SCOPE OF WORKS & SPECIFICATIONS

For

Design, Redevelopment, Construction of Biju Patnaik Indoor Stadium (Sports plex) in Rourkela on Turnkey Basis

OWNER: ROURKELA SMART CITY LIMITED

ROURKELA
SMART CITY LTD.

1. Scope of Work

The scope of works consists of design, engineering & construction of new annex building along with retrofitting & finishing works for the existing building and site development for Biju Patnaik Indoor Stadium (BPIS) at Rourkela. 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. The work is divided into following three parts:

A. Retrofitting and finishing of existing building.
B. Construction of new annex building.
C. Site Development & landscaping works

1.1 Retrofitting and Finishing Of Existing Building.

In this part the contractor has to carry out finishes of the existing structure and complete the building as per the intended usage through the following major works but not limited to:

- EB-Vinyl flooring (as approved by Badminton World Federation) in the indoor hall (Play Area).
- Anti-skid heavy duty Vitrified Tiles (outside the play area).
- Metal “T” profile in the junction between vinyl & tile (a & b above).
- Insulation works under metal roof sheeting (painted in grey).
- Acoustic treatment of the indoor hall.
- AAC Block Masonry to close the existing windows/ openings.
- Modification of the internal layouts of rooms in both the floors including the provision of seatings for the physically challenged people in the sports hall as per the approved drawings dismantling work if required.
- Modification of the existing toilet block with the new provision of drinking water facility & toilet for the physically challenged at the ground floor including dismantling work if required.
- Painting of the walls.
- Provision of two hours rated fire doors at locations as per the approved drawings.
- Providing water-proofing over the flat roof portion of the building.
- Provision of expansion joints in the roof, walls & floor.
- False ceiling with metal sheet roofing in the rooms.
- Gypsum partition wherever required.
- Flooring in various rooms as per the “schedule of finishes”.
- Internal Lighting – Supply, installation of LED fixtures and necessary wiring and conduiting works.

- Badminton court area lighting as per National level standards of Badminton World Federation for CTV telecasted events. The design and installation shall be in accordance with the truss load catering capability.
- External Façade works as per the approved elevation.

1.2 Construction of New Annexe Building.

This part involves design & construction of the new building as per the functional requirement and as highlighted in the gap-analysis report which is as follows.

- The connection between existing and new annex building.
- Separate dressing rooms for girls & boys with attached facilities of wash & toilet. The location of this facility should be such that it has easy access not only to the hall but also to the outdoor multi-purpose play court.
- Gymnasium for players as well as the common public.
- Separate entry for the players & VIPs with a drop-off
- Flooring in various rooms as per the “schedule of finishes”.
- Internal Electrical Works including lighting, power receptacles, conduiting, point wiring, distribution boards, etc.
- External Façade works as per the approved elevation.
- Feature wall with a metal mural (backlit) depicting the game of badminton.

2 Site Development & landscaping works.

The broad scope of work for landscape shall include design and execution of all, Landscape works (Including Soft-scape & Hard-scape Works), related civil works, the design of dustbins and Electrical works including decorative lights and site development through (but not shall be limited to) the following:

a) Multipurpose open-air sports court with markings for Volley Ball & Tennis along with lighting for night-play (only for practice purpose).
b) Boundary wall along with gate-house structure with signages as per the approved drawings.
c) Provision of circulation roads with parking facility.
d) All Landscaping and horticulture work including planting operations (Lawn, shrubs, ground-covers & trees), decorative post top street lamps, as proposed and mentioned in drawings.
e) Supply and installation of non-toxic lead-free painted FRP dustbins and other outdoor furniture suitable to the overall design.
f) All Hardscape and finishing materials including Cement concrete interlocking Paver blocks, Grass-pavers wherever specified as per design and as mentioned in drawings.
g) Façade lighting for the buildings.

1.3 Electrical works

The 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, Dry Type Transformer & LT breaker.

(c) 1 No. Diesel Generator set with AMF Panel.

(d) 3 Phase, 415 V, 50 Hz LT Power Control Centre (PCC) panel.

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

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

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

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

(i) Earthing System.

(j) Lightning Protection System

(k) Indoor and Outdoor Lighting Work including decorative lighting fixtures, poles, power receptacles, etc.

(l) Passenger Elevators

For commercial floors, scope shall be providing power supply feeder at each floor and shall not include point wiring, DB, Luminaire and other electrical works.

1.4 HVAC Works

This section covers the scope of work of HVAC for existing buildings as well as new annex building.

Air circulation system shall be designed to operate around the perimeter of the hall, to limit air movement over the court. The air velocities within the playing area should not exceed 0.1 m/s (meters per second). The ducts shall be designed accordingly with very low velocity to meet the above requirement along with suitable acoustic treatment inside the duct. Since the height of hall is very high, the necessary arrangement is to be made to remove stratification heat from the hall. The ventilation system of the hall shall be selected to meet latest NBC 2016 Fire Norm for evacuation of smoke in case of fire.

For balance areas, the air conditioning shall be designed for human comfort application.

1.5Plumbing Works

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

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 Water Supply Distribution System, Sanitary fixtures and accessories, Soil, Waste, and vent pipe system, Rainwater piping system for terrace floor as per the IS standards.

1.6 ICT Works

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 Biju Patnaik Indoor Stadium (BPIS), Rourkela (Odisha).

1. Supply Installation Testing & Commissioning (SITC) of **Fire Detection & Alarm System** at all Indoor Coverage of Stadium, Rooms, Lounge, Store, Offices and Spectators Zones (new building & annex building both)
2. Supply Installation Testing & Commissioning (SITC) of **Public Address System** at Indoor Stadium, VIP Lounge & Spectator Zones
3. Supply Installation Testing & Commissioning (SITC) of **Door Frame Metal Detector** at Entry Gates.
4. Supply Installation Testing & Commissioning (SITC) of **LED TVs** in Referee Room and VIP Lounge.
5. Supply Installation Testing & Commissioning (SITC) of Projector with Projector Screen in Meeting Room.

1.7 Drainage Works

This section covers planning, designing, and execution of drainage network along with groundwater recharge for the entire site.

Internal drainage network has been planned along the periphery of the building, landscaped area, and road for avoiding the water logging inside the building premises during rain.

The alignment/direction of the drain network has been decided on the basis of the direction of gradient/slope provided to the landscaped area and road area. Following the gradient, the drain channel/ pipes shall be taken to connect the Inlet chamber of Rain Water Harvesting Structures proposed at two different locations of the building premises. For draining the runoff from road and landscaped areas, UPVC pipes have been proposed of size 200mm diameter that will be connected with 100mm thick catch basins of size 0.3m(W)x0.4m(L) at an interval of 5 meters, perforated concrete cover of size 0.4m(W)x0.5m(L) and 50mm thick will be provided at each catch basin.

At each corner of building 100mm thick concrete (M25) Catch basins/chambers of size 0.4m(W)x0.4m(L)x0.5m(D) has been proposed for collection of rooftop runoff from down take pipes,

catch basins will be covered with 50mm thick concrete (M25) perforated drain cover of size 0.5m(W)x0.5m(L).

For crossing of a drain across the road, concrete RCC NP3 pipes of diameter 200mm shall be provided. The slope of all the pipes shall be maintained properly so as to connect at the inlet of RWHS at an invert of 0.4m depth from the ground elevation. Typical detail of catch basin and pipe bedding has been shown below.

1.8 Road Works:

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 436 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.

1.9 Fire Fighting works

The scope of work by VENDOR shall include design manufacture, inspection and testing at manufacturer's works, packing, forwarding and delivery to site, unloading and storage at site, erection, testing and commissioning and taking necessary approval of Fire Fighting System comprising as per National Building Code.
As per National Building Code Part IV, Table 7. Following are the provisions for Fire Fighting { Group- D Assembly Buildings } works which need to install under the supervision of Engineer in charge.

- External Hydrant system
- Wet Riser System
- Fire Pumps & Accessories
- Portable Fire extinguishers

1.10 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. Time Period for Completion

The total period of contract including Survey, Investigation, Soil Exploration and Laboratory Testing, detailed Design, and Execution shall **be 12 calendar months**. The defect liability period for the building shall be **three (3) 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.

3. 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

4. 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

5. 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)

6. PAYMENT SCHEDULE AT ARCHITECTURAL DRAWINGS AND DESIGN STAGE

The architectural drawings and design cost for the building shall be 2% of the Contract Price**.** The client shall effect payments for the design cost in accordance with the following payment schedule.

SL No	**Activities/Deliverables**	**Payment% of Total Project Cost**
1	On approval of details survey and architectural drawing approved by concerned development authorities.	20%
2	On approval of structural design	20%
3	On approval of Final Architectural drawing showing electrical and sanitary diagram,HVAC, Fire Fighting and detail structural design.	20%
4	On Completion of Construction and submission of "As built drawings	40%

TECHNICAL SPECIFICATIONS

1.0 CIVIL WORK – TECHNICAL SPECIFICATION

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 materialll 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**.**

1.2 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**.**

1.3 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 are 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**.**

1.4 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**.**

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1.05 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.

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.

1.12 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

1.13 MATERIALS

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.

AGGREGATE***S***

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

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.

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.

CONCRETE MIX PROPORTIONS

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 to produce the proper placebility, durability, strength and other required properties.

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.

Durability

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

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.

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.

Admixtures:

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

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.

Ready mix concrete

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 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.

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.

CONCRETE PLACEMENT

Concrete, when deposited, shall have a temperature of not less than 5^{o}C (41^{o}F) and not more than 32^{o}C(90^{o}F).The concrete shall be placed in the positions and sequences indicated on the drawings, in this specification or as directed by the Project Manager.

Contractor shall give adequate notice to the 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 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 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 the concrete and the removal of concrete in the case of segregations.

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 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.

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.

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.

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.

STEEL REINFORCEMENT

.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***.***

Applicable standards

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

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.

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.

BRICK MASONRY

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.

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.

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.

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.

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.

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.

FINISHING

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 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 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.

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 Project Manager.

GENERAL PROVISION

SCAFFOLDING

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.

PROTECTION

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.

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.

During installation of piping, open end of pipe shall be protected with temporary cover to prevent dust or other materials entering in it.

Protection during construction: Decorative surfaces shall be carefully protected during construction by a temporary cover.

Protection of finished work: At all stages of the Contract it is essential that all works are properly protected.

Suitable packing shall be used to ensure that scaffolding does not damage erected stone, marble, granite or other finished works.

Any disfigurement, discolouration 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.

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.

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 man hole 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 galvanising
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 bath tubs
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.

QUALITY ASSURANCE AND QUALITY CONTROL

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.

At the site level the Contractor shall arrange the materials, their stacking/ storage in 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.

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 labour for collecting the samples. Nothing extra shall be payable to the Contractor for samples or for the collection of the samples.

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.

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 from the Contractor's bills.

Testing charges shall be borne by the Contractor.

Testing may be witnessed by the Contractor or his authorised representative. Whether witnessed by the Contractor or not, the test results shall be binding on the Contractor.

SANITARY WARE AND OTHER APPLIANCES

SCOPE OF WORK

Without restricting to the generality of the foregoing, sanitary and other appliances shall inter-alia include the following:-

a) Sanitary appliances and fixtures for toilets
b) Chromium plated brass fittings
c) Stainless steel sinks
d) Accessories e.g. towel rods, toilet paper holders, soap dish, liquid soap dispensers, towel rails, coat hooks etc.
e) Mirrors, hand driers, drinking water fountains, etc.

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, adopters, bolts, screws, hangers etc as required. All exposed pipes within toilets and near appliances/ fixtures shall be of chromium plated brass or copper unless otherwise specified.

GENERAL REQUIREMENTS

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.

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**.**

Fixing screws shall be half round head chromium plated (CP) brass screws, with CP brass washers unless otherwise specified.

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 colour of the Sanitary ware shall be that of the Engineer-in-Charge and nothing extra shall be payable to the Contractor for fixing of Sanitary ware of any colour.

Sinks for kitchen shall be of stainless steel or as specified in the Schedule of Quantities.

Chromium plated fittings shall be cast brass chromium plated of the best quality approved by the Engineer-in-Charge.If 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. All appliances, fittings and fixtures shall be fixed in a neat workmanlike manner true to level and to heights shown on 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.All materials shall be rust proofed; materials in direct or indirect contact shall be compatible to prevent electrolytic or chemical (bimetallic) corrosion.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 afterwards 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 pipe work 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 minimises noise transmission.

e) Appliances shall not be bedded (e.g. WC pans, pedestal units) in thick strong mortar that could crack the unit (e.g. a ceramic unit).

f) Pipe connections shall be made with de-mountable unions. Pipe work shall not be fixed in a manner that it supports or partially supports an appliance.

g) Appliances shall be fixed so that water falls to the outlet (e.g. baths).

h) All appliances shall be secured as per the recommendations of 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.

Sizes of Sanitary fixtures given in the Specifications or in the Schedule of Quantities are for identification with reference to the catalogues 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**.**

Water Closet

WC shall be wash 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**.** Each WC set shall be provided with a solid plastic seat, rubber buffers and chromium plated brass hinges. Plastic seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the WC**.**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.

Pan Connector

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 confirm to the BS: 5627: 1984. The pan connector must be supplied with factory fitted spring loaded seal guard.

The connector shall not be allowed to come in contact with mineral oil, grease, putty or any compound containing mineral oil or grease.

The pan connectors must be stored away from the direct sunlight and flames.

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.

Urinals

Urinals shall be lipped type half stall white glazed vitreous china of size as called for in the Schedule of Quantities**.**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 wall by CI brackets, CI wall clips and CP brass screws as recommended by manufacturer complete as directed by the Engineer-in-Charge.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. brackets, and painted with two coats of approved paint of approved shade and confirming to IS: 2326**.**

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**.**PVC waste pipes shall be provided for urinals. Waste pipes may be exposed on wall or concealed in chase as directed by the Engineer-in-Charge. These shall be measured and paid for separately.

Urinal Partitions

Urinal partitions shall be white glazed vitreous china of size specified in the Schedule of Quantities.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.

Wash Basin

Wash basins shall be white glazed vitreous china of size, shape and type specified in the Schedule of Quantities.

Each basin shall be provided with painted MS angle or C.I. brackets and clips and the basin securely fixed to 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 colour as approved by the Engineer-in-Charge.

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.

Wash basin shall be provided with hot and cold water mixing fitting or as specified in the Schedule of Quantities.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**.**

Sinks

Sinks shall be stainless steel or any other material as specified in the Schedule of Quantities.Each sink shall be provided with painted MS or CI brackets and clips and securely fixed. Counter top 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 colour as approved by the Engineer-in-Charge. Flow Rate = 4.5 to 6 Litres per minute @ 80 PSI

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.

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.

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.

Soil, Waste, Vent and Rainwater Pipes

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 rain water 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) Connection of all pipes to sewer lines as shown on 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.

General Requirements

Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.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.

Pipes shall be securely fixed to walls, and ceilings by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for fixing pipes on RCC ceilings and RCC/ masonry walls.

Access doors for fittings and clean outs shall be so located that they are easily accessible for repair and maintenance.

Long bends shall be used on all main pipelines as far as possible. Use of elbows shall be restricted for short connections.

Wherever piping is going across the separation/expansion joints of buildings, piping shall be provided with flexible connectors on both sides of such joints or on single side depending on whether any wall is to be crossed or not.

Waste Pipe From Appliances

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.

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 aluminium grating in 25×25 MS angle

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**.**

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..

The pipes shall be of class III, 6 Kg/cm2. The pipes shall conform to IS 4985 - 2000. Fittings shall be of injection moulded PVC conforming to IS 7834 (Part1) - 1975.

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**.**

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**.**

Connection to the sewer or storm water collection sumps to be perfectly water tight and as specified in the drawing**.**

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**.**

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**.**

Bathroom C.P. grating shall be having bolted down design out of heavy cast brass with chromium plating of the best approved standards**.**

Cast iron grating shall be flat with perfect edge and of the best quality procurable of the specified width and thickness and in the available length.

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 jointed using solvent cement or rubber ring joints. The pipes and fittings shall be jointed accurately without any stress to achieve leak proof joints.

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 pipe line static pressure.
- Sum of the maximum sustained operating pressure and the maximum surge pressure.
- Sum of the maximum pipe line 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.

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Cutting 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.

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.

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.

Rainwater 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.

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.

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.

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 pipe line has been tested under pressure. Rest of pipe line 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 rain water down takes.

Rainwater down takes are separate and independent of the soil and waste system and will discharge to rain water harvesting tank and excess rain water will be diverted to the external storm water drain.

Water Supply System

General Requirements

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.

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.

GI Pipes, Fittings and Valves

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.

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.

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**.**

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.

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.

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.

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.

Trenches

All GI/PVC/HDPE pipes running below ground shall have minimum cover of 600mm.

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.

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.

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 chase:

   All hot water pipes fixed in wall chase shall be properly insulated by elastomeric tape as per manufacturer's recommendation.

Pipe protection

Where specified, pipes below floor or below ground shall be protected against corrosion by the application of two or more coats of solvent based rubberised 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.

Valves & Fittings

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 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.

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 resilient seat suitable for flow in either direction and seal in both directions.

Butterfly valve shall conform to IS: 13095.

Non Return Valve

Where specified non return 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.

Forged Brass Ball Valve

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 minimum working pressure of 16 bar. Valves shall be tested at manufacturer's works and the same stamped on it.

Air Release Valve (ARV)

Pressurized water supply lines shall be provided with air release valve at 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 minimum working pressure of 10 Kegs.

Ball float valve

Ball valves with Heavy duty floats 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.

Testing

(a) 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/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.

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 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 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 is 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 shutoff.

(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.

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.

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.

Underground /Overhead Storage Tanks

Storage tanks for water supply shall be in RCC.

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 appropriate size as directed by the Engineer-in-Charge.

Each storage tank shall be provided with high and low level annunciation by means of magnetic level switches.

One solid state electronic annunciation panel fully wired with 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

All the necessary arrangements for fixing the panel shall be provided by the Contractor.

All the cabling from the respective level switches to the Annunciation Panel, MCC Switch gear to Annunciation Panel, including power supply from MCC shall be provided by the Contractor.

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.

Testing

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/cm2 or 1.5 times the shut off head of the pump whichever is greater.

The test pressure shall be maintained for a period of at least thirty minutes without any drop in pressure.

A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and the Engineer-in-Charge.

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.

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.

Insulation

All open hot water flow and return pipes shall be insulated with preformed fibrous pipe sections conforming to IS: 9842.

Insulation to pipes shall be with pre-moulded pipe sections, thickness for sections shall be:

a) Pipe 50mm diameter and below - 25mm thick
b) Pipe 65mm diameter and above - 40mm thick

Application:

a) All surfaces shall be thoroughly cleaned with a wire brush.
b) One layer of approved primer shall be applied and pre-moulded pipe insulation sections shall be fixed.
c) One layer of aluminium foil of thickness 0.711mm (20 SWG), shall be applied as a finish layer.

Insulation for hot water pipes in chase:

All hot water pipes in chase shall be insulated with 3 mm elastomeric tape as per manufacturer's recommendations.

Connection to RCC Water Tanks(Puddle Flange)

The contractor shall provide all inlets, outlets, washouts, vents, ball cocks, overflows control valves and all such other piping connections including 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 bronze screen on vent.

The overflow pipe shall be so placed to allow the discharge of water being readily seen. The overflow pipe shall be of 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.

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, Fire fighting etc.)

Level Sensors

Level sensor shall consist of 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 aluminium weather proof suitable for black panel / wall mounting etc.,

The enclosure of probes shall be manufactured with SS316 material. The least count of the central unit with amplifier should be +/- 0.10mm for response value of 30 seconds.

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.

Insulation

The insulation for hot water pipes shall be done as specified in Bill of Quantities and accordingly following guidelines shall be followed:

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 metre along the centre line of the pipe, over the finished surface and shall include all valves and fittings for which no deduction shall be made.

Air Release Valves

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 of specification given above.

Pumps for Water Supply & Storm Drainage System

(a) Hydro-pneumatic Pumps for domestic and flushing water supply (transfer pumps)

Pumps shall be vertical, centrifugal, multistage directly coupled to motor. Provision of 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 Hydro pneumatic 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 cost of foundation channel complete.

The Contractor shall supply and install pumps of the type and performance as shown on 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 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 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 hydro pneumatic 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 microp

TECHNICAL SPECIFICATION OF FIRE FIGHTING WORKS

1. 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, 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 100 mm dia. Connected to internal hydrants.

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

3.1.1 Fire water storage

Fire water storage tank for Fire Protection System has been provided at under-ground level of 100 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 2280LPM 70 Mt head.
(c)	Jockey Pump	Capacity 180-LPM 70- Mt head.
(d)	Electric 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. EXCLUSIONS:

Civil Works for Water Tank.
Pumps to be installed at below basement levels .

6.0 PIPE WORK

6.2.1 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.

6.2.2 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 bitumenSteel 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.

6.2.3 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.

6.2.4 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.

6.2.5 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.

6.2.6 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.

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

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	XLPE / PVC Insulated Aluminium Conductor Armoured Cables.	Finolex / Polycab / Skytone/ RR / LAPP
17	CABLE TRAY	Indiana / Bharti / Slotco / Steelways / Profab / Rico / MEM
18	Copper Conductor Armoured Control Cables.	Finolex / Polycab / Skytone / RR / LAPP
19	MCCB (Microprocessor)	ABB - T-max, L&T - D sine, Schneider - Compact NS / NSX, Siemens - 3VL, Legrand- DPX
20	CONTACTORS / RELAYS	L & T / Siemens / ABB / Schneider
21	Current Transformers	Kappa / AE / ECS / Kalpa / Pragathi
22	Voltage Transformers	Kappa / AE / ECS / Kalpa / Pragathi
23	Ammeters / Voltmeters and metering equipments	L & T / Siemens / Automatic Electric / Neptune / enercon / Schneider / ABB
24	Selector Switches	Kaycee / Salzar / L&T / Schneider / ABB / Siemens
25	LED Lamps	L&T / Vaishno / Siemens / Schneider / ABB / Teknic

26	Pump Control Panel	Tricolite / Ambit / Adlec / Advance / Milestone / RST / Vidyut Control / Dynamic / Jakson / Conquerent (Madhu)
27	Fire Fighting Pumps	Kirloskar / Mather+Platt
28	Diesel Engine	Kirloskar / Cummins/Greaves
29	Electric Motors	Kirloskar / Crompton / Siemens
30	Pressure Switches	Danfoss / Indfoss
31	Pressure Gauge	H Guru / FIBIG
32	Flow Switches	System sensor / Honeywell
33	Sprinkler Annunciator Panel	Safeway / Agni Suraksha (ASES) / Daksh / Morley / Agni Devices
34	Sprinklers	Tyco / HD / Globe / Viking / Reliable
35	Sprinklers Flexible Hose	Tyco / HD / Globe / Viking / Padmini / Newage
36	Installation Control valve / Deluge Valve	Tyco / HD / Newage / Viking / Globe
37	Anchor Fastener / U clamp / Clevis / sprinkler hangers	Hilti / Intello Tech / Hightech / Fisher / Easy flex
38	Anti Vibration Mounting / Expansion Joint	Easyflex / Resistoflex / Kanwal / Precise
39	Paint	Asian / Berger / Nerolac / ICI
40	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

ELECTRICAL	
Equipment / Material / Component	**Manufacturers Name**
MCB / RCCB / RCBO / DB	L&T / Hager / ABB / Legrand (Lexic) / Schneider (Acti 9)
Industrial outlet	L&T / Hager / ABB / Legrand (Lexic) / Schneider (Acti 9)
Switchgear & Accessories	ABB / Schnieder / L&T / Seimens / Legrand
MCCB	ABB (T max) / L & T (D sine) / Schneider (Easy pact CVS) / Siemens (3VL) / Legrand
Switch Fuse Unit With HRC Fuses	L & T / ABB / Schneider / Siemens / GE
Contactors / Relays	L & T / Siemens / ABB / Schneider
Ammeters / Voltmeters and metering equipments	L & T / Siemens / Automatic Electric / Neptune / Enercon
Selector Switches	Kaycee / Salzar / L&T
LED Lights	L&T / Vaishno / Siemens
PVC Insulated Copper Conductor Wires	Finolex / Polycab / Skytone / RR
PVC / XLPE INSULATED 1.1 KV CABLES	Finolex / Polycab / Skytone / RR
Lugs	Dowells / 3D / C.C.I. / 3 M / Comet / Hex
Cable Glands	Siemens / Comet / Grippwel
MS Conduits And Accessories	B.E.C. / AKG / MK

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:

a. Indoor Badminton Stadium
b. Gym and other miscellaneous areas

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.	Badminton Hall	21 ± 1	50-60
2.	Other areas like VIP Room/Meeting Room etc	23 ± 1	55-65
3.	Gym Areas	25 ± 1	55-65

Noise Level Design Criteria

VIP Room/Gym Room	50 - 55 dBA approx.
Meeting 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) :

S.No	Description	Cooling Load	Type of Equipment	TR (each)	Qty.	Dehumidied CFM –Each	TOTAL TR	TOTAL HP	Selected HP
		(TR)							
	Ground Floor								
1	Badminton Hall	63	AHU	31.5	2	6500	63	79	84
2	First Aid Room	1.2	Cassette	1.7	1	530	1.7	11	10
3	Office	1.2	Cassette	1.7	1	530	1.7		
4	Media Room	2.2	Cassette	2.1	1	671	2.1		
5	Lobby+ Corridor	3.3	Cassette	1.7	2	530	3.4		
	First Floor								
7	VIP Sitting	5.6	Ductable	5.6	1	1624	5.6	20.3	18
8	ICT Room	1	Cassette	1	1	335	1		
9	Meeting Room	1.9	Cassette	2.1	1	671	2.1		
10	Umpires Room	1.7	Cassette	2.1	1	671	2.1		
11	Coach Room	1.7	Cassette	2.1	1	671	2.1		
12	VIP Lounge	3.2	Cassette	1.7	2	530	3.4		
	OTHER AREAS								
13	Gym Office	4.6	Cassette	2.1	3	671	6.3	37.1	20x1 +18x1
14	Gym Instructor	3.4	Cassette	1.7	2	530	3.4		
15	Gymnasium	16	Cassette	4	5	1198	20		

Equipment Configuration for ventilation system & equipment selection (Table II):

	VENTILATION SYSTEM			
		Capacity CMH	Qty	Type
1	**Ground Floor**			
1.1	Boy's Changing	1500	1	Ducted Cabinet Fan
1.2	Girls Changing	1500	1	Ducted Cabinet Fan
1.3	Girls Toilet	900	1	Ducted Cabinet Fan
1.4	Boy Toilet	900	1	Ducted Cabinet Fan
1.5	Pump Room	2200	1	Axial Fan
1.6	Electrical Room	2200	1	Axial Fan
1.7	Toilet Block - Stadium Side	2600	1	Ducted Cabinet Fan
2	**First Floor**			
2.1	Girl Changing/Toilet	1500	1	Ducted Cabinet Fan
2.2	Boys Changing /Toilet	1500	1	Ducted Cabinet Fan
2.3	Toilet Block Stadium Side	2600	1	Ducted Cabinet Fan
2.4	Electrical Room/Control Room	2200	1	Axial Fan
3	**Hall Ventilation**			
3.1	Hall Area (including smoke evacuation)	5800	22	Wall mounted Low Speed 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.

As any heating or ventilating system that moves the air can deflect the shuttlecock; heating and ventilation systems shall be designed taking this aspect into account. In badminton stadium, the location and protection of all air input and extraction grilles or openings must be carefully considered, particularly in relation to the flight path of the shuttlecock. Considering the above facts, air circulation system shall be designed to operate around the perimeter of the hall, to limit air movement over the court. The air velocities within the playing area should not exceed 0.1 m/s (metres per second). The ducts shall be designed accordingly with very low velocity to meet the above requirement along with suitable acoustic treatment inside the duct. Since, the height of hall is very high, necessary arrangement is to be made to remove stratification heat from the hall. The ventilation system of the hall shall be selected to meet latest NBC 2016 Fire Norm for evacuation of smoke in case of fire.

The Floor Mounted AHUs have been proposed for Badminton Hall areas, which will be located in the dedicated AHU rooms in the terrace. Circular spiral duct will distribute the cold air inside the playing hall in the periphery and return air will be taken to AHU Room through another return air circular duct. Duct and AHU room shall be suitably acoustically treated from inside to reduce noise level. 22 Nos wall mounted Axial Flow Fans have been proposed to evacuate smoke in case of Fire as per NBC norm. In normal condition, 3 Nos Fans will be working to remove stratified hot air from the upper level. For other air conditioning applications, dedicated outdoor units of VRF/VRV system have been proposed as per Table I.

For toilet areas, a common centrifugal inline fan shall have ducted suction grilles for exhaust purpose. In each building, input power will be made available by Electrical Contractor and subsequent distribution to various HVAC equipment shall be under HVAC contractor's scope.

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.

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:

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.

Equipment Design Parameters:

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	5.5
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- Hall area	0.1
Max. Outlet velocity at Grille/ Diffusers, m/sec- other area	2

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.

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

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 : Dynacraft/ Trox / System Air/ Green-heckDamper

G I Sheets : Jindal / Sail / Nippon.

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

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

REFERENCE DOCUMENTS :

I. Biju Patnaik Indoor Stadium Ground Floor -HVAC Scheme (Drawing No. TCE.10839A-ME-6054-FD-65009)

II. Biju Patnaik Indoor Stadium First Floor -HVAC Scheme (Drawing No. TCE.10839A-ME-6054-FD-65010)

III. Biju Patnaik Indoor Stadium Terrace - HVAC Scheme (Drawing No. TCE.10839A-ME-6054-FD-65011)

IV. Biju Patnaik Indoor Stadium Sections (Sheet 1 of 2) -HVAC Scheme (Drawing No. TCE.10839A-ME-6054-FD-65012)

V. Biju Patnaik Indoor Stadium Sections (Sheet 2 of 2) - HVAC Scheme (Drawing No. TCE.10839A-ME-6054-FD-65013)

Technical Specifications for ICT Works

Design concept for - ICT components

ICT components and solutions are very broad range and category. As per retrofit requirements and drawing for a minimum ICT components for a International Standard of Indoor Stadium are as mentioned below:

1. **Fire Detection Alarm System (FDAS):** It is mandatory requirement of any commercial building.
2. **PA system (PAS):** PA system required for any announcement and live commentary and audio propagation inside the stadium to larger number of spectators inside the stadium.
3. **Video Wall System:** A better viewing experience of live match and score card display to spectators inside the stadium.
4. **Access Control System (ACS):** Door Frame Metal Detector (DFMD) is proposed at entry gate of stadium.
5. **LED TV:** LED TVs are proposed in Referee Room and VIP Lounge.

6. **Projector & Projector Screen:** Proposed for meeting room at first floor.

Fire Detection Alarm System (FDAS):

Technical Specifications:

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.

Public address System (PAS):

Technical specifications

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.

Access Control System (ACS):

Technical Specification

1. International norms (NILECJ-0601 L1-5/IP54/IEC 348/EN60950 Class1) In conformity with CE European Union Norms and produced under ISO 9001: 2000 QMS
2. Multi-Zone - minimum 9 real detection zones
3. Auto Calibration (Automatically calibrates itself up to Environmental Conditions)
4. Human friendly VLF technology (Certified) Green/Red bi-color traffic through LEDs
5. 20 sensitivity levels, 5 Security levels set to International Security Standards (fixed NILECJ security levels),
6. 246 adjustable sensitivity steps at each, applicable to all zones separately.
7. Separate Zone Sensitivity Settings
8. Automatic Sensitivity Program selects the correct sensitivity for a specific weapon or a recognized test object.
9. Metal Density Display at 10-level-VU meter with green, yellow, red LEDs Environment magnetic noise level detection display on LCD Screen Adjustable audio alarm at 10 tons/level
10. Alarm Counter & Five Digit Separate incoming & outgoing counters (Visible/invisible) Mechanical Lock for control panel and four-digit changeable digital Pin Code Automatic Failure Display
11. Standard Uninterruptible Power Supply (UPS) enabling 4 hours operation without mains
12. Reloading the factory default settings by one-touch button Easy programming and monitoring with LCD display Relay outputs for recording CCTV, controlling turnstiles, etc on Alarms
13. Modem and RS232 output for SCADA remote data communication- Send Receive - Change settings by direct cable or modem over Telecom Lines by PC- Audible & Visual alarms can be monitored by PC and can be logged into Hard Disk (optional Software)
14. Certificate approved "Safe for wearers of pacemakers and pregnant women" -- No effect to magnetic media (eg. Memory sticks, tape, proximity cards)
15. Easy-to-mount and assemble walk through door frame metal detector (15 minutes)

LED Television (LED TV):

Technical Specifications

1. Wide color gamut with TRILUMINOS Display
2. Enhanced 4K detail with 4K X-Reality PRO
3. Cable Management hides cables for a clean look
4. Android TV for movies, games and connectivity

Preferred Make: Sony, Panasonic, Samsung

Screen Size	50 Inch – 2 Nos. & 32 Inch – 1 No.
Display Resolutions	Full HD 1080x1920 pixel
Connectivity	Ethernet, HDMI, RF Cable, Digital Audio O/P, Audio Headphone, HDCP, USB, Composite Video (Anlogue & Hybrid)
Picture (processing)	Full DH picture Processing, Dual database processing, Dynamic Contrast Enhancer, Object-based HDR remaster, X-tended Dynamic Range PRO, Vivid, Standard, Custom, Cinema Pro, Cinema Home, Sports, Animation, Photo-Vivid, Photo-Standard, Photo-Custom, Game, Graphics
Video Signal Support	1080p (50, 60 Hz), 1080i (50, 60 Hz), 720p (50, 60 Hz), 576p, 576i, 480p, 480i, 1080p (30, 50, 60 Hz), 1080/24p, 1080i (50, 60 Hz), 720p (30, 50, 60 Hz), 720/24p, 576p, 480p
Sound (Speakers and Amplifier)	10 W+10 W Output, Bass Reflex Speaker
Sound (Processing)	Dolby™ Digital, Dolby™ Digital Plus, Dolby™ Pulse, S-Force front surround, DTS Digital Surround, Standard / Cinema / Live Football / Music
Content Bar	Yes
Internet Browser	Opera or Chrome
Display Language	ENGLISH
Tuner Channel Coverage.	45.25 MHz-863.25 MHz, (VHF/UHF)
Power Requirements.	50/60 Hz, AC 110-240 V

Projector

Technical Specifications

Preferred Make: Sony, Panasonic, Epson, Canon

Brightness:	1,500 Lumens
Resolution:	Full HD 1080x1920 pixel
Aspect Ratio:	1.85:1 (Quad HD)
Video Modes:	720p, 1080i, 1080p/60, 1080p/24, 1080p/50,
Data Modes:	MAX 4096x2160
Panel & Interface	HDMI , RS232 (DB-9pin), Network (RJ-45) & 12-Volt Trigger
Connection Port	VGA, HDMI, USB, SD card for various uses like gaming etc.
Lamp Life(eco-mode):	6,000 hours
Lamp Type:	UHP
Display Type:	SXRD (3)
Standard Zoom Lens:	Powered, 2.06:1
Standard Lens Focus:	Powered
Optional Lenses:	No
Lens Shift:	Horz & Vert
Throw Dist (m):	5.0 - 6.1
Image Size(cm):	203 - 508
Throw Ratio(D:W):	1.38:1 - 2.82:1
Voltage:	100V - 240V AC

Projector Screen:

TECHNICAL SPECIFICATIONS

Screen Size	W x H = 3048 mm x 2286 mm (3810 mm ~150" Diagonal)
Aspect Ratio	1.78:1 (16:9) for HDTV & 4K Viewing
For Viewing	Perfect for full HD and HD Resolutions
Viewing Angle:	120° / Gain: 1.0
Color of Casing	White or black powder coated aluminum casing creates an attractive appearance that matches any décor
Fabric	Matte White
Type	Electric projector screens
Control / Operations	IR(Infrared) remote controls

SCOPE OF WORKS TECHNICAL SPECIFICATIONS OF ELECTRICAL WORKS

1.1 Scope of Works

1.2 Scope of Works

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 Electrical system of **Biju Patnaik Indoor Stadium (BPIS) at Rourkela**.

The indoor stadium is being developed in two phases. This report pertains to second phase of execution. Refer drawing no. TCE-10839A-AC-1003-MP-10011 (Site Plan) wherein the existing building is indicated.

In the 1st phase, civil works for building infrastructure of the indoor badminton court area along with certain services room had been taken up by R&B, Rourkela. The electrical conduiting and wiring for the rooms have been considered in this phase. The requisite LDBs for the already constructed building (in the 1st phase) shall be provided in the 1st phase. Any additional requirement of LDBs or conduit work shall be taken up in the 1st phase, as indicated in the Reflected Ceiling Plan (RCP) (TCE.10839A-AC-1003-IW-10031, TCE.10839A-AC-1003-IW-10032, TCE.10839A-AC-1003-IW-10033). The 1st phase also shall be taking care of the power points requirements indicated in the RCP plan drawing.

In the 2nd phase, it is proposed to complete the works of existing building developed by R&B, Rourkela along with design, construction and commissioning of a new building (Sportsplex) so as to fill the gaps to meet the international standards. The 2nd phase intents to provide facilities like gymnasium, outdoor multi-purpose court. The site landscaping and outdoor area lighting works are to be executed under the 2nd phase. The detailed scope of work is indicated below.

Following shall be considered for the Electrical Works in the 2nd phase:

For New building or services (Green field work):

(a) Metering equipments as per OERC Net Metering / CERC regulation. Provision for a HT (11kV) meter room (4.0x4.0m) with a Load Break Switch (LBS) to be made as per DISCOM requirement. The meter room shall have access, limited to DISCOM representatives / authority only, from road with locking facility.

(b) Outdoor 11kV RMU with VCB ICOG.

(c) 11kV Compact substation having VCB ICOG, Dry Type Transformer & LT breaker.

(d) 1 No Diesel Generator set with AMF Panel.

(e) 3 Phase, 415 V, 50 Hz LT Power cum Motor Control Centre (PMCC) panel.

(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) All Indoor and Outdoor Lighting Luminaires

(m) UPS for escape lighting

(n) Other necessary works requisite for completion of work such as embedment, chipping, punching, making holes, openings in walls, pipe sleeves, fire and water proof sealing, concealed conduiting etc.

For Existing building (Retrofitting work):

(m) Indoor badminton court area lighting for international (as per International Badminton Federation), national and recreational purpose events with switching facility. All necessary sports LED fixtures, mounting arrangements in the fabricated truss, wiring, conduiting, etc are to be carried out.

(n) Supply, Installation and Testing of LED luminaries for various service rooms, corridor, electrical room, umpire room etc. with necessary wiring and conduiting works from nearest DB.

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.

1.3 List of Submissions

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.

1.4 General

The proposed Electrical Power Distribution and Lighting System for Biju Patnaik Indoor stadium 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) Suitability for applicable environmental factors.

i) Service Condition

j) Indoor Badminton Lighting Work as per International Badminton Federation requirement for CRT Telecasted event.

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.

1.5 Applicable Codes and Standard

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.

1.6 System Design Parameter:

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

1.7 Service Condition:

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

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

1.8 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 5% (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)

1.9 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 1.1.

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

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

1.10 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 Biju Patnaik Indoor 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 metering unit located at the meter room. 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 power within Biju Patnaik Indoor stadium shall be stepped down to 415 V by 1 No. of 11/0.433kV Dry type transformer being located in the Compact Sub-Station (CSS) comprising of 11kV VCB ICOG, 11/0.433kV Dry type transformer and LT MCCB. The power from LT switchgear panel of the CSS shall be distributed to different DBs for interior area distribution and other utility services such as HVAC, Fire fighting, plumbing, ICT, etc. and feeder pillars for external area distribution through the LT Power-cum-Motor Control Centre (PMCC) panel, located in the electrical room. Refer drawing no. TCE.10839A-EL-4002-AU-40009 for the electrical single line diagram for power distribution schematic.

1.11 Compact Substation (CSS)

Compact Sub-Station (CSS) shall comprise of 1 No. of 11kV VCB ICOG, 1 No Dry type distribution transformer and ACB/ MCCB 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.

1.12 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) Ensure 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.

1.13 Emergency Power Supply – Diesel Generator (DG) Set

100% emergency backup shall be provided for Biju Patnaik Indoor stadium with **LT DG set with Auto-Mains Failure (AMF) panel**. Provision for integration of 2 nos of LT DG set shall be made at the LT PMCC panel.

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.

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.

In order to ensure uninterrupted power supply during national level matches, the badminton court area lighting shall be operated on DG power supply. One LT DG set shall be taken on rent to ensure power reliability during such matches. During such events, the incoming power supply from the DISCOM shall be disconnected with the AMF sensing being overridden.

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.

1.14 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.

1.15 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 or 50 kVAR capacitor bank.

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

d) 5% of the capacity shall be provided separately at the PMCC panel for no load compensation of transformer.

1.16 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 50^0C.

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 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.

1.17 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 50^0C).

  (ii) Ambient ground temperature (minimum 40^0C 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 150^0C 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.

1.18 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.

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 : 25kA 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 25x6 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.

1.19 Point Wiring

Point wiring for the constructed building in 1st phase shall be taken care as specified in the scope above. Requisite wiring and conduiting, if any, to the load points from the nearest point of the existing routing shall be carried to ensure completion of work.

The internal lighting installation shall be installed using single core of 1.5mm², PVC insulated FRLS copper wires enclosed in FR PVC conduit. The FR PVC conduit shall be of minimum 20mm size. The contractor shall size the required size of conduit considering 70% occupancy by cables. Lighting in external areas shall be installed using multi-core armoured cable of suitable sizes. The wiring shall be using 5C cable such that alternate fixtures are on different phases for external area lighting and badminton sports lighting.

The 6A and 16A outlets installation shall be installed using 2.5mm^2 and 4mm^2, PVC insulated FRLS copper wires respectively enclosed in PVC conduit. Necessary plug sockets as per requirement and applicable standards shall be provided.

1.20 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 Rooms, Metering rooms	150	2X 18W LED or 1 x40 W LED batten
b)	Common areas – Corridor and	100	1X10 W LED Surface mounted decorative down

Sr. No.	AREA	Average Illuminance (Lux)	Type of Fixture
	Lobby, Passage, Toilets, Staircase		lighter fitting with polycarbonate cover 1x6W LED Mirror Lights
c)	Areas involving concentrated working - First aid room, Office, Media Room, ICT room, Umpire's room	500	1X36 W LED Surface mounted decorative down lighter fitting with polycarbonate cover
d)	Coach room, Pantry, Meeting room, VIP seating	200	1X36 W LED Surface mounted decorative down lighter fitting with polycarbonate cover
e)	Street lighting	10 - 15	1X40 W LED fitting with solar panel and polycarbonate cover
f)	Outdoor multipurpose court	300 - 500	10m pole with LED flood lights
g)	Landscape	10	1x12W LED angle adjustable spot lighters LED Bollards 1x8W tree uplighters Building Uplighters Road 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 Color of the wall and Ceiling as given below:

- White and very light colors : 0.7
- Light colors : 0.5
- Middle tints : 0.3
- Dark colors : 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.

Solar decorative post top lights shall be used for street lighting with 180Wp – 200Wp solar PV panel along the light columns, battery of 60 – 80Ah and lumen output of 2500lumen LED fixtures.

1.21 Indoor Badminton Court Lighting

The civil works for the badminton court area has been carried out by R&B, Rourkela which poses the following limitations:

- The clear height requirement of 12m over the play area shall not be achieved as the height of building from FFL is 11.2m.
- The truss over the court area has been fabricated. The truss has been checked for loading of 45kN of point loads as per TCE.10839A-CV-3000-RC-30000 & 30001.

Considering the above requirements and limitations, the Badminton Court lighting shall be designed for - National event and Recreational event with the following requirements:

Event	**CRT Telecasted (National Event)**	**Non Telecasted (Recreational Event)**
Parameter		
Horizontal Lux	1000 – 2000	500 – 750
Horizontal Uniformity	Min / Avg – 0.7 Min / Max – 0.5	-

Event	CRT Telecasted (National Event)	Non Telecasted (Recreational Event)
Vertical lux	1000	-
Vertical uniformity	Min / Avg – 0.6 Min / Max – 0.4	-
Glare	<50	High quality
CRI	>80	-
Mounting Height	Atleast 9m clear height above play area from bottom of fixtures	
Truss Loading Limitation	As indicated above	

The lights arrangement shall be such that no light fixture is located above the play area. The fixtures shall be positioned along the side lines of the play area.

The sports LED light fixture shall be mounted / supported from the existing truss arrangement. Hence, the lighting design shall be done taking into account the truss loading constraint.

The O&M shall be through means of a moveable hydraulic lift. The hydraulic lift should be able to cater to the working requirements of an electrician (platform of about 2x2m) at the light mounting height (> 9m). This lift shall be taken on rent basis at the time of O&M or sports events. A provision for locating the lift shall be made at the stadium premises. There shall be no provision of a catwalk arrangement for maintenance purpose of the light due to existing building truss design constraint.

DETAILED ELECTRICAL TECHNICAL SPECIFICATIAONS

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. 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 and IP55 for outdoor as per IS: 13947 (Part-I).

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 to be achieved by using metal separators, use of PVC sheet / Hylem sheets shall not be allowed.

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 2000mm.

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.

BUS-BARS:

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. Make and Type test reports carried out at accredited laboratory, of such sleeves shall be submitted during testing.

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) Bus bar supports shall only be SMC irrespective of bus bar size. 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.

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.

b) Power connections for rating above 63A shall be done with AL bus bars (machine bend for proper profile) insulated with black heat shrinkable sleeves with phase identification coloured tapes duly supported on SMC insulators and placed with required minimum clearance of 25mm between phases and between phase to ground/ neutral. Such bus when brought out of the feeder for cable connections shall be sufficient enough and profiled suitable for termination of the number of LT cables as indicated above.

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.

EQUIPMENT REQUIREMENT:

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.

6. 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.

7. 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.

8. 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 (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 LED modules : IS 16104
- Method of measurement of lumen maintenance of solid state light (LED) sources : IS 16105
- Method of electrical and photometric 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
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	>4 KV

Sr. No.	Parameter	Requirement / Value
	Protection	
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
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.

9. 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.

10. 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.

11. 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.

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

DG Set Capacity (KVA)	Typical Depth of PCC Foundation (For soil bearing capacity 5000 kg/sqm)
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)
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:		

S.No.		RATING	ATTRIBUTE
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, WHETHER IN ISOLATION/ IN PARALLEL		NA
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)	*

S.No.		RATING	ATTRIBUTE
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 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		Yes

S.No.		RATING	ATTRIBUTE
	STANDARD IS 4722 / BS 5000 PART 99		
52.0	EXCITER		
52.1	TYPE AND ROUTINE TESTS AS PER STANDARD IS 4722 / BS 5000 PART 99		Yes

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
GENERAL	**1.0**	**ENCLOSURE SPECIFICATIONS**		
	1.1.	Make		
	1.2.	Applicable Standards		
	1.3.	Rated maximum power of substation	kVA	
	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	
	2.5.	Power frequency withstand (one minute) voltage		
		a) Short circuit withstand	kV	

	SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
		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	
	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		

	SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
	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		
	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	

	SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
	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	
TRANSFORMER	8.17.	Magnetization current at rated voltage and frequency in percent of full load current	%	
	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 :
	12.3.	Continuous current rating under site conditions	A	
	12.4.	Busbar insulation		
	12.5.	Minimum clearance		
		a) Phase to phase	mm	

	SL. NO.	ITEM	UNIT	TECHNICAL PARTICULARS
		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		
	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		

Sr. No	Description		Unit	Technical Particulars
(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 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			

Sr. No	Description	Unit	Technical Particulars
(b)	Voltage transformer		
	(i) Ratio		
	(ii) Burden		
	(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				
7.2	Weight of cable drum without cables				
7.3	Weight of cable drum with				

S.N.	Description	Unit	Technical Particulars	Technical Particulars	Technical Particulars
			0.415kV power cables	11kV power cables	Control cables
	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 module	
f.	Short Circuit	
g.	Over Voltage	

Sr. No.	Parameter	Technical Particulars (To be filled by BIDDER)
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	
35.	Maintenance factor	
36.	Total of LED fixture	
37.	Wattage of each fixture	

Sr. No.	Parameter	Technical Particulars (To be filled by BIDDER)		
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		
(i)	Main Lighting distribution board(A.C.)		
	Make		
	Type		
	Degree of protection		
	Bus bar material		

S.N.	Description	Unit	Technical Particulars
	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		
	Type		
	Details of Incoming and Outgoing feeders		
	Degree of Protection		
(v)	Paint Finish		
	Colour shade		
2	**MINIATURE CIRCUIT BREAKER**		

S.N.	Description	Unit	Technical Particulars
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	
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**		

S.N.	Description	Unit	Technical Particulars
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**		Quantity - As per requirement & Sizes – As per Fault level
a)	Buried in earth	MS	
b)	Buried in floor slabs in buildings	MS	
2	**Conductor Leads To Equipment (above ground) – Substation Equipment & Structures**		
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	

S. No.	Description	Material	Technical Particulars
	(iii) Transformer tanks and radiator bank	GS	calculations
	(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	
	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

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	%	
	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		

Sr. No.	Description	Unit	Technical Particulars
	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	
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	Pa	

Sr. No.	Description	Unit	Technical Particulars
	value indicated in 3.9 above		
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		
	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	% of rated	

Sr. No.	Description	Unit	Technical Particulars
	from application of the load indicated in item 3.16.1 above	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 load after “start” impulse	Secs.	
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	%	

Sr. No.	Description	Unit	Technical Particulars
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 :		
	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		

Sr. No.	Description	Unit	Technical Particulars
	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
	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 :		

Sr. No.	Description	Unit	Technical Particulars
	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	
	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)		

Sr. No.	Description	Unit	Technical Particulars
	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		
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 :		

Sr. No.	Description	Unit	Technical Particulars
	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	
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		

Sr. No.	Description	Unit	Technical Particulars
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 shaft		
	e) Motor Rating	KW	
g	Radiator (if required)		
	a) Type		
	b) Overall size		
	c) Materials of construction :		
	i) Tubes		

Sr. No.	Description	Unit	Technical Particulars
	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	
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	

Sr. No.	Description	Unit	Technical Particulars
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		
	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	

Sr. No.	Description	Unit	Technical Particulars
	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	
	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		

Sr. No.	Description	Unit	Technical Particulars
	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		
	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.	

Sr. No.	Description	Unit	Technical Particulars
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		
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		

Sr. No.	Description	Unit	Technical Particulars
7.12	Temperature rise above ambient of 45°C (by thermometer):		
	a) Stator	°C	
	b) Rotor	°C	
	c) Cores	°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	
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	

Sr. No.	Description	Unit	Technical Particulars
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		
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	

Sr. No.	Description	Unit	Technical Particulars
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	
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		

Sr. No.	Description	Unit	Technical Particulars
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,

0-1

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	Busduct
a)	General arrangement and dimensioned layout of the bus duct installation showing the connections to equipment and tap-offs, if any. Arrangement of the bus, insulators etc. within the bus duct
b)	Structural drawings along with foundation details for the structure
c)	Drawing showing the terminal connection between the bus duct and the equipment terminals, Details of bus duct bonding arrangement , Details of Seal-off bushing and wall frame assembly ,Details showing a typical bus duct joint between sections , Details of typical rigid and expansion connections , Details of Bus duct supports , Quality Approval Procedure

S.N.	Deliverables
6.0	DG Sets
d)	General arrangement drawing shall indicate the overall dimensions, net weights and the general constructional features.
e)	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.
f)	Control wiring diagram for Synchronizing Panel
7.0	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.
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.
8.0	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
9.0	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.	Indoor stadium lighting fixing arrangement, mounting structure details etc.
10.0	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,

S.N.	Deliverables
	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.
11.0	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
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.

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.

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

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

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.

Indoor Badminton Court lighting system

a) Check of electrical wiring.

b) Functional tests.

c) Lux level measurement both horizontal and vertical.

d) Lux uniformity check

e) Glare measurement

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

0-1

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.

List of Drawings in Biju Patnaik Indoor Stadium

1	SITE PLAN	TCE-10839A-AC-1003-MP-10011
2	DETAIL OF GATES	TCE-10839A-AC-1003-MP-10012
3	BOUNDARY WALL DETAIL	TCE-10839A-AC-1003-MP-10013
	LANDSCAPE PLANS	
4	LANDSCAPE SITE PLAN	TCE-10839A-AC-1003-LP-10041
5	PROPOSED SOFTSCAPE LAYOUT	TCE-10839A-AC-1003-LP-10042
6	PROPOSED HARD SCAPE LAYOUT	TCE-10839A-AC-1003-LP-10043
7	PROPOSED LIGHTING LAYOUT	TCE-10839A-AC-1003-LP-10044
	FLOOR PLANS	
8	GROUND FLOOR PLAN_EXISTING BUILDING	TCE-10839A-AC-1003-AC-10016
9	FIRST FLOOR PLAN_EXISTING BUILDING	TCE-10839A-AC-1003-AC-10017
10	TERRACE PLAN_EXISTING BUILDING	TCE-10839A-AC-1003-AC-10018
11	GROUND FLOOR PLAN_ANNEXE BUILDING	TCE-10839A-AC-1003-AC-10023
12	FIRST FLOOR PLAN_ANNEXE BUILDING	TCE-10839A-AC-1003-AC-10024
13	TERRACE PLAN_ANNEXE BUILDING	TCE-10839A-AC-1003-AC-10025
	ELEVATIONS & SECTIONS	
14	ELEVATIONS SHEET 1 OF 2_EXISTING BUILDING	TCE-10839A-AC-1003-AC-10021
15	ELEVATIONS SHEET 2 OF 2_EXISTING BUILDING	TCE-10839A-AC-1003-AC-10022
16	ELEVATIONS SHEET 2 OF 2_ANNEXE BUILDING	TCE-10839A-AC-1003-AC-10028
17	ELEVATIONS SHEET 1 OF 2_ANNEXE BUILDING	TCE-10839A-AC-1003-AC-10027
18	SECTIONS SHEET 1 OF 2_EXISTING BUILDING	TCE-10839A-AC-1003-AC-10019
19	SECTIONS SHEET 2 OF 2_EXISTING BUILDING	TCE-10839A-AC-1003-AC-10020
20	SECTIONS_ANNEXE BUILDING	TCE-10839A-AC-1003-AC-10026
	RCP	
21	GROUND FLOOR COORDINATED RCP EXISTING BUILDING	TCE-10839A-AC-1003-IW-10031
22	FIRST FLOOR COORDINATED RCP EXISTING BUILDING	TCE-10839A-AC-1003-IW-10032
23	TERRACE COORDINATED RCP EXISTING BUILDING	TCE-10839A-AC-1003-IW-10033
24	GROUND FLOOR COORDINATED RCP ANNEXE BUILDING	TCE-10839A-AC-1003-IW-10034
25	FIRST FLOOR COORDINATED RCP ANNEXE BUILDING	TCE-10839A-AC-1003-IW-10035
	DEMOLITION PLAN	
26	GROUND FLOOR PLAN_EXISTING BUILDING	TCE-10839A-AC-1003-AC-10033
	TOILET DETAIL	
27	GROUND FLOOR TOILET PLAN_EXISTING BUILDING	TCE-10839A-AC-1003-AC-10029
28	FIRST FLOOR TOILET PLAN_EXISTING BUILDING	TCE-10839A-AC-1003-AC-10030
29	GROUND FLOOR TOILET PLAN_ANNEXE BUILDING	TCE-10839A-AC-1003-AC-10031
30	FIRST FLOOR TOILET PLAN_ANNEXE BUILDING	TCE-10839A-AC-1003-AC-10032

SINGLE LINE DIAGRAM-ELCTRICAL		
31	Single Line Diagram	TCE-10839A-EL-4002-AU-40009
DRAINAGE PLAN		
32	Rain Water Recharging Pit	TCE-10839A-CV-3018-RC-30001
33	Internal Drainage Plan	TCE-10839A-CV-3018-IP-30001
	FINISHING SCHEDULE	
34	FINISHING SCHEDULE	