or other forms of supports, which can conveniently be so designed, shall be rigidly built up of steel by rivetting or welding in preference to the use of castings. No point of passage of pipes through floors or walls shall be used as a point of support, except with the approval of the Engineer. After the collars and boxes or other fitting have been fixed in position, the floors, walls and roof structure will be made good by the Contractor.

Thrust Blocks

Thrust Blocks shall be provided, to counteract hydraulic thrust, at places wherever directed by the Engineer.

Jointing

Jointing for pipes and fittings / specials shall be done in accordance with the relevant Employer's Requirement depending upon the type of pipes being used.

Valve chamber

Valve chambers shall be constructed according to approved drawings suitable for the respective valve. They shall be constructed in RCC. The chambers shall be constructed after the laying of the pipes and the assembly of specials and valves. The size of the chambers shall be according to the following criteria/ as per direction of Engineer.

- Minimum distance of flanges from walls : 30 cm
- Minimum distance of sockets from walls : 30 cm
- Minimum distance between highest point of equipment and roof slab : 30 cm

Pipes passing through walls should be coated by two layer of soft material (hessian felt) to allow for differential settling and longitudinal expansion if directed by Engineer. Only metallic pipes may be cast into the walls for anchoring purposes.

Testing and Commissioning

Testing and commissioning of pipes shall be done in accordance with the relevant Employer's Requirement and as per the relevant IS codes of the pipe material used.

Backfilling

Backfilling of trenches for pipes shall be commenced after the pipes have been successfully tested. The backfilling material shall be properly consolidated by watering and ramming, taking due care that no damage is caused to the pipes.

All fill material shall be subject to the Engineer's approval. If any material is rejected by the Engineer, the Contractor shall remove the same forthwith from the site. Surplus fill

material shall be deposited/disposed of as directed by Engineer after the filling work is completed.

Back fill material

To the extent available, selected surplus soils from excavations shall be used as backfill provided that it complies to IS 12288 and such material consists of loam, clay, sand, fine gravel or other materials which are suitable for backfilling. All backfill material shall be free from clods, salts, sulphates, cinders, ashes, slag, refuse, rubbish, lumps, vegetable or organic material, lumpy or frozen material, boulders, rocks or stone or other foreign material. All lumps of earth shall be broken or removed. If fill material is required to be imported, the Contractor shall make arrangements to bring such material from outside borrow pits. The material and source shall be subject to the prior approval of the Engineer.

Backfilling of Pipe Trenches

For the purpose of back filling, the depth of the trench shall be considered as divided into the following three zones from the bottom of the trench to its top:

Zone A	From the bottom of the trench to the level of the centre line of the pipe in case of excavation in soil and from the top of the pipe bedding to the level of the centre line of the pipe in case of excavation in rock.	Backfilling in this zone shall be done with carefully selected excavated material compacted by hand in layers not exceeding 150 mm with 95% proctor density. The back-filling material shall be deposited in the trench for its full width of each side of the pipe, specials and appurtenances simultaneously. Special care shall be taken to avoid damage of the pipe and the coating or moving of the pipe.
Zone B	From the level of the centre line of the pipe to a level 300 mm above the top of the pipe.	Backfilling in this zone shall be done with carefully selected excavated material compacted by hand or approved mechanical methods in layers not exceeding 150 mm with 95% proctor density, special care being taken to avoid injuring or moving the pipe.
Zone C	From a level 300 mm above the top of the pipe to the top of the trench.	Backfilling in this zone shall be done with suitable excavated material and shall be compacted using mechanical compactors in layers not exceeding permissible thickness relevant to the type of mechanical compactors deployed to achieve 95% Proctor Density.

Filling of the trenches shall be carried out simultaneously on both sides of the pipe to avoid unequal pressure on the pipe.

Where the excavation is made through permanent pavements, curbs, paved footpaths, or where such structures are undercut by the excavation, the entire back-fill to the subgrade of the structures shall be made with sand in accordance with IS 12288.

The Contractor shall take proper precautions against the risks of floatation. Should any section of the pipeline be affected by floatation shall be removed and reinstalled to the satisfaction of the Engineer

The Contractor shall carry out field tests that on each layer to confirm that the specified density has been obtained.

All excavations shall be backfilled to the level of the original ground surfaces unless otherwise shown on the drawings or ordered by the Engineer, and in accordance with the requirements of the specification. The material used for backfill, the amount thereof, and the manner of depositing and compacting shall be subject to the approval of the Engineer, but the Contractor will be held responsible for any displacement of pipe or other structures, any damage to their surfaces, or any instability of pipes and structures caused by improper depositing of backfill materials.

Trenches crossing a road shall be backfilled with selected material placed in layers not exceeding 15 cm in thickness after compacting, wetted and compacted to a density of not less than 90 percent of the maximum dry density at optimum moisture content of the surrounding material. Any deficiency in the quantity of material for backfilling the trenches shall be supplied by the Contractor at his expense.

The Contractor shall at his own expense make good any settlement of the trench backfill occurring after backfilling and until the expiry of the defects liability period.

On completion of pressure and leakage tests exposed joints shall be covered with approved selected backfill placed above the top of the pipe and joints in accordance with the requirements of the above specifications. The Contractor shall not use backfilling for disposal of refuse or unsuitable soil.

Disinfection of Water Mains

The mains intended for potable water supplies should be disinfected before commissioning them for use. Special care should be taken to ensure disinfection of new mains. Among possible sources of contamination are sewer drainage, contaminated soil in the trench, contamination from workmen or their equipment or both and unavoidable foreign material present in the trench during construction.

Education of crew members as to the need for avoiding contamination of the main during construction is fundamental. Contractors and workmen should be thoroughly familiar with all pertinent state and local requirements governing installation of mains. All sewers, water mains and other underground conduits should be located prior to construction, relocated, if necessary, to prevent contamination during construction. Pipe should be strung on high ground. At all times when construction is not actually in progress, watertight plugs should be installed in all pipe openings. Gunny sack and rags are not adequate. Provision should be made to pump any other water that might collect in the trench. Special care should be taken to avoid contamination of valves, fittings, and pipe interiors, both before and during

construction each of them should be inspected and, if necessary, cleaned before installation.

After pressure testing the main, it should be flushed with clean water at sufficient velocity to remove all dirt and other foreign materials in the constructed pipeline. When this process has been completed, disinfection (using liquid chlorine, sodium or calcium hypochlorite) should proceed by one of the recommended methods as described in the following clauses

Continuous Feed

In this method, water from the distribution system or other approved source and the chlorine is fed at constant rate into the new main at a concentration of atleast 20 mg/1. A property adjusted hypochlorite solution injected into the main with a hypo-chlorinator, or liquid chlorine injected into the main through a solution feed chlorinator and booster pump may be used. The chlorine residual should be checked at intervals to ensure that the proper level is maintained. Chlorine application should continue until the entire main is filled. All valves, hydrants, etc., along the main should be operated to ensure their proper disinfection. The water should remain in the main for a minimum of 24 hours. Following the 24 hours period no less than 10 mg/1 chlorine residual should remain in the main. The Contractor is requested to provide photo and take a record the value of chlorine residual at starting point and after 24 hours before completion of work. The Engineer shall jointly check the test at sites. If the value is insufficient, the disinfections work shall be repeated until satisfactory results are achieved. Waste chlorine residual water must be neutralized before it is discharged to any drainage.

Slug Method

In this method a continuous flow of water is fed with a constant dose of chlorine (as in the previous method) but with rates proportioned to give a chlorine concentration of at least 300 mg/1. The chlorine is applied continuously for a period of time to provide a column of chlorinated water that contacts all interior surfaces of the main for a period of at least 3 hours. As the slug passes tees, crosses, etc., proper valves shall be operated to ensure their disinfection. This method is used principally for large diameter mains where continuous feed is impractical.

Regardless of the method used, it is necessary to make certain that backflow of the strong chlorine solution into the supplying line does not occur. Following the prescribed contact period, the chlorinated water should be flushed to waste until the remaining water has a chlorine residual approximating that throughout the rest of the system. Bacteriological tests as prescribed by the authorities should be taken, and if the results fail to meet minimum standards, the disinfecting procedure should be repeated and the results again tested before placing the main in service. If continuous feed method is difficult to apply, Retention Method shall be considered as alternative way. The area or pipe line to be disinfected shall be fed with chlorine solution from up stream under flowing water condition. The chlorine solution fed in the pipeline shall be kept for 1 day before measurement of residual chlorine is undertaken. After 3 days later, the chlorine residual value shall be tested at sampling points at up stream and at downstream end to check whether the value is in range or not. The Contractor shall provide photo and take a record

the value of chlorine residual at starting point and after 24 hours before completion of work. The Engineer shall jointly check the test at sites. If the value is insufficient, the disinfections work shall be repeated until satisfactory results are achieved. Waste chlorine residual water must be neutralized before it is discharged to any drainage, as approved by Engineer.

Dynamic commissioning

The dynamic commissioning shall commence after the work has been physically completed to the satisfaction of the Engineer- in -Charge. It shall simulate the design and operation conditions which are as follows:

- Water being put into the system through overhead tank or direct pumping as the case maybe.
- Closing of the valves against full static or dynamic pressure.
- Operation of all valves including scour valves (open-close-open).
- Operation of all air valves.

Technical Specifications for Road Works

PPLICABLE CODES AND SPECIFICATIONS

The following IS (Indian Standard) Codes and IRC (Indian Road Congress) Codes, specifications etc. shall be applicable. In all cases the latest revision of the codes and specifications shall be referred to:

Sr. No.	IS / IRC Code Nos.	Description
1	MORT&H	Specifications for Road and Bridge works, Fifth Revision, Ministry of Road Transport and Highways, New Delhi 2013
2	IRC : 35	Code of Practice for Road Markings.
3	IRC : 36	Recommended Practice for Construction of Earth Embankments and Sub-grade for road works
4	IRC : 86	Geometric Design standards for Urban roads in plans
5	IRC : 37	Guidelines for the Design of Flexible Pavements
6	IRC : 67	Code of Practice for Road Signs
7	IRC:SP:63	Guidelines for the use of Interlocking Concrete Block Pavement
8	IRC:SP:41	Guidelines on Design of At-Grade Intersections in Rural & Urban Areas
9	IRC : 94	Specification for Dense Bituminous Macadam
10	IRC : 29	Specifications for Bituminous Concrete for Road Pavement
11	IS : 73	Specifications for Paving Bitumen
12	IS : 217	Specification for cut back Bitumen
13	IS : 400	Specification for Test Sieve
14	IS : 454	Specification for Digboi type cut back Bitumen
15	IS : 456	Specifications for plain and reinforced concrete.
16	IS : 2720 : (Part 5)	Method of Test for Soils: Determination of Liquid and Plastic Limit.
17	IS : 2720 : (Part 8)	Method of Test for Soils: Determination of water content – dry density relation using Light compaction
18	IS : 2720 : (Part 16)	Method of Test for Soils: Laboratory determination of CBR
19	IS : 1124	Method of Test for determination of water Absorption, apparent specific gravity & porosity of Building stone

Sr. No.	IS / IRC Code Nos.	Description
20	IRC: 103	Guidelines for Pedestrian Facilities

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NOTE

1. Relevant clauses of Ministry of Road Transport & Highways (MORT&H) Specifications for Roads and Bridge works relevant to this tender only are reproduced.

2. In case of any variation between the reproduced specification and the original specification of MORT&H Publication, the reproduce publication shall prevail and shall be construed accordingly.

3. If MORT&H clauses referred to in the reproduced specifications herein are not included in the latter, the same shall be read from MORT&H specifications.

Topographic Survey, & Geotechnical investigation

Contractor to conduct detail topographical site survey and Geotechnical investigation before execution of work and submit the same to the Engineer in charge for approval

Earthworks:

Earthworks shall involve of Clearing and Grubbing and excavation for roadway and drains, excavation for structures and embankment Construction for Road.

201.0 CLEARING AND GRUBBING

201.1 SCOPE

This work shall consist of cutting, removing and disposing of all materials such as trees, bushes, shrubs, stumps, roots, grass, weeds, top organic soil not exceeding 150 mm in thickness, rubbish etc. which in the opinion of the Engineer are unsuitable for incorporation in the works, from the area of road land containing road embankment, drains, cross-drainage structures and such other areas as may be specified on the drawings or by the Engineer. It shall include necessary excavation, backfilling of pits resulting from uprooting of trees and stumps to required compaction, handling, salvaging, and disposal of cleared materials. Clearing and grubbing shall be performed in advance of earthwork operations and in accordance with the requirements of these Specifications.

201.2 PRESERVATION OF PROPERTY/AMENITIES

Roadside trees, shrubs, any other plants, pole lines, fences, signs, monuments, buildings, pipelines, sewers and all highway facilities within or adjacent to the highway which are not to be disturbed shall be protected from injury or damage. The Contractor shall provide and install at his own expense, suitable safeguards approved by the Engineer for this purpose.

During clearing and grubbing, the Contractor shall take all adequate precautions against soil erosion, water pollution, etc. and where required undertake additional works to that effect vide Clause 306. Before start of operations, the Contractor shall submit to the Engineer for approval, his work plan including the procedure to be followed for disposal of waste materials, etc. and the schedules for carrying out temporary and permanent erosion control works as stipulated in Clause 306.3.

201.3 METHODS, TOOLS AND EQUIPMENT

Only such methods, tools and equipment as are approved by the Engineer and which will not affect the property to be preserved shall be adopted for the work. If the area

has thick vegetation/roots/trees, a crawler or pneumatic tyre dozer of adequate capacity may be used for clearance purposes. The dozer shall have ripper attachments for removal of tree stumps. All trees, stumps, etc. falling within excavation and fill lines shall be cut to such depth below ground level that in no case these fall within 500mm of the sub-grade bottom. Also, all vegetation such as roots, under-growth, grass and other deleterious matter unsuitable for incorporation in the embankment/sub-grade shall be removed between fill lines to the satisfaction of the Engineer. On areas beyond these limits, trees and stumps required to be removed as directed by the Engineer, shall be cut down below ground level so that these do not present an unsightly appearance. All branches of trees extending above the roadway shall be trimmed as directed by the Engineer.

All excavations below the general ground level arising out of the removal of trees, stumps, etc., shall be filled with suitable material and compacted thoroughly so as to make the surface at these points conform to the surrounding areas.

Anthills both above and below the ground as are liable to collapse and obstruct free sub-soil water flow shall be removed and their workings, which may extend to several metres, shall be suitably treated.

201.4 DISPOSAL OF MATERIALS

All materials arising from clearing and grubbing operations shall be taken over and shall be disposed of by the Contractor at suitable disposal sites with all leads and lifts. The disposal shall be in accordance with local, State and Central regulations.

201.5 MEASUREMENT FOR PAYMENT

Clearing and grubbing for road embankment, drains and cross-drainage structures shall be measured on area basis in terms of hectares. Cutting of trees up to 300 mm in girth including removal of stumps, including removal of stumps up to 300 mm in girth left over after trees have been cut by any other agency, and trimming of branches of trees extending above the roadway and backfilling to the required compaction shall be considered incidental to the clearing and grubbing operations. Clearing and grubbing of borrow areas shall be deemed to be a part of works preparatory to embankment construction and shall be deemed to have been included in the rates quoted for the embankment construction item and no separate payment shall be made for the same.

Ground levels shall be taken prior to and after clearing and grubbing. Levels taken prior to clearing and grubbing shall be the base level and will be accordingly used for assessing the depth of clearing and grubbing and computation of quantity of any unsuitable material which is required to be removed. The levels taken subsequent to clearing and grubbing shall be the base level for computation of earthwork for embankment.

Cutting of trees, excluding removal of stumps and roots of trees of girth above 300 mm shall be measured in terms of number according to the girth sizes given below: -

i. Above 300 mm to 600 mm

ii. Above 600 mm to 900 mm

iii. Above 900 mm to 1800 mm

iv. Above 1800 mm

Removal of stumps and roots including backfilling with suitable material to required compaction shall be separate item and shall be measured in terms of number according to the sizes given below:-

i. Above 300 mm to 600 mm

ii. Above 600 mm to 900 mm

iii. Above 900 mm to 1800 mm

iv. Above 1800 mm

For the purpose of cutting of trees and removal of roots and stumps, the girth shall be measured at the height of 1 m above ground or at the top of the stump if the height of the stump is less than one metre from the ground.

201.6 RATES

201.6.1 The contract unit rates for the various items of clearing and grubbing shall be payment in full for carrying out the required operations including full compensation for all labour, materials, tools, equipment and incidentals necessary to complete the work. These will also include removal of stumps of trees less than 300 mm girth excavation and backfilling to required density, where necessary, and handling, giving credit towards salvage value disposing of the cleared materials with all lifts and leads. Clearing and grubbing done in excess of 150 mm by the contractor shall be made good by the Contractor at his own cost as per Clause 301.3.3 to the satisfaction of the Engineer prior to taking up Earthwork. Where clearing and grubbing is to be done to a level beyond 150 mm, due to site considerations, as directed by the Engineer, the extra quantity shall be measured and paid separately.

201.6.2 The Contract Unit rate for cutting trees of girth above 300 mm shall include handling, giving credit towards salvage value disposing of the cleared materials with all lifts and leads.

201.6.3 The Contractor unit rate for removal of stumps and roots of trees girth above 300 mm shall include excavation and backfilling with suitable material to required compaction, handling, giving credit towards salvage value disposing of the cleared materials with all lifts and leads.

201.6.4 The Contract unit rate is deemed to include credit towards value of usable materials, salvage value of unusable materials and off-set price of cut trees and stumps belonging to the Forest Department. The off-set price of cut trees and stumps belonging to the Forest Department shall be deducted from the amount due to the Contractor and deposited with the State Forest Department. In case the cut trees and stumps are required to be deposited with the Forest Department the Contractor shall do so and no deduction towards the off-set price shall be effected. The offset price shall be as per guidelines/estimates of the State Forest Department.

201.6.5 Where a Contract does not include separate items of clearing and grubbing, the same shall be considered incidental to the earthwork items and the Contract unit prices for the same shall be considered as including clearing and grubbing operations.

EXCAVATION FOR ROADWAY AND DRAINS

301.1 SCOPE

This work shall consist of excavation, removal and satisfactory disposal of all materials necessary for the construction of roadway, side drains and waterways, in accordance with requirements of these specifications and the lines, grades and cross–section shown in the drawings or as indicated by the Engineer. It shall include the hauling and stacking of or hauling to sites of embankment and sub-grade construction, suitable cut materials as required, as also the disposal of unsuitable cut materials in specified manner, with all leads and lifts, reuse of cut materials as may be deemed fit, trimming and finishing of the road to specified dimensions or as directed by the Engineer.

Excavated material shall be stacked off in the manner indicated at the site including stacking of excavated material up to any lead and lift. The rate shall only cover the cost of excavation, stacking and/or spreading of the material, if required at the site.

301.2 CLASSIFICATION OF EXCAVATED MATERIAL

301.2.1 Classification.

All materials involved in excavation shall be classified by the Engineer in the following manner:

a) Soil:

This shall comprise topsoil, turf, sand, silt, loam, clay, mud, peat, black cotton soil, soft shale or loose moorum, a mixture of these and similar material which yields to the ordinary application of pick, spade and/or shovel, rake or other ordinary digging implement. Removal of gravel or any other nodular material having diameter in any one direction not exceeding 75 mm shall be deemed to be covered under this category.

b) Ordinary Rock (not requiring blasting) :

This shall include:

i) rock types such as laterites, shales and conglomerates, varieties of limestone and sandstone etc., which may be quarried or split with crow bars, also including any rock which in dry state may be hard, requiring blasting but which, when wet, becomes soft and manageable by means other than blasting.

ii) macadam surfaces such as water bound and bitumen/tar bound; soling of roads, cement concrete pavement, cobble stone, etc, compacted moorum or stabilized soilpaths, etc. and hard core; compact moorum or stabilised soil requiring use of pick axe or shovel or both.

iii) lime concrete, stone masonry in lime mortar and brick work in lime/cement mortar below ground level, reinforced cement concrete which may be broken up with crow bars or picks and stone masonry in cement mortar below ground level; and

iv) boulders which do not require blasting found lying loose on the surface or embedded in river bed, soil, talus, slope wash and terrace material of dissimilar origin.

c) Hard Rock (requiring blasting) :

This shall comprise:

i) Any rock or cement concrete for the excavation of which the use of mechanical plant and/or blasting is required.

ii) Reinforced cement concrete below ground level and in bridge/ROB/RUB/flyover piers and abutments.

iii) boulders requiring blasting

d) Hard Rock (using controlled blasting)

Hard rock requiring blasting as described under (c) but where controlled blasting is to be carried out in locations where built-up area, huts, and are situated at within 200m of the blast site.

e) Hard Rock (blasting prohibited)

Hard rock requiring blasting as described under (c) but where blasting is prohibited for any reason like people living within 20 m of blast sites etc, and excavation has to be carried out by chiselling, wedging of any other agreed method.

f) Marshy Soil

This shall include soils like soft clays and peats excavated below the original ground level of marshes and swamps and soils excavated from other areas requiring continuous pumping or bailing out of water.

301.2.2 Authority for Classification

The classification of excavation shall be decided by the Engineer and his decision shall be final and binding on the Contractor. Merely the use of explosives in excavation will not be considered as a reason for higher classification unless blasting is clearly necessary in the opinion of the Engineer.

301.3 CONSTRUCTION OPERATIONS

301.3.1 Setting Out:

After the site has been cleared as per Clause 201, the limits of excavation shall be set out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Engineer. Clause 109 shall be applicable for setting out operations.

301.3.2 Stripping and Storing Top Soil

When so directed by the Engineer, the top soil existing over the sites of excavation shall be stripped to specified depths and stockpiled at designated locations for re-use in covering embankment slopes, cut slopes, berms and other disturbed areas where re-vegetation is desired in accordance with Clause 305.3.3. Prior to stripping the topsoil, all trees, shrubs etc. shall be removed along with their roots with approval of the Engineer.

301.3.3 Excavation - General

All excavations shall be carried out in conformity with the directions laid herein under and in a manner approved by the Engineer. The work shall be so done that the suitable materials available from excavation are satisfactorily utilised as deemed fit or as approved by the Engineer.

While planning or executing excavations, the Contractor shall take all-adequate precautions against soil erosion, water pollution etc. as per Clause 306, and take appropriate drainage measures to keep the site free of water in accordance with Clause 311.

The excavations shall conform to the lines, grades, side slopes and levels shown on the drawings or directed by the Engineer. The Contractor shall not excavate outside the slopes or below the established grades or loosen any material outside the limits of excavation. Subject to the permitted tolerances, any excess depth excavated below the specified levels on the road shall be made good at the cost of the Contractor with suitable material of similar characteristics to that removed and compacted to the requirements of Clause 305.

All debris and loose material on the slopes of cuttings shall be removed. No backfilling shall be allowed to obtain required slopes excepting that when boulders or soft materials are encountered in cut slopes these shall be excavated to approved depth on instructions of the Engineer and the resulting cavities filled with suitable material and thoroughly compacted in an approved manner.

After excavation, the sides of excavated area shall be trimmed and the area contoured to minimise erosion and ponding, allowing for natural drainage to take place.

301.3.4 Methods, Tools and Equipment:

Only such methods, tools and equipment as approved by the Engineer shall be adopted / used in the work. If so desired by the Engineer, the Contractor shall demonstrate the efficacy of the type of equipment to be used before the commencement of work.

301.3.5 Rock Excavation:

Rock, when encountered in road excavation, shall be removed up to the sub-grade top level or as otherwise indicated on the drawings. Where, however, unstable shales or other similar materials are intersected at the sub-grade top level, these shall be excavated to the extent of 500 mm below the formation level or as otherwise specified. In all cases, the excavation operations shall be so carried out that at no point on cut formations the rock protrudes above the specified levels. Rocks and boulders which are likely to cause differential settlement and also local drainage problems should be removed to the extent of 500 mm below the formation level in the formation width including side drains.

Where excavation is done to levels lower than those specified, the excess excavation shall be made good as per Clauses 301.3.3 and 301.6 to the satisfaction of the Engineer.

Slopes in rock cutting shall be finished to uniform lines corresponding to slope lines shown on the drawings or as directed by the Engineer. Notwithstanding the foregoing,

all loose pieces of rock on excavated slope surface which move when pierced by a crowbar shall be removed.

Where blasting is to be resorted to, the same shall be carried out to Clause 302 and all precautions indicated therein observed.

Where pre-splitting is prescribed to be done for the establishment of a specified slope in rock excavation, the same shall be carried out as per Clause 303.

301.3.6 Marsh Excavation

The excavation of marshes/swamps shall be carried out as per the programme approved by the Engineer.

Excavation of marshes shall begin at one end and proceed in one direction across the entire marsh immediately ahead of back filling. The method and sequence of excavating and back-filling shall be such as to ensure, to the extent practicable, the complete removal or displacement of all muck from within the lateral limits indicated on the drawings or as staked by the Engineer.

301.3.7 Excavation of Road Shoulders/Verge/Median for Widening of Pavement or providing treated shoulders:

In the works involving widening of existing pavements or providing paved shoulders, the existing shoulder/verge/median shall be removed to its full width and upto top of the subgrade. The subgrade material within 500 mm from the bottom of the pavement for the widened portion or paved shoulders shall be loosened and recompacted as per Clause 305. Any unsuitable material found in this portion shall be removed and replaced with the suitable material. While doing so, care shall be taken to see that no portion of the existing pavement designated for retention is loosened or disturbed. If the existing pavement gets disturbed or loosened, it shall be dismantled and cut to a regular shape with sides vertical and the disturbed/loosed portion removed completely and re-laid as directed by the Engineer, at the cost of the Contractor.

301.3.8 Excavation for Surface/Sub-surface Drains

Where the Contract provides for construction of surface/sub-surface drains to Clause 309, excavation for these shall be carried out in proper sequence with other works as approved by the Engineer.

301.3.9 Slides:

If slips, slides, over-breaks or subsidence occur in cuttings during the process of construction, they shall be removed at the cost of the Contractor as ordered by the Engineer. Adequate precautions shall be taken to ensure that during construction, the slopes are not rendered unstable or given rise to recurrent slides after construction. If finished slopes slide into the roadway subsequently, such slides shall be removed and paid for at the contract rate for the class of excavation involved, provided the slides are not due to any negligence on the part of the Contractor. The classification of the debris material shall conform to its condition at the time of removal and payment made accordingly regardless of its condition earlier.

301.3.10 De-watering:

If water is met with in the excavations due to springs, seepage, rain or other causes, it shall be removed by suitable diversions, pumping or bailing out and the excavation kept dry whenever so required or directed by the Engineer. Care shall be taken to so discharge the drained water as not to cause damage to the works, crops or any other property. Due to any negligence on the part of the Contractor, if any such damage is caused, it shall be the sole responsibility of the Contractor to repair/restore to the original condition at his own cost or compensate for the damage.

301.3.11 Use and Disposal of Excavated Materials:

All the excavated materials shall either be reused with the approval of the Engineer or disposed off with all leads and lifts as directed by the Engineer.

301.3.12 Back-filling :

Back-filling of masonry / concrete/ hume pipe or drain excavation shall be done with approved material with all lead and lifts after concrete/masonry hume pipe is fully set and carried out in such a way as not to cause undue thrust on any part of the structure and/or not to cause differential settlement. All space between the drain walls and the side of the excavation shall be refilled to the original surface making due allowance for settlement, in layers generally not exceeding 150 mm compacted thickness to the required density, using suitable compaction equipment such as trench compactor, mechanical tamper, rammer or plate compactor as directed by the Engineer.

301.4 PLYING OF CONSTRUCTION TRAFFIC

Construction traffic shall not use the cut formation and finished sub grade without the prior permission of the Engineer. Any damage arising out of such use shall be made good by the contractor at his own cost.

301.5 PRESERVATION OF PROPERTY

The Contractor shall undertake all reasonable precautions for the protection and preservation of any or all existing roadside trees, drains, sewers or other sub-surface drains, pipes, conduits and any other structures under or above ground, which may be affected by construction operations and which in the opinion of the Engineer, shall be continued in use without any change. Safety measures taken by the Contractor in this respect, shall be got approved by him from the Engineer. However, if any of these objects is damaged by reason of the Contractor's negligence, it shall be replaced or restored to the original condition at his cost. If the Contractor fails to do so, within the required time as directed by the Engineer or if, in the opinion of Engineer, the actions initiated by the Contractor to replace/restore the damaged objects are not satisfactory, the Engineer shall arrange the replacement/restoration directly through any other agency at the risk and cost of the Contractor after issuing a prior notice to the effect.

301.6 PREPARATION OF CUT FORMATION

The cut formation, which serves as a sub-grade, shall be prepared to receive the sub-base/base course as directed by the Engineer.

Where the material, in the sub-grade has a density less than specified in Table 300-1, the same shall be loosened to a depth of 500 mm. and compacted in layers in accordance with the requirements of Clause 305 adding fresh material, if any required, to maintain the formation level as shown in the drawings. Any unsuitable material

encountered in the sub-grade shall be removed as directed by the Engineer, replaced with suitable material compacted in accordance with Clause 305.

In rocky formations, the surface irregularities shall be corrected and the levels brought up to the specified elevation with granular base material as directed by the Engineer, laid and compacted in accordance with the respective specifications for these materials. The unsuitable material shall be disposed of in accordance with Clause 301.3.11. After satisfying the density requirements, the cut formation shall be prepared to receive the sub-base/base-course in accordance with Clause 310 and 311.

301.7 FINISHING OPERATIONS

Finishing operations shall include the work of properly shaping and dressing all excavated surfaces.

When completed, no point on the slopes shall vary from the designated slopes by more than 150 mm. measured at right angles to the slope, except where excavation is in rock (hard or soft) where no point shall vary more than 300 mm from the designated slope. In no case shall any portion of the slope encroach on the roadway.

The finished cut formation shall satisfy the surface tolerances described in Clause 902.

Where directed, the topsoil removed earlier and conserved (Clauses 301.3.1 and 305.3.3) shall be spread over cut slopes, shoulders and other disturbed areas. Slopes may be roughened and moistened slightly, prior to the application of topsoil, in order to provide satisfactory bond. The depth of topsoil shall be sufficient to sustain plant growth, the usual thickness being from 75 to 100 mm.

304 EXCAVATION FOR STRUCTURES

304.1 SCOPE

Excavation for structures shall consist of the removal of material for the construction of foundations for bridges, culverts, retaining walls, head-walls, cut off walls, pipe culverts and other similar structures, in accordance with the requirements of these Specifications and the lines and dimensions shown on the drawings or as indicated by the Engineer. The work shall include construction of the necessary cofferdams and cribs and their subsequent removal; all necessary sheeting, shoring, bracing, draining, and pumping; the removal of all logs, stumps, grubs and other deleterious matter and obstructions necessary for placing the foundations; trimming bottoms of excavations; back filling and clearing up the site and the disposal of all surplus material.

304.2 CLASSIFICATION OF EXCAVATION

All materials involved in excavation shall be classified in accordance with Clause 301.2.

304.3 CONSTRUCTION OPERATIONS

304.3.1 Setting out:

After the site has been cleared to Clause 201, the limits of excavation shall be set out true to lines curves and slopes to Clause 301.3.1.

304.3.2 Excavation:

Excavation shall be taken to the width of the lowest step of the footing including additional width as required for construction operation. The sides shall be left plumb where the nature of soil allows it. Where the nature of soil or the depth of the trench and season of the year do not permit vertical sides, the Contractor at his own cost shall put up necessary shoring, strutting and planking or cut slopes to a safer angle or both width due regard to the safety of personnel and works and to the satisfaction of the Engineer.

The depth to which the excavation is to be carried out shall be as shown on the drawings, unless the type of material encountered is such as to require changes, in which case the depth shall be as ordered by the Engineer. Propping shall be undertaken when any foundation or stressed zone from an adjoining structure is within a line of 1 vertical to 2 horizontal from the bottom of the excavation.

Where blasting is to be resorted to, the same shall be carried out to Clause 302 and all pre -cautions indicated therein observed. Where blasting is likely to endanger adjoining foundations or other structures, necessary precautions such as controlled blasting, providing rubber mat cover to prevent flying of debris etc. shall be taken to prevent any damage.

304.3.3 Dewatering and Protection:

Normally, open foundation shall be laid dry. Where water is met with in excavation due to stream flow, seepage, springs, rain or other reasons, the Contractor shall take adequate measures such as bailing, pumping, constructing diversion channels, drainage channels, bunds, cofferdams and other necessary works to keep the foundation trenches dry when so required and to protect the green concrete/masonry against damage by erosion or sudden rising of water level. The methods to be adopted in this regard and other details thereof shall be left to the choice of the Contractor but subject to approval of the Engineer. Approval of the Engineer shall, however, not relieve the Contractor of the responsibility for the adequacy of dewatering and protection arrangements and for the quality and safety of the Works.

Where cofferdams are required, these shall be carried to adequate depths and heights, be safely designed and constructed and be made as watertight as is necessary for facilitating construction to be carried out inside them. The interior dimensions of the cofferdams shall be such as to give sufficient clearance for the construction and inspection and to permit installation of pumping equipments, etc. inside the enclosed area.

If it is determined beforehand that the foundations cannot be laid dry or the situation is found that the percolation is too heavy for keeping the foundation dry, the foundation concrete shall be laid under water by tremie pipe only. In case of flowing water or artesian springs, the flow shall be stopped or reduced as far as possible at the time of placing the concrete.

Pumping from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of the movement of water through any fresh concrete. No pumping shall be permitted during the placing of concrete or for a period of at least 24 hours thereafter, unless it is done from a suitable sump separated from the concrete work by a watertight wall or other similar means.

At the discretion of the Contractor, cement grouting or other approved methods may be used to prevent or reduce seepage and to protect the excavation area.

The Contractor shall take all precautions in diverting channels and in discharging the drained water as not to cause damage to the works, crops or any other property.

304.3.4 Preparation of Foundation:

The bottom of the foundation shall be levelled both longitudinally and transversely or stepped as directed by the Engineer. Before footing is laid, the surface shall be slightly watered and rammed. In the event of excavation having been made deeper than that shown on the drawings or as otherwise ordered by the Engineer, the extra depth shall be made up with concrete or masonry of the foundation at the cost of the Contractor as per Clause 2104.1 Ordinary filling shall not be used for the purpose to bring the foundation to level.

When rock or other hard strata is encountered, it shall be freed or all soft and loose material, cleaned and cut to a firm surface either level, stepped or serrated as directed by the Engineer. All seams shall be cleaned out and filled with cement mortar or grout to the satisfaction of the Engineer. In the case of excavation in rock, annular space around footing shall be filled with lean concrete M 15 up to the top level of rock.

If the depth of fill required is more than 1.5 m in soft rock or 0.6 m in hard rock above the foundation level, the filling up to this level shall be done with M-15 concrete and portion above shall be filled by concrete or by boulders grouted with cement.

When foundation piles are used, the excavation for pile cap shall be done after driving/casting of all piles forming the group. After pile driving operations in a given pit are completed, all loose and displaced materials therein shall be removed to the level of the bottom of the pile cap.

304.3.5 Slips and Blows:

If there are any slips or blows in the excavation, these shall be removed by the Contractor at his own cost.

304.3.6 Public Safety:

Near towns, villages and all frequented places, trenches and foundation pits shall be securely fenced, provided with proper caution signs and marked with red lights at night to avoid accidents. The Contractor shall take adequate protective measures to see that the excavation operations do not affect or damage adjoining structures. For safety precautions, guidance may be taken from IS: 3764.

304.3.7 Back Filling:

Back filling shall be done with approved material after concrete or masonry is fully set and carried out in such a way as not to cause undue thrust on any part of the structure. All space between foundation masonry or concrete and the sides of excavation shall be refilled to the original surface in layers not exceeding 150 mm compacted thicknesses. The compaction shall be done with the help of suitable equipment such as mechanical tamper, rammer, plate vibrator etc. after necessary watering, so as to achieve the maximum dry density.

304.3.8 Disposal of Surplus Excavated Materials:

Clause 301.3.11 shall apply.

305 EMBANKMENT CONSTRUCTION

305.1 GENERAL

305.1.1 Description:

These specifications shall apply to the construction of embankments, sub-grades, earthen shoulders and miscellaneous back fills with approved material obtained either from excavation for road construction, borrow pits or other sources. All embankments and sub-grades shall be constructed to accordance with the requirements of these specifications and in conformity with the lines, grades, and cross-sections shown on the drawings or as directed by the Engineer.

305.2 MATERIALS AND GENERAL REQUIREMENTS

305.2.1 Physical Requirements:

305.2.1.1 The materials used in embankments, sub-grades, earthen shoulders and miscellaneous backfills shall be soil, moorum, gravel, reclaimed material from pavement, fly ash, pond ash, a mixture of these or any other material as approved by the Engineer. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment.

The following types of material may be considered unsuitable for embankment:

a) Material from swamps, marshes or bogs

b) Peat, log, stump or perishable material; any soil classifies as OL, OI, OLL or Pt in accordance with IS: 1498.

c) Material susceptible to spontaneous combustions

d) Material in a frozen condition

e) Clay having liquid limit exceeding 50 and plasticity index exceeding 25; and

f) Materials with salts resulting in leaching in the embankment.

305.2.1.2 Expansive clay exhibiting marked swell and shrinkage properties (“free swelling index” exceeding 50 per cent when tested as per IS: 2720 – Part 40) shall not be used as a fill material. Where an expansive clay having “free swelling index” value less than 50 percent is used as a fill material, sub-grade and top 500mm portion of the embankment just below sub-grade shall be non-expansive in nature.

305.2.1.3 Any fill material with a soluble sulphate content exceeding 1.9 grams of sulphate (expressed as SO3) per litre when tested in accordance with BS: 1377, Part 3, but using a 2:1 water-soil ratio shall not be deposited within 500mm distance (or any other distance described in the Contract), of permanent works constructed out of concrete, cement bound materials or other cementitious material.

Material with a total sulphate content (expressed as SO3) exceeding 0.5 percent by mass, when tested in accordance with BS:1377, Part 3 shall not be deposited within 500 mm, or other distances described in the Contract, or metallic items forming part of the Permanent Works.

305.2.1.4 The size of the coarse material in the mixture of earth shall ordinarily not exceed 75 mm. when being placed in the embankment and 50 mm. when placed in the sub-grade. However, the Engineer may at his discretion permit the use of material coarser than this also if he is satisfied that the same will not present any difficulty as regards the placement of fill material and its compaction to the requirements of these specifications. The maximum particle size shall not be more than two-third of the compacted layer thickness.

305.2.1.5 Ordinarily, only the materials satisfying the density requirements given in Table 300.1 shall be employed for the construction of the embankment and the sub-grade.

TABLE 300.1 DENSITY REQUIREMENTS OF EMBANKMENT AND SUB-GRADE MATERIALS

Sl. No	Type of Work	Maximum laboratory dry density when tested as per IS: 2720 (Part 8)
1.	Embankments up to 3 m height, not subjected to extensive flooding.	Not less than 15.2 KN/cu.m
2.	Embankments exceeding 3 metre height or embankments of any height subject to long periods of inundation.	Not less than 16 KN/cu.m
3.	Sub-grade and earthen shoulders /verge/backfill	Not less than 17.5 KN/cu.m

Note:

1) This table is not applicable for lightweight fill material e.g. cinder, fly ash etc.

2) The material to be used in subgrade shall be non-expansive and shall satisfy design CBR at the specified dry density and moisture content. In case the available materials fail to meet the requirement of CBR, use of stabilization methods in accordance with Clauses 403 and 404 or by any stabilization method approved by the Engineer shall be followed.

305.2.1.6 The material to be used in subgrade shall confirm to the design CBR value at the specified dry density and moisture content of the test specimen. In case the available materials fails to meet the requirement of CBR, use of stabilization methods in accordance with Clauses 403 and 404 or by any stabilization method approved by the Engineer or by the IRC Accreditation Committee shall be followed.

305.2.1.7 The material to be used in high embankment construction shall satisfy the specified requirements of strength parameters.

305.2.2 General Requirements:

305.2.2.1 The materials for embankment shall be obtained from approved sources with preference given to acceptable materials becoming available from nearby roadway excavation under the same contract.

The work shall be so planned and executed that the best available materials are saved for the sub-grade and the embankment portion just below the sub-grade.

305.2.2.2 Borrow Materials:

The arrangement for the source of supply of the material for embankment and sub-grade and compliance with the guidelines, and environment requirements, in respect of excavation and borrow areas as stipulated, from time to time by the Ministry of Environment and Forests, Government of India and the local bodies, as applicable shall be the sole responsibility of the Contractor.

Borrow pits along the road shall be discouraged. If permitted by the Engineer, these shall not be dug continuously. Ridges of not less than 8m width should be left at intervals not exceeding 300 m. Small drains shall be cut through the ridges to facilitate drainage. The depth the pits shall be so regulated that their bottom does not cut an imaginary line having a slope of 1 vertical to 4 horizontal projected from the edge of the final section of the bank, the maximum depth in any case being limited to 1.5 m. Also no pit shall be dug within the offset width from the toe of the embankment required as per the consideration of stability with a minimum width of 10 m.

Haulage of material to embankments or other areas of fill shall proceed only when sufficient spreading and compaction plant is operating at the place of deposition.

Where the excavation reveals a combination of acceptable and un-acceptable materials, the Contractor shall unless otherwise agreed by the Engineer, carry out the excavation in such a manner that the acceptable materials are excavated separately for use in the permanent works without contamination by the unacceptable materials. The acceptable materials shall be stockpiled separately.

The Contractor shall ensure that he does not adversely affect the stability of excavation or fills by the methods of stockpiling materials, use of plants or siting of temporary buildings or structures.

305.2.2.3 Fly Ash

Use of fly ash shall confirm to the Ministry of Environment and Forest guidelines. Where fly-ash is used the embankment construction shall conform to the physical and chemical properties and requirements of IRC: SP: 38-2001, “Guidelines for Use of Fly ash in Road Construction”. The term fly ash shall cover all types of coal ash such as pond ash, bottom ash or mound ash.

Embankment constructed out of fly ash shall be properly designed to ensure stability and protection against erosion in accordance with IRC guidelines. A suitable thick cover may preferably be provided at intervening layers of pond ash for this purpose. A thick soil cover shall bind the edge of the embankment to protect it against erosion. Minimum thickness of such soil cover shall be 500 mm.

305.2.2.4 Compaction Requirements

The Contractor shall obtain representative samples from each of the identified borrow areas and have these tested at the site laboratory following a testing programme approved by the Engineer. It shall be ensured that the sub-grade material when compacted to the density requirements as in Table 300.2 shall yield the specified design CBR value of the sub-grade.

TABLE: 300.2 COMPACTION REQUIREMENTS FOR EMBANKMENT AND SUBGRADE

Sl. No	Type of Work/ Material	Relative compaction as percentage of max. laboratory dry density as per IS : 2720 (Part 8)
1.	Sub-grade and earthen shoulders	Not less than 97%
2.	Embankment	Not less than 95%
3.	Expansive clays a) Sub-grade and 500mm. portion just below b) Remaining portion of embankment	 Not allowed 90 -95%

The Contractor shall at least 7 working days before commencement of compaction submit the following to the Engineer for approval.

a) The values of maximum dry density and optimum moisture content obtained in accordance with IS: 2720 (Part 8), appropriate for each of the fill materials he intends to use.

b) A graph of density plotted against moisture content from which each of the values in (i) above of maximum dry density and optimum moisture content were determined.

The maximum dry density and optimum moisture content approved by the Engineer shall form the basis for compaction.

305.3 CONSTRUCTION OPERATIONS

305.3.1 Setting Out:

After the site has been cleared to Clause 201, the work shall be set out to Clause 301.3.1. The limits of embankment/sub-grade shall be marked by fixing batter pegs on both sides at regular intervals as guides before commencing the earthwork. The embankment/sub-grade shall be built sufficiently wider than the design dimension so that surplus material may be trimmed, ensuring that the remaining material is to the desired density and in position specified and conforms to the specified side slopes.

305.3.2 Dewatering:

If the foundation of the embankment is in an area with stagnant water, and in the opinion of the Engineer it is feasible to remove it the same shall be removed by bailing out or pumping, as directed by the Engineer and the area of the embankment foundation shall be kept dry. Care shall be taken to discharge the drained water so as

not to cause damage to the works, crops or any other property. Due to any negligence on the part of the Contractor, if any such damage is caused, it shall be the sole responsibility of the Contractor to repair/restore it to original condition or compensate the damage at his own cost.

If the embankment is to be constructed under water, Clause 305.4.6 shall apply.

305.3.3 Stripping and Storing Top Soil:

When so directed by the Engineer, the topsoil from all areas of cutting and from all areas to be covered by embankment foundation shall be stripped to specified depths not less than 150 mm and stored in stockpiles of height not exceeding 2 m for covering embankment slopes, cut slopes and other disturbed areas where re-vegetation is desired. Topsoil shall not be unnecessarily subjected to traffic either before stripping or when in a stockpile. Stockpiles shall not be surcharged or otherwise loaded and multiple handling shall be kept to a minimum.

305.3.4 Compacting Ground Supporting Embankment/Sub-grade

Where necessary, the original ground shall be levelled to facilitate placement of first layer of embankment, scarified, mixed with water and then compacted by rolling so as to achieve minimum dry density as given in Table 300-2.

In a case where the difference between the sub grade level (top of the sub-grade on which pavement rests) and ground level is less than 0.5 m and the ground does not have 97 percent relative compaction with respect to the dry density (as given in Table 300-2), the ground shall be loosened up to a level 0.5 m below the sub-grade level, watered and compacted in layers in accordance with Clauses 305.3.5 and 305.3.6 to achieve dry density not less than 97 percent relative compaction as given in Table 300-2.

Where so directed by the Engineer any unsuitable material occurring in the embankment foundation (500 mm portion just below the sub-grade) shall be removed and replaced by approved materials laid in layers to the required degree of compaction.

Any foundation treatment specified for embankments especially high embankments, resting on suspect foundations as revealed by borehole logs shall be carried out in a manner and to the depth as desired by the Engineer. Where the ground on which an embankment is to be built has any of the material types (a) to (f) in Clause 305.2.1, at least 500 mm of such material must be removed and replaced by acceptable fill material before embankment construction commence.

305.3.5 Spreading material in layers and bringing to appropriate moisture content.

305.3.5.1 The embankment and sub-grade material shall be spread in layers of uniform thickness in the entire width with a motor grader. The compacted thickness of each layer shall not be more than 250 mm when vibratory roller/vibratory soil compactor is used and not more than 200 mm when 80-100 KN static roller is used. The motor grader blade shall have hydraulic control suitable for initial adjustment and maintain the same so as to achieve the specific slope and grade. Successive layers shall not be placed until the layer under construction has been thoroughly compacted to the specified requirements as in Table 300.2 and got approved by the Engineer. Each

compacted layer shall be finished parallel to the final cross-section of the embankment.

305.3.5.2 Moisture content of the material shall be checked at the site of placement prior to commencement of compaction; if found to be out of agreed limits, the same shall be made good. Where water is required to be added in such constructions, water shall be sprinkled from a water tanker fitted with sprinkler capable of applying water uniformly with a controllable rate of flow to variable widths of surface but without any flooding. The water shall be added uniformly and thoroughly mixed in soil by blading, using disc harrow until a uniform moisture content is obtained throughout the depth of the layer.

If the material delivered to the roadbed is too wet, it shall be dried, by aeration and exposure to the sun, till the moisture content is acceptable for compaction. Should circumstances arise, where owing to wet weather, the moisture content cannot be reduced to the required amount by the above procedure, work on compaction shall be suspended.

Moisture content of each layer of soil shall be check in accordance with IS: 2720 (Part-2) and unless otherwise mentioned, shall be so adjusted, making due allowance for evaporation losses, that at the time of compaction is in the range of 1 per cent above to 2 per cent below the optimum moisture content determined in accordance with IS: 2720 (Part-8) as the case may be. Expansive clays shall, however, be compacted at moisture content corresponding to the specified dry density, but on the wet side of the optimum moisture content obtained from the laboratory compaction curve.

After adding the required amount of water, the soil shall be processed by means of graders, harrows, rotary mixers or as otherwise approved by the Engineer until the layer is uniformly wet.

Clods or hard lumps of earth shall be broken to have a maximum size of 75 mm. when being placed in the embankment and a maximum size of 50 mm. when being placed in the sub-grade.

305.3.5.3 Embankment and other areas of fill shall, unless otherwise required in the Contract or permitted by the Engineer, be constructed evenly over their full width and their fullest possible extent and the Contractor shall control and direct construction plant and other vehicular traffic uniformly over them. Damage by construction plant and other vehicular traffic shall be made good by the Contractor with material having the same characteristics and strength as the material had before it was damaged.

Embankments and other areas of unsupported fills shall not be constructed with steeper side slopes, or to greater widths than those shown in the Contract, except to permit adequate compaction at the edges before trimming back, or to obtain the final profile following any settlement of the fill and the underlying material.

Whenever fill is to be deposited against the face of a natural slope, or sloping earthworks face including embankments, cuttings, other fills and excavations steeper than 1 vertical or 4 horizontal, such faces shall be benched as per Clause 305.4.1 immediately before placing the subsequent fill.

All permanent faces of side slopes of embankments and other areas of fill formed shall, subsequent to any trimming operations, be reworked and sealed to the

satisfaction of the Engineer by tracking a tracked vehicle, considered suitable by the Engineer, on the slope or any other method approved by the Engineer.

305.3.6 Compaction:

Only the compaction equipment approved by the Engineer shall be employed to compact the different material types encountered during construction. Static three wheeled roller, self propelled single drum vibratory roller, tandem vibratory roller, pneumatic tyre roller, pad foot roller etc, of suitable size and capacity as approved by the Engineer shall be used for the different types and grades of materials required to be compacted either individually or in suitable combinations.

The compaction shall be done with the help of self-propelled single drum vibratory roller or pad foot vibratory roller of 80 to 100 KN static weight or heavy pneumatic tyre roller of adequate capacity capable of achieving the required compaction. The Contractor shall demonstrate the efficacy of the equipment he intends to use by carrying out compaction trials. The procedure to be adopted for these site trials shall first be submitted to the Engineer for approval.

Earthmoving plant shall not be accepted as compaction equipment nor shall the use of a lighter category of plant to provide any preliminary compaction to assist the use of heavier plant be taken into account.

Each layer of the material shall be thoroughly compacted to the densities specified in Table 302-2. Subsequent layers shall be placed only after the finalised layer has been tested according to Clause 903.2.2 and accepted by the Engineer. The Engineer may permit measurement of field dry density by a nuclear moisture/density gauge used in accordance with agreed procedure and the gauge is calibrated to provide results identical to that obtained from tests in accordance with IS:2720 (Part 28). A record of the same shall be maintained by the Contractor.

Where density measurements reveal any soft areas in the embankment/sub-grade/earthen shoulder, further compaction shall be carried out as directed by the Engineer. If in spite of that, the specified compaction is not achieved, the material in the soft areas shall be removed and replaced by approved material, compacted using appropriate mechanical means such as light weight vibratory roller, double drum walk behind roller, vibratory plate compactor, trench compactor or vibratory tamper to the density requirements and satisfaction of the Engineer.

305.3.7 Drainage:

The surface of the embankment/sub-grade at all times during construction shall be maintained at such a cross fall (not flatter than that required for effective drainage of an earthen surface) as will shed water and prevent ponding.

305.3.8 Repairing of damages caused by rain/spillage of water

The soil in the affected portion shall be removed in such areas as directed by the Engineer before next layer is laid and refilled in layers and compacted using appropriate mechanical means such as small vibratory roller, plate compactor or power rammer to achieve the required density in accordance with Clause 305.3.6. If the cut is not sufficiently wide for use of required mechanical means for compaction, the same shall be widened suitably to permit their use for proper compaction. Tests

shall be carried out as directed by the Engineer to ascertain the density requirements of the repaired area. The work of repairing the damages including widening of the cut, if any, shall be carried out by the Contractor at his own cost, including the arranging of machinery/equipment for the purpose.

305.3.9 Finishing Operations

Finishing operations shall include the work of shaping and dressing the shoulders/verge road bed and side slopes to conform to the alignment, levels, cross - sections and dimensions shown on the drawings or as directed by the Engineer subject to the surface tolerances described in Clause 902. Both the upper and lower ends of the side slopes shall be rounded off to improve appearance and to merge the embankment with the adjacent terrain.

The top soil, removed and conserved earlier (Clauses 301.3.2 and 305.3.2) shall be spread over the fill slopes as per directions of the Engineer to facilitate the growth of vegetation. Slopes shall be roughened and moistened slightly prior to the application of the topsoil in order to provide satisfactory bond. The depth of the topsoil shall be sufficient to sustain plant growth, the usual thickness being from 75mm to 150mm.

Where directed, the slopes shall be turfed with sods in accordance with Clause 307. If seeding and mulching of slopes is prescribed, this shall be done to the requirement of Clause 308.

When earthwork operations have been substantially completed the road area shall be cleared of all debris, and ugly scars in the construction area responsible for objectionable appearance eliminated.

305.4 CONSTRUCTION OF EMBANKMENT AND SUB-GRADE UNDER SPECIAL CONDITIONS

305.4.1 Earthwork for Widening Existing Road Embankment:

When an existing embankment and/or sub-grade is to be widened and its slopes are steeper than 1 vertical on 4 horizontal, continuous horizontal benches, each at least 300mm. wide, shall be cut into the old slope for ensuring adequate bond with the fresh embankment /sub-grade material to be added. The material obtained from cutting of benches could be utilised in the widening of the embankment/sub-grade. However, when the existing slope against which the fresh material is to be placed is flatter than 1 vertical on 4 horizontal the slope surface may only be ploughed or scarified instead of resorting to benching.

Where the width of the widened portions is insufficient to permit the use of usual wider rollers, compaction shall be carried out with the help of tandem sheep's foot rollers, mechanical tampers or other approved equipment. End dumping of material from trucks for widening operations shall be avoided except in difficult circumstances, when the extra width is too narrow to permit the movement of any other types of hauling equipment.

305.4.2 Earthwork for Embankment and Sub-grade to be Placed against Sloping Ground:

Where an embankment/sub-grade is to be placed against sloping ground, the latter shall be appropriately benched or ploughed/scarified as required in Clause 305.4.1,

before placing the embankment/sub-grade material. Extra earthwork involved in benching or due to ploughing/scarifying etc. shall be considered incidental to the work.

For wet conditions, benches with slightly inward fall and subsoil drains at the lowest point shall be provided as per the drawings before the fill is placed against sloping ground.

Where the contract requires construction of transverse sub-surface drain at the cut-fill interface, work on the same shall be carried out to Clause-309 in proper sequence with the embankment and sub-grade work as approved by the Engineer.

305.4.3 Earthwork over Existing Road Surface:

Where the embankment is to be placed over an existing road surface, the work shall be carried out as indicated below:

i) If the existing road surface is of granular or bituminous type and lies within 1m of the new formation levels, it shall be scarified to a depth of 50mm. or as directed so as to provide ample bond between the old and new material ensuring that at least 500mm. portion below the top of new sub-grade level is compacted to the desired density.

ii) If the existing road surface is of bituminous type or cement concrete and lies within 1m of the new formation level, the bituminous or cement concrete layer shall be removed completely.

iii) If the level difference between the existing road surface and the new sub-grade level is more than 1m the existing surface shall be roughened after ensuring that the maximum thickness of 500 mm of sub grade is available.

305.4.4 Embankment and Sub-grade around Structures:

To avoid interference with the construction abutments, wing walls or return walls of culvert/bridge structures, the Contractor shall, at points to be determined by the Engineer suspend work on embankments forming approaches to such structures, until such time as the construction of the letter is sufficiently advanced to permit the completion of approaches without the risk of interference of damage to the structure.

Unless directed otherwise, the filling around culverts, bridges and other structures up to distance of twice the height of the road from the back of the abutment shall be carried out independent of the work on the main embankment. The fill material shall not be placed against any abutment or wing wall unless permission has been given by the Engineer but in any case not until the concrete or masonry has been in position for 14 days. The embankment and sub-grade shall be brought up simultaneously in equal layers on each side of the structure to avoid displacement and unequal pressure. The sequence of work in this regard shall be got approved from the Engineer.

The material used for backfill shall not be an organic soil or highly plastic clay having plasticity index and liquid limit more than 20 and 40 respectively when tested according to IS : 2720 (Part-5). Filling behind abutments and wing walls for all structures shall conform to the general guidelines given in IRC: 78-1983 The fill material shall be deposited in horizontal layers not exceeding 150mm in loose thickness and compacted thoroughly to the requirements of Table 300-2.

Where the provision of any filter medium is specified behind the abutment, the same shall be laid in layers simultaneously with the laying of fill material. The material used for filter shall conform to the requirements for filter medium spelt out in Clause 2504 unless otherwise specified in the contract.

Where it may be impracticable to use power rollers or other heavy equipment, mechanical tampers shall carry out the compaction or other methods approved by the Engineer. Care shall be taken to see that the compaction equipment does not hit or come too close to any structural member so as to cause any damage to them or excessive pressure against the structure.

305.4.5 Construction of embankment over ground incapable of supporting construction equipment

Where embankment is to be constructed across ground which will not support the weight of repeated heavy loads of construction equipment, the first layer of the fill may be constructed by placing successive loads of material in a uniformly distributed layer of a minimum thickness required to support the construction equipment as permitted by the Engineer. The Contractor, if so desired by him, may also use suitable geo-synthetic material to increase the bearing capacity of the foundation. This exception to normal procedure will not be permitted where, in the opinion of the Engineer, the embankments could be constructed in the approved manner over such ground by the use of lighter or modified equipment after proper ditching and drainage have been provided. Where this exception is permitted, the selection of the material and the construction procedure to obtain an acceptable layer shall be the responsibility of the Contractor. The cost of providing suitable traffic conditions for construction equipment over any area of the Contractor will be the responsibility of the Contractor and no extra payment will be made to him. The remainder of the embankment shall be constructed as specified in Clause 305.3.

305.4.6 Embankment Construction under Water and Waterlogged Areas

305.4.6.1 Embankment construction under Water

Where filling or backfilling is to be placed under water, only acceptable granular material or rock shall be used unless otherwise approved by the Engineer. Acceptable granular material shall be of GW, SW, GP, SP as per IS: 1498 and consist of graded, hard durable particles with maximum particle size not exceeding 75mm. The material should be non-plastic having uniformity coefficient of not less than 10. The placed in open water shall be deposited by end tipping without compaction.

305.4.6.2 Embankment construction in Waterlogged and Marshy Areas

The work shall be done as per IRC:34

305.4.7 Earthwork for high embankment

The material for high embankment construction shall confirm to Clause 305.2.1.7. In the case of high embankments (more than 6 m), the Contractor shall normally use fly ash in conformity with Clause 305.2.1.1 or the material from the approved borrow area.

Where provided, stage construction of embankment and controlled rates of filling shall be carried out in accordance with the Contract including installation of instruments and its monitoring.

Where required, the Contractor shall surcharge embankments or other areas of fill with approved material for the periods specified in the contract. If settlement of surcharged fill results the Contractor shall bring the resultant level up to formation level with acceptable material for use in fill.

305.4.8 Settlement Period

Where settlement period is specified in the Contract, the embankment shall remain in place for the required settlement period before excavating for abutment, wing wall, retaining wall, footings, etc. or driving foundation piles. The duration of the required settlement period at each location shall be as provided for in the contract or as directed by the Engineer.

305.5 PLYING OF TRAFFIC

Construction and other vehicular traffic shall not use the prepared surface of the embankment and / or sub-grade without the prior permission of the Engineer. Any damage arising out of such use shall, however, be made good by the Contractor at his own cost as directed by the Engineer.

305.6 SURFACE FINISH AND QUALITY CONTROL OF WORK

The surface finish of construction of sub-grade shall conform to the requirements of Clause 902. Control on the quality of materials and works shall be exercised in accordance with Clause 903.

305.7 SUB-GRADE STRENGTH

305.7.1 It shall be ensured prior to actual execution that the borrow area material to be used in the sub-grade satisfies the requirement of design CBR.

305.7.2 Sub-grade shall be compacted and finished to the design strength consistent with other physical requirements. The actual laboratory CBR values of constructed sub-grade shall be determined on remoulded samples, compacted to the field density at the field moisture content and tested for soaked/unsoaked condition as specified in the Contract.

401 GRANULAR SUB-BASE

401.1 SCOPE

This work shall consist of laying and compacting well-graded material on prepared sub-grade in accordance with the requirements of this specifications. The material shall be laid in one or more layers as sub-base of lower sub-base and upper sub-base (termed as sub-base hereinafter) as necessary according to lines, grades and cross sections shown on the drawings or as directed by the Engineer.

401.2 MATERIALS

401.2.1 The material to be used for the work shall be natural sand, murum, gravel, crushed stone, crushed slag, or combinations thereof depending upon the grading required. Use of materials like brick metal, kankar and crushed concrete shall be permitted in

the lower sub-base. The material shall be free from organic or other deleterious constituents and conform to one of the three grading given in Table 400-1 and physical requirements given in Table 400-2.Gradings III and IV shall preferably be used in lower sub-base. Gradings V and VI shall be used as a sub-base cum drainage layer. The grading to be adopted for a project shall be as specified in the Contract. Where the sub-base is laid in two layers as upper sub-base and lower sub-base, the thickness of each layer shall not be less than 150 mm.

401.2.2 If the water absorption of the aggregates determined as per IS:2386 (Part 3) is greater than 2 percent, the aggregates shall be tested for Wet Aggregate Impact Value (AIV) (IS:5640). Soft aggregates like kankar, brick ballast and laterite shall also be tested for Wet AIV (IS:5640).

TABLE 400-1

GRADING FOR GRANULAR SUB-BASE MATEIRALS

IS Sieve Designation	Percent by Weight Passing the IS Sieve					
	Grading I	Grading II	Grading III	Grading IV	Grading V	Grading VI
75.0mm.	100	--	--		100	
53.0 mm.	80-100	100	100	100	80-100	100
26.5.5mm	55-90	70-100	55-75	55-80	55-90	75-100
9.50mm.	35-65	50-80	--	--	35-65	55-75
4.75mm.	25-55	40-65	10-30	15-35	25-50	30-55
2.36mm.	20-40	30-50	--	--	10-20	10-25
0.85mm.	--	--	--	--	2-10	--
0.425mm.	10-15	10-15	--	--	0-5	0-8
0.075mm.	<5	<5	<5	<5	--	0-3

TABLE 400-2

PHYSICAL REQUIREMENTS FOR MATERIALS FOR GRANULAR SUB-BASE

504.1.1 Aggregate Impact Value (AIV)	504.1.2 IS:2386 (Part 4) or IS:5640	504.1.3 40 Maximum
504.1.4 Liquid Limit	504.1.5 IS:2720 (Part 5)	504.1.6 Maximum 25
504.1.7 Plasticity Index	504.1.8 IS:2720 (Part 5)	504.1.9 Maximum 6
504.1.10 CBR at 98% dry density (at IS:2720-Part 8)	504.1.11 IS:2720 (Part 5)	504.1.12 Minimum 30 unless otherwise specified in the Contract

401.3 CONSTRUCTION OPERATIONS

401.3.1 Preparation of Sub-grade:

Immediately prior to the laying of sub-base, the sub-grade already finished to Section 301 or 305 as applicable shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water if necessary and rolled with two passes 80-100 kN smooth wheeled roller.

401.3.2 Spread and Compacting:

The sub-base material of grading specified in the Contract shall be spread on the prepared sub-grade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and maintain the required slope and grade during the operation or other means as approved by the Engineer.

When the sub-base material consists of combination of materials mentioned in Clause 401.2.1, mixing shall be done mechanically by the mix-in-place method.

Moisture content of the loose material shall be checked in accordance with IS: 2720 (Part-2) and suitably adjusted by sprinkling additional water from a truck mounted or trailer mounted water tank and suitable for applying water uniformly and at controlled quantities to variable widths of surface or other means approved by the Engineer so that at the time of compaction it is from 1 percent above to 2 percent below the optimum moisture content corresponding to IS:2720 (Part 8). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means if so directed by the Engineer until the layer is uniformly wet.

Immediately after spreading the mix, rolling shall be done by an approved roller. If the thickness of the compacted layer does not exceed 100mm, a smooth wheeled roller of 80 to 100 KN weight may be used. For a compacted single layer up to 200mm the compaction shall be done with the help of a vibratory roller of minimum 80 to 100 KN static weight capable of achieving the required compaction. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional cross fall and super elevation. For carriageway having crossfall on both sides, rolling shall commence at the edges and progress towards the crown.

Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and cross fall (camber) shall be checked and any high spots or depressions, which become apparent, corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 km. per hour.

Rolling shall be continued till the density achieved is at least 98 per cent of the maximum dry density for the material determined as per IS: 2720 (Part 8). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

401.4 SURFACE FINISH AND QUALITY CONTROL OF WORK

The surface finish of construction shall conform to the requirements of Clause 902. Control on the quality of materials and works shall be exercised by the Engineer in accordance With Section 900.

401.5 ARRANGEMENT FOR TRAFFIC

During the period of construction arrangement of traffic shall be maintained in accordance with Clause 112.

401.6 MEASUREMENTS FOR PAYMENT

Granular sub-base shall be measured as finished work in position in cubic metres.

The protection of edges of granular sub-base extended over the full formation as shown in the drawing shall be considered incidental to the work of providing granular sub-base and as such no extra payment shall be made for the same.

401.7 RATE

The Contract unit rate for granular sub-base shall be payment in full for carrying out the required operations including full compensation for:

i) making arrangements for traffic to Clause 112 except for initial treatment to verge shoulders and construction of diversions;

ii) supplying all materials to be incorporated in the work including all royalties, fees, rents where necessary and all leads and lifts;

iii) all labour, tools, equipment and incidentals to complete the work to the specifications; and

iv) carrying out the work in part widths of road where directed and

v) carrying out the required tests for quality control.

402 LIME TREATED SOIL FOR IMPROVED SUBGRADE

402.1 SCOPE

This work shall consist of laying and compacting an improved sub-grade/lower sub-base of soil treated with lime on prepared sub-grade in accordance with the requirements of these Specifications and in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer. Lime treatment is generally effective for soils, which contain a relatively high percentage of clay and silty clay.

402.2 Materials

402.2.1 Soil:

Except when otherwise specified, the soil used for stabilisation shall be the local clayey soil having a plasticity index greater than 8.

402.2.2 Lime:

Lime for lime-soil stabilisation work shall be commercial dry lime slaked at site or pre-slaked lime delivered to the site in suitable packing. Unless otherwise permitted by the Engineer, the lime shall have purity of not less than 70 per cent by weight of Quicklime

(CaO) when tested in accordance with IS: 1514. Lime shall be properly stored to avoid prolonged exposure to the atmosphere and consequent carbonation, which would reduce its binding properties.

402.2.3 Quantity of Lime in stabilised mix:

Quality of lime to be added as percentage by weight of the dry soil shall be as specified in the Contract. The quantity of lime used shall be related to its calcium oxide content, which shall be specified. Where the lime of different calcium oxide content is to be used, its quantity shall be suitably adjusted to the approval of the Engineer so that equivalent calcium oxide is incorporated in the work. The mix design shall be done to arrive at the appropriate quantity of lime to be added, having due regard to the purity of lime, the type of soil, the moisture-density relationship, and the design CBR/Unconfident Compressive Strength (UCS) value specified in the Contract. The laboratory CBR/UCS value shall be at least 1.5 times the minimum field value of CBR/UCS stipulated in the Contract.

402.2.4 Water:

The water to be used for lime stabilisation shall be clean and free from injurious substances. Potable water shall be preferred.

402.3 Construction Operations

402.3.1 Weather limitations:

Lime-soil stabilisation shall not be done when the air temperature in the shade is less than 10 C.

402.3.2 Degree of pulverisation:

For lime-soil stabilisation, the soil before addition of stabiliser, shall be pulverised using agricultural implements like disc harrows (only for low volume roads) and rotavators to the extent that it passes the requirements set out in Table 400-3 when tested in accordance with the method described in Appendix -3, “Method of Sieving for wet soils to determine the degree of pulverisation”.

TABLE 400-3.

SOIL PULVERISATION REQUIREMENTS FOR LIME STABILISATION

IS Sieve Designation	Minimum Percent by weight passing the IS Sieve
26.5mm	100
5.6mm	80

402.3.3 Equipment for Construction:

Stabilised soil sub-bases shall be constructed by mix-in-place method of construction or as otherwise approved by the Engineer. Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations, as in small-sized jobs.

The equipment used mix-in-place construction shall be rotavator or similar approved equipment capable of pulverising and mixing the soil with additive and water to specified degree to the full thickness of the layer being processed, and of achieving the desired degree of mixing and uniformity of the stabilised material. If so desired by the Engineer, trail runs with the equipment shall be carried out to establish its suitability for work.

The thickness of any layer to be stabilised shall be not less than 100 mm when compacted. The maximum thickness shall be 200 mm, provided the plant used is accepted by the Engineer.

402.3.4 Mix-in-place method of construction:

Before deploying the equipment, the soil after it is made free of undesirable vegetation or other deleterious matters shall be spread uniformly on the prepared sub-grade in a quantity sufficient to achieve the desired compacted thickness of the stabilised layer. Where single-pass equipment is to be employed, the soil shall be lightly rolled at the discretion of the Engineer.

The Equipment used shall either be of single-pass or multiple pass type. The mixers shall be equipped with an appropriate device for controlling the depth of processing and the mixing blades shall be maintained or reset periodically so that the correct depth of mixing is obtained at all times.

With single-pass equipment the forward speed of the machine shall be so selected in relation to the rotor speed that the required degree of mixing, pulverisation and depth of processing is obtained. In multiple-pass processing, the prepared sub-grade shall be pulverised to the required depth with successive passes of the equipment and the moisture content adjusted to be within prescribed limits mentioned hereinafter. The blending or stabilising material shall then be spread uniformly and mixing continued with successive passes until the required depth and uniformity of processing have been obtained.

The mixing equipment shall be so set that it cuts slightly into the edge of the adjoining lane processed previously so as to ensure that all the material forming a layer has been properly processed for the full width.

402.3.5 Construction with manual means:

Where manual mixing is permitted, the soil from borrow areas shall first be freed of all vegetation and other deleterious matter and placed on the prepared sub-grade. The soil shall then be pulverised by means of crow-bars, pick axes or other means approved by the Engineer.

Water in requisite quantities may be sprinkled on the soil for aiding pulverisation. On the pulverised soil, the blending materials(s) in requisite quantities shall be spread uniformly and mixed thoroughly by working with spades or other similar implement till the whole mass is uniform. After adjusting the moisture content to be within the limits mentioned later, the mixed material shall be levelled up to the required thickness so that it is ready to be rolled.

402.3.6 Addition of Lime :

Lime may be mixed with the prepared material either in slurry form or dry state at the option of the Contractor with the approval of the Engineer.

Dry lime shall be prevented from blowing by adding water to the lime or other suitable means selected by the Contractor, with the approval of the Engineer.

The tops of windrowed material may be flattened or slightly trenched to receive the lime. The distance to which lime may spread upon the prepared material ahead of the mixing operation shall be determined by the Engineer.

No traffic other than the mixing equipment shall be allowed to pass over the spread lime until after completion of mixing.

Mixing or re-mixing operations, regardless of equipment used, shall continue until the material is free of any white streaks or pockets of lime and the mixture is uniform.

Non-uniformity of colour reaction, when the treated material is tested with the standard phenolphthalein alcohol indicator, will be considered evidence of inadequate mixing.

402.3.7 Moisture content for compaction:

The moisture content at compaction checked vide IS: 2720 (Part 2) shall neither be less than the optimum moisture content corresponding to IS: 2720 (Part 8) nor more than 2 per cent above it.

402.3.8 Rolling:

Immediately after spreading, grading and levelling of the mixed material, compaction shall be carried out with approved equipment preceded by a few passes of lighter rollers if necessary. Rolling shall commence at edges and progress towards centre, except at superelevated portions where it shall commence at the inner edge and progress towards outer edge. During rolling the surface shall be frequently checked for grade and cross-fall (camber) and any irregularities corrected by loosing the material and removing/adding fresh material. Compaction shall continue until the density achieved is at least 98 per cent of the maximum dry density for the material determined in accordance with IS: 2720 (Part 8).

Care shall be taken to see that the compaction of lime stabilised material is completed within three hours of its mixing or such shorter period as may be found necessary in dry weather.

During rolling it shall be ensured that roller does not bear directly on hardened or partially hardened treated material previously laid other than what may be necessary for achieving the specified compaction at the joint. The final surface shall be well closed, free from movement under compaction planes, ridges, cracks or loose material. All loose or segregated or otherwise defective areas shall be made good to the full thickness of the layer and re-compacted.

402.3.9 Curing:

The sub-base course shall be suitably cured for a minimum period of 7 days after which subsequent pavement courses shall be laid to prevent the surface from drying out and becoming friable. No traffic of any kind shall ply over the completed sub-base unless permitted by the Engineer.

402.4 Surface Finish and Quality Control of Work

The surface finish of construction shall confirm to the requirements of Clause 902. Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900.

402.5 Strength

When lime is used for improving the sub-grade, the soil-lime mix shall be tested for its CBR value. When lime stablised soil is used in a sub-base, it shall be tested for unconfined compressive strength (UCS) at 7 days. In case of variation from the design CBR/UCS, in situ value being lower, the pavement design shall be reviewed based on the actual CBR/UCS value shall be constructed by the Contractor at his own cost.

402.6 Arrangements for Traffic

During the period of construction, arrangements for traffic shall be provided and maintained in accordance with Clause 112.

402.7 Measurements for Payment

Stabilised soil sub-graded sub-base shall be measured as finished work in position in cubic metres.

402.8 Rate

The Contract unit rate for lime stabilised soil sub-graded/sub-base shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 401.7 (i) to (v).

406. WET MIX MACADAM SUB-BASE / BASE

406.1. SCOPE

This work shall consist of clean aggregates mechanically interlocked by rolling and bonding together with sceening, binding material where necessary and water laid on a properly prepared subgrade/sub-base/base or existing pavement, as the case may be and finsihed in accordance with the requirements of these specifications and in close conformity with the lines, grades, cross-sections and thickness as per approved plans or as directed by the Engineer.

The thickness of a single compacted Wet Mix Macadam layer shall not be less than 75 mm. When vibrating or other approved types of compacting equipment are used, the compacted depth of a single layer of the sub-base course may be upto 200 mm with the approval of the Engineer.

406.2. MATERIALS

406.2.1. Aggregates

406.2.1.1. Physical requirements:

Coarse aggregates shall be crushed stone. If crushed gravel is used, not less than 90 percent by weight of the gravel pieces retained on 4.75 mm sieve shall have at least two fractured faces. The aggregates shall conform to the physical requirements as given below table 400-12.

TABLE 400-12 PHYSICAL REQUIREMENTS OF COARSE AGGREGATES FOR WET MIX MACADAM FOR SUB-BASE/BASE COURSES

Test		Test Method	Requirements
1.	• Los Angeles Abrasion Value* Or • Aggregate Impact Value*	IS : 2386 (Part – 4) IS : 2386 (Part – 4) or IS:5640 **	40 per cent (Max) 30 per cent (Max)
2.	Combined Flakiness and Elongation Indices (Total)	IS : 2386 (Part – 1)	30 per cent (Max)**

* Aggregate may satisfy requirements of either of the two tests.

** To determine this combined proportion, the flaky stone from a Representative sample should first be separated out. Flakiness index is weight of flaky stone metal divided by weight of stone sample. Only the elongated particles be separated out from the remaining (non-flaky) stone metal. Elongation index is weight of elongated particles divided by total non-flaky particles. The value of flakiness index and elongation index so found are added up.

If the water absorption value of the coarse aggregate is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as per IS: 2386 (Part-5).

406.2.1.2. Grading Requirements

The aggregates shall conform to the grading given in Table 400-13.

TABLE 400-13. GRADING REQUIR EMENTS OF AGGREGATES FOR WET MIX MACADAM

IS Sieve Designation	Per Cent by Weight Passing IS Sieve
53 mm	100
45 mm	95-100
26.50 mm	-
22.4 mm	60-80
11.2 mm	40-60
4.75 mm	25-40
2.36 mm	15-30
600 micron	8-22
75 micron	0-5

Materials finer than 425 micron shall have Plasticity Index (PI) not exceeding 6.

The final gradation approved within these limits shall be well graded from

coarse to fine and shall not vary from the low limit on one sieve to the high

limit on the adjacent sieve or vice versa.

406.3. CONSTRUCTION OPERATIONS

406.3.1. Preparation of base:

Clause 404.3.1 shall apply.

406.3.2. Provision of lateral confinement of aggregates:

While constructing wet mix macadam, arrangement shall be made for the lateral confinement of wet mix. This shall be done by laying materials in adjoining shoulders along with that of wet mix macadam layer and following the sequence of operations described in Clause 404.3.3.

406.3.3. Preparation of mix:

Wet Mix Macadam shall be prepared in an approved mixing plant of suitable capacity having provision for controlled addition of water and forced/positive mixing arrangement like pugmill or pan type mixer of concrete batching plant. The plant shall have features:

i. For feeding aggregates – three/four bin feeders with variable speed motor
ii. Vibrant screen for removal oversize aggregates
iii. Conveyor belt'
iv. Controlled system for addition of water
v. Forced/positive mixing arrangement like pug-mill or pan type mixer
vi. Centralized control panel for sequential operation of various devices and precise process control
vii. Safety devices

Optimum moisture for mixing shall be determined in accordance with IS: 2720 (Part-8) after replacing the aggregate fraction retained on 22.4 mm sieve with material of 4.75 mm to 22.4 mm size. While adding water, due allowance should be made for evaporation losses. However, at the time of compaction, water in the wet mix should not vary from the optimum value by more than agreed limits. The mixed material should be uniformly wet and no segregation should be permitted.

406.3.4. Spreading of mix:

Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared subgrade/sub-base/base in required quantities. In no case should these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed stretch be permitted.

The mix may be spread either by a paver finisher or motor grader. The paver finisher shall be self-propelled, having the following features:

i. Loading hoppers and suitable distribution system, so as to provide a smooth uninterrupted material flow for different layer thickness from the tipper to the screed.

ii. Hydraulically operated telescopic screed for paving width up to 8.5m and fixed screed beyond this. The screed shall have tamping and vibrating arrangement for initial compaction of the layer.

iii. Automatic levelling control system with electronic sensing device to maintain mat thickness and cross slope of mat during laying procedure.

In exceptional cases where it is not possible for the paver to be utilized, mechanical means like motor grader may be used with the prior approval of the Engineer. The motor grader shall be capable of spreading the material uniformly all over the surface.

The surface of the aggregate shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. The layer may be tested by depth blocks during construction. No segregation of larger and fine particles should be allowed. The aggregates as spread should be of uniform gradation with no pockets of fine materials.

The Engineer may permit manual mixing and/or laying of wet mix macadam where small quantity of wet mix macadam is to be executed. Manual mixing/laying in inaccessible/remote locations and in situations where use of machinery is not feasible can also be permitted. Where manual mixing/laying is intended to used, the same shall be done with the approval of the Engineer.

406.3.5. Compaction:

After the mix has been laid to the required thickness, grade and crossfall/camber the same shall be uniformly compacted, to the full depth with suitable roller. If the thickness of single compacted layer does not exceed 100 mm, smooth wheel roller of 80 to 100 kN weight may be used. For a compacted single layer upto 200 mm, the compaction shall be done with the help of vibratory roller of minimum static weight of 80 to 100 kN or equivalent capacity roller. The speed of the roller shall not exceed 5 km/h.

In portions having unidirectional cross fall/super elevation, rolling shall commence from the lower edge and progress gradually towards the upper edge. Thereafter, roller should progress parallel to the centre line of the road, uniformly over-lapping each preceding track by at least one third width until the entire surface has been rolled. Alternate trips of the roller shall be terminated in stops at least 1 m away from any preceding stop.

In portions in camber, rolling should begin at the edge with the roller running forward and backward until the edges have been firmly compacted. The roller shall then progress gradually towards the centre parallel to the centre line of the road uniformly overlapping each of the preceding track by at least one third width until the entire surface has been rolled.

Any displacement occurring as a result of reversing of the direction of a roller or from any other cause shall be corrected at once as specified and/or removed and made good.

Along forms, kerbs, walls or other places not accessible to the roller, the mixture shall be thoroughly compacted with mechanical tampers or a plate compactor. Skin

patching of an area without scarifying the surface to permit proper bonding of the added material shall not be permitted.

Rolling should not be done when the subgrade is soft or yielding or when it causes a wave-like motion in the sub-base/base course or subgrade. If irregularities develop during rolling which exceed 12 mm when tested with a 3 meter straight edge, the surface should be loosened and premixed material added or removed as required before rolling again so as to achieve a uniform surface conforming to the desired grade and cross fall. In no case should the use of unmixed material be permitted to make up the depressions.

Rolling shall be continued till the density achieved is at least 98 per cent of the maximum dry density for the material as determined by the method outlined in IS: 2720 (Part-8).

After completion, the surface of any finished layer shall be well-closed, free from movement under compaction equipment or any compaction planes, ridges, cracks and loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of the layer and recompacted.

406.3.6. Setting and drying

After final compaction of wet mix macadam course, the road shall be allowed to dry for 24 hours.

406.4. OPENING TO TRAFFIC

No vehicular traffic shall be allowed on the finished wet mix macadam surface. Construction equipment may be allowed with the approval of the Engineer.

406.5. SURFACE FINISH AND QUALITY CONTROL OF WORK

406.5.1. The surface finish of construction shall confirm to the requirements of Clause 902.

406.5.2. Control on the quality of materials and works shall be exercised by the Engineer in accordance with Section 900.

409 CEMENT CONCRETE KERB

409.1 SCOPE

This work shall consist of constructing cement concrete kerbs along the Footpath in conformity with the lines, levels and dimensions as specified in the drawings or as directed by the Engineer.

409.2 MATERIALS

Kerbs shall be provided in cement concrete of grade M20 in accordance with clause 1700 of these specifications.

409.3 TYPE OF CONSTRUCTION

These shall be cast-in-situ construction with suitable kerb casting machine in all situations except at locations where continuous casting with equipment is not practicable. In those situations pre-cast concrete blocks shall be used.

409.4 EQUIPMENT

A continuous kerb casting equipment of adequate capacity and controls, capable of laying the kerbs in required cross-sections and procuring a well-compacted mass of concrete free of voids and honeycombs, shall be used.

409.5 CONSTRUCTION OPERATION

409.5.1 Kerbs shall be laid on firm foundation of minimum 150mm concrete of M15 grade cast in situ or on extended width of pavement; the foundation shall have a projection of 50mm beyond the kerb stone. Before laying the foundation of lean concrete, the base shall be levelled and slightly watered to make it damp.

409.5.2 In the median portions in the straight reaches, the kerb shall be cast in continuous lengths. In the portions where footpath is provided and/or the slope of the carriageway is towards median (as in case of super elevated portions), there shall be sufficient gap/recess left in the kerb to facilitate drainage openings.

409.5.3 After laying the kerbs and just prior to hardening of the concrete, saw-cut grooves shall be provided at 5m intervals or as specified by the Engineer.

409.5.4 Kerbs on the drainage ends such as along the footpath or the median in super elevated portions shall be cast with monolithic concrete channels as indicated in drawings. The slope of the channel towards drainage pipes shall be ensured for efficient drainage of the road surface.

409.5.5 Vertical and horizontal tolerance with respect to true line and level shall be ±6mm.

409.6 MEASUREMENT FOR PAYMENT

409.6.1 Cement concrete kerb/kerb drains shall be measured in linear metre for the complete item of work.

409.7 RATES

The contract unit rates for cement concrete kerb/kerb drain and foundation for kerb shall be payment in full compensation for furnishing all materials, labour, tools, equipment for construction and other incidental cost necessary to complete the work.

410 FOOTPATHS AND SEPARATORS

410.1 Scope

The work shall consist of constructing footpaths and/or separators at locations as specified in the drawings or as directed by the Engineer.

The lines, levels and dimensions shall be as per the drawings. The scope of the work shall include provision of all drainage arrangements as shown in the drawings or as directed by the Engineer.

410.2 Materials

The footpaths and separators shall be constructed with any of the following types:

a) Cast-in-situ cement concrete of Grade M 20 as per Section 1700 oftheSpecifications. The minimum size of the panels shall be as specified inthe drawings.

b) Precast cement concrete blocks and interlocking blocks/tiles of grade not less than M 30 as per Section 1700 of the Specifications. The thickness and size of the cement concrete blocks or interlocking blocks/ tiles shall be as specified in the drawings.

c) Natural stone slab cut and dressed from stone of good and sound quality, uniform in texture, free from defects and at least equal to a sample submitted by the Contractor and approved by the Engineer. The thickness and size of the natural stone slab shall be as specified in the drawings.

410.3 Construction Operations

410.3.1 Drainage pipes below the footpath originating from the kerbs shall be first

laid in the required slope and connected to the drains/sumps/storm water drain/drainage chutes as per provisions of the drawings, or as specified.

410.3.2 Portion on back side of kerbs shall be filled and compacted with granular

sub-base material as per Clause 401 of the Specifications in specified thickness.

410.3.3 The base for cast-in-situ cement concrete panels/ tiles/ nature stone slab shall be prepared and finished to the required lines, levels and dimensions as indicated in the drawings. Over the prepared base, precast concrete interlocking blocks/tiles/natural stone slabs and/or cast-in- situ slab shall be set/laid as described in Clauses 410.3.4 and 410.3.5.

410.3.4 Tiles/Natural Stone Slabs

The blocks/tiles/slabs shall be set on a layer of average 12 mm thick cement-sand mortar (1 :3) laid on prepared base in such a way that there is no rocking. The gaps between the blocks/tiles/slabs shall not be more than 12 mm and shall be filled with cement-sand mortar (1 :3).

410.3.5 Cast-in-5itu Cement Concrete

The panels of specified size shall be cast on the prepared base in panels of specified size in a staggered manner. Construction joints shall be provided as per Section 1700 of the Specifications.

410.3.6 Precast Concrete Blocks and Interlocking Concrete Block Pavements)

The precast concrete blocks and interlocking concrete block pavement shall be laid on a bedding of sand of thickness specified in the drawing. The grading of the sand layer shall be as in Table 400-16.

Table 400-16

IS Sieve Size	Percent Passing
9.52 mm	100
4.75 mm	95–100
2.36 mm	80–100
1.18 mm	50–95
600 micron	25–60
300 micron	10–30
150 micron	0–15
75 micron	0–10

The joints shall be filled with sand passing a 2.35 mm size with the grading as in

Table 400-17.

IS Sieve Size	Percent Passing
2.36 mm	100
1.18 mm	90–100
600 micron	60–90
300 micron	30–60
150 micron	15–30
75 micron	0–10

The bedding sand slightly moist, the moisture content being about 4 percent. The bedding sand shall be compacted by vibratory plate compactor.

The blocks shall be laid to the levels indicated on the drawings and to the pattern directed by the Engineer. The surface tolerance shall be ±10 mm with respect to the design level. The blocks shall be embedded using a hammer.

410.4 Measurements for Payment

Footpaths and separators shall be measured in Sq.m between inside of kerbs. The edge restraint block and kerb shall be measured separately in linear meter. The items pertaining to drainage shall be measured separately.

410.5 **Rate**

Contract unit rates shall be inclusive of full compensation for all labour, materials, tools equipment for footpaths including the base. Cost of providing pipes and arrangement for their discharge into appropriate drainage channels shall be incidental to the construction of footpaths.

502 PRIME COAT OVER GRANULAR BASE

502.1 SCOPE

This work shall consist of the application of a single coat of low viscosity liquid bituminous material to a porous granular surface preparatory to the superimposition of bituminous treatment or mix. The work shall be carried out on a previously prepared granular/ stabilized surface to Clause 501.8.

502.2 Materials

502.2.1 The primer shall be cationic bitumen emulsion SS1 grade conforming Bto IS: 8887 or medium curing cutback bitumen conforming to IS:217 or as specified in the Contract.

502.2.2 Quantity of SS1 grade bitumen emulsion for various types of granular surface shall be as given in Table 500-3.

Table;- 500-3 Quantity of Bitumen Emulsion for Various Types of Granular Surfaces

Type of Surface	Rate of Spray (kg/sq.m)
WMM/WBM	0.7–1.0
Stabilized soil bases/Crusher Run Macadam	0.9–1.2

502.2.3 Cutback for primer shall not be prepared at the site. Type and quantity of cut back bitumen for various types of granular surface shall be as given in Table 500-4.

Table;- 500-4 Type and Quantity of Cutback Bitumen for Various Types of Granular Surface

Type of Surface	Type of Cutback	Rate of Spray (kg/sq.m)
WMM/WBM	MC 30	0.6–0.9
Stabilized soil bases/ Crusher Run Macadam	MC 70	0.9–1.2

502.2.3

502.2.4 The correct quantity of primer shall be decided by the Engineer and shall be such that it can be absorbed by the surface without causing run-off of excessive primer and to achieve desired penetration of about 8-10 mm.

502.3 Weather and Seasonal Limitations

Primer shall not be applied during a dust storm or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 100C. Cutback bitumen as primer shall not be applied to a wet surface. Surfaces which are to receive emulsion primer should be damp, but no free or standing water shall be present. Surface can be just wet by very light sprinkling of water.

502.4 Construction

502.4.1 Equipment

The primer shall be applied by a self-propelled or towed bitumen pressure sprayer equipped for spraying the material uniformly at specified rates and temperatures. Hand spraying shall not be allowed except in small areas, inaccessible to the distributor, or in narrow strips where '" primer shall be sprayed with a pressure hand sprayer, or as directed by the Engineer.

502.4.2 Preparation of Road Surface

The granular surface to be primed shall be swept clean by power brooms or mechanical sweepers and made free from dust. All loose material and other foreign

material shall be removed completely. If soil/ moo rum binder has been used in the WBM surface, part of this should be brushed and removed to a depth of about 2 mm so as to achieve good penetration.

502.4.3 Application of Bituminous Primer

After preparation of the road surface as per Clause 502.4.2, the primer shall be sprayed I uniformly at the specified rate. The method for application of the primer will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar and speed of forward movement. The Contractor shall demonstrate at a spraying trial, that the equipment and 'i method to be used is capable of producing a uniform spray, within the tolerances specified.

No heating or dilution of SS1 bitumen emulsion and shall be permitted at site. Temperature of cutback bitumen shall be high enough to permit the primer to be sprayed effectively though the jets of the spray and to cover the surface uniformly.

502.4.4 Curing of Primer and Opening to Traffic

A primed surface shall be allowed to cure for at least 24 hours or such other higher period as is found to be necessary to allow all the moisture/volatiles to evaporate before any subsequent surface treatment or mix is laid. Any unabsorbed primer shall first be blotted with a light application of sand, using the minimum quantity possible. A primed surface shall not be opened to traffic other than that necessary to lay the next course.

502.5 Quality Control of Work

For control of the quality of materials and the works carried out, the relevant provisions of Section 900 shall apply.

502.6 Arrangements for Traffic

During construction operations, arrangements for traffic shall be made in accordance with the provisions of Clause 112.

502.7 Measurement for Payment

Prime coat shall be measured in terms of surface area of application in square metres.

502.8 Rate

The contract unit rate for prime coat shall be payment in full for carrying out the required operations including full compensation for all components listed in Clause 401.7 (i) to (v) and as applicable to the work specified in these Specifications. Payment shall be made on the basis of the provision of prime coat at an application rate of quantity at 0.6 kg per square metre or at the rate specified in the Contract, with adjustment, plus or minus, for the variation between this quantity and the actual quantity approved by the Engineer after the preliminary trials referred to in Clause 502.4.3.

503 TACK COAT

503.1 SCOPE

The work shall consist of the application of a single coat of low viscosity liquid bituminous material to existing bituminous, cement concrete or primed granular

surface preparatory to the superimposition of a bituminous mix, when specified in the Contract or as instructed by the Engineer. The work shall be carried out on a previously prepared surface in accordance with Clause 501.8.

503.2 Materials

The binder used for tack coat shall be either Cationic bitumen emulsion (RS 1) complying with IS:8887 or suitable low viscosity paving bitumen of VG 10 grade conforming to IS:73. The use of cutback bitumen RC:70 as per IS:217 shall be restricted only for sites at sub-zero temperatures or for emergency applications as directed by the Engineer. The type and grade of binder for tack coat shall be as specified in the Contract or as directed by the Engineer.

503.3 Weather and Seasonal Limitations

Bituminous material shall not be applied during a dust storm or when the weather is foggy, rainy or windy or when the temperature in the shade is less than 10°C. Where the tack coat consists of emulsion, the surface shall be slightly damp, but not wet. Where the tack coat is of cutback bitumen, the surface shall be dry.

503.4 Construction

503.4.1 Equipment

The tack coat shall be applied bya self-propelled or towed bitumen pressure sprayer, equipped for spraying the material uniformly at a specified rate. Hand spraying shall not be permitted except in small areas, inaccessible to the distributor, or narrow strips, shall be sprayed with a pressure hand sprayer, or as directed by the Engineer.

503.4.2 Preparation of Base

The surface on which the tack coat is to be applied shall be clean and free from dust, dirt, and In any extraneous material, and be otherwise prepared in accordance with the requirements of Clauses 501.B. The granular or stabilized surfaces shall be primed as per Clause 502.Immediately before the application of the tack coat, the surface shall be swept clean with a mechanical broom, and high pressure air jet, or by other means as directed by the Engineer.

503.4.3 Application of Tack Coat

The application of tack coat shall be at the rate specified in Table 500-5, and it shall be applied uniformly. If rate of application of Tack Coat is not specified in the contract, then it shall be the rate specified in Table 500-5. No dilution or heating at site of RS1 bitumen emulsion shall be permitted. Paving bitumen if used for tack coat shall be heated to appropriate temperature in bitumen boilers to achieve viscosity less than 2 poise. The normal range of spraying temperature for a bituminous emulsion shall be 20°C to 70°C and for cutback, 50°C to BO°C. The method of application of tack coat will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar, and speed or forward movement. The Contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

Table 500-5

Type of Surface	Rate of Spray of Binder in Kg per sq. m
Bituminous surfaces	0.20 – 0.30
Granular surfaces treated with primer	0.25 – 0.30
Cement concrete pavement	0.30 – 0.35

: Rate of Application of Tack Coat

503.4.4 Curing of Tack Coat

The tack coat shall be left to cure until all the volatiles have evaporated before any subsequent construction is started. No plant or vehicles shall be allowed on the tack coat other than those essential for the construction.

503.5 Quality Control of Work

For control of the quality of materials and the works carried out, the relevant provisions of Section 900 shall apply.

503.6 Arrangements for Traffic

During construction operations, arrangements for traffic shall be made in accordance with the provisions of Clause 112.

503.7 Measurement for Payment

Tack coat shall be measured in terms of surface area of application in square metres.

503.8 Rate

The contract unit rate for tack coat shall be payment in full for carrying out the required

operations including for all components listed in Clause 401.8 (i) to (v) and as applicable to the work specified in these Specifications. The rate shall cover the proviSion of tack coat, at 0.2 kg per square metre or at the rate specified in the Contract, with the provision that the variation between this quantity and actual quantity of bitumen used will be assessed and the payment adjusted accordingly.

505 DENSE BITUMINOUS MACADAM

505.1 Scope

The specification describes the design and construction procedure for Dense Bituminous Macadam, (DBM), for use mainly, but not exclusively, in base/binder and profile corrective courses. The work shall consist of construction in a single or multiple layers of DBM on a previously prepared base or sub-base. The thickness of a single layer shall be 50 mm to 100 mm.

505.2 Materials

505.2.1 Bitumen

The bitumen shall be viscosity grade paving bitumen complying with the Indian Standard Specification IS:73, modified bitumen complying with Clause 501.2.1 or as otherwise specified in the Contract.

The type and grade of bitumen to be used shall be specified in the Contract.

505.2.2 Coarse Aggregates

The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on 2.36 mm sieve. They shall be clean, hard, durable, of cubical

shape, free from dust and soft or friable matter, organic or other deleterious substances. Where the Contractor's selected source of aggregates has poor affinity for bitumen, the Contractor shall produce test results that with the use of anti-stripping agents, the stripping value is improved to satisfy the specification requirements. The Engineer may approve such a source and as a condition for the approval of that source, the bitumen shall be treated with an approved anti-stripping agent, as per the manufacturer's recommendations, at the cost of the Contractor. The aggregates shall satisfy the requirements specified in Table 500-8.

Where crushed gravel is proposed for use as aggregate, not less than 90 percent by weight of the crushed material retained on the 4.75 mm sieve shall have at least two fractured faces.

505.2.3 Fine Aggregates

Fine aggregates shall consist of crushed or naturally occurring mineral material, or a combination of the two, passing the 2.36 mm sieve and retained on the 75 micron sieve. These shall be clean, hard, durable, dry and free from dust, and soft or friable matter, organic or other deleterious matter. Natural sand shall not be allowed in binder courses. However, natural sand upto 50 percent of the fine aggregate may be allowed in base courses. The fine aggregate shall have a sand equivalent value of not less than 50 when tested in accordance with the requirement of IS:2720 (Part 37). The plasticity index of the fraction passing the in 0.425 mm sieve shall not exceed 4, when tested in accordance with IS:2720 (Part 5).

505.2.4 Filler

Filter shall consist of finely divided mineral matter such as rock dust, hydrated lime or cement approved by the Engineer. The filler shall be graded within the limits indicated in Table 500-9. The filler shall be free from organic impurities and have a plasticity Index not greater than 4. The Plasticity Index requirement shall not apply if filler is cement or lime. Where the aggregates fail to meet the requirements of the water sensitivity test in Table 500-8, then 2 percent by total weight of aggregate, of hydrated lime shall be used and percentage of fine aggregate reduced accordingly.

505.2.5 Aggregate Grading and Binder Content

505.2.5.1. When tested in accordance with IS:2386 Part 1 (wet sieving method), the :l combined grading of the coarse and fine aggregates and filler for the particular mixture shall 3 fall within the limits given in Table 500-10 for grading 1 or 2 as specified in the Contract. To avoid gap grading, the combined aggregate gradation shall not vary from the lower limit on one sieve to higher limit on the adjacent sieve.

Table 500-8 : Physical Requirements for Coarse Aggregate for Dense Bituminous Macadam

Property	Test	Specification	Method of Test
Cleanliness (dust)	Grain size analysis	Max 5% passing 0.075 mm sieve	IS:2386 Part I
Particle shape	Combined Flakiness and Elongation Indices*	Max 35%	IS:2386 Part I
Strength	Los Angeles Abrasion Value or Aggregate Impact Value	Max 35% Max 27%	IS:2386 Part IV
Durability	Soundness either :Sodium Sulphate or Magnesium Sulphate	Max 12% Max 18%	IS:2386 Part V
Water Absorption	Water Absorption	Max 2%	IS:2386 Part III
Stripping	Coating and Stripping of Bitumen Aggregate Mix	Minimum retained coating 95%	IS:6241
Water Sensitivity	Retained Tensile Strength**	Min. 80%	AASHTO 283

*

To determine this combined proportion, the flaky stone from a representative sample should first be separated out. Flakiness index is weight of flaky stone metal divided by weight of stone sample. Only the elongated particles be separated out from the remaining (non-flaky) stone metal. Elongation index is weight of elongated particles divided by total non-flaky particles. The values of flakiness index and longation index so found are added up.

** If the minimum retained tensile test strength falls below 80 percent, use of anti tripping agent is recommended to meet the requirement.

Table 500-9 : Grading Requirements for Mineral Filler

IS sieve (mm)	Cumulative Percent Passing by Weight of Total Aggregate
0.6	100
0.3	95 – 100
0.075	85 – 100

Table 500-10 : Composition of Dense Graded Bituminous macadam

Grading	1	2
Nominal aggregate size*	37.5 mm	26.5 mm
Layer thickness	75 – 100 mm	50 – 75 mm
IS Sieve[1] (mm)	Cumulative % by weight of total aggregate passing	
45	100	
37.5	95 – 100	100
26.5	63-93	90-100
19	–	71-95
13.2	55-75	56-80
9.5	–	–
4.75	38-54	38-54
2.36	28-42	28-42
1.18	–	–
0.6	–	–
0.3	7 – 21	7 – 21
0.15	–	–
0.075	2 – 8	2-8
Bitumen content % by mass of total mix	Min 4.0**	Min 4.5**

* The nominal maximum particle size is the largest specified sieve size upon which any of the aggregate is retained

** Corresponds to specific gravity of aggregates being 2.7. In case aggregate have specific gravity more than 2.7, the minimum bitumen content can be reduced proportionately. Further the region where highest daily mean air temperature is 3aoC or lower and lowest daily air temperature is - 1 aoc or lower, the bitumen content may be increased by 0.5 percent.

505.2.5.2. Bitumen content indicated in Table 500-10 is the minimum quantity. The quantity shall be determined in accordance with Clause 505.3.

505.3 Mix Design

The bitumen content required shall be determined following the Marshall mix design procedure contained in Asphalt Institute Manual MS-2.The Fines to Bitumen (FIB) ratio by weight of total mix shall range from 0.6 to 1.2.

505.3.1 Requirements for the Mix

Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in Table 500-11.

Table 500-11 : Requirements for Dense Graded Bituminous Macadam

Properties	Viscosity Grade Paving Bitumen	Modified bitumen		Test Method
		Hot climate	Cold climate	
Compaction level	75 blows on each face of the specimen			
Minimum stability (kN at 600C)	9.0	12.0	10.0	AASHTO T245
Marshall flow (mm)	2 – 4	2.5 – 4	3.5 – 5	AASHTO T245
Marshall Quotient $\left(\frac{\text{Stability}}{\text{Flow}}\right)$	2 – 5	2.5 – 5		MS-2 and ASTM D2041
% air voids	3 – 5			
% Voids Filled with Bitumen (VFB)	65 – 75			
Coating of aggregate particle	95% minimum			IS:6241
Tensile Strength ratio	80% Minimum			AASHTO T 283
% Voids in Mineral Aggregate (VMA)	Minimum percent voids in mineral aggregate (VMA) are set out in Table 500-13			

505.3.2 Binder Content

The binder content shall be optimized to achieve the requirements of the mix set out inTable 500-11. The binder content shall be selected to obtain 4 percent air voids in the mix design. The Marshall method for determining the optimum binder content shall be adopted as described in the Asphalt Institute Manual MS-2.

Where maximum size of the aggregate is more than 26.5 mm, the modified Marshall method using 150 mm diametre specimen described in MS-2 and ASTM D 5581 shall be used. This method requires modified equipment and procedures. When the modified Marshall test is used, the specified minimum stability values in Table 500-12 shall be multiplied by 2.25, and the minimum flow shall be 3 mm.

Table 500-12 : Minimum Percent Voids In Mineral Aggregate (VMA)

Nominal Maximum Particle Size[1] (mm)	Minimum VMA Percent Related to Design Percentage Air voids		
	3.0	4.0	5.0
26.5	11.0	12.0	13.0
37.5	10.0	11.0	12.0

505.3.3 Job Mix Formula

The Contractor shall submit to the Engineer for approval at least 21 days before the start the work, the job mix formula proposed for use in the works, together with the following details:

i) Source and location of all materials;

ii) Proportions of all materials expressed as follows:

a) Binder type, and percentage by weight of total mix;

b) Coarse aggregate/Fine aggregate/Mineral filler as percentage by weight of total aggregate including mineral filler;

iii) A single definite percentage passing each sieve for the mixed aggregate;

iv) The individual grading of the individual aggregate fraction, and the proportion of each in the combined grading;

v) The results of mix design such as maximum specific gravity of loose mix (Gmm), compacted specimen densities, Marshall stability, flow, air voids, VMA, VFB and related graphs and test results of AASHTO T 283 Moisture susceptibility test;

vi) Where the mixer is a batch mixer, the individual weights of each type of aggregate, and binder per batch;

vii) Test results of physical characteristics of aggregates to be used;

viii) Mixing temperature and compacting temperature.

While establishing the job mix formula, the Contractor shall ensure that it is based on a correct and truly representative sample of the materials that will actually be used in the work and that the mix and its different ingredients satisfy the physical and strength requirements of these Specifications.

Approval of the job mix formula shall be based on independent testing by the Engineer for which samples of all ingredients of the mix shall be furnished by the Contractor as required by the Engineer.

The approved job mix formula shall remain effective unless and until a revised Job Mix

Formula is approved. Should a change in the source of materials be proposed, a new job mix formula shall be forwarded by the Contractor to the Engineer for approval before the placing of the material.

505.3.4 Plant Trials - Permissible *Variation* in Job Mix Formula

Once the laboratory job mix formula is approved, the Contractor shall carry out plant trials to establish that the plant can produce a uniform mix conforming to the approved job mix formula. The permissible variations of the individual percentages of the various ingredients in the actual mix from the job mix formula to be used shall be within the limits as specified in Table 500-13 and shall remain within the gradation band. These variations are intended to apply to individual specimens taken for quality control tests in accordance with Section 900.

Table 500-13 : Permissible Variations in the Actual Mix from the Job Mix Formula

Description	Base/binder Course
Aggregate passing 19 mm sieve or larger	± 8%
Aggregate passing 13.2 mm, 9.5 mm	± 7%
Aggregate passing 4.75 mm	± 6%
Aggregate passing 2.36 mm, 1.18 mm, 0.6 mm	± 5%
Aggregate passing 0.3 mm, 0.15 mm	± 4%
Aggregate passing 0.075 mm	± 2%
Binder content	± 0.3%
Mixing temperature	± 10°C

505.3.5 Laying Trials

Once the plant trials have been successfully completed and approved, the Contractor shall carry out laying trials, to demonstrate that the proposed mix can be successfully laid and compacted all in accordance with Clause 501. The laying trial shall be carried out on a suitable area which is not to form part of the works. The area of the laying trials shall be a minimum of 100 sq.m of construction similar to that of the project road, and it shall be in all respects, particularly compaction, the same as the project construction, on which the bituminous material is to be laid.

The Contractor shall previously inform the Engineer of the proposed method for laying and compacting the material. The plant trials shall then establish if the proposed laying plant, compaction plant, and methodology is capable of producing satisfactory results. The density of the finished paving layer shall be determined by taking cores, no sooner than 24 hours after laying, or by other approved method. The compacted layers of Dense Graded Bituminous Macadam (DBM) shall have a minimum field density equal to or more than 92% of the density based on theoretical maximum specific gravity (Gmm) obtained on the day of compaction in accordance with ASTM D 2041.

Once the laying trials have been approved, the same plant and methodology shall be applied to the laying of the material on the project, and no variation of either shall be acceptable, unless approved in writing by the Engineer, who may at his discretion require further laying trials.

505.4 Construction Operations

505.4.1 Weather and Seasonal Limitations

The provisions of Clause 501.5.1 shall apply.

505.4.2 Preparation of Base

The base on which Dense Graded Bituminous Material is to be laid shall be prepared in accordance with Clauses 501 and 902 as appropriate, or as directed by the Engineer.

505.4.3 Geosynthetics

Where Geosynthetics are specified in the Contract, this shall be in accordance with the requirements stated in Clause 703.

505.4.4 Stress Absorbing Layer

Where a stress absorbing layer is specified in the Contract, this shall be applied in accordance with the requirements of Clause 517.

505.4.5 Prime Coat

Where the material on which the dense bituminous macadam is to be laid is other than a bitumen bound layer, a prime coat shall be applied, as specified, in accordance with the provisions of Clause 502, or as directed by the Engineer.

505.4.6 Tack Coat

Where the material on which the dense bituminous macadam is to be laid is either bitumen bound layer or primed granular layer, tack coat shall be applied, as specified, in accordance with the provisions of Clause 503, or as directed by the Engineer.

505.4.7 Mixing arid Transportation of the Mix

The provisions as specified in Clauses 501.3 and 501.4 shall apply. Table 500-2 gives the mixing, laying and rolling temperature for dense mixes using viscosity grade bitumen. In case of modified bitumen, the temperature of mixing and compaction shall be higher than the mix with viscosity grade bitumen. The exact temperature depends upon the type and amount of modifier used and shall be adopted as per the recommendations of the manufacturer. In order to have uniform quality, the plant shall be calibrated from time to time.

505.4.8 Spreading

The provisions of Clauses 501.5.3 and 501.5.4 shall apply.

505.4.9 Rolling

The general provisions of Clauses 501.6 and 501.7 shall apply, as modified by the approved laying trials. The compaction process shall be carried out by the same plant, and using the same method, as approved in the laying trials, which may be varied only with the express approval of the Engineer in writing.

505.5 Opening to Traffic

It shall be ensured that the traffic is not allowed without the approval of the Engineer in writing, on the surface until the dense bituminous layer has cooled to the ambient temperature.

505.6 Surface Finish and Quality Control of Work

The surface finish of the completed construction shall conform to the requirements of Clause 902. All materials and workmanship shall comply with the provisions set out in Section 900 of these Specifications.

505.7 Arrangements for Traffic

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of Clause 112.

505.8 Measurement for Payment

Dense Graded Bituminous Materials shall be measured as finished work either in cubic metres, tonnes or by the square metre at a specified thickness as indicated in the Contract drawings, or documents, or as otherwise directed by the Engineer.

505.9 Rate

The contract unit rate for Dense Graded Bituminous Macadam shall be payment in full for carrying out all the required operations as specified and shall include, to all components listed in Clause 501.8.8.2. The rate shall include the provision of bitumen, at 4 percent and 4.5 percent by weight of the total mixture for grading 1 and grading 2 respectively. The variation in actual percentage of bitumen used shall be assessed and the payment adjusted plus or minus accordingly.

507 BITUMINOUS CONCRETE

507.1 Scope

This work shall consist of construction of Bituminous Concrete, for use in wearing and profile corrective courses. This work shall consist of construction in a single layer of bituminous concrete on a previously prepared bituminous bound surface. A single layer shall be 30 mm/40 mm/50 mm thick.

507.2 Materials

507.2.1 Bitumen

The bitumen shall conform to Clause 504.2.1.

507.2.2 Coarse Aggregates

The coarse aggregates shall be generally as specified in Clause 504.2.2, except that the aggregates shall satisfy the physical requirements of Table 500-16 and where crushed ravel is proposed for use as aggregate, not less than 95 percent by weight of the crushed material retained on the 4.75 mm sieve shall have at least two fractured faces.

Table 500-16 : Physical Requirements for Coarse Aggregate for Bituminous Concrete

Property	Test	Specification	Method of Test
Cleanliness (dust)	Grain size analysis	Max 5% passing 0.075 mm sieve	IS:2386 Part I
Particle shape	Combined Flakiness and Elongation Indices	Max 35%	IS:2386 Part I
Strength	Los Angeles Abrasion Value or Aggregate Impact Value	Max 30% Max 24%	IS:2386 Part IV
Durability	Soundness either:Sodium Sulphate or Magnesium Sulphate	Max 12% Max 18%	IS:2386 Part V
Polishing	Polished Stone Value	Min 55	BS:812-114
Water Absorption	Water Absorption	Max 2%	IS:2386 Part III
Stripping	Coating and Stripping of Bitumen Aggregate Mix	Minimum retained coating 95%	IS:6241
Water Sensitivity	Retained Tensile Strength*	Min 80%	AASHTO 283

* If the minimum retained tensile test strength falls below 80 percent, use of anti stripping agent is recommended to meet the requirement.

507.2.3 Fine Aggregates

The fine aggregates shall be all as specified in Clause 505.2.3.

507.2.4 Filler

Filler shall be as specified in Clause 505.2.4.

507.2.5 Aggregate Grading and Binder Content

When tested in accordance with IS:2386 Part 1 (Wet grading method), the combined rading of the coarse and fine aggregates and filler shall fall within the limits shown in Table 500-17. The grading shall be as specified in the Contract.

Table 500-17 : Composition of Bituminous Concrete Pavement Layers

Grading	1	2
Nominal aggregate size*	**19 mm**	**13.2 mm**
Layer thickness	**50 mm**	**30–40 mm**
IS Sieve[1] (mm)	**Cumulative % by weight of total aggregate passing**	
45		
37.5		
26.5	100	
19	90-100	100
13.2	59-79	90-100
9.5	52-72	70-88
4.75	35-55	53-71
2.36	28-44	42-58
1.18	20-34	34-48
0.6	15-27	26-38
0.3	10-20	18-28
0.15	5-13	12-20
0.075	2-8	4-10
Bitumen content % by mass of total mix	Min 5.2*	Min 5.4**

Notes:

* The nominal maximum particle size is the largest specified sieve size up on which any of the aggregate is retained.

** Corresponds to specific gravity of aggregate being 2.7. In case aggregate have specific gravity more than 2.7, the minimum bitumen content can be reduced proportionately. Further the region where highest daily mean air temperature is 30°C or lower and lowest daily air temperature is - 1 DoC or lower, the bitumen content may be increased by 0.5 percent.

507.3 Mix Design

507.3.1 Requirements for the Mix

Clause 505.3.1 shall apply.

507.3.2 Binder Content

Clause 505.3.2 shall apply.

507.3.3 Job Mix Formula

Clause 505.3.3 shall apply.

507.3.4 Plant Trials - Permissible Variation in Job Mix Formula

The requirements for plant trials shall be as specified in Clause 505.3.4, and permissible limits for variation as given in Table 500-18.

Table 500-18 : Permissible Variations in Plant Mix from the Job Mix Formula

Description	Permissible Variation
Aggregate passing 19 mm sieve or larger	± 7%
Aggregate passing 13.2 mm, 9.5 mm	± 6%
Aggregate passing 4.75 mm	± 5%
Aggregate passing 2.36 mm, 1.18 mm, 0.6 mm	± 4%
Aggregate passing 0.3 mm, 0.15 mm	± 3%
Aggregate passing 0.075 mm	± 1.5%
Binder content	± 0.3%
Mixing temperature	± 10°C

507.3.5 Laying Trials

The requirements for laying trials shall be as specified in Clause 505.3.5. The compacted layers of bituminous concrete (BC) shall have a minimum field density equal to or more than 92 percent of the average theoretical maximum specific gravity (G) obtained on the day of . mm compaction in accordance with ASTM 02041.

507.4 Construction Operations

507.4.1 Weather and Seasonal Limitations

The provisions of Clause 501.5.1 shall apply.

507.4.2 Preparation of Base

The surface on which the bituminous concrete is to be laid shall be prepared in accordance with Clauses 501 and 902 as appropriate, or as directed by the Engineer. The surface shall be thoroughly swept clean by mechanical broom and dust removed by compressed air. In locations where a mechanical broom cannot get access, other approved methods shall be used as directed by the Engineer.

507.4.3 Geosynthetics

Where Geosynthetics are specified in the Contract, this shall be in accordance with the requirements stated in Clause 703.

507.4.4 Stress Absorbing Layer

Where a stress absorbing layer is specified in the Contract, this shall be applied in accordance with the requirements of Clause 517.

507.4.5 Tack Coat

The provisions as specified in Clause 504.4.6 shall apply.

507.4.6 Mixing and Transportation of the Mix

The provisions as specified in Clauses 501.3,501.4 and 504.4.7shall apply.

507.4.7 Spreading

The general provisions of Clauses 501.6 and 501.7 shall apply, as modified by the approved laying trials.

507.4.8 Rolling

The general provisions of Clauses 501.6 and 501.7 shall apply, as modified by the approved laying trials.

507.5 Opening to Traffic

Provisions in Clause 504.5 shall apply.

507.6 Surface Finish and Quality

The surface finish of the completed construction shall conform to the requirements of Clause 902. All materials and workmanship shall comply with the provisions set out in Section 900 of these Specifications.

507.7 Control Arrangements for Traffic

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of Clause 112.

507.8 Measurement for Payment

The measurement shall be as specified in Clause 505.8.

507.9 Rate

The contract unit rate shall be all as specified in Clause 504.9, except that the rate shall include the provision of bitumen at 5.2 percent & 5.4 percent for grading 1 and grading 2 by weight of total mix respectively. The variation in actual percentage of bitumen used will be assessed and the payment adljusted plus and minus accordingly.

903 QUALITY CONTROL TESTS DURING CONSTRUCTION

903.1 General

The materials supplied and the works carried out by the Contractor shall conform to the specifications prescribed in the Clauses for the relevant items of work.

For ensuring the requisite quality of construction, the materials and works shall be subjected to quality control tests, as described hereinafter. The testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to carry out additional tests as frequently as he may deem necessary, to satisfy himself that the materials and works comply with the appropriate specifications. However, the number of tests recommended in Tables 900-3 and 900-4 may be reduced at the discretion of the Engineer if it is felt that consistency in the quality of materials can still be maintained with the reduced number of tests.

Test procedures for the various quality control tests are indicated in the respective Sections of these Specifications or for certain tests within this Section. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted engineering practice to the directions of the Engineer.

Table 900-3 : Control Tests and their Minimum Frequency for Sub-Bases and Bases

S. No.	Type of Construction	Test		Frequency (min.)
1)	Granular	i)	Gradation	One test per 400 cu.m
		ii)	Atterberg limits	One test per 400 cu.m
		iii)	Moisture content prior to compaction	One test per 400 cu.m
		iv)	Density of compacted layer	One test per 1000 sq.m
		v)	Deleterious constituents	As required
		vi)	CBR	As required
2)	Lime/Cement Stabilised Soil Sub-base	i)	Quality of lime/ cement	One test for each consignment subject to a minimum of one test per 5 tonnes
		ii)	Lime/Cement content	Regularly, through procedural checks
		iii)	Degree of pulverization	Periodically as considered necessary
		iv)	CBR or Unconfined Compressive Strength test on a set of 3 specimens	As required
		v)	Moisture content prior to compaction	One set of two tests per 500 sq.m
		vi)	Density of compacted layer	One set of two tests per 500 sq.m
		vii)	Deleterious constituents	As required
3)	Water Bound Macadam	i)	Aggregate Impact Value	One test per 1000 cu.m of aggregate
		ii)	Grading of aggregate	One test per 250 cu.m
		iii)	Combined Flakiness and Elongation Indices	One test per 500 cu.m of aggregate
		iv)	Atterberg limits of binding material	One test per 50 cu.m of binding material
		v)	Atterberg limits of screenings	One test per 100 cu.m of aggregate
4)	Wet Mix Macadam	i)	Aggregate Impact Value	One test per 1000 cu.m of aggregate
		ii)	Grading of aggregate	One test per 200 cu.m of aggregate
		iii)	Combined Flakiness and Elongation Indices	One test per 500 cu.m of aggregate
		iv)	Atterberg limits of portion of aggregate passing 425 micron sieve	One test per 200 cu.m of aggregate
		v)	Density of compacted layer	One set of three tests per 1000 sq.m

Table 900-4: Control Tests for Bituminous Works and their Minimum Frequency

5)	Dense Bituminous Macadam/Bituminous Concrete	i)	Quality of binder	Number of samples per lot and tests as per IS:73 or IRC:SP:53, IS:15462
		ii)	Aggregate Impact Value/ Los Angeles Abrasion Value	One test per 350 cu.m of aggregate for each source and whenever there is change in the quality of aggregate
		iii)	Flakiness and Elongation Indices	One test per 350 cu.m of aggregate for each source and whenever there is change in the quality of aggregate
		iv)	Soundness test (Sodium or Magnesium Sulphate test)	One test for each source and whenever there is change in the quality of aggregate
		v)	Water absorption of aggregates	One test for each source and whenever there is change in the quality of aggregate
		vi)	Sand equivalent test	One test for each source and whenever there is change in the quality of aggregate
		vii)	Plasticity Index	One test for each source and whenever there is change in the quality of aggregate
		viii)	Polished stone value	One test for each source and whenever there is change in the quality of aggregate
		ix)	Percentage of fractured face	One test per 350 cu.m of aggregate when crushed gravel is used
		x)	Mix grading	One set for individual constituent and mixed aggregate from dryer for each 400 tonnes of mix subject to minimum of two tests per day per plant
		xi)	Stability and voids analysis of mix including theoretical maximum specific of loose mix	Three tests for stability, flow value, density and void contents for each 400 tonnes of mix subject to minimum of two tests per day per plant
		xii)	Moisture Susceptibility of mix (AASHTO T283)	One test for each mix type whenever there is change in the quality or source of coarse or fine aggregate
		xiii)	Temperature of binder in boiler, aggregate in dryer and mix at the time of laying and compaction	At regular intervals
		xiv)	Binder content	One set for each 400 tonnes of mix subject to minimum of two tests per day per plant
		xv)	Rate of spread of mix material	After every 5th truck load
		xvi)	Density of Compacted layer	One test per 700 sq.m area

800 TRAFFIC SIGNS, MARKINGS AND OTHER ROAD APPURTENANCES

801 TRAFFIC SIGNS

801.1 Scope

The work shall consist of the fabrication, supply and installation of ground mounted traffic signs on roads. The details of the signs shall be as shown in the drawings and in conformity with the Code of Practice for Road Signs, IRC:67-2010.

801.2 Materials

The various materials and fabrication of the traffic signs shall conform to the following requirements:

801.2.1 Concrete

Concrete for foundation shall be of M 15 Grade as per Section 1700 or the grade shown on the drawings or otherwise as directed by the Engineer.

801.2.2 Reinforcing Steel

Reinforcing steel shall conform to the requirement of IS:1786 unless otherwise shown on the drawing.

801.2.3 Bolts, Nuts, Washers

High strength bolts shall conform to IS:1367 whereas precision bolts, iluts, etc., shall conform to IS:1364.

801.2.4 Plates and Supports

Plates and support sections for the sign posts shall conform to IS:226 and IS:2062 or any other relevant IS Specifications.

801.2.5 Substrate

Sign panels shall be fabricated on aluminium sheet, aluminium composite panel, fibre glass sheeting, or sheet moulding compound. Aluminum sheets used for sign boards shall be of smooth, hard and corrosion resistant aluminium alloy conforming to IS:736-Material Designation 24345 or 1900. Aluminium Composite Material (ACM) sheets shall be sandwiched construction with a thermoplastic core of Low Density Polyethylene (LOPE) between two thick skins/sheets of aluminium with overall thickness and 3 mm or 4 mm (as specified in the Contract), and aluminium skin of thickness 0.5 mm and 0.3 mm respectively on both sides.

The mechanical proportion of ACM and that of aluminium skin shall conform to the requirements *given* in Table 800-1, when tested in accordance with the test methods mentioned against each of them.

Table 800-1 : Specifications for Aluminium Composite Material (ACM)

S. No.	Description	Specification	
		Standard Test	Acceptable Value
A	**Mechanical Properties of ACM**		
1)	Peel off strength with retro reflective sheeting (Drum Peel Test)	ASTM D903	Min. 4 N/mm
2)	Tensile strength	ASTM E8	Min. 40 N/mm^2
3)	0.2% Proof Stress	ASTM E8	Min. 34 N/mm^2
4)	Elongation	ASTM E8	Min. 6%
5)	Flexural strength	ASTM 393	Min. 130 N/mm^2
6)	Flexural modulus	ASTM 393	Min. 44.00 N/mm^2
7)	Shear strength with Punch shear test	ASTM 732	Min. 30 N/mm^2
B	**Properties of Aluminium Skin**		
1)	Tensile strength (Rm)	ASTM E8	Min. 65 N/mm^2
2)	Modulus of elasticity	ASTM E8	Min. 70,000 N/mm^2
3)	Elongation	ASTM E8	A50 Min. 2%
4)	0.2% Proof Stress	ASTM E8	Min. 10 N/mm^2

801.2.6 Plate Thickness

Shoulder mounted ground sings with a maximum side dimension not exceeding, 600 mm shall not be less than 1.5 mm thick with Aluminium and 3 mm thick with Aluminium Composite Material. All other signs be at least 2 mm thick with Aluminium and 4 mm thick with Aluminium Composite Material. The thickness of the sheet shall be related to the size of the sign and its support and shall be such that it does not bend or deform under prevailing wind and other loads.

801.2.7 In respect of sign sizes not covered by IRC:67, the structural details (thickness, etc.) shall be as per the approved drawings or as directed by the Engineer.

801.3 Traffic Signs having Retro-Reflective Sheeting

801.3.1 General Requirements

The retro-reflective sheeting used on the sign shall consist of the white or coloured sheeting having a smooth outer surface which has the property of retro-ref/ection *over* its entire surface. It shall be weather-resistant and show colour fastness. It shall be new and unused and shall show no evidence of cracking, scaling, pitting, blistering, edge lifting or curling and shall have negligible shrinkage or expansion. A certificate of having tested the sheeting for co-efficient of retro-reflection, day/night time colour luminous, shrinkage, flexibility, linear removal, adhesion, impact resistance, specular gloss and fungus resistance and its having passed these tests shall be obtained from a Government Laboratory / institute, by the manufacturer of the sheeting. The retro-reflective sheeting shall be either of Engineering Grade material with enclosed lens, High Intensity Grade with encapsulated lens or Micro-prismatic Grade retro-reflective element material as given in Clauses

801.3.2 to 801.3.7. Guidance on the recommended application of each class of sheeting may be taken from IRC:67.

801.3.2 High Intensity Grade Sheeting

801.3.4.3 Prismatic Grade Sheeting (Type XI)

A Retro-reflective sheeting typically manufactured as a cube corner. The reflective sheeting shall be retro-reflective sheeting made of micro prismatic retro-reflective material. The retro- reflective surface, after cleaning with soap and water and in dry condition shall have the minimum co-efficient of retro-reflection (determined in accordance with ASTM E 810) as indicated in Table 800-6.

Table 800-6 : Acceptable Minimum Co-efficient of Retro-Reflection for Prismatic Grade Sheeting Type A (Type XI) (Candelas Per Lux per Square Metre)

Obser-vation	Entrance Angle	White	Yellow	Orange	Green	Red	Blue	Brown	Fluore-scent Yellow/ Green	Fluore-scent Yellow	Fluore-scent Orange
0.1°B	-4°	830	620	290	83	125	37	25	660	500	250
0.1°B	+30°	325	245	115	33	50	15	10	260	200	100
0.2°	-4°	580	435	200	58	87	26	17	460	350	175
0.2°	+30°	220	165	77	22	33	10	7.0	180	130	66
0.5°	-4°	420	315	150	42	63	19	13	340	250	125
0.5°	+30°	150	110	53	15	23	7.0	5.0	120	90	45
1.0°	-4°	120	90	42	12	18	5.0	4.0	96	72	36
1.0°	+30°	45	34	16	5.0	7.0	2.0	1.0	36	27	14

A. Minimum Coefficient of Retro reflection (RA) *cdffcfft*> (cd-lx-1 m2)
B. Values for 0.1^0 observation angles are supplementary requirements that shall apply only when specified by the purchaser in the contract or order. When totally wet, the sheeting shall show not less than 90 percent of the values of retro reflection indicated in above Table. At the end of 10 years, the sheeting shall retain at least 80 percent of its original Retro-reflectance.

801.3.5 Adhesive

The sheeting shall have a pressure-sensitive adhesive of the aggressive-tack type requiring no heat, solvent other preparation for adhesion to a smooth clean surface, in a manner recommended by the sheeting manufacturer. The adhesive shall be protected by an easily removable liner (removable by peeling without soaking in water or other solvent) and shall be forma durable bond to smooth, corrosion and weather resistant surface of the base plate sucht hat it shall not be possible to remove the sheeting from the sign base in one piece by use of sharp instrument. The sheeting shall be applied in accordance with the manufacturer's specifications.

801.3.6 Fabrication

Surface to be reflectorised shall be effectively prepared to receive the retro-reflective sheeting. The aluminium sheeting shall be de-greased either by acid or hot alkaline etching and all scale/dust removed to obtain a smooth plain surface before the application of retro-reflective sheeting. If the surface is rough, approved surface primer may be used. After cleaning, metal shall not be handled, except by suitable device or clean canvas gloves, between all cleaning and preparation operation and application of reflective sheeting/primer. There shall be no opportunity for metal to come in contact with grease, oil or other contaminants prior to the application of retro-reflective sheeting. Complete sheets of the material shall be used on the signs except where it is unavoidable. At splices, sheeting with pressure-sensitive adhesives shall be overlapped not less than 5 mm. Where screen printing with transparent colours is proposed, only butt joint 'shall be used.- The material shall cover the sign surface evenly and shall be free from twists, cracks and folds. Cut-outs to produce legends and borders shall be bonded with the sheeting in the manner specified by the manufacturer.

801.3.7 Messages/Borders

The messages (legends, letters, numerals etc.) and borders shall either be screen-printed or of cut out from durable transparent overlay or cut out from the same type of reflective sheeting for the cautionary/mandatory sign boards. Screen printing shall be processed and finished with materials and in a manner specified by the sheeting manufacturer. For the informatory and other sign boards, the messages (legends, letters, numerals etc.) and borders shall be cut out from durable transparent overlay film or cut-out from the same reflective sheeting only. Cut-outs shall be from durable transparent overlay materials as specified by the sheeting manufacturer and shall be bonded with the sheeting in the manner specified by the manufacturer. For screen-printed transparent coloured areas on white sheeting, the coefficient of retro-reflection shall not be less than 50 percent of the values of corresponding colour in Tables 800-2 to 800-8 as applicable. Cut-out messages and borders, wherever used, shall be either made out of retro-reflective sheeting or made out of durable transparent overlay except those in black which shall be of non-reflective sheeting or opaque in case of durable transparent overlay.

801.3.8 Colour for Signs

801.3.8.1 Signs shall be provided with retro-reflective sheeting and/or overlay film screening ink. The reverse side of all signs shall be painted grey.

801.3.8.2 Except in the case of railway level crossing signs the sing posts shall be painted in 250 mm side bands, alternately black and white. The lowest band next to be ground shall be in black.

801.3.8.3 The colour of the material shall be located within the area defined by the chromaticity coordinates in Table 800-7 and comply with the luminance factor when measured as per ASTM 0-4956.

Table 800-7 : Colour Specified Limits (Daytime)

Colour	1		2		3		4		Daytime Luminance Factor (Y%)	
	x	y	x	y	x	y	x	y	Min.	Max.
White	0.303	0.300	0.368	0.366	0.340	0.393	0.274	0.329	15	- -
Yellow	0.498	0.412	0.557	0.442	0.479	0.520	0.438	0.472	24	45
Green	0.026	0.399	0.166	0.364	0.286	0.446	0.207	0.771	2.5	11
Red	0.648	0.351	0.735	0.265	0.629	0.281	0.565	0.346	2.5	11
Blue	0.140	0.035	0.244	0.210	0.190	0.255	0.065	0.216	1	10
Orange	0.558	0.352	0.636	0.364	0.570	0.429	0.506	0.404	12	30
Brown	0.430	0.340	0.610	0.390	0.550	0.450	0.430	0.390	1	6
Fluorescent Yellow-Green	0.387	0.610	0.369	0.546	0.428	0.496	0.460	0.540	60	- -
Fluorescent Yellow	0.479	0.520	0.446	0.483	0.512	0.421	0.557	0.442	45	- -
Fluorescent Orange	0.583	0.416	0.535	0.400	0.595	0.351	0.645	0.355	25	- -

The colours shall be durable and uniform in acceptable hue when viewed in day light or under normal headlights at night.

801.3.8.4 The Regulatory/Prohibitory and warning signs shall be provided with white background and red border. The legend/ symbol for these signs shall be in black colour. he Mandatory sign shall be provided with Blue background and white Symbol/letter.

801.3.8.5 The colours chosen for informatory or guide signs shall be distinct for different classes of roads. For National Highways and State Highways, these signs shall be of green' background and for Expressways these signs shall be of blue background with white border, legends and word messages.

801.3.9 Refurbishment

Where existing signs are specified for refurbishment, the sheeting shall have a semi-rigid aluminum backing or materials as per Clause 801.2,5, pre-coated with aggressive-tack type pressure sensitive adhesive. The adhesive shall be suitable for the type of material used for the sign and should thoroughly bond with that material.

801.3.10 Sizes of Letters

801.3.10.1 Letter size should be chosen with due regard to the speed, classification and location of the road, so that the sign is of adequate size for legibility but without being too large or obtrusive. The size of the letter, in terms of x-height, to be chosen as per the design speed is given in Table 800-8.

Table 800-8 : Acceptable Limits for Sizes of Letters

Design Speed (Km./hr.)	Minimum 'x' Height of the Letters (mm)	Minimum Sight Distance/ Clear Visibility Distance (m)	Maximum Distance from Centre Line (m)
40	100	45	12
50	125	50	14
65	150	60	16
80	250	80	21
100	300	90	24
120	400	115	32

The thickness of the letters and their relation to the x-height, the width, the heights are indicated in Table IV (a) of the Annexure-4 of IRC:67 to facilitate the design of the informatory signs and definition plates.

801.3.10.2 For advance direction signs on non-urban roads, the letter size ('x' height)

should be minimum of 150 mm for Expressway, National and State Highways and 100 mm for other roads. In case of overhead signs, the size ('X' height) of letters may be minimum. 300 mm. Thickness of the letter could be varied from 1/6 to 1/5 of the letter 'x' size. The size of the initial uppercase letter shall be 1-1/3 times x-height. In urban areas, letter size shall be 100 mm on all directional signs. For easy and better comprehension, the word messages shall be written in upper case letters only.

801.3.10.3 Letter size on definition plates attached with normal sized signs should be 100 mm or 150 mm. In the case of small signs, it should be 100 mm. Where the message is

long, as for instance in "NO PARKING" and "NO STOPPING" signs, the message may be broken into two lines and size of letters may be varied in the lines so that the definition plate is not too large. The lettering on definition plates will be all in upper case letters.

801.3.11 Warranty and Durability

The Contractor shall obtain from the manufacturer a ten year warranty for satisfactory field performance including stipulated retro-reflectance of the retro-reflective sheeting of micro-prismatic sheeting and a seven-year warranty for high intensity grade and submit the same to the Engineer. The warranty shall be inclusive of the screen printed or cut out letters/legends and their bonding to the retro-reflective sheeting. The Contractor/supplier shall also furnish the LOT numbers and certification that the signs and materials supplied against the assigned work meets all the stipulated requirements and carry the stipulated warranty and that the contractor/supplier is the authorized converter of the particular sheeting.

All signs shall be dated during fabrication with indelible markings to indicate the start of warranty. The warranty shall also cover the replacement obligation by the sheeting manufacturer as well as contractor for replacement/repair/restoration of the retro-reflective efficiency.

A certificate in original shall be given by the sheeting manufacturer that its offered retroreflective sheeting has been tested for various parameters such as co-efficient of retroreflection, day/night time colour and luminance, shrinkage, flexibility, linear removal, adhesion, impact resistance, specular gloss and fungus resistance; the tests shall be carried out by a Government Laboratory in accordance with various ASTM procedures and the results must show that the sheeting has passed the requirements for all the above mentioned parameters. A copy of the test reports shall be attached with the certificate.

801.4 Installation

801.4.1 The traffic signs shall be mounted on support posts, which may be of GI pipes conforming to IS:1239, Rectangular Hollow Section conforming to IS:4923 or Square Hollow Section conforming to IS:3589. Sign posts, their foundations and sign mountings shall be so constructed as to hold these in a proper and permanent position against the normal storm wind loads or displacement by vandalism. Normally, signs with an area up to 0.9 sq.m shall be mounted on a single post, and for greater area two or more supports shall be provided. Post-end(s) shall be firmly fixed to the ground by means of properly designed foundation. The work of foundation shall conform to relevant Specifications as specified.

801.4.2 All components of signs (including its back side) and supports, other than the reflective portion and G.I. posts shall be thoroughly de-scaled, cleaned, primed and painted with two coats of epoxy/ fiber glass/ powder coated paint. Any part of support post below ground shall be painted with protective paint.

801.4.3 The signs shall be fixed to the posts by welding in the case of steel posts and by bolts and washers of suitable size. After the nuts have been tightened, the tails of the bolts shall be furred over with a hammer to prevent removal.

801.5 Measurement for Payment

The measurement of standard cautionary, mandatory and information signs shall be in numbers of different types of signs supplied and fixed, while for direction and place identification signs, these shall be measured by area in square meters.

801.6 Rate

The Contract unit rate shall be payment in full for the cost of making the road sign, including all materials, installing it at the site furnishing of necessary test certificates, warranty and incidentals to complete the work in accordance with these Specifications.

803.4 Hot Applied Thermoplastic Road Marking

803.4.1 Thermoplastic Material

803.4.1.1 General

The thermoplastic material shall be homogeneously composed of aggregate, pigment, resins and glass reflectorizing beads. The colour of the compound shall be white or yellow (IS colour No. 356) as specified in the drawings or as directed by the Engineer.

803.4.1.2 Requirements:

i. Composition: The pigment, beads, and aggregate shall be uniformly dispersed in the resin. The material shall be free from all skins, dirt and foreign objects and shall comply with requirements indicated in Table *800-9.*

Table 800-9 : Proportions of Constituents of Marking Material (Percentage by Weight)

Component	White	Yellow
Binder	18.0 min.	18.0 min.
Glass Beads	30–30	30–30
Titanium Dioxide	10.0 min.	- -
Calcium Carbonate and Inert Fillers	42.0 max.	See Note below
Yellow Pigments	- -	See Note below

Note: Amount of yellow pigment, calcium carbonate and inert fillers shall be at the option of the manufacturer, provided all other requirements of this Specification are met.

ii. Properties: The properties of thermoplastic material, when tested in accordance with ASTM D36/BS-3262-(Part I), shall be as below:

a) luminance:

White: Daylight luminance at 45°-65 percent min. as per AASHTO M249

Yellow: Daylight luminance at 45°-45 percent min. as per AASHTO M 249

b) Drying time: When applied at a temperature specified by the manufacturer and to the required thickness, the material shall set to bear traffic in not more than 15 minutes.

c) Skid resistance: not less than 45 as per BS:6044.

d) Cracking resistance at low temperature: The material shall show no cracks on application to concrete blocks.

e) Softening point: 1 02.5°C ± 9.5°C as per ASTM D 36.

f) Yellowness index (for white thermoplastic paint): not more than 0.12 as per AASHTO M 249

iii. Storage life : The material shall meet the requirements of these Specifications for a period of one year. The thermoplastic material must also melt uniformly with no evidence of skins or unmelted particles for the one year storage period. Any material not meeting the above requirements shall be replaced by the manufacturer/supplier/Contractor.

iv. Reflectorisation: Shall be achieved by incorporation of beads, the grading and other properties of the beads shall be as specified in Clause 803.4.2.

v. Marking: Each container of the thermoplastic material shall be clearly and indelibly marked with the following information:

1) The name, trade mark or other means of identification of manufacturer
2) Batch number
3) Date of manufacture
4) Colour (white or yellow)
5) Maximum application temperature and maximum safe heating temperature.

vi. Sampling and Testing: The thermoplastic material shall be sampled and tested in accordance with the appropriate ASTM/BS method. The Contractor shall furnish to the Engineer a copy of certified test reports from the manufacturers of the thermoplastic material showing results of all tests specified herein and shall certify that the material meets all requirements of this Specification.

803.4.2 Reflectorizing Glass Beads

803.4.2.1 General

This Specification covers two types of glass beads to be used for the production of refiectorised pavement markings.

Type 1 beads are those which are a constituent of the basic thermoplastic compound vide Table 800-9 and Type 2 beads are those which are to be sprayed on the surface vide Clause 803.6.4.

803.4.2.2 The glass beads shall be transparent, colourless and free form milkiness,

dark particles and excessive air inclusions. These shall conform to the requirements spelt out in Clause 803.4.2.3.

803.4.2.3 Specific Requirements

a. Gradation: The glass beads shall meet the gradation requirements for the two types as given in Table 800-10.

Table 800-10: Gradation Requirements for Glass Beads

Sieve Size	Percent Retained	
	Type 1	Type 2
1.18 mm	0 to 3	
850 micron	5 to 20	0 to 5
600 micron	- -	5 to 20
425 micron	65 to 95	- -
300 micron	- -	30 to 75
180 micron	0-10	10 to 30
Below 180 micron	- -	0 to 15

b. Roundness: The glass beads shall have a minimum of 70 percent true spheres.

c. Refractive index: The glass beads shall have a minimum refractive index of 1.50.

d. Free flowing properties: The glass beads shall be free of hard lumps and clusters and shall dispense readily under any conditions suitable for paint striping. They shall pass the free flow-test.

803.4.2.4 Test Methods

The specific requirements shall be tested with the following methods:

i. Free-flow test: Spread 100 grams of beads evenly in a 100 mm diameter glass dish. Place the dish in a 250 mm inside diameter dessicator which is filled within 25 mm of the top of a dessicator plate with sulphuric acid water solution (specific gravity 1.10). Cover the dessicator and let it stand for 4 hours at 20°C to 29°C. Remove sample from dessicator, transfer beads to a pan and inspect for lumps or clusters. Then pour beads into a clean, dry glass funnel having a 100 mm stem and 6 mm orifice. If necessary, initiate flow by lightly tapping the funnel. The glass spheres shall be free of lumps and clusters and shall flow freely through the funnel.

ii. The requirements of gradation, roundness and refractive index of glass beads and the amount of glass beads in the compound shall be tested as per BS:6088 and BS:3262 (Part I).

iii. The Contractor shall furnish to the Engineer a copy of certified test reports from the manufacturer of glass beads obtained from a reputed laboratory showing results of all tests specified herein and shall certify that the material meets all requirements of these Specifications. However, if so required, these tests may be carried out as directed by the Engineer.

803.4.3 Application Properties of Thermoplastic Material

803.4.3.1 The thermoplastic material shall readily get screeded /extruded at temperatures specified by the manufacturers for respective method of application to produce a line of specified thickness which shall be continuous and uniform in shape having clear and sharp edges.

803.4.3.2 The material upon heating to application temperatures shall not exude fumes, which are toxic, obnoxious or injurious to persons or property.

803.4.4 Preparation

i. The material shall be melted in accordance with the manufacturer's instructions in a heater with a mechanical stirrer to give a smooth consistency to the thermoplastic material to avoid local overheating. The temperature of the mass shall be within the range specified by the manufacturer, and shall on. no account be allowed to exceed the maximum temperature stated by the manufacturer. The molten material should be

used as expeditiously as possible and for thermoplastic material which has natural binders or is otherwise sensitive to prolonged heating, the material shall not be maintained in a molten condition for more than 4 hours.

ii. After transfer to the laying equipment, the material shall be maintained within the temperature range specified by the manufacturer for achieving the desired consistency for laying.

803.5 Reflectorised Paint

Refiectorised paint, if used, shall conform to the Specification by the manufacturers and approved by the Engineer. Refiectorising glass beads for refiectorising paints where used shall conform to the requirements of Morth Clause 803.4.2.

803.6 Application

803.6.1 Marking shall be done by machine. For locations where painting cannot be done by machine, approved manual methods shall be used with prior approval of the Engineer. The Contractor shall maintain control over traffic while painting operations are in progress so as to cause minimum inconvenience to traffic compatible with protecting the workmen.

803.6.2 Where the compound is to be applied to cement concrete pavement, a sealing pnmier as recommended by the manufacturer, shall be applied to the pavement in advance of placing of the stripes to ensure proper bonding of the compound. On new concrete surface any laitance and/or curing compound shall be removed before the markings are applied.

803.6.3 The thermoplastic material shall be applied hot either by screeding or extrusion process. After transfer to the laying apparatus, the material shall be laid at a temperature within the range specified by the manufacturer for the particular method of laying being used. The paint shall be applied using a screed or extrusion machine.

803.6.4 The pavement temperature shall not be less than 10°C during application. All surfaces to be marked shall be thoroughly cleaned of all dust, dirt, grease, oil and all other foreign matter before application of the paint.

The material, when formed into traffic stripes, must be readily renewable by placing an overlay of new material directly over an old line. Such new material shall so bond itself to the old line that no splitting or separation takes place.

Thermoplastic paint shall be applied in intermittent or continuous lines of uniform thickness of at least 2.5 mm unless specified otherwise. Where arrows or letters are to be provided, thermoplastic compound may be hand-sprayed. In addition to the beads included in the material, a further quantity of glass beads of Type 2, conforming to the above noted Specification shall be sprayed uniformly into a mono-layer on to the hot paint line in quick succession of the paint spraying operation. The glass beads shall be applied at the rate of 250 grams per square metre area.

803.6.5 The minimum thickness specified is exclusive of surface applied glass beads. The method of thickness measurement shall be in accordance with Appendices Band C of BS:3262 (Part 3).

803.6.6 The markings shall be done to accuracy within the tolerances given below:

i. Width of lines and other markings shall not deviate from the specified width by more than 5 percent.

ii. The position of lines, letters, figures, arrows and other markings shall not eviate from the position specified by more than 20 mm

iii. The alignment of any edge of a longitudinal line shall not deviate from the specified alignment by more than 10 mm in 15 m.

iv. The length of segment of broken longitudinal lines shall not deviate from the specified length by more than 150 mm.

In broken lines, the length of segment and the gap between segments shall be as indicated on the drawings; if these lengths are altered by the Engineer, the ratio of the lengths of the painted sections shall remain the same.

803.6.7 Properties of Finished Road Markings

The finished lines shall be free from ruggedness on sides and ends and be parallel to the general alignment of the carriageway. The upper surface of the lines shall be level, uniform and free from streaks.

a) The stripe shall not be slippery when wet.

b) The marking shall not lift from the pavement in freezing weather.

c) After application and proper drying, the stripe shall show no appreciable deformation or discoloration under traffic and under road temperatures upto 60°C.

d) The marking shall not deteriorate by contact with sodium chloride, calcium chloride or oil dripping from traffic.

e) The stripe or marking shall maintain its original dimensions and position. Cold ductility of the material shall be such as to permit normal movement with the road surface without chopping or cracking.

f) The colour of yellow marking shall conform to IS Colour No. 356 as given in IS:164

803.6.8 Measurements for Payment

803.4.3.3 The painted markings shall be measured in sq. metres of actual area marked (excluding the gaps, if any).

803.4.3.4 8 In respect of markings like directional arrows and lettering, etc., the

803.6.9 Rate

The Contract unit rate for road markings shall be payment in full compensation for furnishing all labour, materials, tools, equipment, including all incidental costs necessary for carrying out the work at the site conforming to these Specifications complete as per the approved drawing(s) or as directed by the Engineer and all other incidental costs necessary to complete the work to these Specifications. Measurement shall be by numbers.

803 REFLECTIVE PAVEMENT MARKERS (ROAD STUDS)

804.1 Scope

The work shall cover the providing and fixing of reflective pavement marker (RPM) or road stud, a device which is bonded to or anchored within the road surface, for lane marking and delineation for night-time visibility, as specified in the Contract.

804.2 Material

804.2.1 Plastic body of RPM/road stud shall be moulded from ASA (Acrylic Styrene Acrylonitrite) or HIPS (Hi-impact Polystyrene) or Acrylonitrile Butadiene Styrene (ABS) or any other suitable material approved by the Engineer. The markers shall support a load of 13,635 kg tested in accordance with ASTM 04280.

804.2.2 Reflective panels shall consist of number of lenses containing single or dual prismatic cubes capable of providing total internal reflection of the light entering the lens face. Lenses shall be moulded of methyl methecrylate conforming to ASTM 0 788 or equivalent.

804.3 Design

The slope or retro-reflecting surface shall preferably be 35 ± 5° to base and the area of each retro-reflecting surface shall not be less than 13.0 sq.cm.

804.4 Optical Performance

804.4.1 Unidirectional and Bi-directional Studs

Each reflector or combination of reflectors on each face of the stud shall have a Coefficient of Luminous Intensity (C.I.L). not less than that given in Tables 800-13 or 800-14 as appropriate.

804.4.2 Omni-directional Studs

Each Omni-directional stud shall have a C.I.L. of not less than 2 mcd/l

Table 800-13 : Minimum C.I.L. Values for Category 'A' Studs

Entrance Angle	Observation Angle	C.I.L. in mcd/lx		
		White	Amber	Red
0° U 5° L &R	0.3°	220	110	44
0° U 10° L&R	0.5°	120	60	24

Table 800-14 : Minimum C.I.L. Values for Category 'B' Studs

Entrance Angle	Observation Angle	C.I.L. in mcd/lx		
		White	Amber	Red
0° U 6° L&R	0.3°	20	10	4
0° U 10° L&R	0.5°	15	7.5	3

Note:

1. The entrance angle of 0° U corresponds to the normal aspect of the reflectors when the reflecting road stud is installed in horizontal road surface.

2. The stud incorporating one or more corner cube reflectors shall be included in Category 't>;. The stud incorporating one or more bi-convex reflectors shall be included in Category 'B'.

804.5 Tests

804.5.1 Co-efficient of luminance intensity can be measured by procedure described

in ASTM E 809 "Practice for Measuring Photometric Characteristics" or as recommended in BS:873-Part 4: 1973.

804.5.2 Under test conditions, a stud shall not be considered to fail the photometric requirements if the measured C.I.L. at anyone position of measurement is less than the values specified in Tables 800-13 or 800-14 provided that

i) The value is not less than 80 percent of the specified minimum, and

ii) The average of the left and right measurements for the specific angle is greater than the specified minimum.

804.6 Solar Powered Road Markers (Solar Studs)

Deleted

804.7 Fixing of Reflective Markers

804.7.1 Requirements

The enveloping profile of the head of the stud shall be smooth and the studs shall not present any sharp edges to traffic. The reflecting portions of the studs shall be free from crevices or ledges where dirt might accumulate. Marker height shall not be less than 10 mm and shall not exceed 20 mm. and its width shall not exceed 130 mm. The base of the marker shall be flat within 1.3 mm. If the bottom of the marker is configured, the outermost faces of the configurations shall not deviate more than 1.3 mm from a flat surface. All road studs shall be legibly marked with the name, trade mark or other means of identification of the manufacturer.

804.7.2 Placement

The reflective marker shall be fixed to the road surface using the adhesives and the procedure recommended by the manufacturer. No nails shall be used to affix the marker so that they do not pose safety hazard on the roads. Regardless of the type of adhesive used, the markers shall not be fixed if the pavement is not surface dry and on new asphalt concrete surfacing until the surfacing has been opened to traffic for a period of not less than 14 hours. The portions of the highway surface, to which the marker is to be bonded by the adhesive, shall be free of dirt, curing compound, grease, oil, moisture, loose or unsound layers, paint and any other material which would adversely affect the bond of the adhesive.

The adhesive shall be placed uniformly on the cleaned pavement surface or on the bottom of the of the marker in a quantity sufficient to result in complete coverage of the area of contract of the marker with no voids present and with a slight excess after the marker has been lightly pressed in place. For epoxy installations, excess adhesive around the edge of the marker, excess adhesive on the pavement and adhesive on the exposed surfaces of the markers shall be immediately removed.

804.7.3 Warranty and Durability

The contractor shall submit a two year warranty for satisfactory field performance including stipulated retro-reflectance of the reflecting panel, to the Engineer. In

addition, a two year warranty for satisfactory infield performance of the finished road marker shall also be given by the contractor who carries out the work of fixing of reflective road markers. In case the markers are displaced, damaged, get worn out or lose their reflectivity compared to stipulated standards, the contractor would be required to replace all such markers within 15 days of the intimation from the Engineer, at his own cost.

804.8 Measurement for Payment

The measurement of reflective road markers/solar powered road studs shall be in numbers of different types of markers supplied and fixed.

804.9 Rate

The contract unit rate for reflective road markers/solar powered road studs shall be payment in full compensation for furnishing all labour, material, tools, equipment including incidental costs necessary for carrying out the work at site conforming to the specification complete as per approved drawings or as directed by the Engineer.

900 QUALITY CONTROL

Please refer to Clause 900, Quality Control for Road works in "Specifications for road and bridge works", (Fifth Revision) Ministry of Road Transport and Highways, Published by Indian Road Congress, New Delhi 2013.

3000 MAINTENANCE OF ROAD

Please refer to Clause 3005, Maintenance of Cement Concrete Road in "Specifications for road and bridge works", (Fifth Revision) Ministry of Road Transport and Highways, Published by Indian Road Congress, New Delhi 2013.

Paver Blocks

Providing and fixing pre-cast Rubber Dye inter locking concrete block 60mm thick with grade of concrete M-30 compressed by mechanically pressed and as per approved design including 50 mm Sand layer for levelling and filling the joint with sand in proper line and level etc complete.

Scope work:

The scope of work includes supplying and lying of precast paver blocks at site, as mentioned in the Item. All relevant provisions of IS 15658:2006 shall apply. Laying of paver blocks at site as per requirement in technical specification, within shortest possible time. The site is public place hence care should be taken to ensure that the routine activities shall not be disturbed. The job of laying may required to be carried out during night also. The work shall be executed in perfect line and level as per instructions of Engineer in charge. Colored concrete paver blocks shall be manufactured as per specifications using approved color pigment. The color shade shall be as selected by employer before commencement of the work. The contractor shall guarantee that all material and components designed, fabricated, supplied and laid by him shall be free from any type of defect due to faulty material and/Workmanship/erection For a period of One year from the date of completion of work.

TECHNICAL SPECIFICATION FOR LANDCAPING WORK

1.1 General

The works shall be performed conforming to the Indian Standard codes, P.H.D &P.W.D. specifications of the State Government. Wherever such specifications are not available, CPWD specifications, relevant references, manuals etc. shall be followed as directed by Owner.

For Horticulture and landscaping works OPWD Schedule of Rates, Analysis of Rate and Specifications (Horticulture & Landscaping) shall be followed.

1.2 General Specifications

Part-I: Entire area of the garden is mainly distributed as,

(a) Hardscape

The landscape area involves pathways under paver block, sand where most of the children's play equipment's are placed and Rubberized tile flooring for Outdoor Gym Equipments etc.

(b) Softscape

The balance area that is covered under Softscape (lawn development, shrubbery, trees, small and medium palms, specimen shrubs, etc.)

The entire area is mildly rolling more or less flat and to be cleared of all debris, rock pieces, stumps, weeds, roots etc. thoroughly.

The area will be properly graded in a slope of 1:100 from the as per availability of SWD to facilitate drainage of rain water into the drain of the adjoining road.

Contractor to maintain the site slope as per the survey levels. Slope prepared for all finished surfaces shall be in a fashion to flow all storm water collected towards the nearest SWD available.

As per the plan, marking will be given on the land showing Hardscape area path under paver block, EPDM flooring and the rest area marked for Softscape area.

The area under Hardscape will be taken up under civil work. The balance area under Softscape will be treated by trenching, rough dressing, flooding with water, uprooting weeds, stumps etc. Operations involved in landscaping, procurement of manures, staking, digging of pits etc, measurements, rates, qualities of materials will be in accordance to the principles as laid out in Sub- head 2.0 of CPWD Analysis, 2016, Horticulture and Landscaping.

Irrigation Layout based on type of irrigation system finalized to be prepared and detailed at the later stages based on the survey drawings and availability of existing water source. Layout to be submitted for approval of Engineer in charge, and based on the approval, irrigation system shall be installed by contractor at site.

Part-II: Species to be planted:-

As specified in drawing

1.3 Horticulture Work

Horticultural operations shall be started on ground previously levelled and dressed to required

formation levels and slopes.

In case where unsuitable soil is met with, it shall be either removed or, replaced or it shall be covered over to a thickness decided by the Engineer-in-charge with good earth.

In the course of excavation or trenching during horticultural operations, any walls, foundations, etc. met with shall not be dismantled without pre-measurement and prior to the written permission of the Engineer-in-charge.

1.4 Trenching in Ordinary soil

Trenching is done in order to loosen the soil, turn over the top layer containing weeds etc. and to bring up the lower layer of good earth to form a proper medium for grassing, regrassing, hedging and shrubbery.

Trenching shall be done to the depth ordered by the Engineer-in-charge. The depth is generally 30 cm for grassing and 60 cm for re-grassing in good soil.

The trenched ground shall, after rough dress, be flooded with water by making small kiaries to enable the soil to settle down. Any local depression unevenness etc. shall be made good by dressing and/or filling with good soil.

Weeds or other vegetation which appear on the ground are then uprooted and removed and disposed off and paid.

1.5 Trenching

Trenching shall consist of the following operations:

1. The whole plot shall be divided into narrow rectangular strips of about 1.5 m width or as directed by the Engineer-in-Charge.
2. These strips shall be sub-divided lengthwise into about 1 m long sections. Such sections shall be excavated serially and excavated soil deposited in the adjacent section preceding it.
3. In excavating and depositing care shall be taken that the top soil with all previous plant growth including roots, get buried in the bottom layer of trenched area, the dead plants so buried incidentally being formed into humus.
4. The excavated soil shall be straight away dumped into the adjoining sections so that double handling otherwise involved in dumping the excavated stuff outside and in back filling in the trenches with leads is practically eliminated.

1.6 Good Earth

The earth shall be stacked at site in stacks not less than 50 cm high and of volume not less than 3.0 cum.

1.7 Oil Cake

Neem/Castor: The cake shall be free from grit and any other foreign matter. It should be un-decorticated and pulverized. The material shall be packed in old serviceable gunny bags of 50 kg

capacity approximately. The weight of gunny bag shall be deducted @1 kg per bag and payment shall be made for net quantity. The quality of cake should be got approved by the Engineer-in-charge before supply.

1.8 Supply and Stacking of Sludge

It shall be transported to the site in lorries with efficient arrangement to prevents pilling en-route. It shall be stacked at site. Each stack shall not be less than 50cm height and volume not less than 3cum.

1.9 Rough Dressing Of The Trenched Ground

Rough dressing of the area shall include making kiaries for flooding.

The trenched ground shall be leveled and rough dressed and if there are any hollows and depressions resulting from subsidence which cannot be so leveled, these shall be filled properly with earth brought from outside to bring the depressed surface to the level of the adjoining land and to remove discontinuity of slope and then rough dressed again. The supply and spreading of soil in such depressions is payable separately.

In rough dressing, the soil at the surface and for 75mm depth below shall be broken down to particle size not more than 10 mm in any direction.

1.10 Uprooting Weeds from Trenched Areas

After 10 days and within 15 days of flooding the rough dressed trenched ground with water, the weeds appearing on the ground shall be rooted out carefully and the rubbish disposed off as directed by the Engineer-in-charge.

1.11 Fine Dressing the Ground

Slight unevenness, ups, and down sand shallow depressions resulting from the settlement of the flooded ground, in drying and from the subsequent weeding operations, shall be removed by fine dressing the surface to the formation levels of the adjoining land as directed by the Engineer-in-charge, and by adding suitable quantities of good earth brought from outside, if necessary.

1.12 Spreading Good Earth

Good earth shall be removed from stacks by head load and spread evenly over the surface to the thickness ordered by the Engineer-in-charge. It shall be spread with a twisting motion to avoid segregation and to ensure that spreading is uniform over the entire area.

1.13 Spreading Sludge/Manure

Good earth shall be thoroughly mixed with sludge or manure in specified proportion as described in the item or as directed by the Engineer-in-Charge. The mixing shall be spread to the thickness ordered by the Engineer-in-Charge.

1.14 Mixing of Good Earth and Sludge/Manure

The stacked earth shall, before mixing be broken down top particle of sizes not exceeding 6mm in any direction. Good earth shall be thoroughly mixed with sludge or manure in specified proportion as described in the item or as directed by the Engineer-in-charge.

1.15 Grassing with Select Grass No.1

The area from where the grass roots are to be obtained shall be specified by the Engineer-in-Charge at the time of execution of the work and no royalty shall be charged on this account from the contractor. Grass is to be arranged by contractor (cost of grass to be paid separately).

The soil shall be suitably moistened and then the operation of planting grass shall be commenced. The grass shall be dibbled at 10 cm, 7.5 cm, 5 cm apart in any direction or other spacing as described in the item. Dead grass and weeded shall not be planted. The contractor shall be responsible for watering and maintenance of levels and the lawn for 30 days or till the grass forms a thick lawn free from weeded and fit for moving whichever is later. Generally planting in other direction at 15 cm, 10 cm, spacing is done in the case of large open spaces, at 7.5 cm spacing in residential lawn and at 5cm spacing for Tennis Court and sports ground lawn. Rates are including cost of labour and material (grass shall be paid separately.)

During the maintenance period, any irregularities arising in ground levels due to water in accumulation due to trampling by labour, or due to cattle traying thereon, shall be constantly made up to the proper levels with earth as available or brought from outside as necessary, Constant watch shall be maintained to ensure that dead patches are replanted and weeds are removed.

1.16 Renovation of Lawns

The area shall be first weeded out of all undesirable growth. The entire grass shall be scrapped without damaging roots and level of the grounds. Slight irregularities in surface shall be leveled off and the area shall then be for ked so as to aerate the roots of the grass without, however up-rooting them.

Specified quantity of sludge or manure shall than be spread uniformly with wooden straight edge (phatti) as directed by the Engineer-in-charge. The area shall then be slightly sprinkled with water to facilitate proper integration of the manure or sludge with the soil and later flooded. The contractor shall be responsible for watering, proper maintenance and tending of the lawn for 30 days or till the grass forms a lawn fit for mowing, whichever is later.

During the above operations, all undesirable growths shall be constantly weeded out and all rubbish removed and disposed off as directed by the Engineer-in-Charge.

1.17 Uprooting Rank Vegetation, Weeds and Preparing the Ground for Planting 'Select Grass No.1'

Initially the area shall be dug up to a depth of 30 cm. and weeds and rank vegetarian with roots removed thereon by repeated forking. The whole area then shall be retrenched to a depth of 60 cm in the same manner as described in 1.5.

Clods of excavated earth shall then be broken upto the size not more than 75 mm in any direction.

The area shall then be flooded with water and after 10 days and within 15 days of flooding, weeds shall be uprooted carefully.

The rubbish arising from the above operations shall be removed and disposed off in a manner

directed by the Engineer-in-charge, away from the site. The earth shall then be rough dressed and fine dressed.

1.18 Excavation and Trenching for Preparation of Beds for Hedge and Shrubbery

Beds for hedges and shrubbery are generally prepared to width of 60 cm. to 125 cm. and 2 to4 meters respectively.

The beds shall first be excavated to a depth of 60cm. and the excavated soil shall be stacked on the sides of the beds. The surface of the excavated bed shall then be trenched to a further depth of 30 cm, in order to loosen the soil, in the manner described in 1.5.

No flooding will be done at this stage but the top surface shall be rough dressed and leveled. The excavated soil from the top 60 cm depth of the bed stacked at the site shall then be thoroughly mixed with sludge over manner in the proportion 8:1 by ratio or other proportion described in the item.

The mixed earth and manure shall be refilled over the trenched bed, leveled neatly and profusely flooded so that the water reaches even the bottom most layers of the trenched depth of the bed.

The surface after full subsidence shall again be refilled with the earth and manure mixture, watered and allowed to settle and finally fine dressed to the level of 50mm to 75mm below the adjoining ground or as directed by the Engineer-in-Charge.

Surplus earth if any, shall be disposed off as directed by the Engineer-in-charge. Any surplus earth if removed beyond initially lead shall be paid separately. Stones, bricks bats and other foreign matter if met with during excavation or trenching shall be removed and stacked within initially lead & lift, such material as is declared unserviceable by the Engineer-in-charge shall be disposed by spreading and levelling at designated places. If disposed outside the initial lead & lift, then the transport for the extra leads will be paid for separately.

If a large proportion of material unsuitable for the hedging and shrubbery operations is met with and earth from outsides is required to be brought in for mixing with manure and filling, the supply and stacking of such earth will be paid for separately.

1.19 Digging Holes for Planting Trees

In ordinary soil, including refilling earth after mixing with oil cake, manure and watering.

Holes of circular shape in ordinary soil shall be excavated to the dimensions described in the items and excavate soil broken to clods of size not exceeding 75 mm in any direction, shall be stacked outside the hole, stones, brick bats, unsuitable earth and other rubbish, all roots and other undesirable growth met with during excavation shall be separated out and unserviceable material removed from the size as directed. Useful material, if any, shall be stacked properly and separately. Good earth in quantities as required to replace such discarded stuff shall be brought and stacked at site by the contractor which shall be paid for separately.

The tree holes shall be manure with powdered Neem/Castor oil cake at the specified rate along with farm yard manure over sludge shall be uniformly mixed with the excavated soil after the manure has been broken down to powder, (size of particle not be exceeded 6 mm in any direction) in the specified proportion, the mixture shall be filled into the hole up to the level of adjoining ground and then profusely watered and enable the soil to subside the refilled soil shall then be dressed evenly with its surface about 50 to 75mm below the adjoining ground level or as directed by the Engineer-in-charge.

1.20 In Soil other than Ordinary Soil

Where holes are dug in (a) Hard soil (b) Ordinary rock or (c) Hard rock, the above soils occurring independently over in conjunction with each other and /or ordinary soil in any hole, the different excavated soil shall be stacked separately. Excavation in hard rock shall be carried out by chiseling only.The stack measurement of ordinary rock and hard rock shall be reduced by 50% and of soil by 20% to arrive at the excavated volume. This excavation shall be paid for as extra over the rate for holes dug in ordinary soil above, at rate appropriate to particular soil concerned.

Sufficient quantity of good soil to replace the solid volume of stones, brick bats, unsuitable earth and other rubbish, all roots and other undesirable growth, ordinary and hard stacks shall be brought and stacked at site but the supply and stacking of such shall be paid for separately.

The useless excavated stuff shall be disposed off by spreading at places as ordered by the Engineer-in-charge. If such places are outside initially leads, carriage for the extra lead shall be paid for separately.

The ordinary soil excavated from the hole and the earth brought from outside shall then be mixed with manure screened through sieve of IS designation 16 mm in the proportion specified in the description of the item and filled with the pit and the same watered and finally dressed.

1.21 Filling Mixture of Earth & Sludge Over Manure

The separately specified earth and sludge shall be broken down to particles of size not exceeding 6mm in any directions before mixing.

Good earth shall be thoroughly mixed with sludge over manure in specified proportions as directed by Officer-in-Charge. During the process of preparing the mixture as above, trenches shall be flooded with water and leveled.

1.22 Excavation of Dumped Stone or Malba

Excavation operations shall include excavation and getting out water if required. During the excavation stone, brick bats and other foreign material if met shall be removed and stacked within 50 meter lead sand lifts. Such materials is declared unserviceable by the Engineer-in-Charge be disposed within 50 m. The excavated surface shall be neatly dressed and leveled.

Measurements: Measurement shall be made in (Length, breadth and height of stacks) cubic meter. The cubical contents shall be worked out to the nearest two places of decimal in cubic meter.

Rate: The rate shall include the cost of all the labour and material involve in all the operations described above.

1.23 Excavation in Bajripath

All excavated operations shall include excavation and stacking of serviceable and unserviceable material. Excavated surface of Bajri path shall be removed and stacked upto 50 meter lead and disposed material neatly dressed.

1.24 Excavation of Water Bound Macadam

All excavated operations shall include excavation, stacking of serviceable and unserviceable material. Excavation shall be straight and uniform in width. Soling stone and aggregate obtained from excavation of W.B.M. shall be stacked separately and unserviceable material disposed off with lead upto 50 meter and lift upto 1.50 meter and neatly dressed.

1.25 Flooding the Ground with Water and Making Kiaries

The water for flooding shall be of soft water and free from chemical and good for growing the trees and shrubs etc. Before flooding the kiaries shall be made in required size and shape as per directions of Officer-in-charge. After uprooting weeds from the trenched area and uprooting vegetation, kiaries shall be dismantled.