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LODHA CLARIANT

PLOT C, SG

INFRA WORKS

EXTERNAL INFRA

ELECTRICAL TENDER

BH-ZSG-SPE-E-0002

ELECTRICAL INFRA WORKS

BUROHAPPOLD ENGINEERING

Rev	Date	Issue	Prepared by	Checked by	Client
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PLOT C SALES GALLERY, INFRA WORKS

SECTION – A

GENERAL

BUROHAPPOLD ENGINEERING

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1.1 SCOPE

A. Technical specifications, bill of quantities, Tender drawings and all the other sections enclosed here in cover the design verification, preparation of shop drawing, selection, manufacture, handling at site, supply, installation, testing, commissioning and handing over of completely operational Low Voltage Electrical System **for Lodha, Clarient (Phase-1)** at Kolshet, Thane.

B. It is not the intent to specify completely herein all details of design and construction of system/ plant/ equipment to be supplied / erected. However the system/ plant/ equipment supplied shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous commercial operation in a manner acceptable to the employers Representative who will interpret the meaning of drawings and specifications and shall have the power to reject any work or material which in his judgement are not in full accordance therewith.

C. The entire works which is part of this contract shall be completed in all respects and handed over in line with the employers programme.

1.2 SCOPE

A. Technical specifications, bill of quantities, Tender drawings and all the other sections enclosed here in cover the design verification, preparation of shop drawing, selection, manufacture, handling at site, supply, installation, testing, commissioning and handing over of completely operational Low Voltage Electrical System for Lodha Kolshet, External Infra Works, Thane.

B. It is not the intent to specify completely herein all details of design and construction of system/ plant/ equipment to be supplied / erected. However the system/ plant/ equipment supplied shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous commercial operation in a manner acceptable to the employers Representative who will interpret the meaning of drawings and specifications and shall have the power to reject any work or material which in his judgement are not in full accordance therewith.

C. The entire works which is part of this contract shall be completed in all respects and handed over in line with the employers programme.

1.3 COORDINATION

A. Work shall be carried out in conformity with the specifications and accompanying drawings after approval by the Employer's Representative. The Contractor shall be responsible for over-all co-ordination with all the trades & for preparation of the detailed co-ordination drawings, builder's work drawing etc. for wall and floor penetrations through structure including dimensioned drawings showing coordinated setting out. This includes full coordination with all facets of the Contract works. The Contractor is solely responsible to prepare overall fully co-ordinated drawings for all trades.

B. The Contractor shall also co-operate with the Employer's Representative's other Contractors, compare and coordinate drawings, specifications and time schedules and so arrange his work that there will be no interferences. The Contractor shall forward to the Employer's Representative copies of all correspondence and drawings so exchanged. Failure to check plans and conditions will render the Contractor responsible for bearing the cost of any subsequent change found necessary.

C. The contractor shall be required to do the part / complete installation work in phases so as to take maximum advantage of the work front as and when it gets available.

1.4 PROJECT INFORMATION

External Infra Works Project coming up at Thane. The site is spread over an area of 23 Acres comprises of 43 Towers & clubhouse, Multilevel Car Park including basement & podium Levels.

The tender is for Lodha Kolshet, External Infrastructure Works.

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a. Location : Thane
b. Elevation above Sea Level : Less than 11 meters
c. Maximum DBT with corresponding WBT : 37.8 ºC/27.8 ºC
d. Minimum DBT with corresponding WBT : 18.3 ºC/14.4 ºC
e. Design temperature for Fire Fighting equipment/devices : 40 ºC
f. Relative Humidity: Monsoon- 86% , December to January-65%
g. Air quality: Atmosphere generally hot, humid, dusty, polluted conducive to dust and fungus growth.
h. Earthquake Factor : Zone III as per IS:1893
i. AC Voltage : Voltage variations ± 10%, Frequency variation ± 3%

The Intended Usage of the space is as external infrastructure works.

1.5 ELECTRIC SUPPLY

A. Three phase electric supply will be 415 V, 50 Hz, 4 wires.

B. Single phase electric supply will be 240 V, 50 Hz, 3 wires.

C. TN-S type of earthing is to be provided throughout.

1.6 INSTRUCTION TO CONTRACTOR

A. The Contractor shall furnish all the information called for all the sections of this contract, failing which the bid will be treated as incomplete and the Employer's Representative reserves the right to reject the bid. The Contractor is advised to fill information strictly in the format enclosed.

B. The Contractor shall carefully study all sections and drawings enclosed (if any) with specification and indicate deviations in the relevant Sections of the Specification. If no deviations are stated it will be assumed that the offer conforms in all respects to the specification and the Employer's Representative reserves the right to evaluate the Bid as such without further reference to the Contractor.

C. The Contractor is also advised to have discussion with Employer's Representative before preparing the Bid and bring out clearly in the Bid any discrepancies found in the tender package or any items which in his opinion have not been included in the tender package but is required for the completion of the project.

D. The Contractor must obtain for himself on his own responsibility and at his own expense all the information's which may be necessary for the purpose of making a tender and for entering it into a contract and must examine the drawings, inspect the site of the work and acquaint himself with all local conditions means of access to the work, nature of the work and all matters appertaining thereto.

E. Time allowed for carrying out the work as mentioned in the Memorandum shall be strictly observed by the Contractor and it shall be reckoned from the day written order to commence the work is issued. The work shall proceed with all due diligence, if the contractor fails to complete the work within the specified period he shall be liable to pay a penalty as defined in the General Conditions of Contract. The Contractor shall before commencing work prepare a detailed work programme which shall be approved by the Employer's Representative.

F. Each Contractor shall submit in his bid a list of large works of a like nature he has executed giving details as to their magnitude and cost, the proportion of work done by the Contractor in it and the time within which the works were completed, the Contractor shall also submit along with his bid a list of long lead items & his procurement strategy.

G. The successful Contractor is bound to carry out any item of work necessary for the completion of the job even though such items are not included in the quantities and rates. Schedule of instructions in respect of such additional items and their quantities will be issued in writing by the Consultants with the prior consent in writing to the Employer's Representative.

1.7 QUALITY ASSURANCE AND QUALITY CONTROL

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A. 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.

B. Following plans shall be prepared and submitted to Employer's Representative within 30 days after award of the contract.

   a. Quality Plan to be submitted for approval.

   b. QA/QC Procedure and Inspection Test Plan.

   c. Material inspection schedule. (all incoming material)

   d. Work Inspection schedule (Installation inspection)

   e. Area Clearance and handing over formats.

   f. QA/QC team structure.

C. 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 Employer's Representative for all final approvals. 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.

D. The Employer's Representative 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.

E. The test shall be conducted at the site laboratory that may be established by the Employer or at any other NRTL (National Regional Testing Laboratory) selected by the client. Test certificates to be submitted for factory / test authority certification.

F. 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, Client shall have them transported and recover two times the actual cost from the Contractor's bills.

1.8 EXTENT OF SERVICE

A. Works to be carried out under this Contract includes BOQ verification as per drawings & highlighting any discrepancy before submission of tender, the preparation of shop drawing, selection, manufacture, supply, installation, testing and commissioning of the Electrical System and associated installation to comply with the requirements from any authorities having jurisdiction over the said system and installation and the requirements on performance, materials and equipment as stipulated in the Technical Specifications.

B. The Contractor's proposals shall work under the space/area limitations shown on the drawings for compliance.

C. Contractor shall also note the limitation of equipment access as shown on the drawings and shall ensure that all equipment can be safely transferred to the planned space. The Contractor shall include in his scope if necessary the work for dismantling and reassembly / assembly of the equipment to accommodate any access restriction.

D. Clearing away rubbish.

E. Tools, Tackles, Scaffolding including the provision, maintenance and removal of any special scaffolding as required.

F. Unloading, distribution and placing in position all plant, machinery, etc.

G. Coordination of the other services entering in your work front.

H. Cutting chases for sleeves, containment and the like in walls, floors, partitions etc (except on structural members) and the like and subsequent making good.

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I. Cutting or forming holes for pipes, ducts and the like through walls, floors, partitions, roofs and the like (except Structural members), subsequent making good and providing sleeves and/or sub-frames as required.

J. Pinning ends of supports for containment, equipment, appliances, fittings and the like to wall, floors, partitions, soffits etc and making good.

K. Leaving mortices, sinking and the like for holding down bolts, brackets, supports and the like and grouting in.

L. Filling around, boring holes through and making good of finishing up to pipes, supports, brackets and the like.

M. Application of Paint on exposed containment, fittings, equipment and the similar items with Rust proof paint.

N. Co-ordination and connection of the lighting protection systems air termination network to the buildings concrete embedded down conductor network to the earth termination network.

O. All equipotential / supplementary bonding of buildings exposed metalwork to earthing system will be in the scope of the contractor.

P. The contractor must bear in mind that all the work shall be carried out strictly in accordance with the approved specifications and approved working drawings as instructed by the Employer's Representative and also in compliance with the local public authorities and to the requirements of any acts, rules and regulations. No deviation on any account will be permitted.

Q. Any other Minor civil work pertaining to main work

R. Getting all approvals as required from Statutory / Local authorities required during construction and till commissioning and handing over the entire fire fighting system.

S. Electrical works from and including control panel, inside the Electrical system plant room.

1.9 OTHER ASSOCIATED WORKS

1.8.1 ASSOCIATED CIVIL WORK

a) Following civil works associated with Electrical installation are excluded from the scope of this contract except for all minor civil work like wall chasing by wall chaser, making holes etc. for installation of conduits/cables and making good.

b) Floor/ wall cutouts inside Electrical / Panel room or wherever required.

c) Fire doors of minimum 2 hours fire rated as per local codes for Electrical/ LT panel rooms.

d) Electrical supply to work front during construction.

e) False ceiling work as shown on the Employer's Representative drawings.

1.8.2 PLUMBING & DRAINAGE SYSTEM

a) Terminating power and earthing up to MCC panel for Pumps shall be in the scope of Electrical contractor. Supply of MCC, further power cabling and earthing from MCC panel up to equipment by Plumbing Contractor.

1.8.3 ELV SYSTEM

a. Sockets will be free issued by Lodha and termination of UPS power/ earthing connection by Electrical Contractor.

1.8.4 SECURITY SYSTEMS

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a. Sockets will be free issued by Lodha and termination of UPS power/ earthing connection plus associated provision of conduits and containment further UPS by the Security Contractor.

1.10 SUBMISSIONS

A. After Award of contract

Within 7 days of acceptance or as specified in GCC/SCC of the tender the contractor shall submit for approval:

1. Refer comments for item Section1.12 item E for all planning related submittal.
2. Shop Drawing Submittal schedule.
3. Material Submittal Schedule.
4. Procurement Schedule.
5. Method statement submittal schedule.
6. Inspection Test Plan Schedule.
7. Logistic plan
8. Construction schedule with WBS.

Schedule of manufacturers for all major equipment, devices & installation, etc or as required by Employers Representative's

B. Tender Stage

The following shall be submitted together with the tender for consideration:-

1. The Contractor shall furnish all the information called for in the relevant sections attached with the tender, failing which the bid will be treated as incomplete and the Employer's Representative reserves the right to reject the bid. The Contractor is advised to fill information strictly in the format enclosed.
2. Preliminary design drawings including system schematic and layout plans showing the arrangement of the Electrical System to demonstrate adequacy of the allocated plant space and all being accommodated within the given architectural and structural constraints.
3. Preliminary design calculations.
4. Proposed equipment schedule showing capacities and rating required with the corresponding selection of manufacturer, model, types, etc. Relevant technical catalogues shall also be submitted with relevant sections clearly highlighted. In all cases compliance certificates to be provided.
5. Previous local job reference for major plant and equipment for the last 5 years.

C. Contract Stage:

These submissions shall among other things include the following major items:-

1. Within 10 days of award of contract,(Or As Mentioned in GCC & SCC) the contractor shall submit for approval the Shop drawing delivery schedule, Resource allocation schedule, Technical submittal schedule and the construction schedule in line with the project construction master schedule.
2. After award of the contract, the Contractor shall make all the necessary submission at such appropriate times to suit the works programme of the Project.
3. Builder work drawings with detailed setting-out and dimensions showing requirements for all water tanks, pits, plinth, support, structural and non-structural openings etc. These shall be submitted within 15 days after award of the Contract. (Or As Mentioned in GCC& SCC)

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4. Detailed system schematic diagram.
5. Detailed layout plans for the Electrical Systems.
6. Installation details
7. Wiring diagram including power installation for motor control centre, control schematic, etc.
8. Equipment and material submittals and schedule.
9. Detailed design calculations.
10. Necessary drawings for submission to the local authorities for approval.
11. As-fitted drawings and O&M Manuals.

D. Commissioning Stage:

1. Detailed commissioning report to be prepared and furnished by Contractor to the Employer's Representative for approval during handing over.

NOTE: No drawings / submittals will be accepted for examination by the Employer's Representative unless entirely complete, first checked and approved by the Contractor.

1.11 DRAWINGS AND LITERATURE

A. List of Equipment/ Materials:

B. The Following submittals shall be included with the tenders. Failure to provide the required information may cause rejection of the tender. Detailed equipment list, identifying types, models, and all materials & equipment proposed. This submittal shall include manufacturer's data sheets showing the types and models of all equipment and materials. The submittals shall be in the format given in relevant sections of tender documents.

C. When a data sheet shows more than one make, the proposed make shall be clearly indicated by arrows or other suitable means.

D. The data shall be submitted in a ring binder, indexed by product.

E. The data shall not include superfluous cut sheets (i.e. unedited manufacturer's catalogues are not acceptable).

F. Origin of material / components to be included.

G. Shop Drawings / Technical Data:

1. After the award of work, the Contractor shall submit shop drawings including Builders Work Drawings and technical data for approval. Shop drawings and technical submittals shall include sufficient data to indicate complete compliance with Specification, Contract Documents and System Requirements. Submissions shall be in the form of drawings, brochures, catalogues and/or narrative descriptions with certified standards.
2. Tender Drawings have been prepared by the Architects/Consultants/Employer's Representative showing the equipment and Electrical system layouts and the space allocated for Plant/ Equipment.
3. The tender drawings represent the design intent and a feasible scheme / layout that may be re-arranged in the space allocated during the shop drawing preparation subjected to prior approval by the Architects / Consultants / Employer's Representative before the actual shop drawing and execution.
4. Within 15 days of the award of Contract (Or As Mentioned in GCC/SCC) the Contractor shall submit for approval, Technical submittals for equipment/ System/ Plant including detailed selection chart, performance curves and calculation marking the selection of all equipment, general layout, Equipment submittals, assembly drawings and such additional assembly and sub-assembly detailed drawings as are necessary to

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demonstrate fully that all parts of the apparatus to be furnished conform to the specifications.

5. Four sets of all catalogues (at least one set original) for all equipment, accessories and materials shall be submitted to the Employer's Representative for approval.

6. Within 10 days of the award of contract(Or as mentioned in GCC/SCC), the Contractor shall furnish Eight (8) prints and soft copy of the equipment layouts, containment layouts, riser layouts, SLDs and assembly and erection drawings etc for approval. If modifications are proposed by the Employers Representative's, three (3) further prints of the modified drawings shall be submitted. Modifications shall be only made in the drawing after it has been approved by the Employers Representative's with their prior consent. All drawings necessary for assembly, erection, maintenance, repair and operation of the system /equipment/ materials shall be furnished. Scale for the shop drawings shall be minimum 1:100 for the plans and 1:50 for sections. All plans should be provided with adequate sections at critical locations.

7. After the award of work, all changes in architectural, structural, interior design, facilities planning or any decision of Employer's Representative causes redesign of the system, the contractor shall carry out the same in shop drawings / calculations and get approval from the Employer's Representative. The Employer's Representative will advise / guide the Contractor to carry out such changes but will not provide any drawing further to the tender drawings, issued with these documents.

8. Approval by the Employer's Representative of the Technical Submittals and drawings shall not relieve the contractor of any part of his obligation to meet all the requirements of the Contract or of the correctness of his drawings. The Contractor shall be responsible for and pay for all alterations of the works due to discrepancies or omissions in the drawings or other particulars supplied by him, whether such drawings have been approved by the Employers Representative's/ or not.

H. Contractor shall furnish and install in or near all the machine rooms the following:

1. A neatly typed/ stencilled set of operating and maintenance instructions for the relevant equipment.

2. Neatly drawn and well presented schematic diagrams for all the systems viz. LV SLD, wiring diagrams, DB schedules etc. All the drawings shall be glazed and securely framed at convenient locations within the machine room.

3. Samples of materials/fabrications shall be submitted for approval to the Employer's Representative as required or called for by the Employer's Representative before installation.

I. As-Built Drawings:

1. A separate set of approved shop drawings corrected to indicate the as-built conditions shall be kept at the site. These drawings shall be maintained in a current condition at all times and shall be made available for review upon request. All variations from the approved shop drawings, for whatever reason, including those occasioned by modifications, change orders, optional materials and/or required coordination between other Contractors shall be indicated in sufficient detail to accurately reflect the as-built conditions.

2. Upon completion of the work, before final payment, one complete Mylar set and two additional blue-line sets of as-built drawings shall be submitted for approval, which shall include plans, sections, specific details, schematic diagrams, riser diagrams, control diagrams and any other drawing as directed by the Employers Representative's.

3. Contractor shall submit as-built drawings on CD-ROM in addition to the above. All drawings shall be made on Auto CAD.

J. Quality Control Submittals:

1. Proof of compliance to applicable codes and standards.

2. Final commissioning and testing reports.

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K. Operation and Maintenance (O & M) Manuals :

1. Submit two (2) draft copies of O & M manuals for review. After review by Employer's Representative, the Contractor shall incorporate review comments and submit Six (6) final copies.
2. During guarantee period, the Contractor shall update the manuals with modifications made to system, providing replacement pages or supplements in quantity stated above.
3. O & M manuals shall be assembled into multi-volume sets as necessary and required by the Employers Representative's.
4. Each volume shall be protected with a heavy duty vinyl plastic binder. Volumes shall have plastic printed dividers between major sections and shall have oversized binders to accommodate up to 20 mm thick set of additional information.
5. Each binder shall be silk screened with project name and volume title on front cover and binder.
6. First page of each manual shall be identified with project name, manual title, Employer's Representative name address and service phone number and person who prepared the manual.
7. Operating and maintenance Manual shall serve as training and reference manual for all aspects of day-to-day operation of the system, such as:
   - Technical descriptions of each system.
   - Step by step direction.
   - Provision of alarms and their sequences.
   - Do's and Don'ts in operation.
   - Fault location and remedy chart.
   - Operation Instructions (full operating information to be attached).
   - Recommended maintenance schedule.
   - Parts List.
   - Schedule of spares.
   - 24/7 Emergency Contact Numbers and Names against each system.
   - Full Warranty Information
   - Modification Instructions
   - Disposal Instructions.
   - Etc.

1.12 TESTING:

A. All equipment and the whole system shall be tested as required by the various sections of the specifications and test data as required shall be furnished.

B. Routine tests for the various items of equipment shall be performed at the Contractor's works and relevant test certificates to be furnished. If required by the Employer's Representative, the Contractor shall permit the Employer's Representative to be present during any of the tests. After notification of the Employer's Representative that installation has been virtually completed, the Contractor shall conduct under the direction and in the presence of the Employers Representative's, such tests and inspection as have been specified or as the Employer's Representative shall consider necessary to determine whether or not the full intent of the Requirements of the drawings and specifications have been fulfilled. In case the work does not meet the full intent of the specifications and further tests considered necessary, the Contractor shall conduct such tests and bear the expenses thereof.

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C. The Contractor shall operate, test and adjust all lighting, switchgear, RCDs, power systems and other electrical equipment provided in connection with this installation and shall make all necessary adjustments and corrections to establish the specified system / equipment capacity at given designed condition.

D. All cabling shall be tested and visually checked to ensure outer sheeting is not damaged, that the cabling is properly supported and not under stress.

E. All equipment and systems shall be tested after installation and test readings submitted as specified.

1.13 REJECTION OF DEFECTIVE EQUIPMENT

A. If the completed system installation or any portion thereof, before it is taken over or during the guarantee and defects liability period, is found to be defective or fails to fulfil the intent of these specifications, the Contractor shall on receipt of notice from the Employer's Representative forthwith dismantle and replace the defective equipment/ material/ system installations.

B. Should he fail to do so within 15 days (or as noted in the GCC or SCC) of notification by the Employers Representative's, the Employer's Representative may reject and replace at the risk and expense of the Contractor, the whole or any portion of the equipment/ material/ system installations found defective or that fails to fulfil the requirements of the Contract.

C. The Employer's Representative shall have the right to operate all equipment or systems whether or not such equipment or system have been accepted as complete and satisfactory. Repairs and alterations shall be made at such times and as directed by the Employers Representative's.

1.14 SAFETY CODE

A. There shall be maintained in a readily accessible place first-aid appliances including adequate supply of sterilized dressing and cotton wool.

B. The injured person shall be taken to a public hospital without loss of time.

C. Suitable and strong scaffolds should be provided for workmen for all works that cannot be done safely from the ground.

D. No portable single ladder shall be over 8 metres in length. The width between the side rails shall not be less than 30 cm (clear) and the distance between the two adjacent rungs shall not be more than 30 cm. When a ladder is used an extra mazdoor (labour) shall be engaged for holding the ladder.

E. Every opening in a floor of a building or in a working platform shall be provided with suitable means to prevent the fall of persons or materials by providing suitable fencing or railing whose minimum height shall be one metre.

F. No floor, roof or other part of the structure shall be as over-loaded with debris or materials as to render it unsafe.

G. Protective gear such as safety helmets, boots, belts, etc. shall be provided by the Contractor at his own cost to all his manpower at site. The Contractor shall impose such requirements on all Sub-Contractors also. It shall be the responsibility of the Contractor to ensure that such protective gear is worn at all times by all personnel working at site. The Employers Representative shall have the right to stop any person not wearing such protective gear from working on the site.

H. Those engaged in welding works shall be provided with welder's protective eye-shields and gloves. Fire extinguishers must be provided during welding at all times. The Contractor shall employ a welding permit system and shall co-ordinate their works with all relevant parties.

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I. The Contractor shall employ a power on permit system along with a lock and tag system. All areas / systems being made live shall be done only after notification of all relevant parties and operatives and after the earthing system has been properly implemented.

J. No paint containing lead or lead products shall be used except in the form of paste or readymade paint.

K. Suitable facemasks should be supplied for use by the workers when the paint is applied in the form of spray or surface having lead paint dry rubbed and scrapped.

L. Overalls shall be supplied by the Contractor to the painters and adequate facilities shall be provided to enable the working painters to wash during the cessation of work.

M. In case the Contractor fails to make arrangements and provide necessary facilities as aforesaid, the Employer's Representative shall be entitled to do so and recover the costs thereof from the Contractor. The decision of the Employer's Representative in this regard shall be final and binding on the Contractor.

N. Use of hoisting machines and tackle including their attachments, anchorage and supports shall be in perfect condition.

O. The ropes used in hoisting or lowering material or as a means of suspension shall be durable and in perfect condition.

P. All electrical connections for construction activity shall be taken through proper receptacles only. No loose wire connections shall be allowed.

1.15 CONTRACTOR'S REPRESENTATIVES

A. The Contractor shall employ qualified representatives on full time basis (and shall be available at site) whose name shall have previously been communicated in writing to the Employer's Representative and approved by them to supervise the execution. Any written order or instruction given to the representative shall be deemed to have been given to the Contractor.

B. The Employer's Representative shall be at liberty to object to any particular representative or any persons employed by the Contractor on the work and the Contractor shall remove the person objected to, on receipt from the Employers Representative's, in writing, a request requiring him to do so. The Contractor shall provide in his place another competent representative acceptable to the Employer's Representative.

1.16 TEMPORARY CONSTRUCTION POWER

For water and power, the Contractors for subsidiary trades appointed by the Employer shall be allowed connection from the water and power supply arranged by the General Contractor for civil work and for the facility the Contractor will pay to the General Contractor the charges to be decided by them mutually. The Contractors shall install a sub-meter for measuring electric energy at their own cost and maintain the wiring installation in good condition and order and pay the consumption charges directly to the Main Civil Contractor.

However, in absence of adequate Power and Water supply for construction purpose, the Electrical Contractors shall make his own arrangements. The cost shall be borne by the Contractors.

1.15 CONTRACTOR AGREEMENT – The Contractor shall be responsible to read and agree the scope of work as detailed in SOW, GCC & SCC documents.

END OF SECTION

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SECTION – B

ELECTRICAL

TECHNICAL SPECIFICATIONS

BUROHAPPOLD ENGINEERING

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1. GENERAL

1.1. SUMMARY

1.1.1. The entire works which is part of this contract shall be completed in all respects and handed over in line with the employers programme.

1.1.2. The Electrical System must comply with the standard acceptable authority requirements, State PWD, NEC2011, IEC Reference, NBC2005, IPC, Local Municipal Authorities, MOEF guidelines and subject to approval by the Employers Representatives.

1.1.3. The entire work shall be carried out in a manner consistent with good engineering practice. The Contractor shall take into account all site conditions including space allocation for Electrical System while designing the system and selecting the equipment.

1.1.4. **The Contractor shall be responsible for engaging a qualified, competent and experienced Electrical System staff to perform the system design verification, preparation and submission of system proposal, obtaining approvals from relevant authorities and site supervision for installation, testing and commissioning.**

1.1.5. The Contractor shall perform the system design verification based on the criteria / data and technical requirements specified in this section / drawings and the local Authorities regulations / requirements.

1.1.6. The Contractor shall provide systems which comprises products of manufacturers who have designed, developed and used these products successfully for a period of at least five years.

1.1.7. The Contractor shall submit catalogue information, design calculations and samples complete with full technical data and shop drawings for the entire system, test certificates, etc. and any other information required by the Employer's Representative for acceptance prior to commencement of installation.

1.1.8. The Contractor shall submit analytical test reports for the Electrical Systems wherever applicable after the commissioning or after the system is put into operation or as required by the Employer's Representative. The result should comply with local authority requirements.

1.2. SCOPE OF ELECTRICAL SYSTEM CONTRACTOR :

1.2.1. Broad scope of Work is as mentioned below but not limited to :

1.2.1.1. Extending LV power from the Existing Feeder Pillar as shown.

1.2.1.2. LV Cables

1.2.1.3. Main LT Panel, Distribution Boards

1.2.1.4. Containment

1.2.1.5. Internal Wiring

1.2.1.6. Installation of Light Fixtures

1.2.1.7. Earthing etc.

1.2.2. The scope of work given below pertains to the entire electrical Works which includes provision of design verification, detailed calculation (if any), selection of equipment, preparation of overall co-ordinated drawings of all trades, working drawings, builder work drawings. Further to this supply, installation, testing, commissioning under normal operational condition and handing

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over for the complete Electrical System to the requirement as stipulated in this specification and local government authority.

1.2.3. For HVAC, Fire Protection and Plumbing systems the electrical works demarcation shall be as described on the Contract drawings.

1.2.4. Priming and finishing coats painting as per the standards.

1.2.5. As-built drawings and operation / maintenance manual as detailed elsewhere in the specification shall be provided.

1.2.6. Where containment passes through the fire rated partitions/walls, the space around /within the containment shall be fire sealed. Seal the gaps between containment sleeves and containment / conduit, etc. if any.

1.2.7. Warranty and maintenance service for the period as specified in GCC, SCC from the date of handover of the works shall be included in the offer.

1.3. SYSTEM DESCRIPTION :

1.3.1. A existing feeder pillar is available at Plot C fed from Construction Power of Plot C1. 3 Phase 415 V 50 Hz AC supply will be extended from that feeder pillar to New Proposed Electrical Room at the Sales Gallery Site.

1.3.2. EC to verify existing cables on site feeding to the existing building. If possible re-route with out damaging and use the same cables per the proposed route in the contract drawings.

1.3.3. If re-route not possible; provide new set of cables as mentioned in the cable schedule.

1.3.4. 1 no. DG is proposed as Stand-by and ATS Panel is proposed for the Automatic Change over in case of power failure.

1.3.5. Main LT panel feeds power to Sales Gallery LPDB, ACDB, Water Pumps, Out Door Units etc.

1.3.6. For common areas, Normal and Emergency lighting shall be provided. In the event of a mains failure causing the normal lighting to fail then emergency lighting shall provide a minimum light level powered by DG Set.

1.3.7. The cables shall comply as specified in technical specification.

1.3.8. The cabling installation shall be sized to ensure the Voltage Drop of 6% upto last circuit within the development.

1. A maximum of 5.0% VD upto DB level

1.3.9. The system shall have a common earthing system as described in the specification and as shown on the drawings. Individual earthing systems as per drawing shall be provided as follows. Generally the following systems shall have 2 connection to the earthing system to provide for redundant paths:

1. LV Electrical Functional Earthing
2. Generator Functional and Neutral Earthing
3. Equipotential bonding of all containment/cable trays, etc, metallic conduits, metallic parts of equipment & all type of panel boards, metallic installation of HVAC, firefighting, plumbing, drainage, etc.
4. Equipotential bonding to all incoming services within each area
5. Supplementary bonding within internal areas and plant areas including piped services.

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1.3.10. The resistance between earthing electrode and the general mass of earth shall not be greater than 5Ω.

1.3.11. The earth loop resistance to any point in the electrical system shall not be in excess of 0.5 ohms in order to ensure satisfactory operation of protective devices.

1.3.12. The resistance to earth shall be measured at the following:-

a) At the test links provided on the columns as specified in the layouts/drawings.
b) At one point each grounding system used to ground wiring system enclosures such as metal conduits and cable sheaths or armoured.

1.4. LIST OF CODES & STANDARDS:

Tender specifications, drawings, schedules, general and special conditions of the Contract apply to this Section.

Sr. No.	Standard Code	Description
1.0	**Complete Electrical System**	
	NBC 2005	National Building Code of India 2005
	NEC 2011	National Electrical Code 2011
	NLC-2010	National Lighting Code 2010
	IE Rules	Indian Electricity Rules 1956
	Electricity Act	1910, Updated as on Date
	MCGM-NOC	NOC from Bombay Municipal Corporation
	CFO-NOC	NOC from Chief Fire Officer
	MOEF- Approval	Approval from Ministry Of Environment & Forest
	Unless specifically mentioned otherwise, all the applicable Codes and Standards published by the Bureau of Indian Standards and their subsequent revision/ BS Standards shall govern the design, workmanship, quality and properties of materials and method of testing.	
2.0	**L.T. Panels**	
	IEC 439-1 1992	Low voltage Switch gear and Control gear assemblies Part-I, type tested and partially type tested assemblies.
	IEC-947-1, 1998	Low voltage Switch gear and Control gear Part-I general rules.

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	IEC-1180-1, 1992	High voltage test techniques for low voltage equipment Part–I definition test and Procedure requirement
	IS : 13947	Low voltage switchgear and control gear.
	IS : 4237	General requirements for switchgear and control gear for voltages not exceeding 1000 V a.c. or 1200 V d.c...
	IS : 8197	Terminal marking for electrical measuring instrument and their accessories.
	IS : 2551	Danger notice plates
	IS : 8623	Specification for factory built assemblies of switchgear and control gear for voltage up to and including 1000 V A.C. and 1200 V D.C.
	IS : 2705	Current transformer
	IS : 3156	Voltage transformer
	IS : 3231	Electrical relay for protection
	IS : 1248	Indicating instrument
	IS : 722	Integrating instrument
	IS : 6875	Control switches and push buttons
	IS : 375	Switchgear bus bars, main connection and auxiliary wiring, marking and arrangement.
	IS : 2147	Degree of protection provided by enclosures for low voltage switchgear and control gear
	IS : 5578, 11353	Busbar Connections and Accessories
	IS : 6005	Code of Practice for Phosphating Iron & Steel
	IS : 694	LSZH Wires
3.0	**LT Switchgear**	
	IS : 2516	Specifications for A.C. circuit breaker
	IS : 9921	Specifications for A.C. isolator and earthing switch

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	IS : 10118	Code of Practice for installation and maintenance of switchgear.
	IS : 8623	Specification for factory built assemblies of switchgear and control gear for voltage up to and including 1000 V A.C. and 1200 V D.C.
	IS : 8828	Miniature circuit breakers.
	IS : 2516	Air circuit breaker
	IS : 4064	Fuse switch and switch fuse unit.
	IS : 9224	HRC fuse links
	IS : 2959	Auxiliary contactor
	IS : 1822	A.C. motor starters of voltage not exceeding 1000 V
	IS 3427	Metal enclosed Switchgear and Control gear for voltages above 1000V but not exceeding 11000V.
	IS 9920 Part 1,3 & 4, IEC:60265	Switches and Switch Isolators for voltages above 1000V, Ring main unit 11 kV grade
	IS 3156	Voltage Transformers
	IS 3231	Electrical Relays for power system protection.
	IS : 2551	Danger notice plates
	IS : 8623	Specification for factory built assemblies of switchgear and control gear for voltage up to and including 1000 V A.C. and 1200 V D.C.
	IS : 2705	Current transformer
	IS : 3156	Voltage transformer
	IS : 3231	Electrical relay for protection
4.0	**Busduct & Plug-in Busbar Trunking**	
	IS 8623	Specification for Low-Voltage Switchgear

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5.0	**LT Cables**	
	IS : 7098 Part I	XLPE insulated electric cables (heavy duty).
	IS : 3961	Recommended current ratings for cables.
	IS : 8130	Aluminium conductors for insulated cables Indian Electricity Act and Rules.
	IS 732 / IS 12307 / IS 12349 / NBC, IS 5578	Guide for marking of insulated conductors.
	BS 6387	Standard for Testing of Fire Survival for Category C, W, Z.
	IEC 60332-1	Standard for Testing of Flame Retardant
	IEC 601034-3	Standard for Testing of Low Smoke
	IS : 7098 (Part I)	Fire Retardant Low Smoke (FRLS) / Flame Retardant Low Smoke Zero Halogen (FRLSZH) compound
6.0	**Cable Trays, Trunking**	
	NEC 2011	National Electric Code 2011
	NEMA VE1, FG1,VE2	NEMA Standards for Manufacturing of Cable Trays
	IS:9537 (Part-II)/ CEE 23 & IEC 60695-2-1:1991	Steel Conduit and Fitting Accessories LSZH Conduit and Fitting Accessories
	ISO 9000, ISO 9001, ISO 9002 or Equivalent IS Standard.	Cable Tray
	ISO 9000, ISO 9001, ISO 9002 or Equivalent IS Standard.	Cable Ladder
	IS 14927, IEC 1084.	Cable Trunking
	IS 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals.
7.0	**Lighting**	
	IS: 3646	1960 Code of practice for interior illuminator.

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	IS :1913	1969 General and Safety requirements for electric lighting fittings
	NLC-2010	National Lighting Code-2010
	IS:1944	Lighting of Public Thoroughfare
	IS:5077	Decorative Lighting
	IS:10322	Luminaire Series
	IS: 13383	Methods of photometry of Luminaire
	IS:1534	Ballast for Fluorescent Lamp
	IS:13021	Electronic Ballast
	IS:15111	Compact Fluorescent Lamp
	IS:2418	Tubular Fluorescent Lamp
	IS:418	Tungsten Filament Lamp
	IS:9900	HPMV Lamp
	IS:9974	HPSV Lamp
8.0	**Aviation lighting**	
	ICAO-Annex 14	International Civil Aviation Organization
9.0	**Earthing, Bonding & Lightning Protection**	
	IS 3043	Earthing Code of Practice
	IS 2309	Lightning Protection System
	IEC 61024-1-2	Lightning Protection System
	BS EN 62305 (1 to 4)	Lightning Protection System
	NFC-17-102	Standard for Lightning Protection
	EN 50164	Accessories for Lightning Protection Systems

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Unless specifically mentioned otherwise, all the applicable Codes and Standards published by the Bureau of Indian Standards and their subsequent revision/ BS Standards shall govern the design, workmanship, quality and properties of materials and method of testing.

1.5. MAINTENANCE

1.5.1. General

Provide the following free maintenance for the time period as per the GCC & SCC after handing over the Electrical System to the Client (i.e. during warranty period)

i. Examinations: Bi-Weekly, including adjustments, cleaning and lubrication of equipment.

ii. Replacement: Replace components when required, using parts produced by original manufacturer.

iii. Spare Parts: Provide necessary spare parts; maintain locally an inventory of all wearing parts of the system.

iv. Call Backs: Provide 24-hour emergency call back service at no expense to the Client.

v. Records: Maintain complete maintenance records including check charts, lubrication logs and activity logs; provide check charts and activity logs.

1.5.2. Extended Service Contract

At time of Bid, submit cost for full maintenance contract i.e. after the expiry of warrantee and free maintenance period as specified in GCC & SCC.

i. Contract Term: Upon expiration of new installation, free maintenance, provide full maintenance service for five (5) years, including spare parts.

ii. Service: Provide examinations, logs, replacements and spare parts as specified for maintenance, including cleaning of tanks, equipment and machinery spaces required to maintain the water output quality and quantity as per design.

1.6. QUALITY ASSURANCE

1.6.1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in IS 732 1989 (reaffirmed 2005) by a qualified testing agency, and marked for intended location and application.

1.6.2. Comply with the "Approval Guide," published by IS.

1.6.3. Workmanship

The workmanship shall be best of its kind and shall conform to the specifications, as below or Indian Standard Specifications in every respect or latest trade practices and shall be subject to approval of the Employer's Representative. All materials and/or Workmanship which in the opinion of the Employer's Site Representative is defective or unsuitable shall be removed immediately from the site and shall be substituted with proper materials and/or workmanship forthwith.

1.6.4. Materials

All materials shall be best of their kind and shall conform to the latest Indian Standards.

All materials shall be of approved quality as per samples and origins approved by the Employer's Representative.

As and when required by the Employer's Representative, the contractor shall arrange to test the materials and/or portions of works at his own cost to prove their soundness and efficiency.

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If after tests any materials, work or portions or work are found defective or unsound by the Employer's Representative the contractor shall remove the defective material from the site, pull down and re-execute the works at his own cost to the satisfaction of the Employer's Site Representative. To prove that the materials used are as specified the contractor shall furnish the Employer's Representative with original vouchers on demand.

1.7. DELIVERY, STORAGE & HANDLING

1.7.1. Preparation for Transport: Prepare equipment, according to the following:

1. Ensure that all material to be transported to be protected against rust and corrosion.
2. Protect the material against damage.
3. Set material in best position for handling. Set material closed to prevent rattling.

1.7.2. During Storage: Use precautions for material, according to the following:

i. Do not remove end protectors / wrappings etc. unless necessary for inspection; then reinstall for storage.

ii. Protect from weather. Store indoors and maintain temperature higher than ambient dew point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

- Handling: Use sling to handle materials if size requires handling by crane or lift. Do not use hand wheels or stems as lifting or rigging points for handing the heavy materials.
- Deliver conduits with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent conduits-end damage and to prevent entrance of dirt, debris, and moisture.
- Protect stored conduits from moisture and dirt. Elevate above grade.
- Protect equipment from moisture and dirt.
- Store plastic conduiting protected from direct sunlight. Provide supports to prevent sagging and bending.

1.8. COORDINATION

- The Electrical contractor shall be solely responsible for overall coordination with all the trades and shall have sole responsibility for the preparation of fully detailed coordinated services drawings for all the trades. Work shall be carried out in conformity with the specifications and accompanying drawings after approval by the Employer's Representative. The Contractor shall also co-operate with the Employers Representative's other Contractors, to compare and coordinate drawings, and time schedules and so arrange his work that there will be no interferences. The Contractor shall forward to the Employers Representative copies of all correspondence and drawings (prior to the execution) so exchange. Failure to check plans and conditions will render the Contractor responsible for bearing the cost of any subsequent change found necessary.
- The contractor shall be required to do part / complete installation work in phases so as to take maximum advantage of the work front as and when it becomes available.

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2. EQUIPMENT AND PRODUCT SPECIFICATIONS

2.1. L.V. PANELS, ENCLOSED SWITCHGEAR, DISTRIBUTION BOARDS, VFD's, CONTROL PANELS & STARTERS

2.1.1. SCOPE :

The specifications are given below to enable the Design as per Form & type specified, Manufacture, Testing and Supplying of L.V. Panels, Enclosed Switchgear, Distribution Board, VFD's, Control Panels & starters appearing in the schedule of quantities.

2.1.1.1. A discrimination study shall be provided for the complete LT distribution system from the incoming protective device downstream to the final circuit protective device. The study shall be provided in paper and electronic format for approval by the Engineer In Charge. If discrimination is not achieved between any 2 Nos protective devices this shall be identified to the Engineer's In Charge and if this is not carried out it shall be deemed that full discrimination has been achieved.

2.1.1.2. Ensure discrimination on overload and short circuit applications is achieved using the proposed switchgear components. Under no operating conditions shall the supply to a whole distribution board be lost due to a fault on a downstream circuit

2.1.1.3. All switchgear shall be sourced from the same manufacturer (i.e. ACBs/MCCBs/MCBs/MPCB/SFU'S etc, mixing of switchgear manufacture shall not be permitted on this project. To allow grading of the switchgear the selected manufacturer shall either (a) have full product range available in Amtech Pro Design 17th Edition or (b) shall have their own software for grading and network analysis. Where (b) is proposed by the Contractor they shall provide for full training to the Engineer and Client in using the software and shall provide a named person working directly for the original manufacturer whose job will be to carry out network and grading analysis for review by the Employers Representative.

2.1.1.4. The electrical arrangement of the switchgear, protection, metering, control, interlocking, inter-tripping, auxiliary power supply etc. shall be as shown on the single-line diagram(s).

2.1.1.5. The control scheme shall provide for automatic load transfer if the normal incoming supply to a bus is lost, and also permit manual switching to remove second incoming line from service or to return an incoming line to service after a transfer, with no break in the power supply.

2.1.1.6. All components of the switchboard shall be rated for the electrical system characteristics shown on the single-line diagram(s). The rating of equipment/component shall take full account of all heat sources and other de-rating factors, non-linear loads within the enclosures. Special reference is made in respect of enhanced circuit making requirements and the DC component of fault current at breaking.

2.1.1.7. The switchgear shall be suitable for operation with system voltage and frequency variations as stated on the single-line diagram(s).

2.1.1.8. Wherever possible rated voltages and lightning impulse withstand voltages shall be selected from the respective IS / IEC standards as specified above.

2.1.1.9. Unless otherwise stated only electronic releases (LSI) will be used on MCCBs and ACBs. These releases shall be integral to the protective device.

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2.1.2. CODES & STANDARDS :

LT Switchgear Panels	
IS : 5082	Material for data for aluminium bus bars
IS : 13703 / IEC 60269	Low Voltage Fuses
IS : 8623 /IEC : 60439	Specification for factory built assemblies of switchgear and control gear for voltage up to and including 1000 V A.C. and 1200 V D.C.
IEC 439-1 1992	Low voltage Switch gear and Control gear assemblies Part-I, type tested and partially type tested assemblies.
IEC-1180-1, 1992	High voltage test techniques for low voltage equipment Part–I definition test and Procedure requirement
IS 2705	Current transformers.
IS 3156	Voltage transformers.
IEC 60044	Instrument transformers.
IS 4146	Application Guide for Voltage Transformers
IS 1248	Electrical indicating instruments.
IS 722	Integrating meters.
IEC 62052	Class 0.5, 1 and 2 alternating current watt-hour meters.
IEC 60051	Direct acting indicating analogue electrical measuring instruments and their accessories.
IEC 60258	Direct acting recording electrical measuring instruments and their accessories.
IS 3231 /IEC : 60255	Electrical relays for power system protection.
IS 6875	Control switches and push buttons.
IS :11353	Guide for uniform system of marking and identification of conductors and apparatus terminals.

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IS : 5578	Guide for marking of insulated conductors.
IEC : 60073	Coding principles for indicator lights and push buttons.
IS : 3618	Phosphate treatment of Iron and steel for protection against corrosion.
IS : 6005	Code of practice of phosphating of Iron and steel.
IS : 5	Colours for ready mixed paints and enamels.
IS : 2147 / IEC : 60529	Degree of protection provided by enclosures for switchgear and Control. (IP Code)
IS: 8623, Part 3	Distribution Boards
IS : 2551	Danger notice plates
IEC :60417 DB/ IEC : 60617 DB	Graphical symbols & Diagrams for use on equipment.
IS: 732 / BS: 7671 -2008	Electrical Wiring Installations.
IEC :60445	Basic and safety principles for man-machine interface marking and identification. Identification of equipment terminals and of terminations of certain designated conductors. Including general rules for an alphanumeric system.
IEC : 60715	Dimensions of low voltage switchgear and control gear. Standardized mounting on rails for mechanical support of electrical devices in switchgear and control gear installations.
IEC : TR 61641	Enclosed LV Switchgear and Control gear assemblies – guide for testing under conditions of arcing due to internal fault.
OISD-RP-149	Design Aspects for Safety in Electrical System.
LT Switchgear	
IS : 13947 :1993	Specification for Low Voltage Switchgear and Control gear Part 5 Control Circuit devices and switching elements Section 1 Electromechanical control circuit devices (First Revision)
IEC-947-1, 1998	Low voltage Switch gear and Control gear Part-I general

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	rules.
IEC 60947	Low Voltage switchgear and control gear
IS : 2516, IEC:60947-2 / IS 13947-2	Air circuit breaker
IS : 4064	Fuse switch and switch fuse unit.
IS : 9224	HRC fuse links
UL 1008	Standard for Transfer Switch Equipment (ATS)
IEC 947-6-1	Low-voltage Switchgear and Control gear; Multifunction equipment; Automatic Transfer Switching Equipment
IEC 60974 / IS1822	Motor Protection Circuit Breaker
IEC 61008	Residual Current Device (RCD) / RCBO.
IS: 8828 / IEC 60898-I	MCB's
IS-8828	Circuit breakers for household applications – MCB
IEC 61643-1	Surge Protective Devices connected to low voltage power distribution systems
IS : 2959	Auxiliary contactor
IS : 1822	A.C. motor starters of voltage not exceeding 1000 V
IS : 10118	Code of Practice for installation and maintenance of switchgear.
IS 13947-4-1	Code for Starters

2.1.3. CONSTRUCTION DETAILS:

1. Switchgear cubicles shall be sheet steel metal enclosed, free standing, floor mounting, flush fronted, totally enclosed dead front, compartmentalised multi-ties formation design and arranged to form a single structure with a common busbar assembly and shall conform to **Form 4 Type 6 for MLTPs and emergency panels** and **Form3b Type 2 for rest of the panels.** (Refer to SLD for specific requirements Enclosed Switches and Circuit Breakers cubicles shall be metal enclosed, floor mounted / Wall mounted. Switchgear assembly shall comply the IS/IEC stated above.
2. All CRCA sheet steel used for the construction of the panels shall be 2mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Sheet steel shrouds and partitions shall be of minimum 1.6 mm thickness. Joints of any kind in sheet steel shall be seam welded, all welding slag grounded off and welding pits wiped smooth

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with plumber metal. Wherever required, stiffeners shall be provided to increase stiffness of large size doors and covers.

3. The panels shall be totally enclosed, completely dust and vermin proof. Gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust proof. All doors and covers shall be fully gasketed with foam rubber and/or rubber strips and shall be lockable. Doors shall have concealed hinges.
4. All panels and covers shall be properly fitted and secured with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with bolt and nuts. Self-threading screws shall not be used in the construction of the panels.
5. A base channel of 75mm x 40mm x 5mm thick shall be provided at the bottom. A clearance of 300mm between the floor of the panels and the bottom of the lower most units shall be provided.
6. Knockout holes of appropriate size and number shall be provided in the panels in conformity with the number, and size of incoming and outgoing conduits/cables.
7. The panels shall be provided with removable un-drilled sheet steel gland plates (3mm thick) at top to drill holes for cable/ conduit entry at site. The panels shall be designed to facilitate easy inspection, maintenance and repair.
8. The panels shall be sufficiently rigid to support the equipment without distortion under normal and short circuit condition. They shall be suitably braced for short circuit duty. Provision shall be made for permanently earthing the frames and other non-current carrying parts of the switchgear by two independent earth connections
9. The height of the panels shall not exceed 2100 mm from finish floor level. The maximum operating levels of the top most cubicles shall not be more than 1800 mm finish floor level. The operating level of the lower most cubicles shall not be less than 200 mm from finish floor level.
10. Every cabinet shall be trifoliate or engraved metal name plates. All panel shall be provided with circuit diagram engraved on FR PVC sheet.
11. The Switchgear shall be provided with integral base frame for each vertical panel which shall be suitable for directly bolting or tack welding to the Buyer's base frame. The structure, including doors and panels, shall be suitable of withstanding the stresses due to seismic conditions as specified in aforementioned site conditions.
12. Switchgear and Busbars shall be arranged to permit future extension at both ends. End of busbar shall be suitably drilled and relevant fishplates shall be provided for main LT panels for this purpose. Panels at extreme ends shall have opening which shall be covered by using screwed plates with neoprene gaskets for moisture egress prevention. Details of drilled holes in bus-bar and opening shall be clearly indicated in the suppliers drawing.
13. The panels shall be of adequate size with a provision of 20% spare space to accommodate possible future additional switch gear. The panel shall be designed such that the internal space is sufficient for hot air movement, and the electrical component do not attain temperature more than 40 degree Celsius. Canopy for busduct riser should be in coordination with busduct detail.
14. Structures, including doors and panels, shall be capable of withstanding the internal pressure created by faults within the structure (equal to the maximum fault-current rating for a specified duration) without danger to the operating personnel. The minimum standard required is detailed in IEC TR 61641 and IS – 3427. Type test certificate(s) shall be provided with the quotation.
15. Structures shall be capable of bearing all mechanical loads viz., cubicle module rack in, rack out and in no case the frame/base plate shall deform during the normal specified operation.
16. The structure, including doors shall be suitable of withstanding the stresses due to seismic conditions as specified in aforementioned site conditions.

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17. Structures shall be provided with barriers to prevent the transfer of ionised gases between adjacent compartments except busbar chambers
18. Switchgear shall generally be self-ventilating.
19. Interlocks, busbar shutters, covers, etc. shall be provided to prevent incorrect or unsafe operation, and to prevent access to live parts. Interlocks shall be provided to prevent opening of the front doors of cubicles whilst the circuit breaker / switch is in the closed position.
20. Key interlocking shall be provided on incoming, outgoing and sectionalised units as required by material requisition and one line diagram(s).
21. Provision of remote tripping of main LT board as per Contract documents.
22. All circuit breaker / switch shall have provision for padlocking. Padlocking facility for multiple locks shall be provided in the Off / Test / Isolated position.
23. Switchgear shall be designed and constructed to facilitate inspection, cleaning, repair and maintenance and to ensure absolute safety during operation, inspection and maintenance. It shall be possible to work safely within individual compartments whilst the remainder of the switchgear is energized.
24. Similar parts and components shall be interchangeable.
25. Unless otherwise stated on the one-line diagram, switchgear intended for indoor installation shall have minimum protection of IP 21 and outdoor installation shall have minimum protection of IP 65 in accordance with IEC 60529 or IS 2147.
26. All hardware shall be corrosion resistant. All joints and connections of the panel members shall be Zinc passivated or Cadmium plated, high quality steel bolts, nuts and washers secured against loosening.
27. Incoming and bus section must be located in non-tiered separate cubicles.
28. All the feeders shall be withdraw-able type. Plug in arrangement is preferred over Slide in contacts for external control cable connection to the module.
29. Each compartment shall have the following features:
    - Space heater operating at one-half or less of rated voltage, sized to prevent condensation.
    - Louvers equipped with insect and rodent screen and filter, and arranged to permit air circulation while excluding rodents and exterior dust.
    - Hinged front door with locking provisions.
    - Interior light with switch.
    - Duplex receptacle.
    - Power for heaters, lights, and receptacles to be standard 230V AC supply through static inverter.
30. Finish: The panels shall be provided with Manufacturer's standard Siemens Grey (RAL7032) finish. The panel shall be treated with 7 –treatment tank process before painting to reduce the chances of corrosion due to surrounding atmosphere conditions.

2.1.4. PANEL COMPONENTS :

2.1.4.1. MAIN BUS :

1. Tin plated copper full length of switchgear up to and including Main Incomer size of 63A and Aluminium for Main Incomer size above 63A Main Incomer. The busbars shall be of 3 phase, 4 wire system with separate neutral & earthing busbar.
2. Busbars and connections shall be supported on unbreakable, non-flammable, hard drawn tinned mounted on non-hygroscopic fire retardant epoxy ceramic or resin cast insulators at

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sufficiently close intervals to prevent busbar sag and shall effectively withstand without damage electromagnetic stresses in the event of short circuit. Bus-bars shall withstand short-circuit capacity as mentioned in BOQ and SLD.

3. The neutral as well as earth bar shall also be capable of withstanding the fault level. Temperature rise in bus-bars shall not exceed 40 deg. above ambient.
4. Busbars including branch connections shall be fully insulated except in cable/busduct compartment(s). FRP shrouds shall be provided at joints and tapoffs. Busbars exposed to air shall be tin plated.
5. Main busbar shall be of the same cross sectional area throughout the length of the switchgear. And Shall be Made up conducting material and breaking capacity as shown on SLD.
6. The current rating of the neutral busbar shall be 100% of the phase busbars.
7. Maximum current density for the busbars shall be 0.8 A/sq.mm for aluminium and 1.4 A/sq.mm for copper busbars
8. Busbars shall be insulated with fire retardant heat-shrink sleeves of applicable grade as approved by the Employer's representative and marked to indicate the phase colouring. Colour coding shall be as per NEC Necessary derating due to insulation shall be considered for sizing the busbars and relevant calculations shall be produced with submittal for final approval by the Employers Representative.
9. Busbars, at bus section switches, shall be arranged to permit safe work with one bus-section de-energised. In addition it shall not be possible for arcs to transfer across a section or coupler.
10. Branch connections shall be sized as per the circuit breaker / switch rating. The busbars shall be housed in a separate compartment.
11. The busbar shall be isolated with 3mm thick FRP sheets or Acrylic Sheet or Metal sheet to avoid any accidental contact. All busbars connections shall be done by drilling holes in busbars and connecting by chromium plated brass bolts and nuts. Additional cross section of bus bars shall be provided in all Panels/ Distribution boards to cover up the holes drilled in the busbars. Spring and flat washers shall be used for tightening the bolts.
12. Minimum clearance between phase & earth shall be 20mm and phase to phase shall be 25mm.
13. An earthing busbar sized for the full rating of the phase shall be provided along the full length of the switchgear structure with provision for earth cable / bar connections at each end. It shall be possible to disconnect the earth cable / bar connection to facilitate meggering, when required. Where frame leakage protection is specified a separate insulated bus bar is required in addition.
14. Busbars and connections shall be adequately sized, braced and supported to withstand the mechanical forces and thermal effects resulting from the switchgear rated short circuit current and carry certification from a recognised testing authority.
15. Each circuit breaker shall be housed in separate compartments and shall be enclosed on all sides. Sheet steel hinged lockable door shall be duly interlocked with the breaker units in "ON" and "OFF" positions. Safety interlocks shall be provided for circuit breaker to prevent the breaker from being drawn-out when the breaker is in "ON" position.
16. The door shall not form an integral part of the draw out position of the circuit breaker. All instruments and indicating lamp shall be mounted on the compartment door. Sheet steel barrier shall be provided between the tiers in a vertical section.
17. Removable sheet steel gland plates shall be provided for fixing the cable glands. The space in cable alleys between gland plates and terminals for connecting the lugs must be adequate for the specified size of cables. Manufacturer shall show these clearances on the general arrangement drawings and the same shall be increased if so instructed by the Consultants, without extra price. The Tenderers may submit such drawings with their

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tenders, if approval is required before finalising the order. Supports for clamping cable cores and module identifying numbers shall be provided in cable alleys.

18. Labelling of panels for feeders shall be as per SLD/actual installed
19. Copper surfaces at aluminium to copper joints shall be silver / tin plated.
20. Engraved PVC labels shall be provided on all incoming and outgoing feeders. Single line circuit diagram showing the arrangements of circuit inside the Panels shall be pasted on inside of the panel door and covered with transparent laminated plastic sheet

2.1.4.2. CIRCUIT BREAKERS :

Circuit breakers shall be.

1. Withdraw-able type.
2. Of air break design.
3. Have the number of poles specified on the system Single-Line-Diagram.
4. Suitable for uninterrupted duty and utilisation category B to IEC 60947 or equivalent standard.

Circuit breakers of identical rating shall be interchangeable. Circuit breakers shall be electrically operated with provision for manual (mechanical) operation. Tripping, closing, control and indication supplies for circuit breakers shall be as shown on the one-line diagram(s). Circuit breaker operating mechanisms shall be motor wound spring. The closing spring shall be automatically recharged after discharge and be ready for next closing command. The closing spring condition - “charged” or “discharged” shall be shown via a positively driven indicator. Test facilities shall be provided to permit operation of the circuit breaker whilst in the test position.

Circuit breakers shall be provided with trip circuit supervision to monitor trip circuit continuity and trip circuit supply. Alarm and indication facilities shall be provided for each circuit breaker and a volt free group contact provided via internal bus wiring for remote common alarm. Circuit breakers shall be provided with four normally open and four normally closed spare, auxiliary contacts wired out to terminals.

5. **In addition auxiliary contacts shall be provided for:-**
   a. Circuit breaker in service position.
   b. Circuit breaker in test position.
   c. Volt free contact for integration to BMS system/ Fire Alarm system.
   d. DG integration with AMF panel.
   e. In any event no fewer than 4No. NO and 4No. NC auxiliary contacts shall be provided.

Auxiliary contacts shall be suitable for inductive circuit switching. Auxiliary contacts multiplication shall be by latch type relays to prevent inadvertent change of contact position on loss of auxiliary supply.

Withdrawable circuit breakers and their Cubicles shall:

6. **Be interlocked to prevent :**
   a. The breaker being inserted into the service position unless it is open.
   b. The breaker being withdrawn from the service position unless it is open.
   c. The breaker being closed unless it is fully in the service, withdrawn/test or earthing position.
   d. Remote operation whilst in the withdrawn/test position.
7. **Be fitted with busbar and cable circuit shutters**
   a. With padlocking facilities.

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b. Coloured red for busbar and yellow for circuit. For bus-section and coupler applications the shutters shall be labelled with the busbar number.

c. Of metal construction and effectively earthed to the main housing.

d. Of the positively driven type, gravity drop shutters are not acceptable.

e. Capable of being individually operated by hand.

Each circuit breaker shall have provision for padlocking in the test and isolated positions and have indications for these positions. Each circuit breaker shall be provided with an anti pumping facility in the circuit breaker closing circuit.

8. Isolator and Fuse Combination Units:

a. Be of the fixed, double air break type.

b. Be of the rating and number of poles as stated on the One-Line Diagram.

c. Be provided with facilities for padlocking in the 'off ' position.

d. Be of the fault-make, load-break type, unless specified otherwise.

e. Be interlocked to prevent the compartment door being opened unless the isolator is in the open position.

2.1.4.3. EARTHING :

1. All metallic non-current carrying parts of the switchgear shall be bonded together and connected to the switchgear earth busbar.
2. All doors shall be bonded to the main structure by means of a flexible copper connection arranged so that it cannot be trapped as the door is opened or closed.
3. Withdrawable parts (e.g. circuit breakers) shall be effectively earthed until they are completely withdrawn with all power and control connections disconnected.
4. Provision shall be made, for earthing cable screen and armouring to the earth busbar, near the gland.
5. All control, instrument and communication cables, if any, shall be earthed suitably to prevent any electromagnetic interference and ensure electromagnetic compatibility.
6. Each earthing point shall be marked with an E.
7. Provision shall be made for an instrument clean earth.
8. 50% additional bar is required if not able to provide body as CPC.

2.1.4.4. CURRENTE TRNASFORMERS :

1. Burden and accuracy class suitable for connected relays, meters, and instruments.
2. The current transformers shall be manufactured in accordance with IEC/EN 60044-1, IS 2705-1. The current transformers shall be of ring type construction. The case of the current transformer shall be of glass filled polycarbonate, flame retardant grade classified UL 94V-0. The CTs shall be varnished, air cooled type,
3. The current transformers shall be of ring type construction. The CT shall be suitale for metering purpose having 1.0 class of accuracy.
4. The Current transformer shall have marking & nameplate as per IS2705 in addition to class of insulation. The marking shall be indelible.

5. The Current Transformer shall have following:

a. Insulation Class : E Class epoxy Resin.

b. Operating Frequecy ; 50 Hz

c. Rated Primary Current: 1A to 7500A

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d. Rated Secondary Current: 5A

e. Rated Burden: 15VA

f. Ambient Temperature: -20ºC to +45ºC

g. Test Voltage: 3KV, 50Hz for 1 minute.

6. The following tests shall be applied to the current transformer.

   a. **Type Test:** The type test shall be carried out as per IS2705 Part I&II including short time current & temperature rise tests in NABL accredited laboratory shall be submitted & got approved before commencement of supply.

   b. **Routine Test:** The supplier shall conduct all the routine tests such as Ratio test, phase **angle** error test for 1.0 accuracy class as per IS 2705 Part I&II.

   c. **Commissioning Test:** In accordance with IS 2075, power frequency test on primary winding shall be carried out at manufacturers works.

2.1.4.5. MULTIFUNCTION DIGITAL METER :

Microprocessor-based unit suitable for three- or four-wire systems, with the following features:

a. Inputs from 5-A current-transformer secondary's, and potential terminals rated to 600 V.

b. Switch-selectable digital display with the following features:

c. Phase Currents, Each Phase: Plus or minus 1%.

d. Phase-to-Phase Voltages, Three Phase: Plus or minus 1%.

e. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1%.

f. Three-Phase Real Power: Plus or minus 2%.

g. Three-Phase Reactive Power: Plus or minus 2%.

h. Power Factor: Plus or minus 2%.

i. Frequency: Plus or minus 0.5%.

j. Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2%.

k. Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.

Communications module suitable for remote monitoring of meter quantities and functions.

2.1.4.6. AUXILIARY SUPPLIES :

1. Auxiliary supplies (closing, tripping, control, indication, heaters, etc.) shall be in accordance with the one-line diagram(s).
2. Where motor charging spring operating mechanism is specified for circuit breaker, it shall be rated for the rated auxiliary control supply operation.
3. Circuit breaker closing, tripping, control and indication power shall be supplied from suitably rated 230 Volt AC supply units backed up by inverter/ DG supply. Where dc supply units are not in the Contractor scope, then he shall specify his standing load, peak load and permissible voltage variation for the respective circuit in the quotation.
4. All auxiliary supplies shall be individually protected within each circuit breaker housing. Individual protection shall be by suitably rated fuses.
5. For shunt trip circuits the protection shall be rated at least 300% of the load.
6. Anti-condensation heater supplies shall be derived internally from each busbar section.

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7. Incoming Auxiliary Supplies shall be protected by suitably rated fuses at the point of entry to the switchboard. The Contractor shall ensure discrimination with individual circuit fuses. Volt free group contact shall be provided via internal bus wiring for remote common alarm.

2.1.5. PANEL CONTROL WIRING :

1. Control wiring shall be fire retardant for LT panels and shall be fire rated as per requirements for all life safety panels; 600V/1000V grade insulated stranded copper conductors. Minimum size shall be 1.5sqmm except for electronic wiring.
2. Control wiring within the switchgear shall be securely held in position (either loomed or run in fire retardant trunking). Where wiring enters or passes through compartments it shall be suitably protected mechanically. Control wiring layout shall permit alterations to individual circuits without requiring shutdown of the complete switchboard.
3. Bus wires for closing, tripping, control, indication, heaters etc. shall be provided and run within the switchgear shall be suitably sized and individually protected. Bus wires for Serial communication shall be run in a separate tray with metallic enclosure.
4. Control wiring for CTs, AC auxiliary supply and inter panel wiring shall be by different colours as specified in the LT & Control cables section.
5. Wiring identification shall be by numbered and/or lettered sleeves, of insulating material adjacent to the terminals. They shall be indelibly marked and removal without disconnecting the wire from its terminal shall not be possible.
6. Flexible cables shall be used for connections on door mounted equipment. Wiring shall be loomed, wrapped in flexible FR PVC conduit and be firmly clamped at both ends to prevent movement at terminations.
7. All flexible control wires of similar types shall be installed in twisted form to reduce EMC propagation.
8. All wiring for external connections shall be brought out to individual terminals on a readily accessible terminal block.
9. Generally no more than two wires shall be connected to a terminal.

2.1.6. CABLE TERMINATION :

1. Cable terminating facilities and terminals shall be suitable for the specified cable type and conductor size. Consideration and provision shall be taken by the Contractor on the equipment design for the use of cables with aluminium / copper conductors as mentioned on Single Line Diagram / Switchgear schedule.
2. The cable terminals and neutral link shall be brought out to a cable alley suitably located and accessible from the panel front. The current transformers for instruments metering shall be mounted on the terminal blocks. No direct connection of incoming or outgoing cables to internal components of the Panels/Distribution board is permitted,
3. Terminal blocks shall be arranged and positioned to afford ready access for carrying out external cable termination, testing, inspection and maintenance. There shall be ample clear space allowed between the terminals and the gland-plate for the spreading and termination of external conductors.
4. Terminal blocks shall be mounted in a single deck arrangement. Terminal blocks for the connection of external control wiring shall be of the clamp type with a facility to connect two wires on each side of the terminal. A minimum of 20% spare terminals shall be provided.
5. All external wiring shall be on one side of the terminal block only.
6. All terminal blocks shall be shrouded or provided with transparent covers. Pinch screw type terminals are not acceptable.
7. Terminals for different voltages shall be separated by partitions.

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8. Terminal boxes (where specified) shall be suitable for dry type terminations unless otherwise specified.
9. A terminal box or chamber with undrilled gland plate or entry panel of sufficient dimensions to terminate the specified cables shall be provided. Direction of cable entry shall be Top / Bottom as per site Conditions & Prior Approval to be taken from Employers Representative
10. Positioning of cable terminations shall avoid obstruction of other cable terminations, removable covers, etc. and provide for easy access for terminating cables.
11. There shall be sufficient clear space allowed between the terminal block and the cable entry for the spreading and termination of external conductors. Should this not be possible using the standard design in relation to specified cable size then the seller shall incorporate an extended cable glanding box within its design.
12. Termination of single core cables shall be through a non-magnetic gland plate and provision made for bonding and earthing any armour and/or concentric ground conductors.
13. Separate cable facilities shall be provided for each cubicle and for power and control cables.
14. Adequate support arrangement shall be provided for each cable to avoid undue strain on the cable terminations.
15. Cable sleeves shall be of the shrink type, applied cold by a mechanical device or by the use of heat. They shall provide a sufficient thickness of insulation to suit the particular application. Insulation tapes used in joints and terminations shall be compatible with, and have a temperature rating and insulating property not less than the cable insulation. When cables are to be connected to bus bar, breakers etc., the insulation and/or sheath shall be removed for a distance of 150 mm from the connection and replaced by suitable heat resisting insulation for all normal and fire rated cables.
16. The terminal blocks shall be mounted so as to not restrict the movement of withdrawable circuit breakers.
17. Where bus duct is specified, adequate provision shall be made for supporting and fastening of the bus duct at the switchgear. The terminals shall be provided with a sufficient pre-drilled contact area for accepting flexible connectors, and proper access shall be provided for making off (or disconnections of), the connections while the bus duct remains in place.
18. Inter panel wiring within each shipping section shall be the Contractors responsibility. For wiring between shipping sections, the Contractor shall provide terminal blocks on adjoining shipping sections and supply suitable connecting (jumping) wires.

2.1.7. METERING, PROTECTION, CONTROL AND INDICATION :

1. Meters will be multifunction type units suitable for three- or four-wire systems, capable of recording current, voltage per phase, frequency, KVA, kW and power factor. The display and control unit that is flush or semi flush mounted in instrument compartment door.
2. Where specified, an “intelligent” control, protection and monitoring system shall be provided. Protective relays shall be of the electronic or microprocessor based type. Meters shall be of the microprocessor based type with serial communication facility.
3. Metering, protection and control shall be provided as shown on the single-line diagram(s).
4. Meters and relays shall be capable of withstanding without damage the secondary currents associated with the switchgear rated fault current flowing in the primary of current transformers.
5. External zero adjustment / calibration shall be possible on all indicating instruments to facilitate adjustment without dismantling the instrument.
6. Protective relays shall, wherever possible, be of the draw out type with hand reset operation indicator. Lockout relays shall be of the hand-reset type.
7. Voltage free alarm contacts shall be provided for alarms as shown on the Single-line diagram(s) and as per the requirements of the BMS.

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8. Status indication illuminators (green-open, red-closed, amber-tripped) and positive drive mechanical position indicators shall be provided for each circuit breaker. Contacts for remote indication shall be provided.
9. Control of circuit breakers shall be carried out at either:-
10. Control Switch at Cubicle Door
11. Remote control desk / panel / DCS (Remote selector switch position indication shall be provided).

2.1.8. ISOLATING SWITCHES :

1. All isolating switches shall be hand operated, single pole and neutral, double pole, triple pole and neutral, or four pole as specified and be ASTA certified to IEC 60947.
2. The neutral contact shall be arranged to be switched or linked as specified and in the switched neutral units the neutral contact shall make before, and break later, than the phase contacts.
3. Units exceeding 100A rating shall have a removable bolted link. Each unit shall be of the 415 volt (a.c. between phase) rating and be complete with a sheet metal case manufactured from not less than 1.7mm thick metal. Each unit shall incorporate a hinged cover provided with adequate lugs to enable padlocks to be fitted if required.
4. Suitable phase identification shall be fitted to all units. Each switch shall have a quick make and break switch action with spring assisted mechanism ensuring positive ON/OFF movement and identification. Operating handles shall be retractable and arranged to close the switch with an upward movement.
5. Adequate wiring space shall be provided in each unit to facilitate wiring and connection and, if possible, removable side and top panels shall be provided. Each complete unit shall be fitted with all necessary terminals, shrouds, earthing connections etc., and be stove enamelled finished to an approved colour. Submit details of the proposed manufacturer to the Employers Representative for review.

2.1.9. AIR CIRCUIT BREAKER :

1. The ACB shall conform to the requirements of IEC & IS mentioned above and shall be type tested & certified for compliance to standards from–CPRI, ERDA/ any accredited international lab. The circuit breaker shall be suitable for 415 V, 50 Hz supply system. Air Circuit Breakers shall be with moulded housing flush front, draw out type and shall be provided with a trip free manual operating mechanism or as indicated in drawings and bill of quantities with mechanical "ON" "OFF" “TRIP” indications. ACBs shall be compact type.
2. The ACB shall be 3/ 4 pole with modular construction, draw out, manually or electrically operated version as specified. The circuit breakers shall be for continuous rating and service short Circuit Breaking capacity (Ics) shall be as specified on the single line diagram and should be equal to the Ultimate breaking capacity(Icu) and short circuit withstand values(Icw) for 1 sec.
3. Circuit breakers shall be designed to ‘close' and `trip' without opening the circuit breaker compartment door. The operating handle and the mechanical trip push button shall be at the front of the breakers panel. Inspection of main contacts should be possible without using any tools. The ACB shall be provided with a door interlock. i.e. door should not be open when circuit breaker is closed and breaker should not be closed when door is open. ACB’s shall be with safety shutter , Anti pumping and Rating error preventor. Electrical/ Mechanical life of ACB’s shall be minimum 15000 cycles upto 2500A & 5000 cycles above 3200A.
4. All current carrying parts shall be silver plated and suitable arcing contacts with proper arc chutes shall be provided to protect the main contacts. The ACB shall have double insulation (Class-II) with moving and fixed contacts totally enclosed for enhanced safety and in accessibility to live parts. All electrical closing breaker shall be with electrical motor wound stored energy spring closing mechanism with mechanical indicator to provide ON/OFF

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status of the ACB. Breaker shall be capable of being racked out into testing, isolation, maintenance positions and kept locked in any position.

Rated insulation voltage shall be 1000 volts AC.

5. Cradle:

The cradle shall be so designed and constructed as to permit smooth withdrawal and insertion of the breaker into it. The movements shall be free from jerks, easy to operate and shall be on steel balls/rollers and not on flat surfaces.

There shall be 4 distinct and separate position of the circuit breaker on the cradle.

Racking Interlock in Connected/Test/Disconnected Position.

a. Service Position : Main Isolating contacts and control contacts of the breaker are engaged.

b. Test Position : Main Isolating contacts are isolated but control contacts are still engaged.

c. Isolated Position : Both main isolating and control contacts are isolated.

d. Maintenance Position: Completely rack out for maintenance.

There shall be provision for locking the breaker in any or all of the first three positions.

6. The following safety features shall be incorporated :

a. Withdrawal or engagement of Circuit breaker shall not be possible unless it is in open condition.

b. Operation of Circuit breaker shall not be possible unless it is fully in service, test or drawn out position.

c. All modules shall be provided with safety shutters operated automatically by movement of the carriage to cover exposed live parts when the module is withdrawn.

d. All Switchgear module front covers shall have provision for locking.

a) Switchgear operating handles shall be provided with arrangement for locking in 'OFF' position.

7. Protections

The breaker should be equipped with micro-controller based , communicable type release with RS 485 port for communication to offer accurate and versatile protection with complete flexibility and shall offer complete over current protection to the electrical system by provision of full microelectronic releases incorporating:

a. **Long-time protection (L):** Long-time current and long-time delay to be adjustable.

b. **Short time protection (S)** Short-time current and short-time delay to be adjustable along with mode (t=k and $t=k/i^2$).

c. **Instantaneous protection (I):** Instantaneous current and long-time delay to be adjustable..

d. **Ground fault protection (G) :** Earth Fault Pick-up current and Earth fault time delay to be adjustable.

e. The **LSIG** feature shall be used at incomer of **Main LT Panel & Main DG Panel**.

The LSI feature shall be used for all the panels except Main LT Panel & main Dg set Panel. The protection release shall have following features and settings:

- **True RMS Sensing**

  The release shall sample the current at the rate of 16 times per cycle to monitor the actual load current waveform flowing in the system and shall monitor the true RMS value of the load current. It shall take into account the effect of harmonics also.

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- **Thermal Memory**

  When the breaker shall reclose after tripping on overload, then the thermal stresses caused by the overload if not dissipated completely, shall get stored in the memory of the release and this thermal memory shall ensure reduced tripping time in case of subsequent overloads. Realistic Hot/Cold curves shall take into account the integrated heating effects to offer closer protection to the system.

- **Defined time-current characteristics :**

  A variety of pick-up and time delay settings shall be available to define the current thresholds and the delays to be set independently for different protection zones thereby achieving a close-to-ideal protection curve.

- **Trip Indication**

  Individual fault indication for each type of fault should be provided by LEDs for faster fault diagnosis.

- **Self-powered**

  The release shall draw its power from the main breaker CTs and shall require no external power supply for its operation.

f. All incomer ACBs for LT panel shall have following additional protections other than mentioned above.

- Under and over voltage
- Under and over frequency

g. The release should provide local indication of actual percentage loading at any instant. The release should be able to communicate on MODBUS RTU protocol using inbuilt RS485 port and shall be integral part of supply with trip unit. Parameters of the Protection Release should be changeable from Release as well as through communication network. Release should have graphical LCD for display of power parameters. The release of incoming breakers should provide comprehensive metering with the following parameters

- Phase currents (running, avg & max) – All parameters in single window.
- Release should be able to capture short circuit current on which ACB has tripped. The last ten trips and alarms shall be stored in memory with the date & time stamping along with type of fault and alarm. The sensing CT Should be Rogowsky type with measurement precision of 1%.
- Release should be self powered .
- Release should have facility to select different type of IDMTL protection(DT,SIT,VIT,EIT,HVF) for better co-ordination with HT Breaker/Fuse.
- Phase voltages (running, avg & max)
- Energy & power parameters (active, reactive and apparent)
- PF
- Frequency
- Maximum Demand (KVA & KW)
- Total Harmonics distortion (From fundamental to 50^{th} harmonic)

8. Safety Features

a. The safety shutter shall prevent inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle.

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b. It shall not be possible to interchange two circuit breakers of two different thermal ratings. For Draw-out breakers, an arrangement shall be provided to prevent rating mismatch between breaker and cradle.

c. There shall be provision of positive earth connection between fixed and moving portion of the ACB either through connector plug or sliding solid earth mechanism. Earthing bolts shall be provided on the cradle or body of fixed ACB.

d. The incoming panel accommodating ACB shall be provided with indicating lamps for ON-OFF positions, digital voltmeter and ammeter of size not less than 96 mm x 96 mm, selector switches, MCB for protection circuit and measuring instrument circuits.

e. It shall be possible to bolt the draw out frame not only in connected position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration and shocks.

f. Draw out breakers should not close unless in distinct Service/Test/Isolated positions.

g. The insulation material used shall conform to Glow wire test as per IEC60695.

h. The ACB shall provide in built electrical and mechanical anti-pumping.

i. All EDO ACB`s Shall have Ready to Close Contact to ensure that the ACB gets a command only when it is ready to close for applications of Remote Control, AMF, Synchronization and Auto Source Change Over Systems.

2.1.10. MOULDED CASE CIRCUIT BREAKERS (MCCB'S) :

1. The Contract shall include for moulded case circuit breakers (MCCB) to be in accordance with respective codes as specified in section 1.4 and used in the locations as indicated on the attached drawings.
2. MCCB shall comply with the requirements of the relevant standards IS13947 – Part 2/IEC 60947-2 and should have test certificates for Breaking capacities from independent test authorities CPRI / ERDA or any accredited international lab.
3. MCCB shall comprise of Quick Make -break switching mechanism, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses
4. **The** breaking capacity of MCCB shall be as specified in the one-Line-Diagram. The rated service breaking capacity (Ics) should be equal to rated ultimate breaking capacities (Icu). MCCBs for motor application should be selected in line with Type-2 Co-ordination as per IEC-60947-2, 1989/IS 13947-2. The breaker as supplied with ROM should meet IP54 degree of protection. All breakers shall be withstand for 2.5 kV voltage level between phase and earth for 1 second.
5. The MCCB shall employ maintenance free minimum let-through energies and capable of achieving discrimination up to the full short circuit capacity of the downstream MCCB. The manufacturer shall provide both the discrimination tables and let-through energy curves for their switchgears.
6. Each unit shall be manufactured from high grade non-track mouldings and be complete with clearly visible enclosed contact areas and de-ionisation chambers ON, OFF and TRIP switch positions, quick make and break switch actions and lockable switch handle or associated control.
7. Adjustable type electronic trips shall be incorporated in each unit as specified to provide satisfactory overload and short circuit protection together with short circuit indicators, under-voltage trips, shunt trips, short circuit delay trips, motor operated drives and auxiliary contacts as indicated on the attached drawings and/or Specification Sections/or Schedules.
8. Each circuit breaker shall be capable of being manually reset only after tripping against overload or short circuit conditions. Short circuit delay trips shall be of the stepless, adjustable type within the range of 0-200 m.s.

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9. Each circuit shunt trip shall be capable of operating satisfactorily when the coil voltage is between 70% and 120% of its rated voltage. Under voltage relay shall be capable of operating on a slowly failing voltage between 70% and 35% of the rated operating voltage. Self-resetting under voltage relays shall be reset at not less than 85% of the rated operating voltage. The under frequency Relay shall operate when the frequency fall below 47.5 Hz or increases above 52.5 Hz i.e +/-5% of the Rated voltage..
10. The power operation of MCCB and MCCBI (isolator) units shall be effected by means of an approved universal type motor complete with electro-magnetic clutch and emergency hand operating handle. The motor operated units shall be capable of operating satisfactorily when the motor terminal voltage is between 85% and 105% of rated voltage.
11. The minimum size of MCCB or MCCBI units indicated on the attached drawings and/or Specification Sections shall be that which has resulted from the application of any temperature, enclosure or similar de-rating factor.
12. The operation of an MCCB or MCCBI unit shall be such that it shall not endanger the operator or show signs of undue wear. In all cases the design of the switch drives shall be arranged to open all poles of the supply positively and simultaneously. The speed at which the switch contacts open or close shall be independent of the speed at which the associated handle is actuated.
13. Where moulded case circuit breakers are used as isolators (MCCBI) they shall be identical to the basic MCCB units described above but without the addition of any form of electronic trips or relays, under-voltage relays, shunt trips, unless otherwise stated.
14. All MCCBs shall include the facility for a remote shunt trip device to be incorporated via a simple on site addition.
15. All MCCBs shall include the facility for an earth leakage trip and/or indication device to be incorporated via a simple on site addition.
16. The fault rating of MCCB employed shall be at least equal to that expected at the point installed in the network.
17. Ensure discrimination on overload and short circuit applications is achieved using the proposed switchgear components. Under no operating conditions shall the supply to a whole distribution board be lost due to a fault on a downstream circuit.
18. **Protection Functions:**

    The breaker should be equipped with micro-controller based , communicable type release with RS 485 port for communication to offer accurate and versatile protection with complete flexibility and shall offer complete over current protection to the electrical system by provision of full microelectronic releases incorporating:

    a. **Long-time protection (L):** Long-time current and long-time delay to be adjustable.

    b. **Short time protection (S)** Short-time current and short-time delay to be adjustable along with mode (t=k and t=k/i2).

    c. **Instantaneous protection (I):** Instantaneous current and long-time delay to be adjustable..

    d. The **LSIG** feature shall be used at incomer of Main LT Panel & Main DG set Panel.

    e. The **LSI** feature shall be used for all the panels except Main LT Panel & main Dg set Panel.

    - Microprocessor trip units shall be adjustable and it shall be possible to fit lead seals to prevent unauthorised access to the settings
    - Microprocessor trip units shall comply with Annexure F of IEC 60947-2 standard (measurement of rms current values, electromagnetic compatibility, etc.)
    - Protection settings shall apply to all poles of circuit breaker.
    - All Microprocessor components shall withstand temperatures up to 125 °C

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f. Testing:

- Original test certificate of the MCCB as per IEC 60947-1 &2 or IS13947 shall be furnished.
- Pre-commissioning tests on the switch board panel incorporating the MCCB shall be done as per standard specifications.
- Sequence of operation for ultimate short circuit breaking capacity and verification of overload release shall be a part of the testing.

g. Interlocking:

Moulded, case circuit breakers shall be provided with the following interlocking devices for interlocking the door of a switch board.

- Handle interlock to prevent unnecessary manipulations of the breaker.
- Door interlock to prevent the door being opened when the breaker is in ON position.
- Defeat-interlocking device to open the door even if the breaker is in ON position.
- The MCCB shall be current limiting type and comprise of quick make – Break switching mechanism. MCCBs shall be capable of defined variable overload adjustment. All MCCBs rated 100 Amps and above shall have adjustable over load & short circuit pick-up both in Thermal magnetic and Microprocessor Trip Units.
- All MCCB with microprocessor based release unit, the protection shall be adjustable Overload, Short circuit and instantaneous earth fault protection with time delay(Provide only where noted on SLD).
- The trip command shall override all other commands.

2.1.11. SWITCH FUSE UNITS (SFU) :

1. All SFUs shall comply with IS 13947 (Part 3) – 1993.
2. All Fuses shall comply with IS 13703- 2 – 1993. Test certificates from independent testing authorities should be submitted.
3. All SFUs from 32A to 800A should be rated for AC-23A utilization category.
4. SFUs shall have pad lock / key lock facility in OFF position with optional door interlock facility.
5. Power loss of HRC fuses should be lower than the power loss limit specified in IS-13703 Part-2.
6. All fuses should be provided with facility of local/remote indication in the event of fuse operation.
7. SFUs should have adequate terminal width to ensure proper contact surface area when terminated with appropriate aluminium cables with lugs.
8. Rated fused short circuit capacity of SFUs should be equal to rated breaking capacity of associated HRC fuse.
9. SFUs should be fitted with enhanced safety features like fuse barriers , terminal shrouds at incoming & outgoing, phase barriers.
10. It should be possible to inspect and replace contacts in installed condition (without removing the cables) .
11. It should have large/adequate ground clearance from terminals to facilitate connection of multiple cables.

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12. It should be possible to fit Castle lock, aux. contact block, Fuse operation indicators, and Fuse monitors in the SFUs.
13. All insulating material of SFUs should meet requirements of glow wire test as per IEC 60947 / IEC 60695.
14. It should be possible to achieve same quadrant of operation for SFUs irrespective of orientation of terminals (mounting of SFUs) with the same handle.
15. SFUs shall have door interlock feature with defeat facility
16. SFUs shall have telescopic shaft with step less adjustment.
17. SFUs shall have positive ON – OFF indication
18. Mechanism shall be front operated, quick make - quick break type.
19. Mechanism to be of quad break type.
20. Ingress protection should be of minimum IP20 for an open execution type
21. SFU should be front operated
22. SFU should have pad lock, door interlock and defeat feature facility

2.1.12. AUTOMATIC TRANSFER SWITCHES (Through Electromechanical interlocks) :

1. Mechanically Held Transfer Switch

a. The transfer switch shall be electrically operated and mechanically held. The electrical operator shall be a momentarily energized, single-solenoid or linear motor mechanism (upto 1000A). Main operators which include over current disconnect devices shall not be acceptable. The switch shall be mechanically interlocked to ensure only two possible positions under normal operation and only one position at a time, normal or emergency.

b. **The** switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.

c. All main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.

d. Inspection of all contacts shall be possible from the front of the switch without disconnection of power conductors. Switches rated 600 amps and higher shall have front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.

e. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources, are not acceptable.

f. Where neutral conductors must be switched as shown on the plans, the ATS shall be provided with fully rated simultaneous switching or overlapping neutral transfer contacts. In case of over lapping neutral, the neutrals of the normal and emergency power sources shall be connected together only during the transfer and retransfer operation and remain connected together until power source contacts close on the source to which the transfer is being made. The overlapping neutral contacts when provided shall not overlap for a period greater than 100 milliseconds.

g. Where neutral conductors are to be solidly connected as shown on the plans, a neutral conductor plate with fully rated AL-CU pressure connectors shall be provided.

2. Mechanically Held Transfer Switch:

a. Voltage and frequency on both the normal and emergency sources (as noted below) shall be continuously monitored, with the following pickup, dropout, and trip setting capabilities (values shown as % of nominal unless otherwise specified):

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Parameter	Sources	Dropout / Trip	Pickup / Reset
Under voltage	TPN&E	70 to 98%	85 to 100%
Overvoltage	TPN&E	102 to 115%	2% below trip
Under frequency	N&E	85 to 98%	90 to 100%
Over frequency	N&E	102 to 110%	2% below trip
Voltage unbalance	N&E	5 to 20%	1%below dropout

b. Repetitive accuracy of all settings shall be within minimum ± 1% over an operating temperature range of -20°C to 60°C.

c. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via serial communications port access.

d. Source status screens shall be provided for both normal & emergency to pro-vide digital readout of voltage on all 3 phases, frequency and phase rotation.

3. Time Delays:

The following adjustable time delays shall be provided:

a. 0 to 6 seconds to override momentary normal source outages and delay all transfer and engine starting signals.

b. 0 to minimum of 120 sec on transfer to emergency for controlled timing of transfer of loads to emergency.

c. 0 to 60 minutes for actual normal power failures and for the test mode function. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.

d. 0 to minimum of 30 minutes on shut down of engine generator for cool down.

e. 0 to minimum of 1 minute to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable time delay.

4. External AC Power Supply:

Provision shall be for static inverter backed 230V AC power supply to allow the LCD and the door mounted control indicators to remain functional when both power sources are dead. The supply shall include 2 hour battery backup and to be charged via mains supply.

5. Withstand and Closing Ratings:

The ATS shall be rated to close on and withstand the available RMS symmetrical short circuit current at the ATS terminals with the type of over current protection shown on the plans.

The ATS shall be labelled in accordance with 1½ and 3 cycle, long-time ratings. ATSs which are not tested and labelled with 1½ and 3 cycle (any breaker) ratings and have series, or specific breaker ratings only, shall not acceptable.

6. Tests & Certification:

The complete ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.

Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial

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number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.

The ATS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001.

7. Service Representation:

The service centre's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.
The manufacturer shall maintain records of each switch, by serial number, for a minimum of 20 years.

2.1.13. MOTOR PROTECTION CIRCUIT BREAKER (MPCB) :

1. The devices shall be in utilization category A, conforming to IEC60947-2 and AC3 conforming to IEC 947-4.MPCB shall have a rated operational and insulation voltage of 690V AC (50 Hz) and MPCB shall be suitable for isolation conforming to standard IEC 60947-2 and shall have a rated impulse withstand voltage (Uimp) of 6 kV.
2. The motor circuit breakers shall be designed to be mounted vertically or horizontally without derating. Power supply shall be from the top or from the bottom. In order to ensure maximum safety, the contacts shall be isolated from other functions such as the operating mechanism, casing, releases, auxiliaries, etc, by high performance thermoplastic chambers. The operating mechanism of the motor circuit breakers must have snap action opening and closing with free tripping of the control devices. All the poles shall close, open, and trip simultaneously.
3. The motor circuit breakers shall accept a padlocking device in the "isolated" position.
4. The insulation coordination within the Low Voltage System shall be according to IS SP: 39-1987.
5. The motor circuit breakers shall be equipped with a "PUSH TO TRIP" device on the front enabling the correct operation of the mechanism and poles opening to be checked.The auxiliary contacts shall be front or side mounting, and both arrangements shall be possible. The front-mounting attachments shall not change the breaker surface area. Depending on its mounting direction the single pole contact block could be NO or NC.
6. All the electrical auxiliaries and accessories shall be equipped with terminal blocks and shall be plug-in type.
7. The motor circuit breakers shall have coordination with the downstream contactor enabling the provision of a perfectly co-ordinated motor-starter. This combination shall enable type 1 or type 2 co-ordination of the protective devices conforming to IEC 60947-4-1.Type 2 co-ordination shall be guaranteed by tables tested and certified by an official laboratory: LOVAG (or other official laboratory).
8. The motor circuit breakers, depending on the type, could be equipped with a door-mounted operator which shall allow the device setting.
9. The motor circuit breakers shall be equipped with releases comprising a thermal element assuring overload protection and a magnetic element for short-circuit protection. In order to ensure safety and avoid unwanted tripping, the magnetic trip threshold (fixed) shall be factory set to an average value of 12 Ir.
10. All the elements of the motor circuit breakers shall be designated to enable operation at an ambient temperature of 40°C without derating. The thermal trips shall be adjustable on the front by a rotary selector. The adjustment of the protection shall be simultaneous for all poles. Phase unbalance and phase loss detection shall be available. Temperature compensation (-20°C to +60°C).

2.1.14. MINIATURE CIRCUIT BREAKER's :

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1. Miniature air break circuit breakers shall be provided in accordance with the following Specification Sections, and shall fully comply with IS 60898, respective codes as specified in section 1.4. Breakers shall be used for the following types of installation:
   a. Type B MCB - Trips between 3 and 5 times of full load current.
   b. Type C MCB - Trips between 5 and 10 times of full load current.
   c. Type D MCB - Trips between 10 and 20 times of full load current
2. Distribution boards incorporating MCB's shall be arranged such that sub-circuits cannot be made alive by unauthorised persons. MCB's shall be of the plug-in type or supplied capable of being locked in the OFF position.
3. All sizes of MCB's shall be checked with the Engineer before any orders are placed. Each MCB, unless otherwise stated, shall be of the hermetically sealed, thermal magnetic type having a rated short circuit capacity Icn of a minimum of 10kA (unless otherwise noted) at 415volts a.c.
4. MCB's used for the final means of protection and isolation to items of fixed or removable equipment shall be complete with flush GI box and with front plate arranged as overlapping for flush mounted units.
5. Assemblies shall be arranged for flush or surface mounting as indicated in the detail sections of this Specification, schedules or drawings, and the associated front plates shall be finished to match the general lighting switches.
6. MCB's shall be provided with positive means for preventing any one pole of a multi-pole MCB being operated or tripped independently of the other poles.
7. Coordination shall be achieved for all load conditions, i.e. a fault on a downstream circuit shall not cause supply to a distribution board to trip. Miniature Circuit Breaker shall comply with IS-8828-1996/IEC60 898-1995. Miniature circuit breakers shall be quick make and break type for 240/415 VAC 50 Hz application with magnetic thermal release for over current and short circuit protection.
8. The MCB shall be suitable for manual closing, opening and automatic tripping under overload and short circuit. The MCB shall also be trip free type.
9. Single pole / three pole versions shall be furnished as required and all MCB's shall be DIN rail mounted with double locking tightening screws.
10. MCB shall ensure complete electrical isolation of downstream circuit or equipment when the MCB is switched OFF.
11. The MCB's shall be housed in the panel boards and shall have suitable connections at the outgoing terminal for termination via tinned cable lugs and for bus-bars connection on the incoming side
12. The housing shall be heat resistant and having a high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP, TPN and 4 Pole miniature circuit breakers shall have a common trip bar independent to the external operating handle.
13. The terminal of the MCB's and their open and close conditions shall be clearly / indelibly marked.
14. The MCB's shall be rated for 10 KA fault level. or as per the rating listed on the drawings/ load schedule/ approved drawings/ or elsewhere to comply with the discrimination and tripping philosophy.
15. The MCB's shall be suitable for housing in the lighting boards and is suitable for connection at the outgoing side by tinned cable lugs and for bus-bars connection on the incoming side.
16. The MCB shall generally conform to respective codes as specified in section 1.4

2.1.15. RCCBs, RCBOs (RCDs) :

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1. All Residual Current Device (RCD) shall comply with the respective codes as specified in section 1.4 .
2. RCDs shall be provided within every distribution board to comply with the requirements of the local supply authority.
3. The RCDs shall be suitable for minimum 20,000 operations.
4. A test device shall be incorporated to check the integrity of the earth leakage detection system and the tripping mechanism. When the unit is connected to service, pressing the test knob shall trip the RCD and the operating handle shall move to the “OFF” position
5. The enclosure of the RCD shall be moulded from high quality insulating material. The material shall be fire retardant, anti tracking, non-hygroscopic, impact resistant and shall with stand high temperature.
6. All parts of switching mechanism shall be non-greasing, self lubricating material so as to provide consistent and trouble free operation.
7. RCD shall be 2/4 pole 415 volts 50Hz, 30-300mA sensitivity. The rating of the RCD shall be as required.
8. These shall be suitable for manual closing and opening and for automatic tripping under earth fault circuit of 30-300 mA where the tripping shall be current/voltage tripping.
9. Operation of RCD shall be independent of mounting position and trip free type. RCDs shall be provided within every distribution board to comply with the requirements of the local supply authority. The sensitivity of the RCDs shall be as follows:-

Circuit/Equipment/Apparatus	Rated Operating Current (mA)
6A switched socket outlets	30
16A switched socket outlets	30
Water heater/coolers	30
Refrigerator/washing machine and similar apparatus	30
Domestic water pumps	30
Jacuzzi pumps	10
Under water lighting	10
16A switched socket outlets (general purpose)	30
General lighting	30
Flood lighting	100/300
VRV/Split type air conditioner	100
Fan coil/air handling units/VAV	100
Package type A/C unit	100/300
Chiller	100-500-1000
Irrigation pump	100
Electric cooker	100
Industrial machine	100/300
Elevators/Escalators	300/500
Neon sign/Cold Cathode/Facade lighting	300

2.1.16. DISTRIBUTION BOARDS :

1. All terminals shall be readily accessible from the front of the distribution board.
2. Include for each distribution board to be of the size and type as detailed in the Specification sections, Particular requirements for consumer units shall be as specified in IS 8623 part III.
3. Each unit shall be of the 500 volt pattern as a minimum requirement and be complete with a pressed or fabricated steel case manufactured from sheet steel having a minimum thickness of 16 swg , double door configuration , painted with primer of 2 coats of low VOC paint of approved colour.

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4. Hinged doors shall be provided and shall be complete with All DB's front door should be self lockable.
5. All live terminals or parts shall be shrouded by insulating material to ensure that it is impossible for any live metal to be touched whilst withdrawing or replacing the MCB units or fuses.
6. The Isolator or miniature circuit breakers (MCB) and/or residual current device (RCD) shall be arranged in banks which shall be easily removable to facilitate wiring and connection. Adequate non-ferrous bus-bars shall be fitted to the banks and shall be complete with suitable cast brass terminal for the termination of the cables. The diameter of each terminal pinching screw shall be not less than 75% of the diameter of the cable entry hole.
7. Each distribution board shall be complete with an internal RCD and MCB circuit chart clearly detailing the circuit numbers, area served and the respective circuit breaker sizes. The charts shall be type-written, glued to stiff cardboard, covered with clear Perspex and fixed to the inside face of the door by means of screws and nuts. In addition to the above the Contractor shall hand over a master copy of all such schedules in a ring binder.
8. In addition, each circuit chart shall contain full details of the size and type of cable feeding the distribution board, grouping factors, length of the cable etc., together with the size, type and location of the main or sub-main distribution board or rising busbar serving the board.
9. Circuit and phase colour identification bands shall be fitted to all phase, neutral, earth and control circuit cables. Distribution boards shall be supplied complete with all outgoing MCBs, RCDs etc. as specified in the schedule and also be supplied with blank ways as necessary.
10. Each distribution board shall be new and complete with all necessary shrouds, carriers, Isolator, RCD and MCB units etc., with metal case stove enameled finished to an approved colour.
11. Where distribution boards are surface mounted, and the installation is concealed within the walls, the conduits shall be terminated in a suitable flush adaptable box measuring not less than 300mm x 300mm. The distribution board shall be mounted over the box and attached to the box with four brass machine screws into threaded holes at the corner of the box and in addition shall be securely fixed to the wall with raw bolts or raw plugs and screws.
12. Final connections between the adaptable box and the distribution board shall be made via a large square or rectangular hole in the back of the distribution board. The edges of the hole shall be finished with a suitable insulating material to ensure that the cables are not pulled over rough or sharp edges.
13. The insulating material shall be securely fixed to the distribution board and the adaptable box shall be adequately bonded to the distribution board by means of a short length of flexible copper tape, bolts, nuts and shake proof washers.
14. Each neutral bar incorporated in distribution boards shall have the same number of connections as there are phase connections within the boards. Each neutral wire connection shall be made in the same order as the phase wires are connected to the protection units.
15. The neutral bar shall be of the same cross sectional area as the respective phase bus-bars.
16. Earth bars shall be provided having the same number of connections as for the phases and the conductors terminated in a like manner.
17. Where the schematic diagrams indicate a single feed serving two separate distribution boards (for example lighting and power boards) include for manufacturing a composite unit with a solid shrouded copper link between the live side of the board isolators and the incoming feeder cable.
18. For all DB's upto 14 way TPN & SPN no pad locks are required. Distribution Boards (DBs) shall be suitable for operation on 3 Phase/single phase, 415/240 volts, 50 cycles, neutral grounded at transformer. The DB shall be minimum di-electric strength of 2.5 KV / Sec.All Distribution Boards shall be manufactured by a manufacturer listed in List of approved makes

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DB's shall comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per IS-13947-1993.

19. All removable/ hinged doors and covers shall be grounded by 4.0 sqm tinned stranded copper connectors. DBs shall be suitable for the climatic conditions. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to IS-8623 for factory built assembled switchgear & control gear for voltage up to and including 1100 V AC.
20. Knockout holes of appropriate size and number shall be provided in the DB's in conformity with the location of cable/conduit connections. Detachable sheet steel gland plates shall be provided at the top / bottom to make holes for additional cable entry at site if required.
21. DBs shall comprises of the following:
    a. Installation accessories shall be part of the DB for fixing conductor and rails for mounting MCB's and (RCD's) etc.. neutral bus bars & earthing bus bars required in the circuit. All busbars in the DBs shall be insulated type.
    b. Service cable /interconnection shall be part of the Distribution Boards.
    c. The board shall be installed at a height such that the operating is within reach of the normal human height i.e. 1.8 meters from finish floor level.
    d. Degree of protection shall be IP-42 for indoor application and IP-65 for outdoor application.
    e. All three phase distribution boards shall have 4 rows and single phase distribution boards shall have single rows for housing of MCB's and RCCB's unless noted otherwise.
    f. Phase segregation to be maintained in all three phase distribution boards.
    g. Earthing shall be provided in each DB's.
    h. 3 Phase board shall have phase to phase isolation (PPI). It shall have one main neutral and 3 separate sub neutral links, one for each phase of adequate capacity as per number of outgoings per phase.
    i. Staircase DBs shall comprise of contactor at incomer of DB with 4NO+4NC contacts for CFO/Fire Fighter's at the entrance to operate all staircase lighting from momentary contact switch located at P0 level. Refer Dwg. No. E-500 (Electrical Details) for detailed connection.

2.1.17. VARIABLE FREQUENCY DRIVES :

2.1.17.1. VFD TECHNICAL DATA :

1. **VFD Description**: Variable-frequency drive (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and over current and overload protection; as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
2. **Design and Rating:** Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
3. **Unit Operating Requirements:**
    a. Input AC Voltage Tolerance: Plus ± 6percent of VFD input voltage rating.
    b. Input AC Voltage Unbalance: Not exceeding 3 percent.
    c. Input Frequency Tolerance: Plus or minus 3 percent of VFD frequency rating.
    d. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.

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e. Minimum Short-Circuit Current (Withstand) Rating: 25 kA.

f. Vibration Withstand: Comply with IEC 60068-2-6.

g. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.

h. Starting Torque: Minimum 100 percent of rated torque from 3 to 50 Hz.

i. Speed Regulation: Plus or minus 5 percent.

j. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.

k. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

4. Internal Adjustability Capabilities:

a. Minimum Speed: 5 to 25 percent of maximum rpm.

b. Maximum Speed: 80 to 100 percent of maximum rpm.

c. Acceleration: 0.1 to 999.9 seconds.

d. Deceleration: 0.1 to 999.9 seconds.

e. Current Limit: 30 to minimum of 150 percent of maximum rating.

5. Self-Protection and Reliability Features:

a. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.

b. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.

c. Under- and overvoltage trips.

d. Inverter over current trips.

e. VFD and Motor Overload / Over temperature Protection: Microprocessor-based thermal protection system for monitoring VFD's and motor thermal characteristics, and for providing VFD over temperature and motor overload alarm and trip; settings selectable via the keypad.

f. Critical frequency rejection, with three selectable, adjustable dead bands.

g. Instantaneous line-to-line and line-to-ground over current trips.

h. Loss-of-phase protection.

i. Reverse-phase protection.

j. Short-circuit protection.

k. Motor over temperature fault.

6. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

7. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Auto speed Search" feature is available and engaged.

8. Bidirectional Auto speed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

9. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

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10. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
11. Integral Input Disconnecting Means and OCPD: NEMA KS 1, fusible switch with pad lockable, door-mounted handle mechanism.
    a. Disconnect Rating: Not less than 115 percent of VFD input current rating.
    b. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.
    c. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
    d. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
    e. NC or NO alarm contact that operates only when circuit breaker has tripped.

2.1.17.2. CONTROLS AND INDICATION :

1. Status Lights: Door-mounted LED indicators displaying the following conditions:
    a. Power on.
    b. Run.
    c. Overvoltage.
    d. Line fault.
    e. Overcurrent.
    f. External fault.
2. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
    a. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
    b. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
    c. Control Authority: Supports at least four conditions: Off, local manual control at VFD, local automatic control at VFD, and automatic control through a remote source.
3. Historical Logging Information and Displays:
    a. Real-time clock with current time and date.
    b. Running log of total power versus time.
    c. Total run time.
    d. Fault log, maintaining last four faults with time and date stamp for each.
4. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFD door and connected to display VFD parameters including, but not limited to:
    a. Output frequency (Hz).
    b. Motor speed (rpm).
    c. Motor status (running, stop, fault).
    d. Motor current (amperes).
    e. Motor torque (percent).
    f. Fault or alarming status (code).

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g. PID feedback signal (percent).

h. DC-link voltage (V dc).

i. Set point frequency (Hz).

j. Motor output voltage (V ac).

5. Control Signal Interfaces:

a. Electric Input Signal Interface:

- A minimum of two programmable analog inputs: 0- to 10-V dc 4- to 20-mA dc.
- A minimum of six multifunction programmable digital inputs.

b. Pneumatic Input Signal Interface: 3 to 15 psig.

c. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:

d. 0- to 10-V dc.

e. 4- to 20-mA dc.

f. Potentiometer using up/down digital inputs.

g. Fixed frequencies using digital inputs.

h. Output Signal Interface: A minimum of one programmable analog output signal(s) (0- to 10-V dc 4- to 20-mA dc), which can be configured for any of the following:

- Output frequency (Hz).
- Output current (load).
- DC-link voltage (V dc).

i. Motor torque (percent).

j. Motor speed (rpm).

k. Set point frequency (Hz).

l. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

- Motor running.
- Set point speed reached.
- Fault and warning indication (overtemperature or overcurrent).
- PID high- or low-speed limits reached.

m. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

n. BMS Interface: Factory-installed hardware and software to enable the BMS to monitor, control, and display VFD status and alarms and energy usage. Allows VFD to be used with an external system within a multidrop LAN configuration; settings retained within VFD's nonvolatile memory.

o. Network Communications Ports: Ethernet and RS-232/485.

2.1.17.3. LINE CONDITIONING AND FILTERING :

Input Line Conditioning: Based on the Contractors harmonic analysis study and report, provide input filtering, as required, to limit THD(i)at input terminals of all VFDs to less than 5 percent and THD(V) to 3 percent.

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2.1.17.4. BYPASS SYSTEMS :

6. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
7. Bypass Mode: Manual operation only; requires local operator selection at VFD. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.
8. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback.
9. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.
    a. Bypass Contactor: Load-break, IEC-rated contactor.
    b. Output Isolating Contactor: Non-load-break, IEC-rated contactor.
    c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.
10. Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter input and output and permit safe testing and troubleshooting of the power converter, both energized and de-energized, while motor is operating in bypass mode.
    a. Bypass Contactor: Load-break, IEC-rated contactor.
    b. Input and Output Isolating Contactors: Non-load-break, IEC-rated contactors.
    c. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

2.1.17.5. LABELS :

1. VFD's shall be identified by labels. Label designation shall be in accordance with the BOQ & Drawings. All removable components shall have a circuit label.

Description	Requirement
Material	Anodised Aluminimum / Trofolite
Engraving	Black engraving on white background
Size of the Label	To suit application / importance
Fixing	With self-tapping screws
Use	Main Panel, feeders and individual devices

2. Labels shall have black characters on a white background and be made of a non-corrodible material. Danger/warning labels shall be engraved with black letters on a yellow background, in English, Hindi and Marathi languages.

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3. Labels shall not be affixed by adhesive.
4. Labels shall be printed in English and Hindi.

2.1.18. SOFT STARTERS :

1. **Provide soft-start starters as noted in Tender Documentation.**
2. Soft start starters shall be provided for the specified service. Soft start starters shall consist of a main disconnect switch, a mechanical contactor, a six-SCR full wave bridge solid state reduced voltage starter, a thermal overload relay factory assembled in a single enclosure, with ratings, features and accessories as specified below. The soft start shall be capable of controlling the starting inrush of a NEMA design B motor, and to reduce water hammer effects of the pumps when the motor is stopped.
3. Ratings and features:
   a. Starter voltage as noted on electrical drawings.
   b. Enclosure type, NEMA 1 ventilated.
   c. Main AC line fused disconnect or circuit breaker mounted and wired, with a door interlock mechanism and padlocking means.
   d. Starter shall include a full NEMA style, HP sized and rated series contactor, including contacts and coils, ahead of the solid state electronics. Contactor shall open on normal stop command, and if a shorted SCR is detected.
   e. Starter shall be rated for a minimum of 350 present current for 30 seconds.
   f. Starter shall include adjustable thermal overload protection.
   g. Starter shall include maintained contact H-O-A selector switch and red running pilot light.
   h. Starter shall include an integral 230V control circuit transformer with primary and secondary fusing.
   i. Starter shall be rated for full current operation at 40 degrees C ambient temperature..
   j. In addition to the interlock & switches specified above each soft start starter shall be provided with (4) four additional spare sets of auxiliary contacts, (2) two normally open & (2) two normally closed.
4. Protective features and adjustments:
   a. SCR's shall be rated 1600 PIV minimum.
   b. Instantaneous overcurrent trip shall be included if current exceeds 900 percent FLA.
   c. Metal Oxide Varistor (MOV) suppressors shall be provided.
   d. Heat sink over temperature switch shall be provided.
   e. Starter shall include shorted SCR detection and lockout.
   f. Starter shall not start if a phase loss condition is present.
   g. Diagnostics shall include LED indicators for:
      - 3 phase power present
      - Shorted SCR detected
      - Motor overload
      - Instantaneous overcurrent
      - Starter ready
      - Starter on

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- Power supply failure

h. A fault relay shall be included to trip the series contactor in the event of motor thermal overload, instantaneous overcurrent, of presence of a shorted SCR.

i. Adjustments shall include ramp time, current limit, jog voltage, jog time, and deceleration time.

5. Operational Features:

a. On starting, the starter shall be capable of applying an adjustable "jog" voltage to the motor for an adjustable time to magnetize the motor, then automatically switch to a controlled current ramp mode to accelerate the load.

b. On stopping, the starter shall include an "anti-water hammer" circuit which is capable of accepting a 0-10V DC signal proportional to flow from the building automation system and controlling the voltage to the motor to obtain a smooth reduction in flow without excessive pipe movement or water hammer. As a backup, a linear voltage ramp deceleration mode shall be available.

6. Field Start-up and Service:

Soft starter supplier shall provide authorized factory trained service personnel to do on-site start-up and adjustment for each soft start starter.

2.1.19. MOTOR STARTERS :

2.1.19.1. TECHNICAL DATA :

- The type of starter to be used shall be as follows (to be read in conjunction with MEP equipment schedules:

2.1.19.2. TYPES OF MOTOR STARTING METHOD :

1. Constant Speed motors upto and including 7.5kW : Automatic Direct on Line starters.
2. Constant Speed motors of above 7.5Kw : Automatic Star/Delta Starters
3. Two Speed Motors Automatic : Star/Delta Starters
4. All Fire fighting Pumps : Soft Start / DOL Start (as noted in Contract Documents)

a. The starting current of the motors shall be limited by using the above mentioned starters, as required.

b. Where individual starters and controls are grouped together, the Contractor shall provide a panel for mounting this equipment.

c. Starter feeders shall be equipped with but not limited to:

- Main MPCB/MCCB with door interlocked rotary handle.(lockable in the off position).
- Contactors for direct on-line starting or star-delta starting as noted in the contract documentation
- Thermal overload relay with built in single phasing prevention feature.
- Hand-Off-Auto control switch.
- Common duty selector switch.
- Thermistor relay.
- RUN/TRIP lamps.
- Auto changeover arrangement.

2.1.19.3. STAR DELTA AND DIRECT ON LINE TYPE :

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1. Motor starters shall be in accordance with respective codes as specified in section 1.4. The starters shall be totally enclosed, metal clad, dust and vermin proof construction. The starters shall be of continuous rating and shall be of automatic type. All starters shall be suitable for 415 volts, 3 phase, 50 HZ, A.C. supply.
2. Provide starters incorporating overcurrent protection for motors starters.
3. Contactors shall have the number of poles as required for appropriate duty. The making capacity of the contactors shall be as per AC23 of ISS.
4. Unless other specified, all starters shall have integral start/stop push buttons. Start push buttons shall be coloured green and shall be shrouded to prevent inadvertent operation. Stop push buttons shall have mushroom heads and shall be coloured red. All push buttons operated contractors shall be provided with a hold-on/running contact.
5. All remote control circuit connected to be starters shall operate at 240 volts or lower voltage.
6. Motor starters shall be provided with thermal overload relay with adjustable settings, one each phase for three phase motors. Single phasing preventers shall be provided for all three phase motors.
7. Terminal block with integral insulating barriers shall be provided for each starter.
8. All the starter shall be provided with a schematic diagram on a durable material fixed permanently within each lid or cover.
9. Starters shall be provided with sufficient extra N/O contacts for interlocks, indicating lamps, etc.
10. Automatic Star/Delta starters shall be provided with adjustable timers.
11. Starters for wound rotor motors shall be rotor resistance type and shall be oil/air immersed, metal clad construction with combination of drum type rotor resistance starter and starter switch. Rotor starter shall be used for starting only. The starter switch shall be of heavy duty, with trip free mechanism. The tripping mechanism shall not reset until the starter handle is in "OFF' position.
12. For Star//Delta starters incorporate adjustable time delay contactor relays, to control star delta changeover, ensuring electrical endurance compatible with starter contactors. Ensure starting sequence activated on voltage restoration.
13. All motor starters will be provided with Type 2 Co-ordination (to IEC 60947-4-1) such that under short circuit conditions, the contactor or starter shall cause no danger to persons or installation and shall be suitable for further use. The risk of contact welding is recognized, in which case the manufacture shall indicate the measures to be taken in regards to equipment maintenance.
14. The start shall be part of Control Panel unless otherwise specified for standalone installation. Then the enclosures type starter should confirm the specification of panels & specified as in SLD for Construction, finish, Painting & IP Rating.
15. Sufficient variety of coil voltages should be available and at least one wide band coil option should be available.
16. The relay should be computer calibrated for accurate protection under overload and single phasing.
17. The Star/ Delta starter shall be fully automatic type, complete with Line, Star and Delta contactors, relays, timers and fully pre-wired for ready use.
18. The enclosure should have the top and bottom openings for the base of the connections.
19. The timer of the star delta starter should be of electronic type so as to have accurate changeover from star to delta.

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2.1.20. QUALITY ASSURANCE :

1. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances, and regulations of Country, State, and Municipal authorities having jurisdiction & applicable Standards.
2. Standards: The Low voltage Switchgear and Accessories shall confirm to the requirement of latest revision of all relevant Indian Standards and also IEC Standards.
3. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing in accordance with IEC/IS/and BS codes and is acceptable to authorities having jurisdiction.
4. Electrical Components, Devices, and Accessories: Listed and labeled as per INDIAN NEC 2011 and IS 732 1989 (reaffirmed 2005), by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

2.1.21. INSPECTION AND TESTING :

1. The Contractor shall provide test certificates with as per the approved material submission schedule each design and rating of switchgear for Type and Routine tests carried out on the switchgear. Tests shall be those listed in the relevant standards. The routine tests shall be for the precise cubicle configuration proposed, including any adapter units between switchgear and control gear.
2. The Contractor shall provide type test certificates for all ratings of Current transformers, Voltage transformers, relays, meters and other auxiliary equipment's used in the switchgear.
3. The Employers Representative reserves the right to witness the following tests:-
   a. Factory acceptance tests including routine tests on all switchgear/components as specified in the relevant standards.
   b. Operational (electrical and mechanical) tests on all components.
   c. Protection operation by secondary injection of current and voltage as required.
   d. Protection operation by primary injection of current as applicable.
   e. Interchange ability test.
4. The Contractor shall give two weeks' notice of tests prior to commencement.
5. The Employers Representative reserves the right to inspect switchgear at the Manufacturer's works at any time prior to despatch to prove compliance with this specification.
6. The Employers Representative shall also have the right to carry out intermediate inspection at Seller's works during manufacturing stage.
7. All the travelling & accommodation expenses towards the Inspection or witnessing the testing of equipment by the Employers Representative will be in Contractors scope.

2.1.22. SHIPPING, HANDLING AND STORAGE :

In the event the LV switchgear is reassembled on site then the SAT (Site acceptance test) as agreed with Employers representative shall be carried out on site to check for proper functionality of respective panels and switchgears.

The test should be accounted for insulation test, functional test, continuity test, sectionally injection test, relay test, visual inspection, functional testing, Hi-Pot test, torque testing.

2.2. L.V. BUSDUCT, BUSBARS & ACCESSORIES :

2.2.1. SCOPE :

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The specifications are given below to enable the Design, Manufacture, Testing and Supplying of the busducts / busbars complete in all respect as reflected in layouts & appearing in the schedule of quantities.

2.2.2. CODES & STANDARDS :

Codes for Busducts	
IEC 61439-1	General rules
IEC 61439-2	Power switchgear and control gear ASSEMBLIES (Replacing IEC 60439-1)
IEC 61439-3	Distribution boards (to supersede IEC 60439-3)
IEC 61439-4	Assemblies for construction sites (to supersede IEC 60439-4)
IEC 61439-5	Assemblies for power distribution (to supersede IEC 60439-5)
IEC 61439-6	Busbar trunking systems (to supersede IEC 60439-2)

1. From the Main LV switchboards, power shall be distributed by 3 Phase, 4 wires, 50Hz, 415V Sandwich Bus -Riser to serve on floor power requirement within the towers. Busbars shall be routed through the service lobby via suitable support and up in the tower through risers/shaft, with proper supports/ expansion joints for wind movement, seismic movement, building shortening (designed by the Busbar specialist and installed by the Contractor).
2. The neutral in each busduct shall be sized at 100% of the phase conductors cross section area.
3. A dedicated earthing conductor shall be provided within the busduct. The busduct earth shall comprise both the bus duct case and the internal earth conductor. The internal earth conductor shall be sized 50% of the phase conductor.
4. Ensure all equipment and systems are to provide electromagnetic compatibility within the systems and with any other systems installed in the same location.
5. The Contractor shall install systems strictly in line with manufacturers recommendations and shall ensure all works are in line with recommended EMC mitigation measures in IEC 61000-5 (Installation and mitigation guidelines).
6. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features. Danger/Warning labels shall have white lettering on a red background and shall be in English, Hindi and Marathi. All other labels shall have black lettering on a white background. All labels shall be fixed by screws or rivets.

2.2.3. TECHNICAL :

1. Busduct systems conform to a Type-Tested low-voltage switchgear and control-gear Assemblies (TTA) to IEC 61439-1 and -6 ready for connection and installation.

   The Busduct system must consist of listed system modules such as:

   a. Single bolt joint and details
   b. Flat wise elbow
   c. Edgewise elbow
   d. Edgewise offset
   e. Combination elbow
   f. Wall & floor flange
   g. Adjustable length.
   h. Flange end connector

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i. Expansion joint unit
j. Terminal end cover
k. Phase Balance Arrangement
l. Horizontal hanger support.
m. vertical installation & spring support
n. Flat wise tee section.
o. Edgewise tee section
p. Elbow flange
q. End feed cable unit
r. Z units / T Units.

2. All units must be available from the factory in standard and optional lengths. Junction units shall be provided to interconnect bus riser.
3. Where required, the busduct system shall be provided with an asbestos-free 2 hrs fire barrier for all wall or ceiling openings through fire rated wall/ slab.
4. The complete bus bar enclosure must be of 1.6 mm thick M.S. sheet steel powder coated with RAL7032 Siemens grey paint finish. Painting shall not compromise the electrical conductivity of casing as on earthing conductor.
5. The individual system modules shall be connected by tightening a joint box. The conductors between two system units should not be connected with screws.
6. The bus bars must be made from Copper / Aluminium (refer to SLD for requirement) and shall be insulated along their entire length. Each bar should be individually wrapped in Mylar / non-hygroscopic Epoxy or Cast Resin Insulation and this assemble of four bus bars should be again wrapped with a common Mylar sheet. The Bus bars are to be insulated with minimum class B 150C insulation over the entire length. Insulation voltage for the system is 1.1K V.
7. Under fire condition Busbar shall not emit toxic fumes.
8. The Contractor's shop drawings shall detail the required location of supports and hangers to ensure adequate support for the busbar sections.

2.2.4. SPECIFIC REQUIREMENTS :

Standards and regulations	IEC60 439 Parts 1 and 2, IS 8623 part-2 1993
Climatic proofing	Damp heat, constant to IEC 60068-2-78 Damp heat, cyclic, to IEC 600068-2-0
Net-systems conform to	IEC 60364-3
Kind of system	Sandwich
Ambient temperature min./max./24-hour average	40°C
Protection type	Busbar to be IP42 when run vertically and IP 54 when run horizontally, IP 65 for external runs
Torque setting for joint block	120 + 10 Nm
Sandwich Busbar surface treatment	Insulated over the entire length
Riser unit material	AL/Cu (Refer to SLD for exact requirement)
Colour of riser units	RAL7032 grey
Rated insulation voltage Ui	(1.1kV)
Power Frequency Withstand (One Minute)	Voltage 2,5 kV / 1 minute
Rated operational voltage Ue	up to 1.1 KV AC
Rated frequency (F)	50 Hz

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2.2.5. CONSTRUCTION REQUIREMENTS :

1. The busway housing shall be a 2-piece design fabricated from extruded electrical grade aluminium. The 2-piece housing shall be bolted together, along the bottom flange, using grade 5, 1/4x20 zinc-plated fasteners on 3-inch canters for maximum mechanical strength. The busway enclosure finish shall be ANSI 61 gray baked epoxy powder paint applied by an electrostatic process.
2. Outdoor feeder busway housing shall be identical to indoor feeder busway housings, and shall be OEM approved for outdoor use. Bus way shall be completely weatherized at the factory, and designed such that only caulking of protective joint covers are required for outdoor application.
3. The housing of the Busduct shall be constructed from M.S. sheet steel powder coated of thickness not less than 1.6mm for each side and 1.6mm for top and bottom to provide maximum protection against corrosion and provide maximum strength and rigidity.
4. The bus duct enclosure shall be heavy duty rated as tested by an independent third party test lab per IEC60439-2, 8.2.10 and 8.2.12.
5. FLEXIBLE EXPANSION JOINTs shall be provided wherever there is a building expansion and when there is a straight section of busway more than 100 meters or at the recommendation of the manufacturer.
6. The terminal enclosures shall be provided with flanged ends connection as required.
7. The material of conductor shall be high conductivity Aluminium.
8. Ratings - Three phase with Neutral Bus Bars shall be designed to carry the rated full load current under normal operating site conditions without exceeding a 55 degree C rise above a 40 degree C ambient or total hot spot temperature of 95 degC. There shall be no derating of busbar upto 55 degC.
9. Each busway section shall be furnished complete with joint hardware and covers. The busway joints shall be a single-bolt, non-rotating, removable bridge design. All bridge joints shall be furnished with torque-indicating double head joint bolts and Belleville washers. The bridge joint shall utilize a captive nut retainer on the opposite side of the torque-indicating bolt. The bridge joint design shall ensure proper installation without the use of a torque wrench, and provide visual indication that the joint has been tightened to the proper torque value. Each busway joint shall allow for a minimum length adjustment of +/- 12.7 mm. De-energization of busway shall not be required for safe testing of joint tightness.
10. Bus bars to be insulated with Class F thermo set epoxy along their entire length using a fluidized bed process to bond the epoxy directly to the bus bar. Any other method of insulation which can allow air gaps shall not be acceptable. Factory production tests to include thickness, impact resistance, and 5000V brush test.
11. Where required, tap-off units of the types and ratings indicated on the plans and specifications shall be supplied. Tap-off units shall be mechanically interlocked with the busway housing to prevent their installation or removal while the switch is in the “ON” position. The enclosure of any tap-off unit shall make positive ground connection to the duct housing before the stabs make contact with the bus bars. All tap-off units shall be equipped with an interlock that can be defeated to prevent the cover from being opened while the switch is in the “ON” position and to prevent accidental closing of the switch while the cover is open. The plugs shall be provided with a means for padlocking the cover closed and padlocking the disconnect device in the “OFF” position. The operating handle and mechanism shall remain in control of the disconnect device at all times, permitting its easy operation from the floor by means of a hook stick or chain. All tap-off units shall be interchangeable without alteration or modification of tap-off duct.
12. All metallic non-current carrying parts of each busduct section shall be connected to a fully fault rated earth bar and be terminated at both ends.

2.2.6. LABELS :

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1. Busduct and associated equipment shall be identified by labels. Label designation shall be in accordance with the BOQ & Drawings. All removable components shall have a circuit label.
2. A main nameplate shall be affixed in a prominent position at one end of each circuit giving the following information with characters written to a minimum size of 12mm in height:
   a. Manufacturers Name and Type
   b. Busbar Tag Number shall be every 2 metres.
   c. System Voltage, Phases, Wires and Frequency
   d. Rated Fault Current
   e. Busbar Rating
   f. Year of Manufacture
   g. Employers Name
   h. Employers Representative Purchase Order No.
3. Labels shall have black characters on a white background and be made of a non-corrodible material. Danger/warning labels shall be engraved with black letters on a yellow background, in English, Hindi and Marathi languages or as per local authority requirements.
4. Labels shall not be affixed by adhesive, screw.

2.2.7. POST BIDDING :

1. Dimensions, Technical catalogue, weight, bus duct schedule, General arrangement and dimensional layout of the bus duct installation showing the connection to equipment, tap off if any and mounting details, End termination details.
2. Mounting and installation Method, Drawing showing the terminal connection between the bus duct and equipment terminals. Details showing a typical bus duct joint between sections flexible connection and expansion joint applicable . Vertical or Horizontal support drawing for bus duct
3. The following information shall be submitted to the Employers Representative:
   a. Master drawing index
   b. Isometric drawing of each busway run
   c. Component list
   d. Busway ratings including:
      - Short-circuit rating
      - Voltage
      - Continuous current
      - Voltage drop calculation.
   e. Major component ratings including:
      - Voltage
      - Continuous current
      - Interrupting ratings
   f. Cable terminal sizes

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g. Product data sheets

h. Installation procedure recommended by manufacturer.

i. Commissioning procedure recommended by manufacturer.

2.2.8. QUALITY ASSURANCE :

1. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances, and regulations of Country, State, and Municipal authorities having jurisdiction & applicable Standards.
2. Standards: The Busduct and Accessories shall confirm to the requirement of latest revision of all relevant Indian Standards and also IEC Standards.
3. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL, CPRI approved/ASTA/KEMA approved), and that is acceptable to local India authorities.
4. Source Limitations: Obtain enclosed bus assemblies through one source from a single manufacturer.
5. Electrical Components, Devices, and Accessories: Listed and labeled as per IS 732 1989 (reaffirmed 2005), by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
6. Comply with IS 732 1989 (reaffirmed 2005),

2.2.9. INSPECTION AND TESTING :

1. The Contractor shall provide test certificates for each design and rating for Type and Routine test carried out on the Busduct. Test shall be those listed in the relevant standards. Type test certificate(s) shall be provided.
2. The Contractor shall give two weeks' notice of tests prior to commencement.
3. The Employers Representative reserves the right to inspect Busduct at the Contractor's works at any time prior to despatch to prove compliance with specification.
4. The OEM supplier shall certify the busbar installation and give guarantee on work executed by the contractor.
5. All the travelling & accommodation expenses towards the Inspection or witnessing the testing of equipment by the Employers Representative shall be in Contractors scope.
6. An IR Thermal test shall be carried out on the Busbars / Busducts at full load after occupation of the building
7. Torque test to be checked for all the joints and terminations.
8. For Type tests the Contractor shall furnish following type-tested certificates of bus duct for all ratings in three (3) copies each from CPRI. Partial ratings will not be accepted. Type tests shall include:

   a. verification of temperature-rise limits

   b. verification of dielectric properties

   c. verification of short-circuit strength for 1 second

   d. verification of the effectiveness of the protective circuit

   e. verification of clearances and creepage distances

   f. verification of mechanical operation

   g. verification of the degree of protection

   h. verification of electrical characteristics of busbar trunking system

   i. verification of structural strength

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j. verification of crushing resistance

k. verification of the resistance of insulating materials to abnormal heat

l. verification of resistance to flame propagation

m. verification of fire barrier in building penetration

n. seismic certificate

o. ISO 9001 or 9002

p. ISO 14001

q. KEMA KEUR/ASTA production verification through marking on all production

9. Routine Tests

The following routine tests shall be carried out in the presence of the Employers Representative and three copies of each test certificates shall be submitted.

a. One-minute di-electric test withstand test at recommended manufacturers voltage, or recommended manufacturers di-electric test.

b. Insulation resistance test at 1000V

c. Visual inspection.

10. The manufacturer of the Busduct system must maintain and certify an ISO 9001 quality management system.

11. Certificates or declarations of conformity must confirm the following qualifications for the entire system:

a. Type testing according to IEC 60 439-1 and -2, IS 8623 part-2 1993 (Whichever is most stringent)

b. Climatic proofing to IEC 60068-2-78 and IEC 600068-2-30

c. Fire barrier to DIN 4102 Part 12

d. IEC : 529 Equipment for Low voltage power distribution.

e. IS : 2147 Degree of protection provided by enclosure.

f. BS : 5486 (Part II) Bus Bar Trunking.

g. UL857 Safety Standard for Busway Systems

h. IBC 2006 : Seismic Requirements

i. Proof that system is maintenance-free

j. Silicon or halogen free

k. Sprinkler tested

l. Separate and insulated bus bars for PE.

2.3. L.V. POWER & CONTROL CABLES, IT/ TELCOM & TV CABLES :

2.3.1. SCOPE :

The specifications given below relates to the Design, Manufacture, Testing and Supplying of length of LV Cables & number of L.V. Cable terminations in schedule of quantities at Site.

2.3.2. CODES & STANDARDS :

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IS 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals.
IS : 7098 Part I	Cross-linked Polyethylene (XLPE) insulated PVC sheathed cables.
IS : 7098 Part II	Cross-linked Polyethylene (XLPE) insulated PVC sheathed cables. For working voltages from 3.3kV upto & including 33kV.
IS : 1554	Specification for PVC insulated (heavy duty) electric cables
IS : 8130	Conductors for insulated electric cables and flexible cords
IS : 3975	Mild steel wires, formed wires and tapes for armouring of cables
IS : 10418	Drums for electric cables
IS 10810	Method of test for cables
IS : 694	PVC insulated cables for working voltages upto and including 1100V.
BS 7846	Electric cables - thermosetting insulated armoured, fire-resistant cables of rated voltage 600/1000V, having low emission of smoke and corrosive gases when affected by fire – specification.
BS:7671 – 2008	IET wiring Regulations
IEC 60502-1	Power cables with extruded insulation and their accessories for rated voltages from 1 Kv (Um = 1,2 Kv) up to 30 Kv (Um = 36 Kv)
BS-8519-2010	Selection and installation of fire-resistant power and control cable systems for life safety and fire-fighting applications – Code of practice
BS 8434-2	Methods of test for assessment of the fire integrity of electric cables. Test for unprotected small cables for use in emergency circuits - BS EN 50200 with a 930°C flame and with water spray (+A2:2009)
BS 8491:2008	Method for assessment of fire integrity of large diameter power cables for use as components for smoke and heat control systems and certain other active fire safety systems
Abbreviations	PVC : Polyvinyl-Chloride XLPE: Cross Linked Polyethylene

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	SWA : Steel Wire Armour PE : Polyethylene FR : Fire Retardant FS : Fire Survival PH120 : 2 Hours Fire resistant

2.3.3. CABLE TYPES :

Aluminium and copper conductors shall have a 90ºC operating temperature, the rated voltage of 600/1100V & system voltage upto 1000V with 3 Phase 3 or 4 wire AC having neutral solidly earthed. The cable constructions for various types are as detailed below :

2.3.3.1. PVC/SWA/FR 1.1kV Grade

Conductor : Conductor of cables up to and including 16 mm^2 shall be of stranded copper conductor and above (including) 25mm^2 shall be Aluminium. Conductor shall be of electrolytic Aluminium/ copper conforming to IS : 8130 and are compact circular or compact shaped.

Insulation : **PVC FR.**

Core Identification: Up to 4 Cores –colours
1C - Black
2C - Red, Black
2C + earth – red, black, green/ yellow
3C - Red, Yellow, Blue
4C – Red, Yellow, Blue & Black
5 or more cores –numbered (Black numbers printed on grey coloured insulation).

Laying up : Cores to be laid up together with non-hygroscopic fillers.

Bedding : FR.

Armouring : Multi core cables - single layer of galvanised steel wires (round or flat). Single core cables - single layer of aluminium wires.

Over Sheathing : FR Type ST-1 of IS: 5831-1984 (Reaffirmed 2001) for maximum conductor temperature 70ºC, colour black.

Fire Performance : IEC 60331 Fire Resistance Test
IEC 60332 Flame Retardant test
IEC 61034 Smoke Emission Test
IEC 60754 Halogen Content Test
ASTM D 2863 Oxygen Index test

Service : General Purpose power distribution & control

2.3.3.2. XLPE/SWA/FR 1.1kV grade

Conductor : Conductor of cables up to and including 16 mm^2 shall be of stranded copper conductor and above (including) 25mm^2 shall be Aluminium. Conductor shall be of electrolytic Aluminium/ copper conforming to IS : 8130 and are compact circular or compact shaped.

Insulation : **XLPE (Cross linked polyethylene) compound of IS- 7098-19-88 for Maximum conductor Temperature 900c).**

Core Identification : Up to 4 Cores –colours

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1C - Black
2C - Red, Black
2C + earth – red, black, green/ yellow
3C - Red, Yellow, Blue
4C – Red, Yellow, Blue & Black
5 or more cores –numbered (Black numbers printed on grey coloured insulation).

Laying up : Cores to be laid up together with glass mica fillers.

Bedding : FR Type ST-2 of IS-: 5831-1984 (Reaffirmed 2001) for maximum conductor temperature 85^0 C.

Armouring : Multi core cables - single layer of galvanised steel wires (round or flat). Single core cables - single layer of aluminium wires.

Over Sheathing : FR type ST-2 of IS: 5831-1984 (Reaffirmed 2001) for maximum conductor temperature 85^0 C.

Fire Performance : IEC 60331 Fire Resistance Test
IEC 60332 Flame Retardant test
IEC 61034 Smoke Emission Test
IEC 60754 Halogen Content Test
ASTM D 2863 Oxygen Index test

Service : **General Purpose power distribution.**

2.3.3.3. EPR/SWA/ FS/ PH120 1.1kV grade

Conductor : Conductor of cables up to 300 mm^2 shall be of stranded copper conductor/ Aluminium conductor shall be of electrolytic Aluminium / copper confirming to IS : 8130 and are compact circular or compact shaped.

Insulation : Glass mica fire barrier tape covered by an extruded layer of cross linkable halogen free Ethylene Propylene Rubber (EPR) insulation and LSZH inner & outer sheath as per BS7846, IEC60520-1, BS 8519 latest edition.

Core Identification : Up to 4 Cores –colours
1C - Black
2C - Red, Black
2C + earth – red, black, green/ yellow
3C - Red, Yellow, Blue
4C – Red, Yellow, Blue & Black
5 or more cores –numbered (Black numbers printed on grey coloured insulation).

Laying up : Cores to be laid up together with non-hygroscopic fillers.

Bedding : Cross linkable halogen free Ethylene Rubber (EPR) insulation and LSZH inner & outer sheath as per BS7846, IEC60520-1, BS 8519 (latest edition) suitable for maximum conductor temperature 850^0 C.

Armouring : Multi core cables - single layer of galvanised steel wires (round or flat). Single core cables - single layer of aluminium wires.

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Over Sheathing : Cross linkable halogen free Ethylene Rubber (EPR) insulation and LSZH inner & outer sheath as per BS7846, IEC60520-1, BS 8519 (latest edition) suitable for maximum conductor temperature 850^0 C.

Fire Performance : Fire survival FS, PH120 (Defined as a catagory3 cable under BS 8519).

Service : General Purpose power distribution & control

2.3.4. CABLE CONSTRUCTION :

1. Cable cross sectional area, conductor material, number of cores, rated voltage and type shall be as stated contract documents.
2. The cable shall be multi-core and outer sheath should have high resistance to flame propagation.
3. The outer sheath of cables shall be embossed or engraved with
   a. Its BIS Certification Marking
   b. The voltage designation
   c. Manufacturers identification
   d. Number of Cores and nominal cross sectional area of conductors
   e. The drum progressive length of cable at every meter. (The starting point being the cable end at its inner coil on the cable drum)
4. Cable shall have uniformity in insulation and outer sheath colour. The XLPE insulation and insulation screen shall be extruded in one operation by triple extrusion process.
5. The insulation of the cable shall be designed and manufactured for the specified system voltage. Under normal conditions, the FR insulated cables shall have operating temperature upto 70 deg. Celsius & 90 deg. Celsius for XLPE insulated cables. The manufacturing process shall ensure that insulation shall be free from voids. The insulation shall withstand mechanical and thermal stress under steady state and transient operating conditions as defined in IS 7098 and IS 1554. The extrusion method should give very smooth interface between the insulation sheaths. The insulation of the cables shall be of high standard quality. The thickness of the insulation shall not be less than that specified in the relevant standards.
6. Sheath: Inner Sheath: In case of cables consisting of two or more cores inner sheath suitable to withstand the site conditions and the desired temperature shall be provided on the individual core and then surrounded by common covering applied either by extrusion or wrapping of a filling material containing thermoplastic material. It shall be of adequate thickness and applied by continuous process to produce a sheath of consistent quality free from all defects. The use of FR cabling is noted on relevant SLDs and Contract documents.
7. Outer Sheath: This is extruded over the armour for armoured cables and covers the inner sheath for unarmoured cables. For Emergency Feeders cables this shall be specially formulated heat resistant black FR compound conforming to the requirement of type ST2 of IS:5831-1984, extruded to form the outer sheath. The cable should also offer a specially formulated Flame Retardant compound (FR) for outer sheath. Suitable additives be added to prevent attack by rodents and termites. All cabling must be given anti-termite treatment. The thickness of the sheaths shall be as per relevant standards. Normal Feeder Cables Sheath shall be Fire Retardant (FR).
8. Equivalent Armour size. Contractor shall refer to SLDs, where armour has been selected as the cabling Circuit Protective Conductor (CPC) the armour shall conform to the following minimum standards:
9. The minimum acceptable technical characteristics for the SWA on cabling shall confirm to the table H2 and N2 on the following page. The Contractor shall be obliged to provide original manufacturer data sheets confirm this criteria is met in all cases. In the absence of original manufacturer data sheets the contractor, at his expense, shall be obliged to submit

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each SWA cable for laboratory testing to demonstrate compliance with BS 6724:1997+A3:2008.

10. The cables shall in all respects be suitable for operation under an ambient temperature of 40ºC. The Contractor shall verify the cable selection for the temperature rating and grouping factors validating the cable selection. The cable selection shall consider the combination of cable grouping and the temperature derating factors. The cables shall have a design life of at least twenty years.
11. All armoured cables shall be suitable for operation when installed:
    a. Direct buried in the ground (including waterlogged ground).
    b. In underground ducts.
    c. Above ground, fastened to cable ladder rack or tray in the open air exposed to direct sunlight.
    d. Below ground in enclosed, air filled trenches, fastened to cable ladder rack or tray.
12. Cables ≤ 16 Sq.mm shall be copper conductor and ≥ 25 Sq.mm shall be Aluminium conductor. For Life safety load FS PH120 type cables shall be used.

2.3.5. FIRE SURVIVAL PH 120 CABLES :

600/1000 Volts, fire survival cable shall be manufactured to BS 7836,IEC 60502-1 and BS 8519. Fire performance tests as per BS 8491:2008 (120 mins) for cables having overall dia of 20mm and above. Cables with overall dia below 20 mm should meet fire performance test as per BS 8434-2:2009 to provide for PH120 certification .Cables shall have IEC/BRE/BASEC/ KEMA/ ASTA approval. The cables shall be circular standard conductor having glass mica fire barrier tape covered by an extruded layer of cross linked halogen free EPR insulation and CSZH inner and outer sheath. They shall be of the soft skinned flexible type, unless armoured cables (galvanized steel wire) are indicated in the single line diagrams or BOQ.

2.3.6. FLEXIBLE / CONTROL CABLES :

a. All flexible cables used for pendant lighting fittings or for final connections to fixed or portable equipment shall be of 300/500 volts grade.
b. Flexible cables shall be of annealed copper conductor insulated with heat resisting FR and of circular construction.
c. Flexible cables shall comply with relevant standards and codes of practice mentioned in the specification.

2.3.7. GENERAL WIRING POINTS IN CONDUIT AND TRUNKING :

d. PVC insulated ,high conductivity multi stranded copper conductor FR wire shall be used.
e. The cable shall be of 600/1000 volts grade.
f. Single core cables shall not be used for MV (250V to 650V) distribution cabling .
g. The cables shall comply with all relevant regulations and codes of practice as mentioned elsewhere in this specification.
h. The cables shall be colored as per National Electrical Code (NEC).

2.3.8. IT- TELECOM SYSTEM :

1. Horizontal Cabling Description :

e. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in each apartment unit. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.

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2. Performance Requirements :

i. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1 when tested according to test procedures of this standard.

j. Electrical Components, Devices, and Accessories: Listed and labeled as defined in IS Code, by a qualified testing agency, and marked for intended location and application.

k. Grounding: Comply with J-STD-607-A.

3. UTP Cable :

Description: 100-ohm, four-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.

a. Comply with ICEA S-90-661 for mechanical properties.

b. Comply with TIA/EIA-568-B.1 for performance specifications.

c. Comply with TIA/EIA-568-B.2, Category 5e.

d. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70.

e. UTP cables should be terminated with standard connectors (plugs and jacks) or punch downs. Plug/jack should be RJ45.

2.3.9. TELPHONE CABLING SYSTEM :

CONDUCTORS AND CABLES

a. Conductors: Jacketed, multi-stranded twisted pair and twisted multipair, untinned solid copper. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG.

b. Insulation: Thermoplastic, not less than 0.8 mm thick.

c. Shielding: For speaker-microphone leads and elsewhere where recommended by manufacturer; No. 34 AWG, tinned, soft-copper strands formed into a braid or equivalent foil.

d. Minimum Shielding Coverage on Conductors: 60 percent.

2.3.10. TV CABLING SYSTEM :

1. Performance Requirement :

Minimum acceptable performance of distribution system at all user-interface points shall be as follows:

a. RF Video-Carrier Level: Between 3 and 12 dBmV.

b. Relative Video-Carrier Level: Within 3 dB to adjacent channel.

c. Carrier Level Stability, Short Term: Level shall not change more than 0.5 dB during a 60-minute period.

d. Carrier Level Stability, Long Term: Level shall not change more than 2 dB during a 24-hour period.

e. Channel Frequency Response: Across any 6-MHz channel in the 54- to 220-MHz frequency range, referenced to video; signal amplitude shall be plus or minus 1 dB, maximum.

f. Carrier-to-Noise Ratio: 45 dB or more.

g. RF Visual Signal-to-Noise Ratio: 43 dB or more.

h. Antenna Combiner Insertion Loss: 40 dB maximum.

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i. Signal Power Splitter and Isolation Tap Return Loss: 17 dB maximum.

j. Cable Connectors Attenuation: Less than 0.1 dB.

k. RF FM Carrier Level: 13 to 17 dB below video-carrier level.

l. FM Frequency Response: More than in the 88- to 108-MHz frequency range; signal amplitude is plus or minus 0.75 dB, maximum.

m. FM Carrier-to-Noise Ratio: More than 24 dB.

2. System requirement :

a. Components: Plug-in, modular, heavy-duty, industrial- or commercial-grade units.

b. Equipment: Silicon-based, solid-state, integrated circuit devices.

c. Power Supply Characteristics: Devices shall be within specified parameters for ac supply voltages within the range of 105 to 130 V.

d. Protect signal cables and connected components against transient-voltage surges by suppressors and absorbers designed specifically for that purpose. Comply with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

e. Provide ac-powered equipment with integral surge suppressors complying with UL 1449.

f. RF and Video Impedance Matching: Signal-handling components, including connecting cable, shall have end-to-end impedance-matched signal paths. Match and balance devices used at connections where it is impossible to avoid impedance mismatch or mismatch of balanced circuits to unbalanced circuits.

3. MATV Equipment :

a. Description: System shall receive, amplify, process, and distribute signals to outlets for receiving sets. Equipment shall provide a digital television feed per apartment, actual decoding of the signal within the apartments will be the responsibility of the tenants.

4. Cables :

a. TV antenna socket outlets are provided in each flats of building.

b. These outlets are connected to splitter units of individual floors as shown in TV schematic, by co-axial TV cable RG-6 grade, 0.7 mm solid copper conductor PE insulated, shielded with fine tinned copper braid and protected with PVC sheath in recessed PVC conduits.

c. RG 11 cables are used as a backbone connecting splitters of individual floors in vertical shaft.

5. Distribution Components :

a. Signal Power Splitters and Isolation Taps: Metal-enclosed directional couplers with brass connector parts. Where installed in signal circuits used to supply cable-powered amplifiers, power throughput capacity shall exceed load by at least 25 percent.

- Return Loss: 17 dB.
- RFI Shielding: 100 dB.
- Isolation: 25 dB.
- I/O Impedance: 75 ohms

b. Cable System Power Supplies: Plug-in, modular construction, with surge, short-circuit, and overload protection.

c. Signal Traps: Packaged filters tuned to interference frequencies encountered in Project.

d. Attenuators: Passive, of fixed value, and used to balance signal levels.

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e. Terminating Resistors: Enclosed units rated 0.5 W and matched for coaxial impedance.

f. Coordinate paragraph below with Drawings.

g. User-Interface Device: Flush, female-type outlets, designed to mimic power duplex outlet; for mounting in standard outlet box; with metallic parts of anodized brass, beryllium copper, or phosphor bronze. Cable connector mounting shall be semirecessed so its protrusion is flush with the plane of device plate. Feed-through-type cable connection shall not be used.

- Cable Connector: Female, Type F.
- Wall Plates: Match materials and finish of power outlets in same space.
- Attenuation: Less than 0.1 dB.
- Voltage Standing-Wave Ratio: Less than 1.15 to 1.

Table N.2 — Gross cross-sectional area of armour wires for two-, three-, four- and five-core 600/1 000 V cables having steel wire armour

Nominal cross-sectional area of conductor	Gross cross-sectional area of armour wires						
	Cables with stranded copper conductors				Cables with solid aluminium conductors		
	Two-core	Three- core	Four-core	Five-core	Two-core	Three- core	Four-core
mm²	mm²	mm²	mm²	mm²	mm²	mm²	mm²
1.5	15	16	17	19	—	—	—
2.5	17	19	20	22	—	—	—
4	19	20	22	25	—	—	—
6	22	23	36	40	—	—	—
10	26	39	42	46	—	—	—
16	42	45	50	72	39	41	46
25	42	62	70	88	38	58	66
35	60	68	78	100	54	64	72
50	68	78	90	144	60	72	82
70	80	90	131	166	70	84	122
95	113	128	147	—	100	119	135
120	125	141	206	—	—	131	191
150	138	201	230	—	—	181	211
185	191	220	255	—	—	206	235
240	215	250	289	—	—	230	265
300	235	269	319	—	—	250	289
400	265	304	452	—	—	—	—

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Table H.2 — Maximum resistance of conductor and armour for two-, three-, four- and five-core cables having steel wire armour

Nominal cross-sectional area of conductor	Maximum resistance per km of cable at 20 °C											
	Copper[a] conductor	Aluminium conductor	Steel wire armour									
			Cables with stranded copper conductors						Cables with solid aluminium conductors			
			Two-core	Three-core		Four-core	Five-core	Two-core	Three-core		Four-core	
			600/1 000 V	600/1 000 V	1 900/3 300 V	600/1 000 V	600/1 000 V	600/1 000 V	600/1 000 V	1 900/3 300 V	600/1 000 V	
mm²	Ω	Ω	Ω	Ω	Ω	Ω	Ω	Ω	Ω	Ω	Ω	
1.5	12.1	—	10.2	9.5	—	8.8	8.2	—	—	—	—	
2.5	7.41	—	8.8	8.2	—	7.7	6.8	—	—	—	—	
4	4.61	—	7.9	7.5	—	6.8	6.2	—	—	—	—	
6	3.08	—	7.0	6.7	—	4.3	3.9	—	—	—	—	
10	1.83	—	6.0	4.0	—	3.7	3.4	—	—	—	—	
16	1.15	1.91	3.7	3.5	1.9	3.1	2.2	4.0	3.8	2.0	3.4	
25	0.727	1.20	3.7	2.5	1.7	2.3	1.8	4.1	2.7	1.9	2.4	
35	0.524	0.868	2.6	2.3	1.8	2.0	1.6	2.9	2.5	1.9	2.2	
50	0.387	0.641	2.3	2.0	1.3	1.8	1.1	2.6	2.2	1.4	1.9	
70	0.268	0.443	2.0	1.8	1.2	1.2	0.94	2.3	1.9	1.3	1.3	
95	0.193	0.320	1.4	1.3	1.1	1.1	—	1.6	1.4	1.2	1.2	
120	0.153	0.253	1.3	1.2	0.76	0.76	—	—	1.2	0.82	0.82	
150	0.124	0.206	1.2	0.78	0.71	0.68	—	—	0.86	0.76	0.74	
185	0.099 1	0.164	0.82	0.71	0.65	0.61	—	—	0.76	0.71	0.67	
240	0.075 4	0.125	0.73	0.63	0.59	0.54	—	—	0.68	0.64	0.59	
300	0.060 1	0.100	0.67	0.58	0.55	0.49	—	—	0.63	0.59	0.54	
400	0.047 0	—	0.59	0.52	0.50	0.35	—	—	—	—	—	

[a] The values given are for plain annealed copper conductors. For tinned conductors reference should be made to A3 BS EN 60228 A3.

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2.3.11. INSPECTION & TESTING :

1. All tests shall be carried out in accordance with relevant Standard Code of Practice and Electricity Rules. The Contractor shall provide necessary instruments, equipment and labour for conducting the above tests and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the Employer's representative on Site, results will be noted and signed by all present and record be maintained.
2. Following Routine Tests shall be witnessed by the Employer's representative at the manufacturer's shop:
    a. Fire Resistance Test.
    b. Insulation Resistance Test.
    c. Continuity resistance test.
    d. Earth test.(in armoured cables)
3. The vendor/Manufacturer shall submit detailed Quality Assurance Plan (QAP), Inspection Test Plan (ITP) & test procedures for review/approval of client.
4. The Employers Representative has the right to have the tests carried out at his own cost by an independent agency whenever there is dispute regarding the quality of supply.
5. The results of all tests carried out shall be tabulated and signed jointly by manufacture and Employers Representative. In case the test results are not satisfactory and in accordance of contract specification and there are defects in the materials the same shall be attended and notified to Employers Representative. The equipment shall be dispatched to site of work only after receipt of acceptance of materials and clearance from Employers Representative.
6. Test shall also be conducted at site for insulation between phases and between phase and earth for each length of cable, before and after jointing.
7. On completion of cable laying work, the following tests shall be conducted in the presence of the Employer representative.
    a. Insulation Resistance Test(Sectional and overall)
    b. Continuity resistance test.
    c. Earth test.
    d. Visual inspection throughout the length.

2.3.12. SHIPPING, HANDLING & STORAGE :

1. Cables shall be drummed in maximum continuous lengths on:
2. Returnable steel drums for all LT Power & Control Cables of large cross sectional areas or long drum lengths.
3. Non-returnable wooden drums where the manufacturer can guarantee that such drums are of sufficient strength to protect cable during shipping, handling and outdoor storage for three year period.
4. Cable ends shall be sealed and fixed to the drum so that both ends are accessible. To protect the cable during shipment battens shall be fitted around the entire periphery of the drum. Drums shall be suitable for long-term outdoor storage at site. Each cable run shall be manufactured in one length where no through joints shall be allowed. Phase identification of cable conductors at the termination at each end of the feeder shall be provided by markers on the respective switchboard terminals. If through joints are to proposed then approval shall be obtained from the Employers Representative.
5. All cable drums shall have the Purchase Order Number, Purchase Order Item Number, Drum Number and Stock Code Number clearly stencilled on the outside of both flanges.

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6. Drum identification labels shall be of non-corrosive, non-hygroscopic material and attached to the outside and inside of the drum flanges. Labels shall be protected by transparent plastic envelopes and give the following information:
   a. Drum identification number and its direction of rotation for cable removal.
   b. Cable voltage grade
   c. Cable construction (e.g. FR SWA FR or AYFY)
   d. Number of cores and cross sectional area
   e. Cable quantity (Metres)
   f. Purchase order number and item number
   g. Total weight of cable and drum (kg)
   h. Manufacturer's name
   i. Year of manufacture
   j. Stock code number
7. The Contractor shall provide the following data with his quotation:
   k. Standard and maximum drum lengths for all the types of cable offered and his proposed drum lengths for all items.
   l. Inspection test plan.
   m. Cable dimensions (together with tolerances) as follows:
      - Diameter of (individual in case of multi stranded) conductor wire
      - Percentage of compaction as per data sheet.
      - Diameter under conductor screen (where applicable)
      - Diameter over conductor screen (where applicable)
      - Diameter over individual core insulators
      - Lay of cable in case of multi-core cable
      - Diameter over inner sheath (mm)
      - Diameter over centre sheath (mm)
      - Diameter over lead sheath (mm) where applicable
      - Diameter under armour (mm)
      - Diameter over armour (mm)
      - Diameter of armour wires (mm)
      - Overall diameter (mm)
   n. Cable Physical Properties
      - The filler materials to be used.
      - Cable weight in kg/km
      - Minimum bending radius (x OD)
      - Maximum conductor continuous operating temperature
      - FR/FS cabling certification
      - Suitability of outer sheath to resist attack from chemicals.
   o. Cable electrical data as follows:

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- Conductor dc resistance per km at ambient temperature 40°C
- Conductor ac resistance per km at operating temperature and system frequency
- Conductor inductive reactance per km at system frequency
- Conductor impedance per km at operating temperature and system frequency
- Conductor capacitance per km
- Cable armour resistance per km

8. The current carrying capacity of single and multi-core cables when installed in defined conditions in air, in ducts and direct buried in the soil, together with rating factors for varying ambient temperatures, grouping and installation conditions and methods.
9. Cable short circuit withstand capacity to include derating factors for temperature, grouping and burying in the ground as per manufacturer recommendation shall be presented in graphical form or by formulae approved by the Employers Representative.
10. Descriptive literature (catalogues etc.).
11. Cross sectional view of the physical make up of each cable.
12. Recommended temperatures below which installation of cable should not be carried out.
13. Minimum ambient temperature at which cables can be used.
14. Maximum pulling force for each cable and any special pulling instructions.
15. Maximum unsupported run of cable both horizontally and vertically.

2.3.13. SPLICE KITS :

1. Connectors and Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.
2. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions. Splicing and terminations shall be by an experienced person and duly approved by the Employers Representative.

2.3.14. CABLE TERMINATIONS :

1. Multi-conductor Cable Sheath Seals: Type recommended by seal manufacturer for type of cable and installation conditions, including orientation.
2. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations, allow also for glanding and bimetallic termination lugs.
3. Cable terminating facilities and terminals shall be suitable for the specified cable type and conductor size. Consideration and provision shall be taken by the CONTRACTOR on the equipment design for the use of cables with aluminium / copper conductors as mentioned on One Line Diagram / Switchgear schedule.
4. Terminal blocks shall be arranged and positioned to afford ready access for carrying out external cable termination, testing, inspection and maintenance. There shall be ample clear space allowed between the terminals and the gland-plate for the spreading and termination of external conductors.
5. Terminal blocks shall be mounted in a single deck arrangement. Terminal blocks for the connection of external control wiring shall be of the clamp type with a facility to connect two wires on each side of the terminal. A minimum of 20% spare terminals shall be provided.
6. All external wiring shall be on one side of the terminal block only.

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7. All terminal blocks shall be shrouded or provided with transparent covers. Pinch screw type terminals are not acceptable.
8. Terminals for different voltages shall be separated by partitions.
9. Terminal boxes (where specified) shall be suitable for dry type terminations unless otherwise specified.
10. A terminal box or chamber with undrilled gland plate or entry panel of sufficient dimensions to terminate the specified cables shall be provided. Direction of cable entry shall be as stated on the one-line diagram(s).
11. Positioning of cable terminations shall avoid obstruction of other cable terminations, removable covers, etc. and provide for easy access for terminating cables.
12. There shall be sufficient clear space allowed between the terminal block and the cable entry for the spreading and termination of external conductors. Should this not be possible using the standard design in relation to specified cable size then the Contractor shall incorporate an extended cable glanding box within its design.
13. Termination of single core cables shall be through a non-magnetic gland plate and provision made for bonding and earthing any armour and/or concentric ground conductors.
14. Adequate support arrangement shall be provided for each cable to avoid undue strain on the cable terminations.
15. Wherever required extra supports, it shall be provided by subcontractor to reduce the extra weight/ stress on the gland plate.
16. Double compression gland to be used.

2.3.15. SEPARABLE INSULATED CONNECTORS :

1. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.
2. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.
3. Contractor to provide a comprehensive Method Statement detailing Site Acceptance Test Procedures.The test should be accounted for insulation test, functional test, continuity test, sectionally injection test, relay test, visual inspection, functional testing, Hi-Pot test, torque testing.

2.4. POINT WIRING DEVICES & ACCESSORIES :

2.4.1. SCOPE :

The specifications given below relates to the supplying, installing, testing and commissioning of point wiring in schedule of quantities at Site.

2.4.2. CODES & STANDARDS :

IS : 3854, IS : 1293 and IS : 4615.	Switches
IS : 1293.	Sockets

2.4.3. DESIGN PARAMETERS :

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Wiring shall be carried out as per following design parameters in ø20mm HMS PVC concealed / ø20mm HMS GI surface conduit / Trunking system as indicated in the Lodha Policy.

1. Only looping system of wiring shall be adopted throughout. No joints shall be permitted except at wiring terminals.
2. All accessories shall be flush type unless otherwise specified.
3. Light shall be wired on a common final sub-circuit. Each sub circuit shall not have more than total 10 nos. lights and fans or load of 800 watts whichever is less unless otherwise specified.
4. Wiring with stranded copper conductor FR insulated 660/1100 volt grade wires including terminations, etc. complete as required.

2.4.4. LODHA POLICY OF POINT WIRING :

Point wiring specified in BOQ shall be read in conjunction with this scheme for type & wire size unless otherwise wire size as specified in BOQ.

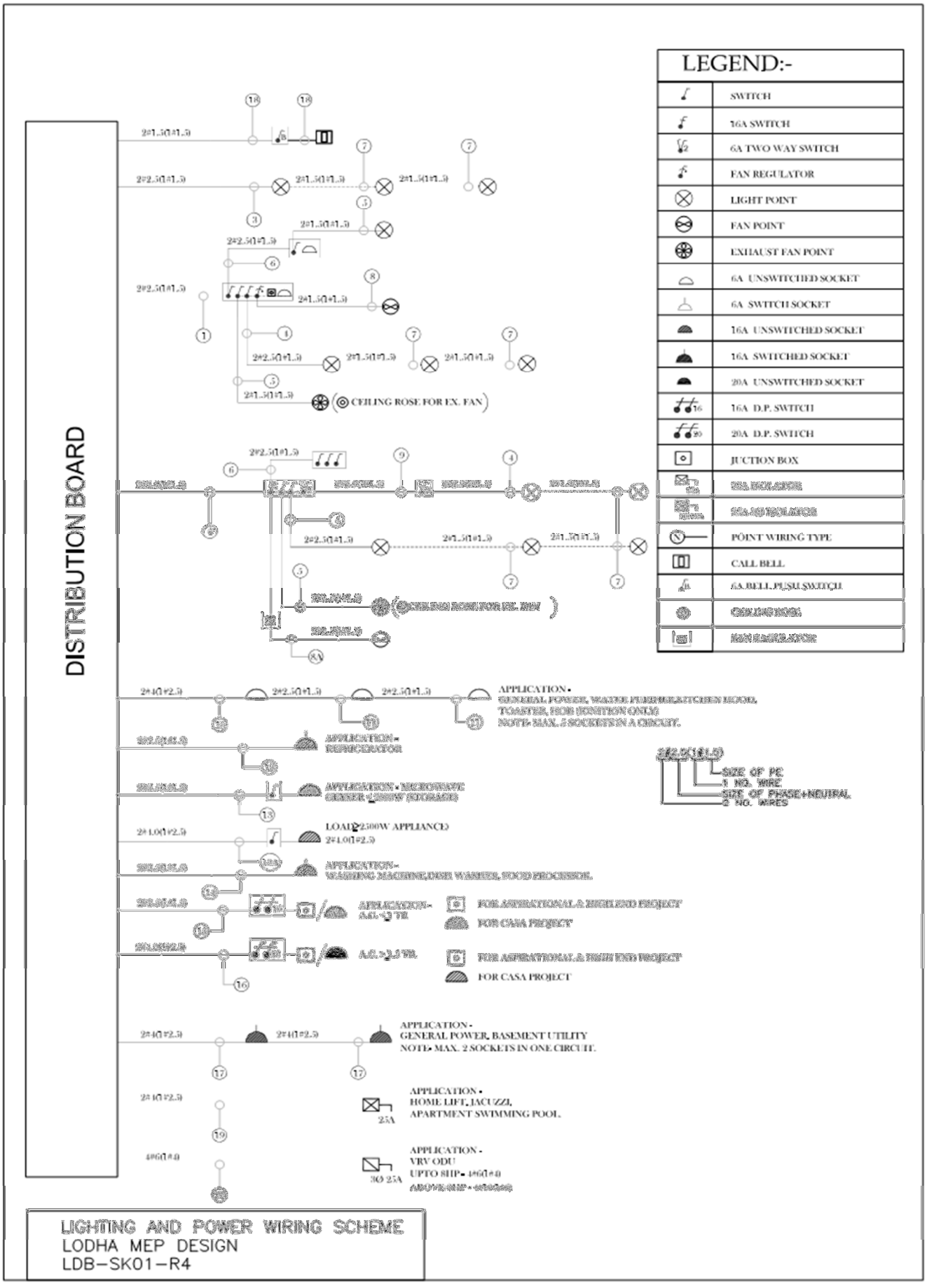
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Type	Conductors	For	Application
Wiring Type 1	2#2.5 (1#1.5)	From DB to first lighting and power switchboard	Lighting, fans and small power
Wiring Type 2	2#2.5 (1#1.5)	From DB to first lighting switchboard	Control Distribution along with switch
Wiring Type 3	2#2.5 (1#1.5)	From DB to first light point (no switch in between)	DB controlled lighting
Wiring Type 4	2#2.5 (1#1.5)	From Switch board to first light point	Lighting
Wiring Type 5	2#1.5 (1#1.5)	From switchboard to single light point	Lighting, exhaust fan
Wiring Type 6	2#2.5 (1#1.5)	From Switchboard to Switchboard	Lighting, fans and small power
Wiring Type 7	2#1.5 (1#1.5)	From light point to light point	Looped lighting
Wiring Type 8	2#1.5 (1#1.5)	Switch & regulator on one switchboard	Ceiling fan
Wiring Type 8A	2#1.5 (1#1.5)	Switch & regulator on seprate location	Ceiling fan
Wiring Type 9	2#2.5 (1#1.5)	From one two way switch to another two way switch	2 way controlled lighting
Wiring Type 10	2#4 (1#2.5)	From DB to first socket (6A) in a circuit with multiple looped sockets	General Purpose, Hood, Hob, Water Purifier, Toaster etc.
Wiring Type 11	2#2.5 (1#1.5)	From Socket to socket (6A) in a circuit with multiple looped sockets	Same as wiring type 9
Wiring Type 12	2#2.5 (1#1.5)	From DB to a socket (16A), with no subsequent looping (switch and socket in the same back box)	Refrigerator 750/1000W
Wiring Type 13	2#2.5 (1#1.5)	From DB to a socket (16A), with no subsequent looping (switch and socket in separate back boxes)	Microwave Oven 1000W, Geyser Storage 2000W
Wiring Type 13A	2#4.0 (1#2.5)	From DB to a socket (20A), with no subsequent looping (switch and socket in separate back boxes)	LOAD ≥ 2500W APPLIANCE
Wiring Type 14	2#2.5 (1#1.5)	From DB to socket (16A), with no subsequent looping (switch and socket in the same back box)	Washing Machine 1000W, Dishwasher 1200W, Food Processor 1000W
Wiring Type 15	2#2.5 (1#1.5)	From DB to AC point, with 16A DP/SP Switch	AC 1TR 1400W
Wiring Type 16	2#4 (1#2.5)	From DB to AC point, with 20A DP/SP Switch	AC 1.TR, 2TR 1600/3000W
Wiring Type 17	2#4 (1#2.5)	Wiring for socket (16A) in a circuit with 2 looped sockets	Basements Utility
Wiring Type 18	2#1.5 (1#1.5)	From DB/SB to push button (6A), push button to call bell	Bell/Buzzers
Wiring Type 19	2#4 (1#2.5)	From DB to isolator, 25A	Apartment swimming pool, Jacuzzi, Home lift,
Wiring Type 20	4#6 (1#4) / 4#10(1#6)	From DB to isolator, 3-Ph, 25A	Similar high power loads

Notes:

1. More than 5 nos 6A sockets shall not be looped in a circuit
2. More than 2 nos 16A sockets shall not be looped in a circuit
3. Care should be taken to preferrably restrict a circuit within a room or a group of the room and its associated ancilliaries (store, bathroom, walk in wardrobe, deck/balcony etc.)
4. DP switches are required in all such situations where the wires are directly terminating in the unit (without a plug/socket point)

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2.4.5. LIGHT POINT :

1. The various types of Light fixtures, ballast, dimmer with associated standard accessories such as down rope, screws, etc; which come with light fixtures shall be supplied by Client.
2. All other accessories like Ceiling rose, down rod, junction boxes etc including flexible wires (300mm , from Ceiling rose to light fixture) and required to complete installation shall be in the scope of Electrical contractor.
3. Surface mounted light fitting shall terminate at junction box having entries appropriate to the run of conduit. This shall be complete with porcelain / PVC connector suitable for the size and number of connections and wiring points to be connected with the specified fitting. Wiring to the light fittings within the false ceiling space shall be by means of 3 core flexible cables i.e. between the junction box and the lamp holder/terminal blocks, in flexible conduits.
4. At every light fitting an approved type earth terminal shall be provided for connection of the circuit protective conductor of the final circuit.
5. Ferrous metal work shall be of minimum of 1mm thickness and treated against corrosion by galvanizing after welding or lead primer or other approved process. Metal work shall be painted with one priming coat, one under-coat and two final coats with stove-enamelled matt white paint unless otherwise specified.
6. Cables used for internal wiring of the lighting fittings shall be with appropriate type and size, number with conductor of size not less than 1.5 sq mm single core. The insulation of the cables shall withstand the maximum temperature throughout the life of the fitting It will be subject to normal use without deterioration which could affect the safety of the fitting.
7. Cables within the lighting fittings shall be neatly bundled by nylon self-locking cable ties. Wiring shall be properly routed and secured away from control gear etc. wherever possible.
8. All cable terminations within the light fittings shall be suitably shrouded.
9. All light fittings shall be supported with appropriate fixing accessories such as clips, anchor fasteners, supporting brackets, suspension sets, nuts, washers, screws etc. for their proper installation on different types of ceiling panels. Suspension sets shall be of adjustable type suitable to carry the weight of the lighting fittings unless otherwise stated or indicated on drawings. The suspension sets shall be generally of 900 mm length. Exact lengths required shall be provided to suit the site requirement.
10. All lamps in operational condition with proper control gear shall be provided together with the light fittings as required and specified.

2.4.6. 6A SWITCHES :

1. Light switches unless otherwise specified, shall be single pole, quick make and break, silent action type with solid silver alloy contacts and totally enclosed for flush or surface mounting as required.
2. Light switches shall be suitable for the environment in which they shall be installed. Manufactured galvanized steel boxes completed with conduit knockouts shall be in single or multi-gang units using a grid switch system of interchangeable components at standard fixing centres. Switches of different types and ratings shall be the same dimensions to include push buttons, neon indicator lamps, blanking units, grids, steel boxes and plates all capable of integration into standard composite assemblies in any combination as required.
3. Grids shall be adjustable for a variation in depth of plaster, for squaring errors and the same type for surface or flush mounting.
4. Switches in mechanical plant rooms, electrical sub-stations and switch rooms shall be IP 44 rated polycarbonate body in flush or surface conduit boxes.
5. Switches on brick or concrete walls shall be mounted in a horizontal arrangement in plaster depth steel boxes or in galvanized steel boxes using box suspension straps and cover plates. Countersunk screws shall be provided for fixing to the conduit boxes.

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6. Switches for external use shall be a weatherproof construction with an IP65 rating.
7. Samples of isolators, switches, conduit boxes and plaster depth boxes shall be provided for approval prior to installation.
8. Switches shall be rated for 6 Amps (minimum light switch rating 6A, 16 Amps or 20 Amps. Inductive lighting circuits shall be at twice the steady state connected load current. One, two ways switches shall be fixed at a height of 1200 mm to the bottom of box from finished floor level. Light switches shall be located in the room on the handle side of the door.
9. Switches served by UPS shall be provided with a blue cover plate and shall be provided with red text labels.
10. Earth continuity terminals shall be provided and connected to the circuit protective conductor at the light switch position.
11. Single pole switches shall be connected to separate the phase wire of the supply. The neutral wire shall not be routed through switch boxes.
12. Switches which are mounted in the same location shall be multi-gang type, of the maximum number of gangs available.
13. All switches used shall be of approved by the local Authorities.
14. Circuit for mains and life safety shall have a separate switch cover plate.

2.4.7. 6 AMP SWITCH SOCKET OUTLETS :

1. Switch socket outlets shall be BS1363 single pole 6 Amp 3 round pin shuttered outlets, one or two gang for indoor service except otherwise specified and suitable for surface or flush mounting according to location.
2. Switches shall be quick-make and break type silent action totally enclosed with solid silver alloy contacts. Switched socket outlets for indoor use shall be housed in suitable galvanized steel boxes as per BS 4662 with conduit knockouts. Types and finishes of socket plates shall match those for the Light switches.
3. Generally switch socket outlets shall be positioned 450 mm above floor level except in plant rooms, kitchen, etc. where they shall be positioned 1400 mm above floor level or 150 mm above counters or benches as per requirement.
4. Switch socket outlet in all mechanical plant rooms, electrical switch rooms shall be IP44 rated polycarbonate, with recessed or protected switch dolly, mounted in flush or surface conduit boxes as specified.
5. All switch socket outlets used shall be approved prior to installation.

2.4.8. 16 AMP SWITCH SOCKET OUTLETS :

1. 16 Amp switch socket outlets shall be 3 pin round type to BS 546 shuttered, of finished similar to 6 Amp switch socket outlets and flush mounted in galvanised steel conduit boxes to BS 4662 requirements.
2. 16 Amps / 6 Amps combination switch shall be round type to BS 546 shuttered switch socket outlets and flush mounted in galvanised steel conduit boxes to BS 4662 requirements.

2.4.9. TELEPHONE OUTLETS :

1. Telephone outlets shall be single or twin flush mounted type suitable to receive a plug-in telephone cable lead in accordance with the Telecom service provider's requirements. The finish of the telephone outlet plates shall match the Light switch finish. Outlets shall be a combined RJ11 outlet.
2. Data outlets shall be single or twin flush mounted type suitable to receive a plug-in data cable lead in accordance with the service provider's requirements. The finish of the data outlet plates shall match the Light switch finish. Outlets shall be a combined RJ45 outlet.

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2.4.10. BELL PUSH SWITCHES :

Bell push switches shall be flush-mounted having single-pole AC switch of 6 amps rating and marked with bell symbol.

2.4.11. WEATHERPROOF ISOLATORS, SWITCHES & SOCKETS :

1. Weatherproof enclosure shall be of the high impact, water resistant to IP65. The isolator provided shall complete with lockable device. Isolators shall be double-pole, 4-pole as specified.
2. The IP55 socket outlet arrangement is suitable for surface or flush mountings.
3. The IP55 outlet should have uncut pierceable membrane at the top & seal at the bottom for easy cable terminations.
4. The IP55 modular boxes shall be equipped with an Nylbloc automatic connector.
5. The IP55 socket modular box shall have visible with transparent lid & accessible fixing points.
6. The IP55 socket modular box shall have locking facility & should allow operation of switches without opening cover.
7. The IP55 socket modular box shall be made up from ABS plastic.
8. The IP66 socket modular box shall be suitable for surface mounting.
9. The IP66 socket modular box shall be supplied with ISO make membrane glans and the caps for rear cabling works.

2.4.12. TIME SWITCHES :

1. Time switches shall be self-contained unit suitable for mains operation. All units shall have self-starting synchronous motor with single-pole fuse in the motor circuit, 3-way terminal block and thirty-six (36) hours spring reserve complete with an automatic solar dial/ solid state switch with timing control. Rating shall be selected 10% excess of the circuit it is feeding.
2. The solar dial shall be capable of switching ON The lighting at sunset and OFF at sunrise throughout the year by control of a secondary calendar dial with month and day settings. The automatic switching time shall be adjustable.
3. Time switches shall be encased in dust-tight metal casing having hinged front cover with clear Perspex window. The casing shall be effectively earthed.
4. A manual bypass switch shall be incorporated with the time switch to facilitate maintenance of the latter.

2.4.13. LIGHTING DIMMER SWITCH :

1. Lighting dimmer switch shall be solid state, variable load and thyristor controlled type suitable for controlling fluorescent or incandescent/ LED lighting circuits operating at 230V ± 6%, 50Hz single phase AC supply.
2. Dimmer switch shall be manufactured to eliminate TV and radio frequency interference in compliance with IS.
3. The ratings of the dimmer units shall be suitable for lighting circuit specified on Drawing.
4. All dimmers shall comply to EMC requirements as per IEC 61000-5

2.4.14. SPUR UNITS :

1. Spur units are to be of the 6A, 230V, 50Hz AC rating shall be without combination of switch/fuse/light.

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2. All wall mounted spur units, with the exception of those to be installed in plant rooms and concealed spaces shall be of the flush type with front plates either all insulated or metal as detailed elsewhere in this specification. Spur units are to be mounted on flush metal boxes. Where surface spur units are to be used, they shall be mounted on either metal or plastic purpose-made mounting boxes to be of the same material as that of the front plates.
3. In plant rooms, spur points shall be of the surface mounted type and shall be metal clad.
4. Where metal cover plates are specified as a metal type the cover plate shall be fabricated from solid metal. All accessories shall be fitted to adjustable grids over lapping standard boxes.

2.4.15. CEILING ROSES :

Ceiling roses shall be of the plug-in type and shall incorporate strain hooks. They shall be suitable for loads up to 5 kg. Current rating for contacts shall maximum 6A.

2.4.16. EMERGENCY START/ STOP PUSH BUTTON :

1. Shall be provided with 2No positive action N/C contacts.
2. Shall be provide with 1 No N/O contacts
3. Housing material shall be Plastic
4. Enclosure rating shall be IP 65
5. Connection type (contacts) shall be Screw connection
6. Mounting diameter shall be a minimum of 22 mm
7. Mechanical life shall be a minimum of 50.000 switching cycles
8. Ambient operating temperature shall be from–40 °C to +70 °C
9. Protection class II
10. Usage category shall comply with IEC 947-5-1 AC-15/DC-13
11. Rated insulation voltage Ui 600 V
12. Minimum switching voltage 5 V DC
13. Minimum switching current 1 mA
14. Connection type (contacts) Screw connection
15. Maximum connection cable cross-section 2.5 mm²
16. LED indicator lamps shall be provided
17. Emergency Start / Stop button to be coloured ‘RED’
18. Emergency push buttons to be provide to the following mechanical equipment (under the relevant services contractors scope
    a. Pumps
    b. AHUs
    c. Fans

2.5. CABLE TRAYS, TRUNKINGS & CONDUITS :

2.5.1. SCOPE :

The specifications are given below to enable the design, manufacture, testing & supplying of cable trays perforated /Cable ladder complete in all repsect as reflected in layout & appearing in schedule of quantities.

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2.5.2. CODES & STANDARDS :

Code for Cable Trays :	
IS-1079, IS- 2629, IS-2633	Cable Tray & Cable Ladder
Code for Trunkings	
IS 14927, IEC 1084.	Cable Trunking
Code for Conduits & Accessories	
IS:9537 (Part-II)/ CEE 23 & IEC 60695-2-1:1991	Steel Conduit and Fitting Accessories PVC Conduit and Fitting Accessories

2.5.3. MATERIAL & FINISHES :

1. **Cable Trays:** Cable trays and accessories shall be manufactured to comply with the specifications of Indian Standards. Cable trays and accessories shall be fabricated using mild steel sheets and hot dip galvanized in accordance with respective codes as specified in section 1.4 after fabrication. All bolts, nuts and washers shall also be hot dip galvanized. The zinc coating shall be uniform, smooth and free from imperfections such as flux & ash, black spots, blisters etc. Cable trays and accessories shall undergo a process of degreasing, pickling in acid & cold rinsing prior to galvanization.
2. For all cable trays ≥ 600mm web height should be 75mm and all containment <600mm web height should be 50mm.
    a. For all cable trays upto and Including 300mm , Thickness of Material to be 1.6mm and Trays above 300mm Thickness of material to be 2mm.
    b. The zinc coating thickness for cable trays shall be minimum 65 microns
    c. Cable trays shall be of the following type:
        - Ladder type with rungs
        - Perforated type.
3. **Perforated cable trays** shall be generally of channel type and the perforations shall be 10x30 mm oval holes. Perforated cable trays shall also be hot dip galvanized. Galvanizing shall be in accordance with that specified above for ladder type cable tray.
4. **Ladder type cable trays** shall be made from 2mm thick sheet formed in `C' section of 75mm height and inward flanges of 15mm as side runners and 30mm wide x 10mm high rungs (`C' shaped) from a 1.5mm thick sheet. Perforations as mentioned above shall be provided in the width of the rungs. Pitch of the rungs shall not exceed 250 mm centre to centre. Rungs shall be tack welded to the side members. Perforated trays shall be of the formed channel shape.
5. Cable trays shall be of following dimensions:
    a. Section Length 2500 mm
    b. Width – as specified in BOQ & Drawings

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c. Flange of perforated tray 25 mm

6. Following accessories and hardware, as required, shall be supplied with cable trays :
   a. Coupler plates
   b. Horizontal and Vertical
   c. Tees
   d. Reducers
   e. 4-way cross
   f. Fasteners (Hardware)
   g. Earth Links.
7. **Trunking:** Unless noted otherwise, trunking and accessories shall be manufactured to comply with the specifications of Indian Standards. Trunking shall be hot dip galvanized. Cable/Wire trunking is proposed to be installed concealed under the floor finish or hung from ceiling. The zinc coating thickness for cable trunking shall be minimum 46 microns. Trunking shall be complete with partition plates and covers. Trunking of each size shall be supplied with following accessories:
   a. 4 way junction boxes with removable covers
   b. Vertical access boxes/ adaptor for conduits.
   c. Couplers
   d. End caps
   e. Earth straps.
8. Any other accessories, if required, for satisfactory installation shall also be included as part of supply.
9. Trunking shall be supplied in standard lengths of 2.5 metres.
   a. For all containment ≥ 600mm web height should be 75mm and all containment <600mm web height should be 50mm.
   b. For all containment upto and Including 300mm , Thickness of Material to be 1.6mm and for above 300mm, Thickness of material to be 2mm.
10. Cable tray Size, cable Load & Cable tray Support Details

Cable Tray	Cable tray Size	Cable Load with 1D Spacing	Support Distance	Anchor required
Perforated	100 to 300mm	30 kg /Mtr.	1.5 Mtrs	HKD M 8x40
Perforated	450 to 600mm	60 kg /Mtr.	1.5 Mtrs	HKD M 8x40
Ladder	600 to 900mm	10 kg /Mtr.	1.0 Mtrs	HKD M 8x40
Ladder	900 to 1200mm	130 kg /Mtr.	1.0 Mtrs	HKD M 8x40

2.5.4. GI CONDUIT AND ACCESSORIES :

1. GI CONDUIT :

a. All exposed conduits shall be of Hot dip galvanized conforming to IS-2629, heavy gauge solid drawn or Electric Resistance Welded(ERW) welded manufactured out of 1.4- 1.8 gauge GI up to 32mm dia and 1.8-2.2mm gauge GI for sizes above 32mm.

b. The weight of zinc deposited for hot dip galvanizing shall be in accordance with that stated in Standard IS-2629 and shall ,not less than 0.61kg/m2 with a minimum thickness of 89 microns for items of thickness more than 5mm 0.46kg/mz (64 microns) for items of

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thickness between 2mm and 5mm and 0.33kgW (47 microns) for items less than 2mm thick.

c. Construction shall be in line with the relevant provisions of Indian Codes

d. Both inner and outer surfaces shall be smooth without burrs, dents and kinks.

e. The cross section of conduit shall be uniform throughout.

f. The welding shall be uniform such that welded joints do not yield when subjected to flattening test. Welded joint shall not break when threaded or bent at an angle.

g. Conduit shall conform to specification of IS: 9537 (Part ll) and the capacity of conduits shall be in accordance with the standards.

h. The minimum size of the conduit shall be 20mm diameter. The diameter of conduit refers only Internal diameter of the conduit cross section.

i. Care shall be taken to ensure that all conduits are adequately protected while stored at site prior to erection and no damaged conduit is used.

j. Coating of Galvanized paint shall be applied to' all the welded and cut conduit joints/parts etc.

2. FITTING :

a. Samples of conduit fittings shall be submitted for approval prior to use on work.

b. Fittings shall be those intended for use with screwed conduits and shall comply with IS 9537. However, bends, elbows and tees shall not be installed.

c. Boxes and cover plates installed outdoors shall have fixing lugs exterior to the box so that fixing screws do not enter the box interior.

d. Adaptors used with flexible conduits shall conform to IS: 9537.

3. CIRCULAR BOXES :

Circular boxes shall be of malleable cast iron, galvanized and of standard pattern with spout(s). When used for connecting lengths of conduits, circular boxes shall be provided with cover plates of similar make that are complete with brass fixing screws.

4. RECTANGULAR BOXES :

Rectangular boxes (adaptable boxes) shall be of mild steel not less than 2.4 mm gauge and galvanized. When used as junction boxes, lids of the same gauge with brass fixing screws shall be used and Brass earth terminal to be provided for the box.

5. BOXES FOR ACCESSORIES :

Boxes for accessories shall be suitable for surface mounting or recessed mounting according to the requirements. Surface mounted boxes and accessories shall be metal clad pattern. Recessed boxes and accessories shall be complete with insulated molded type cover plates conforming to IS: 5133 Part I-1969.

6. COVERS :

All covers for boxes, etc shall be made of galvanized steel of 1.2mm thickness.

2.5.5. PVC CONDUIT AND ACCESSORIES :

1. PVC CONDUIT :

a. All conduits shall be high impact rigid 2mm thickness PVC heavy duty type and shall comply with regulations for non-metallic conduit as per IS-9537/1983 (Part-III).

b. Conduits shall be HMS as noted in the BOQ and shall comply to relevant Indian Codes.

c. All sections of conduit and relevant boxes shall be properly cleaned and glued by using epoxy resin glue and the proper connecting pieces.

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d. Inspection type conduit fittings such as inspection boxes, drawn boxes, fan boxes and outlet boxes shall be of PVC or otherwise mentioned.

i. Conduit shall be terminated with adopter/PVC glands as required.

2. PVC CONDUIT ACCESSORIES :

a. Accessories used for conduit wiring shall be of an approved type conforming to respective codes as specified in section 1.4.

b. All accessories used shall be of standard white or black or half white color, identical to conduit used.

c. Plain conduits should be jointed by slip type of couplers with manufacturer's standard sealing cement.

d. All conduit entries to outlet boxes, trunking and switchgear are to be made with adaptors female thread and male bushes screwed.

e. PVC-switch and socket boxes with round knockouts are to be used. The colors of these boxes and the conduits shall be the same.

f. Standard PVC circular junction boxes are to be used with conduits for intersection, Tee-junction, angle-junction and terminal. For the drawing-in of cables, standard circular through boxes shall be used.

g. Samples of accessories shall be submitted for approval prior to installation.

h. All jointing of PVC conduits shall be by means of nontoxic adhesive jointing. Adequate expansion joints shall be allowed to take up the expansion of PVC conduits.

2.6. EARTHING SYSTEM :

2.6.1. SCOPE :

The specifications given below relates to the design, manufacture, testing and supplying of number of earth pits, number of cables / strips / wires, connectivity with rebar for bonding in schedule of quantities at Site.

All the non-current carrying metal parts of the electrical installation and mechanical equipments shall be earthed properly. The cables armour and sheath, electric panel boards, lighting fixtures, ceiling and exhaust fan and all other parts made of metal shall be bonded together and connected by means of specified earthing system. An earth continuity conductor shall be installed with all the feeders and circuits and shall be connected from the earth bar of the panel boards to the conduit system, earth stud of the switch box, lighting fixture, earth pin of the socket outlets and to any metallic wall plates used. All the enclosures of motors shall be also connected to the earthing system.

2.6.2. CODES & STANDARD :

IS 3034	**Earthing Code of Practice**

2.6.3. PIPE IN PIPE EARTH PIT – CHEMICAL EARTH PIT :

1. PIPE EARTH ELECTRODE :

a. G.I. pipe shall be of medium class as specified in BOQ/Drawing.

b. G.I. Pipe electrode shall be cut tapered at bottom and provided with holes of 12mm dia drilled not less than 7.5cm from each other up to 3m of length from bottom.

c. The electrode shall be buried in the ground vertically with its top being 20cm minimum below ground level.

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d. Clamping of the earth leads to the earth rod shall be made by earth clamp. The clamps shall be capable of providing high pressure contact between the earth rod and the earth leads to achieve low contact resistance.

e. When two or more electrodes are driven to form a group, the heads of the electrodes in the group shall be bonded to each other by means of a GI strip, laid at a depth of at least 600 mm in soil.

f. Recommended water seal insert sleeve approved by Engineer-in-charge shall be provided with all earth electrode penetrations through basement water proofing membranes and the installation is done under strict supervision.

g. Where ASHLOK type Chemical Earthing system is specified this shall be to pipe in pipe technology type to provide for a low impedance path to earth.

2. BONDING SYSTEM:

a. Earth lead shall be Galvanized steel as specified with sizes shown on drawings. Galvanized steel buried in the ground shall be protected with bitumen and hessian wrap or polythene faced hessian and bitumen coating. At road crossing necessary hume pipes shall be laid. Earth lead run on surface of wall or ceiling shall be fixed on saddles so that strip is at least 8 mm away from the wall surface.

b. The complete earthing system shall be mechanically and electrically bonded to provide an independent return path to the earth source.

c. Wherever crossing is required, earthing jumper shall be of insulated wires.

d. Equipotential bars within substation area where the neutral earthing shall be connected to equipment from earth pit.

3. CIRCUIT PROTECTIVE CONDUCTOR :

a. Circuit protective conductor (CPC) is a system of conductors joining together all exposed conductive parts and connecting them to the main earth terminal.

b. The purpose of circuit protective conductor is to provide a path for earth fault circuit so that the protective device will operate to remove dangerous potential differences during a fault condition.

c. The circuit protective conductors shall take the form of separate cable with a sheath in green/yellow colour or G.I tape with sleeves as specified in the drawing. For all cables the CPC shall be FR insulated.

d. All exposed non-current carrying metal parts of light fittings, switchgears, motors, enclosures, etc. shall be effectively earthed by circuit protective conductors for earth continuity protection.

e. For equipment where an earth terminal is provided, the earth continuity wire shall be firmly clamped. Where no earth terminal is provided, the exposed metal part shall be cleaned of paint and surface rust before welding the earth continuity lead.

f. The minimum size of the principal protective conductors shall be in accordance with to the current edition of IS: 3043.

g. The external earth terminal on the outside of the end panel of any switchboard shall be connected to the main earth bar provided in two independent points.

h. Circuit protective conductors shall be provided in electrical and mechanical rooms and along the routes for the bonding of all exposed conductive parts and extraneous conductive parts. A suitably sized earth terminal shall be provided at each zone of the building for this purpose.

i. All exposed conductive parts shall be effectively connected in an approved manner to the principal protective conductors. The circuit protective conductors shall be single core /AL cables or high conductivity Hot dipped GI tapes specified.

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j. Metallic conduit shall not be accepted as an earth continuity conductor. A separate insulated continuity conductor of size 100% of the phase conductor subject to the minimum shall be provided.

k. The earth continuity conductor be drawn inside the conduit shall be insulated.

l. Non-metallic conduit shall have an insulated earth continuity conductor of the same size for metallic conduit. All metal junction and switch boxes shall have an inside earth stud to which the earth conductor shall be connected. The earth conductor shall be distinctly coloured (Green or Green / Yellow) for easy identification.

m. Armoured cable shall be earthed by two distinct earth connections to the armouring at both the ends and the size of connection being as for the metallic conduit.

n. In the case of unarmoured cable, an earth continuity conductor shall either be run outside along with the cable or shall form a separate insulated core of the cable.

o. Three phase power panel and distribution boards shall have two distinct earth connections of the size correlated to the incoming cable size.

2.7. LIGHTNING PROTECTION SYSTEM :

2.7.1. SCOPE :

The specifications given below relates to the testing and supplying of connectivity with rebar & Facade for bonding, lighting surge protective devices of Lighting Protection system in schedule of quantities at Site:

2.7.2. CODES & STANDARDS :

NFC-17 102	Standard of Lightning Protection
IS 2309	Lightning Protection System – Latest Edition
IEC 61024-1-2	Lightning Protection System – Latest Edition
BS EN 62305 (1 to 4)	Lightning Protection System – Latest Edition
EN 50164	Accessories for Lightning Protection Systems

2.7.3. GENERAL :

The lightning protection system designed for this tower-1, shall comprise of connectivity & continuity of Earth through Structural Earth Piles, Structural Column rebars, Façade metal members through Stainless steel lugs, BMU unit & GI mesh on Roof level, Lightning surge protection for power lines/ elv lines etc. as shown in standards details & layouts.

The system shall comprises of following elements:

1. Air Termination
2. Roof steelwork and other equipments.
3. Down conductors
4. Earth Pits
5. Bi metallic test clamps

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6. Electronic Surge Suppression Devices.
7. External Metal structure
8. All architectural metallic extensions from building façade

2.7.4. AIR TERMINATIONS :

Air terminations shall consist of horizontal conductors in the form of networks as per respective codes as specified above.

2.7.5. DOWN CONDUCTORS :

1. The respective codes covers the use of down conductors of various types including the use of strips, rod, reinforcing bars and structural steel stanchions. Any good conductor which may from part of the building structure can be included, appropriately joined to the air and earth terminations and in general the higher the number of down conductors used, the lower the risk of side-flashing and other undesirable phenomena.
2. Likewise, large conductors reduce the risk of side-flashing especially if insulated.
3. The down conductor system should, where practicable, be directly routed from the air termination to the earth termination network and be symmetrically placed around the outside walls of the structure starting from the corners.
4. Pattern and number of down conductors, joints, bonds and test joints shall be as per the recommendations of made in respective code as mentioned in section 1.4.& as per contract document.
5. The façade to structural rebar connection is through using plates, bi-metallic clamps, stainless steel as shown in the contract documents.

2.7.6. EARTH TERMINATION NETWORK :

1. Nominated earth pits identified on the Contract documents shall be used as earth electrodes and shall be connected to the relevant down conductor, these generally comprise reinforcing in the building structure.
2. The whole of the earth termination network should have a combined resistance to earth not exceeding 10 (ten) ohms without taking account of any bonding to other services. Reference shall be made to respective codes as mentioned in section 1.4 for further details.
3. Earthing lugs to be checked for stainless steel availability.

2.7.7. SPECIFIC REQUIREMENT :

1. Carry out the risk assessment system and guarantee that the system shall be capable of protecting the building against a lightning strike.
2. Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level.
3. All metallic structures within a vicinity of 2000 mm in air shall be bonded to the conductors of lightning protection system.
4. All exterior metallic conductor shall be connected to the lightning protection system.

2.7.8. LIGHTNING SURGE PROTECTIVE DEVICES :

2.7.8.1. TRANSIENT-VOLTAGE SURGE SUPPRESSION :

1. The Main LT Supply panel shall be equipped with TVSS as defined in the IEEE standard 1100(1999). The response time of TVSS shall be ≤ 0.5 nanoseconds. **and shall be listed with UL-1449-2.** The TVSS shall provide up to 40dB for RFI & EMI noise attenuation.

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2. The occurrences of damages in the hardware as well as software are increasing due to over voltage surges passed on to the equipment through electrical or data lines. Normally surge works like **slow poison by internally weakening the IC or transistors**, eventually resulting in breakdown of the instrument. **Large surges of the magnitude to 100KA** or above can destroy the equipment completely.

3. Surges pass through any and all copper lines within the premises including **power lines, data lines or any other communication lines**. They are produced both externally and internally.
   a. External surges are produced by natural lighting or erratic power supply.
   b. Internally surges are generated by motors, drives, Generator, AC, copiers or any other heavy duty Office equipment.

2.7.8.2. SURGE ARRESTORS:

1. Comply with UL 1449.
2. Modular design (with field-replaceable modules).
3. Fabrication using bolted compression lugs for internal wiring.
4. Integral disconnect switch.
5. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
6. LED indicator lights for power and protection status.
7. Audible alarm, with silencing switch, to indicate when protection has failed.
8. Four-digit transient-event counter set to totalize transient surges.
9. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2.

2.8. INVERTER SYSTEM (FOR EMERGENCY LIGHTING) :

2.8.1. GENERAL :

1. The system shall be so configured to ensure that it operates continuously not only under normal condition but also under complete failure of the Utility Power system & till the availability of D.G. back-up power.
2. The system offered shall have an output of 415V AC
3. As noted on Contract Documents Inverter shall serve either single / multiple sub-distribution boards via triple / double pole MCB distribution board as located adjacent to the Inverter/Central Battery unit(s).

2.8.2. OPERATIONAL REQUIREMENT :

1. Normal Conditions: Load is supplied with power flowing from the normal power input terminals, through the rectifier-charger and inverter, with the battery connected in parallel with the rectifier-charger output.
2. If normal power fails, energy supplied by the battery through the inverter continues supply to the load without switching or disturbance.
3. When power is restored at the normal supply terminals of the system, The rectifier-charger then supplies power to the load through the inverter and simultaneously recharges the battery.
4. If the battery becomes discharged and normal supply is available, the rectifier-charger charges the battery.

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5. Bypass switch has to be provided incase inverter is faulty and needs to be taken out for maintenance.

2.8.3. SYSTEM PARTICULARS :

1.	Rated system voltage	:	415 V
2.	Input voltage of inverter	:	415V, 3 phase, 4 wire
3.	Rated Frequency	:	50 Hz
4.	Input Voltage Variation	:	+/- 10%
5.	Input Frequency Variation	:	+/- 3%
6.	Combined Input voltage & frequency variation	:	+/- 10%
7.	Output Voltage of Inverter	:	415V, 3 phase, 4 wire
8.	Output voltage variation	:	+/- 1%

2.8.4. STATIC INVERTER :

1. The static inverter shall be of solid state type using proven Pulse Width Modulation (PWM) technique. The inverter shall be used to feed all emergency load like light fittings etc. in case of power failure and hence when normal supply is available these loads will be directly fed from normal source. This normal power source shall also be used to keep the inverter batteries fully charged. The inverter equipment shall include all necessary control circuitry and devices to conform requirements like voltage regulation, current limiting, wave shaping, transient recovery, automatic synchronization etc. as given below.
2. The inverter shall utilize Insulated Gate Bipolar Transistors (IGBT) or Intelligent Power Module (IPM) Transistors which shall provide intelligent features like the drive circuitry, over-current protection, over temperature protection, control power failure protection and short circuit protection.
3. The IGBT / IPM transistors shall enable high speed switching of 6 Khz thus reducing the heat dissipation in the panel and thereby providing high efficiency.
4. Static inverters shall be provided and arranged on a one per area basis and possess the following characteristics:

Item	Characteristic
Output voltage	415V AC. Voltage tolerance is 2% on loads of 0-100% of system rating. Frequency: 50hz. + 0.01%. sinusoidal waveform
Voltage Regulation	Static 2%, dynamic 6%.
Isolation	2kV RMS between input and output terminals.
Total Harmonic Distortion	Less than 3% THD.
Start-up Time	30mS.
Noise Level	Less than 50dBA at 1 meter
Efficiency	≥ 90%
Protection	DC input and AC output MCBs, DC input reverse polarity protection, short circuit protection, pre-charge protection fuse, reverse-fed mains proof.
Low voltage shut down	The inverter module(s) to automatically shut down when the battery discharges to a pre-set level. Re-set allowable following a combination of the restoration of the mains supply and an increase in battery voltage above the disconnect threshold level. Residual current drain when the disconnect circuit has operated ≤1mA

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Item	Characteristic
	per module.
Inhibit	An inhibit switch to control the inverter shall be fitted on a user control PCB in the cubicle.
Technology	Pulse width modulation with high frequency switching.

2.8.5. VOLTAGE REGULATION :

1. The inverter output voltage shall not deviate by more than + 5% RMS due to the following steady state conditions :
   a. From 0 to 100% loading
   b. Inverter DC input voltage varies from maximum to minimum.
   c. Environmental conditions variations within the limitations set in the specification.

2.8.6. FREQUENCY CONTROL :

1. The inverter output frequency shall be controlled by an oscillator. The oscillator, while running asynchronously, shall maintain the frequency as 50 Hz + 0.01% (or + 0.005 Hz).
2. The inverter output frequency shall not vary during steady state or transient operation due to the following conditions:
   a. From 0 to 100% loading.
   b. Inverter DC input varies from maximum to minimum.
   c. Environmental condition variations within the limitations set out in the contract documents.

2.8.7. OUTPUT VOLTAGE HARMONIC DISTORTION :

The inverter output shall limit the amount of harmonic content to the values stated in 'Table below'.

2.8.8. OUTPUT OVERLOAD CAPABILITY :

The inverter output shall be capable of providing an overload current while maintaining rated output voltage. An LED indicator shall be located on the control panel to identify this condition. If the time limit associated with the overload condition expires or the overload is in excess of the set current amplitude, the load shall be transferred to the bypass source without interruption.

2.8.9. INVERTER CURRENT LIMIT :

The inverter output shall be limited to 120% of rated load current. The two sensing locations shall operate separately and independently thus providing redundancy and, in the event of a failure, preventing unnecessary damage to power transistor components / fuses. Load current above 120% shall cause an immediate transfer of the load to the bypass source for fault clearing.

2.8.10. INVERTER OVERLOAD PROTECTION :

1. The AC output from the inverter shall utilize fuses for overload protection. The inverter shall utilize a contactor to isolate the inverter output from the critical bus.
2. The inverter fuses shall be the fast acting semiconductor type.
3. The inverter shall meet the following specifications in addition to other requirements stated herein:

Voltage Input	:	415 V + 5% AC 3 Phase, 4 Wire
Nominal Voltage Output	:	415 V + 5% AC 3 Phase, 4 Wire

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Inverter Capacity	:	As Shown in the drawings
Wave form		
a. Normal frequency	:	50 Hz
b. Frequency regulation for all conditions of input supplies, loads and temperature occurring simultaneously or in any combination (automatically controlled)	:	+ 0.01%
Total voltage harmonic distortion	:	< 3% THD for 100% linear load < 5% THD for 100% non-linear load
Duty	:	Continuous
Cooling	:	Natural
Ambient operating temperature range	:	0 to 50deg.C maximum continuous.
Operating relative humidity	:	0-95% non-condensing.
Operating altitude.	:	Sea level to 1000 meters.
Output	:	Suitable terminals are provided for termination of cables for connecting inverter output to AC distribution board.

2.8.11. PERFORMANCE REQUIREMENT :

Minimum Duration of Supply: If battery is sole energy source supplying rated full load current at 80 percent power factor, duration of supply is **15 minutes.**

2.8.12. BATTERY :

1. Batteries shall be DRY and maintenance free type.
2. Batteries shall be sized to match Inverter requirement, lasting for 15 minutes with rated output at 0.8 PF lagging.
3. Batteries shall be installed along with the Inverter near Emergency DBs in Electrical rooms/Closets. All battery terminals shall have caps in order to prevent contact with live point. The contractor shall not space constraint and ensure his offering shall be accommodated within space provided.
4. Vendor shall include all the accessories, battery racks, tools and tackles required for commissioning, maintenance of batteries in the offer.
5. Battery Voltage & AH capacity: Battery bank voltage to be decided by the Supplier based on his design. For AH calculations, a factor of 1.25 shall be considered for aging and a factor of 1.1 for design margin.
6. DC Cutoff Voltage: Maximum 1.75V per cell
7. DC Ripple: Maximum 1% of DC voltage
8. A battery management system shall be provided in the inverter for online testing of the batteries.
9. Batteries shall be maintenance free, sealed lead acid, gas recombination type with a minimum design life of 10 years at 25deg. C. Batteries shall be low gas generation, low self-discharge and have permanently sealed pressure valve.

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10. Store and install batteries in areas which are not subject to extreme changes in temperature..

2.8.13. RECTIFIER/BATTERY CHARGER :

1. A, solid-state, full-wave bridge rectifier shall convert the incoming AC power to regulated DC voltage, which shall be subsequently filtered to provide power for the inverter and battery charging functions. The rectifier/battery charger shall have sufficient capacity to support a fully loaded inverter and recharge the battery to 95% of its full capacity within 10 times the discharge time. The rectifier/battery charger assembly shall be constructed of modular plug-ins to facilitate maintenance.
2. Input Protection: The rectifier/battery charger shall be protected by means of an AC input circuit breaker. The SCRs shall be protected by semiconductor grade fuses. Overloads in excess of the rectifier/battery charger's normal rating or sensing of an abnormally high DC voltage condition shall cause the AC input circuit breaker to be shunt tripped open.
3. Input Current Limiting: Input current limit shall be set at 150% of nominal input current. A programmable second step input current limit, allowing a further limit of the input current, shall be activated by a dry contact input.
4. Battery Charge Current Limiting: Maximum recharge current shall be limited to 10% of maximum DC discharge current or as recommended by the battery manufacturer.
5. Operating Modes:
   a. Automatic Charge Sequence: The rectifier/battery charger shall automatically charge the batteries at an elevated voltage after an outage of a set (selectable between 0-255 seconds) duration.
   b. Float Service: Nominal DC bus voltage (programmable) provided under nominal operating conditions.
   c. Manual Charge Service: The rectifier/battery charger output voltage shall be selectable to a voltage slightly higher than the normal float voltage setting, normally the maximum float voltage setting specified by the battery manufacturer.
   d. Equalize/Commissioning Service: A high charge rate of DC voltage capable of being set at 2.5 volts per cell at a user selected time period.
   e. Battery chargers shall be capable of recharging the batteries after they have been discharged for the specified duration of the system so that within 14 hours the batteries can again support the load for the specified duration period. This requirement shall be achieved without exceeding the maximum design charging characteristics of the batteries. The charger and controls shall possess the following characteristics:

Item	Characteristic
Main Supply	415 / 240V ± 6% @ 50Hz
Input Control	MCCB / MCB
Fusegear	MCB
Terminals	DIN rail mounted near to cable entry
Transformer	Double wound with earth screen to BS171.
Contactor	Standard contactors comply with the requirements of BS 5424/IEC60947
Charger	Constant voltage, current-limited type with electronic solid state controller. Voltage to be controlled to within 2% of setting at up to 10% mains supply variations
Temp Compensation	The charger voltage to be automatically adjusted with reference to ambient temperature

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Item	Characteristic
Test Push-button	Push button or switch facility to simulate mains failure for 10m partial and 30m full discharge periods

2.8.14. MONITORING BY REMOTE COMPUTER :

1. Provides a Communication module in each unit to provide capability for remote monitoring of status, parameters, and alarms. The remote computer and the connecting signal wiring themselves are not included in this Contract. Include the following features:
2. Connectors and network interface units or modems for data transmission via RS-485 link.
3. The OEM shall have Software solution designed for control and monitoring of Inverter functions and to provide on-screen explanations, interpretations, diagnosis, action guidance, and instructions for use of monitoring indications and development of meaningful reports. The actual supply of this software is not included . The software solution shall under this contract. Permit storage and analysis of power-line transient records.

2.8.15. ADDITIONAL BATTERY MONITORING :

1. Monitoring features and components shall include the following:
   a. Factory-wired sensing leads to cell and battery terminals and cell temperature sensors.
2. Performance: Automatically measures and electronically records the following parameters on a routine schedule and during battery discharge events. During discharge events, records measurements timed to nearest second; includes measurements of the following parameters:
   a. Total battery voltage and ambient temperature.
   b. Individual-cell voltage, impedance, and temperature. During battery-discharging events such as utility outages, measures battery and cell voltages timed to nearest second.
   c. Individual-cell electrolyte levels.

2.8.16. INVERTER/BATTERY CABINET :

1. The Battery Inverter cabinet shall be sheet steel, powder coated paintwork RAL 9002, Grey in colour. The cabinet shall be IP21 with hinged front door for complete access. The display panel shall be mounted flush in the cabinet facia. If the batteries cannot be accommodated in the inverter enclosure then they shall be installed in a separate adjacent enclosure to the same specification at the inverter cabinet .
2. Control equipment including mains failure relays, contactors, battery charger, inverter protection fuses, control switches, instruments and indicators shall be contained in suitable enclosures.
3. Instruments shall provide indication of battery voltage, trickle charge and boost charge currents, indication shall be provided of battery charger functioning and battery charger failure. Instruments for monitoring the current drawn by the emergency luminaire ballast and for causing alarm on failure shall be provided. RS232 / RS 485 interface to be provided to provide alarm / status information to future BMS system.
4. Simulation of central mains failure shall be on electronic switching device or a 2 position type tamper-proof switch operated by a removable key.

2.8.17. EMERGENCY LIGHTING LUMINAIRES :

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Normal type light fixtures to be used for emergency lighting purpose & dedicated circuits of all such emergency lights shall be fed from the inverter via respective emergency distribution boards provided within the power distribution system.

2.8.18. VIBRATION ISOLATION :

1. Floor mounted equipment shall be vibration isolated utilizing neoprene mounts with a minimum static deflection of 12mm.
2. Suspended equipment shall be vibration isolated via neoprene hanger's isolators having a minimum static deflection of 12mm.

2.8.19. SEISMIC RESTRAINTS :

1. Each corner or side seismic restraint shall incorporate a minimum thick pad limit stops
2. Restraints shall be made of plate, structural members or square metal tubing in welded assembly, incorporate resilient pads. Angle bumpers are not acceptable. Systems to be fold bolted to deck with 0.75kg acceleration capacity.
3. Restraint shall be capable of holding equipment captive under seismic loadings of 1.0g
4. Seismic restraints to be provided in line with OEM requirements and as per contractors Seismic Engineers Calculations
5. If spring vibration isolators satisfy seismic requirements, the supplemental restraints are not required.

2.9. OBSTRUCTION BEACON LIGHTING SYSTEM :

2.9.1. SCOPE :

The specifications given below relates to the testing and supplying of obstruction beacon lighting System in schedule of quantities at Site:

2.9.2. CODES & STANDARDS :

ICAO (Annex 14)	Aviation Lighting - Beacon Lighting System

2.9.3. TECHNICAL DETAILS :

1. The Contractor shall Supply, Installation, Testing & Commissioning the complete Obstruction Beacon Lighting System. Obstruction Beacon Lighting System for the building shall comply with local civil aviation requirements.
2. The system shall comprise Low intensity obstacle lights, external photocell, gps unit, wiring system and power supply units serving the obstacle lights. All obstruction lights shall be provided with an interface point to allow a central controller to monitor the status of each light fitting. This shall be provided at a single point on the floor where the lights are located to allow connection into the interface by the contractor.
3. Fittings to incorporate an intensity step changer including all accessories, lighting to be at 2,000cd during dusk till dawn. Fittings to be at levels as per drawings and specification.
4. Louvers to be provide to all lights to avoid dazzle to aircraft and local residents.
5. Panel to incorporate GPS Synchronisation function allowing fitting in site owner to flash in synchronisation. If required it shall be as per BOQ.
6. Panel to FAA and FCC tower light monitoring requirements.
7. Control panel to operate at 240V, 50Hz and include interlocked safety switch. Cable entry shall be through double compression plated brass glands.

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8. The Control panel shall provide for 24h/365d automatic monitoring of all fittings. The system shall be designed to register the malfunction of any light on the tower regardless of its position.
9. The system should automatically change intensity steps when the northern sky illumination in the Northern Hemisphere on a vertical surface is as follows:
10. Day-to-Twilight. This should not occur before the illumination drops to 60 foot-candles (645.8 lux) but should occur before it drops below 35 foot-candles (376.7 lux). The luminance-sensing device should, if practical, face the northern sky in the Northern Hemisphere.
11. Twilight-to-Night. This should not occur before the illumination drops below 5 foot-candles (53.8 lux) but should occur before it drops below 2 foot-candles (21.5lux).
12. Night-to-Day. The intensity changes listed above should be reversed when changing from the night to day mode.
    a. Fittings to come complete with light, controllers, photocell, mounting brackets and all equipment to provide for a fully functional system.
    b. The supplied shall provide for a MTBF of 100,000h and shall be maintenance-free.
    c. Fittings to be shock and vibration proof
    d. Mechanical parts shall be marine grade aluminum, acid proof steel or glass and suitable for the Mumbai environment
    e. Units to come with built in photocell/flasher @ 25FPM.
    f. Each fitting shall be protected via A Class I surge arrester.

2.10. HANGERS & SUPPORTS FOR ELECTRICAL SYSTEM :

2.10.1. SCOPE :

The specifications given below relates to the testing & supplying support system for busducts, busbars, conduits, cable trays, cable ladders in schedule of quantities at Site:

2.10.2. SUPPORT, ANCHORAGE & ATTACHEMENT COMPONENTS :

1. **Steel Slotted Support Systems:** Factory-fabricated components for field assembly.
    a. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to IS Standards.
    b. Non-metallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied.
    c. Painted Coatings: Manufacturer's standard painted coating applied.
    d. Channel Dimensions: Selected for applicable load criteria.
2. **Non-metallic Slotted Support Systems**: Structural-grade, factory-formed, glass-fibre-resin channels and angles with 9/16-inch- diameter holes at a maximum of 8 inches.
3. **Fittings and Accessories:** Products of channel and angle manufacturer and designed for use with those items.
4. **Rated Strength:** Selected to suit applicable load criteria.
5. **Conduit and Cable Support Devices:** Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
6. **Support for Conductors in Vertical Conduit:** Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armoured electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported.

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7. **Structural Steel for Fabricated Supports and Restraints:** ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
8. **Mounting, Anchoring, and Attachment Components**: Items for fastening electrical items or their supports to building surfaces include the following:
   a. **Powder-Actuated Fasteners:** Threaded-steel stud, for use in hardened cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   b. **Available Manufacturers:** Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      - Hilti Inc.
   c. **Mechanical-Expansion Anchors:** Insert-wedge-type, stainless steel, for use in hardened cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   d. **Concrete Inserts:** Steel or malleable-iron, slotted support system units similar to MSS Type 18
   e. **Through Bolts:** Structural type, hex head, and high strength. Comply with ASTM A 325.
   f. Toggle Bolts: All-steel springhead type.
   g. Hanger Rods: Threaded steel.

2.11. IDENTIFICATION FOR ELECTRICAL SYSTEM

2.11.1. SCOPE :

The specifications given below relates to the testing & supplying support system for busducts, busbars, conduits, cable trays, cable ladders in schedule of quantities at Site:

2.11.2. CODES & STANDARDS :

IS 5578	Guide for marking of insulated conductors.
IEC 60068-2-52	Environmental testing - Part 2: Tests - Test Kb: Salt mist, cyclic (sodium, chloride solution)
IEC 61851-1	Electric vehicle conductive charging system - Part 1: General requirements
IEC 61851-21	Electric vehicle conductive charging system - Part 21: Electric vehicle requirements for conductive connection to an a.c./d.c. supply
IEC 61851-22	Electric vehicle conductive charging system - Part 22: AC electric vehicle charging station
IEC 62196-1	Plugs, socket-outlets, vehicle couplers and vehicle inlets - Conductive charging of electric vehicles - Part 1: Charging of

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	electric vehicles up to 250 A a.c. and 400 A d.c.
IEC 62196-2	Part 2: Dimensional compatibility and interchangeability requirements for a.c. pin and contact-tube accessories
ISO/IEC 14443	Identification cards - Contactless integrated circuit cards - Proximity cards specifications (Parts 1-4)
ISO/IEC 15693	Identification cards — Contactless integrated circuit(s) cards — Vicinity cards (Parts 1-4)
IS 732 / IS 12307 / IS 12349 / NBC	Code for identification of Electrical System.

2.11.3. CONDUCTOR IDENTIFICATION MATERIAL

1. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 25 to 50mm wide.
2. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
3. Snap-Around Labels: Slit, pre tensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
4. Snap-Around, Color-Coding Bands: Slit, pre tensioned, flexible, solid-colored acrylic sleeve, 50mm long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
5. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
6. Write-On Tags: Polyester tag, 0.25mm thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
    a. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
    b. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.11.4. WARNING LABELS AND SIGNS

1. Comply with IS 732 and NBC
2. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

2.11.5. INSTRUCTION SIGNS

1. Engraved, laminated acrylic or melamine plastic, minimum 1.5mm thick.
    a. Engraved legend with black letters on white face.
    b. Punched or drilled for mechanical fasteners.
    c. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

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2. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 10mm.
3. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 10mm. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.11.6. EQUIPMENT IDENTIFICATION LABELS

1. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 10mm.
2. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 10mm. Overlay shall provide a weatherproof and UV-resistant seal for label.
3. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 10mm.
4. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 10mm.
5. Stenciled Legend: In non fading, waterproof, black ink or paint. Minimum letter height shall be 25mm.
6. Enclosed Switches and Circuit Breakers shall also be identified by labels. Label designation shall be in accordance with the BOQ & Drawings. All removable components shall have a circuit label.

Description	Requirement
Material	Anodised Aluminimum / Trafolite
Engraving	Black engraving on white background
Size of the Label	To suit application / importance
Fixing	With self-tapping screws
Use	Main Panel, feeders and individual devices

7. Labels shall have black characters on a white background and be made of a non-corrodible material. Danger/warning labels shall be engraved with black letters on a yellow background, in English, Marathi languages.
8. Labels shall not be affixed by adhesive.
9. Labels shall be printed in English.

2.11.7. MISCELLANEOUS IDENTIFICATION PRODUCTS

1. Paint: Select paint system applicable for surface material and location (exterior or interior). Provide data sheets to Client for approval before use!
2. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

2.12. UPS (UN-INTERRUPTABLE POWER SUPPIES)

2.12.1. GENERAL

a) The system shall be so configured to ensure that it operates continuously not only under normal condition but also under complete failure of the Utility Power system& till the availability of D.G. back-up power.

b) The system offered shall have an output of 230V AC (for single phase).

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c) As noted on Contract Documents UPS shall serve single distribution boards via double pole MCB distribution board as located adjacent to the UPS unit(s).

2.12.2. OPERATIONAL REQUIREMENT

a) Normal Conditions: Load is supplied with power flowing from the normal power input terminals, through the rectifier-charger and UPS, with the battery connected in parallel with the rectifier-charger output.

b) If normal power fails, energy supplied by the battery through the UPS continues supply to the load without switching or disturbance.

c) When power is restored at the normal supply terminals of the system, The rectifier-charger then supplies power to the load through the UPS and simultaneously recharges the battery.

d) If the battery becomes discharged and normal supply is available, the rectifier-charger charges the battery.

2.12.3. SYSTEM PARTICULARS

• Rated system voltage phase	:	230 V for 1
• Input voltage of UPS 2 wire	:	230V, 1 phase,
• Rated Frequency	:	50 Hz
• Input Voltage Variation	:	+/- 10%
• Input Frequency Variation	:	+/- 3%
• Output Voltage of UPS 2 wire	:	230V, 1 phase,

2.12.4. UPS

a) The UPS shall be of solid state type using proven Pulse Width Modulation (PWM) technique. The UPS shall be used to feed all security and surveillance load like access controller, vehile access controller, CCTV camera etc. in case of power failure and hence when normal supply is available these loads will be directly fed from normal source. This normal power source shall also be used to keep the UPS batteries fully charged. The UPS equipment shall include all necessary control circuitry and devices to conform requirements like voltage regulation, current limiting, wave shaping, transient recovery, automatic synchronization etc. as given below.

b) The UPS shall utilize Insulated Gate Bipolar Transistors (IGBT) or Intelligent Power Module (IPM) Transistors which shall provide intelligent features like the drive circuitry, over-current protection, over temperature protection, control power failure protection and short circuit protection.

The IGBT / IPM transistors shall enable high speed switching of 6 KHz thus reducing the heat dissipation in the panel and thereby providing high efficiency.

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c) UPS shall be provided and arranged on a one per area basis and possess the following characteristics:

Item	Characteristic
Output voltage	230V AC. Voltage tolerance is 2% on loads of 0-100% of system rating. Frequency: 50hz. + 0.01%. sinusoidal waveform
Voltage Regulation	Static 2%, dynamic 6%.
Isolation	2kV RMS between input and output terminals.
Total Harmonic Distortion	Less than 3% THD.
Start-up Time	30mS.
Noise Level	Less than 50dBA at 1 meter
Efficiency	≥ 90%
Protection	DC input and AC output MCBs, DC input reverse polarity protection, short circuit protection, pre-charge protection fuse, reverse-fed mains proof.
Low voltage shut down	The UPS module(s) to automatically shut down when the battery discharges to a pre-set level. Re-set allowable following a combination of the restoration of the mains supply and an increase in battery voltage above the disconnect threshold level. Residual current drain when the disconnect circuit has operated ≤1mA per module.
Inhibit	An inhibit switch to control the UPS shall be fitted on a user control PCB in the cubicle.
Technology	Pulse width modulation with high frequency switching.

2.12.5. VOLTAGE REGULATION

a) The UPS output voltage shall not deviate by more than + 5% RMS due to the following steady state conditions :

i. Form 0 to 100% loading

ii. UPS DC input voltage varies from maximum to minimum.

iii. Environmental conditions variations within the limitations set in the specification.

2.12.6. FREQUENCY CONTROL

a) The UPS output frequency shall be controlled by an oscillator. The oscillator, while running asynchronously, shall maintain the frequency as 50 Hz + 0.01% (or + 0.005 Hz).

b) The UPS output frequency shall not vary during steady state or transient operation due to the following conditions:

i. From 0 to 100% loading.

ii. UPS DC input varies from maximum to minimum.

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iii. Environmental condition variations within the limitations set out in the contract documents.

2.12.7. OUTPUT VOLTAGE HARMONIC DISTORTION

a) The UPS output shall limit the amount of harmonic content to the values stated in 'Table below'.

2.12.8. OUTPUT OVERLOAD CAPABILITY

a) The UPS output shall be capable of providing an overload current while maintaining rated output voltage. An LED indicator shall be located on the control panel to identify this condition. If the time limit associated with the overload condition expires or the overload is in excess of the set current amplitude, the load shall be transferred to the bypass source without interruption.

2.12.9. UPS CURRENT LIMIT

a) The UPS output shall be limited to 120% of rated load current. The two sensing locations shall operate separately and independently thus providing redundancy and, in the event of a failure, preventing unnecessary damage to power transistor components / fuses. Load current above 120% shall cause an immediate transfer of the load to the bypass source for fault clearing.

2.12.10. UPS OVERLOAD PROTECTION

a) The AC output from the UPS shall utilize fuses for overload protection. The UPS shall utilize a contactor to isolate the UPS output from the critical bus.

b) The UPS fuses shall be the fast acting semiconductor type.

c) The UPS shall meet the following specifications in addition to other requirements stated herein:

	Voltage Input	:	230V, 1 phase, 2 wire
	Nominal Voltage Output	:	230V, 1 phase, 2 wire
	UPS Capacity	:	As Shown in the BOQ
	Wave form		
	a. Normal frequency	:	50 Hz
	b. Frequency regulation for all conditions of input supplies, loads and temperature occurring simultaneously or in any combination (automatically controlled)	:	+ 0.01%
	Total voltage harmonic distortion	:	< 3% THD for 100% linear load < 5% THD for 100% non-linear load
	Duty	:	Continuous
	Cooling	:	Air Natural
	Ambient operating temperature range	:	0 to 50deg.C maximum continuous.

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	Operating relative humidity	:	0-95% non-condensing.
	Operating altitude.	:	Sea level to 1000 meters.
	Output	:	Suitable terminals are provided for termination of cables for connecting UPS output to AC distribution board.

2.12.11. PERFORMANCE REQUIREMENT.

a) Minimum Duration of Supply: If battery is sole energy source supplying rated full load current at 0.8 power factor, duration of supply is **15 minutes.**

2.12.12. BATTERY

a) Batteries shall be DRY type and maintenance free.

b) Batteries shall be sized to match UPS requirement, lasting for 15 minutes with rated output at 0.8 PF lagging.

c) Batteries shall be installed along with the UPS in security control rooms. All battery terminals shall have caps in order to prevent contact with live point. DC circuit breakers shall be used for battery protection.

d) Vendor shall include all the accessories, battery racks, tools and tackles required for commissioning, maintenance of batteries in the offer.

e) Battery Voltage & AH capacity: Battery bank voltage to be decided by the Supplier based on his design. For AH calculations, a factor of 1.25 shall be considered for aging and a factor of 1.1 for design margin.

f) DC Cutoff Voltage: Maximum 1.75V per cell

g) DC Ripple: Maximum 1% of DC voltage

h) A battery management system shall be provided in the UPS for online testing of the batteries.

i) Batteries shall be maintenance free, sealed lead acid, gas recombination type with a minimum design life of 10 years at 25deg. C. Batteries shall be low gas generation, low self-discharge and have permanently sealed pressure valve.

j) Store and install batteries in areas which are not subject to extreme changes in temperature.

2.12.13. RECTIFIER/BATTERY CHARGER

a) A, solid-state, full-wave bridge rectifier shall convert the incoming AC power to regulated DC voltage, which shall be subsequently filtered to provide power for the UPS and battery charging functions. The rectifier/battery charger shall have sufficient capacity to support a fully loaded UPS and recharge the battery to 95% of its full capacity within 10 times the discharge time. The rectifier/battery charger assembly shall be constructed of modular plug-ins to facilitate maintenance.

b) Input Protection: The rectifier/battery charger shall be protected by means of an AC input circuit breaker. The SCRs shall be protected by semiconductor grade fuses. Overloads in excess of the rectifier/battery charger's normal rating or sensing of an abnormally high DC voltage condition shall cause the AC input circuit breaker to be shunt tripped open.

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c) Input Current Limiting: Input current limit shall be set at 150% of nominal input current. A programmable second step input current limit, allowing a further limit of the input current, shall be activated by a dry contact input.

d) Battery Charge Current Limiting: Maximum recharge current shall be limited to 10% of maximum DC discharge current or as recommended by the battery manufacturer.

e) Operating Modes:

i. Automatic Charge Sequence: The rectifier/battery charger shall automatically charge the batteries at an elevated voltage after an outage of a set (selectable between 0-255 seconds) duration.

ii. Float Service: Nominal DC bus voltage (programmable) provided under nominal operating conditions.

iii. Manual Charge Service: The rectifier/battery charger output voltage shall be selectable to a voltage slightly higher than the normal float voltage setting, normally the maximum float voltage setting specified by the battery manufacturer.

iv. Equalize/Commissioning Service: A high charge rate of DC voltage capable of being set at 2.5 volts per cell at a user selected time period.

v. Battery chargers shall be capable of recharging the batteries after they have been discharged for the specified duration of the system so that within 14 hours the batteries can again support the load for the specified duration period. This requirement shall be achieved without exceeding the maximum design charging characteristics of the batteries. The charger and controls shall possess the following characteristics:

Item	**Characteristic**
Main Supply	240V ± 6% @ 50Hz
Input Control	MCB
Fusegear	MCB
Terminals	DIN rail mounted near to cable entry
Transformer	Double wound with earth screen to BS171.
Contactor	Standard contactors comply with the requirements of BS 5424/IEC60947
Charger	Constant voltage, current-limited type with electronic solid state controller. Voltage to be controlled to within 2% of setting at up to 10% mains supply variations
Temp Compensation	The charger voltage to be automatically adjusted with reference to ambient temperature
Test Push-button	Push button or switch facility to simulate mains failure for 10m partial and 30m full discharge periods

2.12.14. MONITORING BY REMOTE COMPUTER

a) Description: Communication module in unit control panel provides capability for remote monitoring of status, parameters, and alarms specified in "Controls and Indications" Article. The remote computer and the connecting signal wiring are not included in this Section. Include the following features:

b) Connectors and network interface units or modems for data transmission via RS-232 link.

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c) Software designed for control and monitoring of UPS functions and to provide on-screen explanations, interpretations, diagnosis, action guidance, and instructions for use of monitoring indications and development of meaningful reports. Permit storage and analysis of power-line transient records. Designs for Windows applications, software, and computer are not included in this Section.

2.12.15. UPS/BATTERYCABINET

a) The Battery UPS cabinet shall be sheet steel, powder coated paintwork RAL 9002, Grey in colour. The cabinet shall be IP21 with hinged front door for complete access. The display panel shall be mounted flush in the cabinet facia. If the batteries cannot be accommodated in the UPS enclosure then they shall be installed in a separate adjacent enclosure to the same specification at the UPS cabinet .

b) Control equipment including mains failure relays, contactors, battery charger, UPS protection fuses, control switches, instruments and indicators shall be contained in suitable enclosures.

c) Instruments shall provide indication of battery voltage, trickle charge and boost charge currents, indication shall be provided of battery charger functioning and battery charger failure. Instruments for monitoring the current drawn by the emergency luminary ballast and for causing alarm on failure shall be provided. RS232 / RS 485 interface to be provided to provide alarm / status information to the BMS system.

d) Simulation of central mains failure shall be on electronic switching device or a 2 position type tamper-proof switch operated by a removable key.

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3. EXECUTION :

3.1. L.V. PANELS, ENCLOSED SWITCHGEAR, DISTRIBUTION BOARDS, VFD's, CONTROL PANELS & STARTERS :

3.1.1. SCOPE :

The scope of work shall include Transporting, loading / unloading the L.V. Panels, Enclosed Switchgear, Distribution Board, VFD's, Control Panels & starters to project site, storing, handling, shifting, installing, testing and commissioning of all the items reflecting in Bill of Quantities & layouts.

3.1.2. EXAMINATION :

Examine elements and surfaces to receive switchgear for compliance with requirements for installation tolerances, required clearances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.1.3. INSTALLATION :

1. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchgear units and components.
2. All electrical switchboards in switch cupboards and plant rooms shall be provided with a 1m wide carbon free rubber mat or mats, having a cross ribbed upper surface and being of such continuous length to suit the full operating extent of each switchboard. The mats shall be in compliance with BS 921 or IS15652 and be fitted to the front of front access panels and to the front and rear of front/rear access panels.
3. An approved type 1.20m wide non-slip rubber floor mat in accordance with IEC 61111 and rated to 1.0kV shall be fitted along the full length of each main LV. switchboard supplied. This material shall suitable for heavy duty electrical safety matting and shall be fully tested and certified for electrical insulation properties to IEC 61111; 2009 and shall be continuously marked with 5kV Proof Test, 10kV Withstand Voltage and 1000V Working. Each matt to IEC 61111 Class 0 - 6mm THICK

3.1.4. ERECTION :

1. The contractor shall make his own arrangement for safe transportation of all the items to the erection site and also carry out complete loading / unloading during transportation. The contractor shall be responsible for final assembly and interconnection of busbars / wiring. Foundation channel shall be delivered in convenient shipping section by the manufacturer. The contractor shall make shall be grouted in the flooring by the contractor. Switchgear shall be aligned and leveled on their base channels and bolted to them as per the instructions of the Engineer –In-Charge of client / consultant. The earth bus shall be made continuous throughout the length. Loosely supplied relays and instruments shall be mounted and connected on the switchgear. The contacts of the draw out circuit breaker shall be checked for proper alignment and inter changeability.
2. After erection, the switchboard shall be inspected for dust and vermin proof. Any hole which might allow dust or vermin, etc. to enter the panel shall be plugged suitably at no extra cost. If the instrument transformers are supplied separately, they shall be erected as per the direction of the client / consultant. The contractor shall fix the cable glands after drilling the bottom / top plates of all switchboards with suitable holes at no extra cost.
3. Range of overload relays / timers etc. shall be checked with requirement of motor actually to be connected at site and if the same is undersized / oversized, it shall be brought to the notice of the client / consultant, who shall arrange procurement of corrected components. However, the contractor shall not charge anything extra for labour for such replacements.

3.1.5. CONNECTIONS :

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Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values.

3.1.6. TESTING :

1. Before electrical panel is energized, the insulation resistance of each bus shall be measured from phase to ground. Measurement shall be repeated with circuit breakers in operating positions and contacts open.
2. Before switchgear is energized, the insulation resistance of all control circuits shall be measured from line to ground.
3. The following tests shall be performed on all circuit breakers during erection.
   a. Contact alignment and wipe shall be checked and adjustment where necessary in accordance with the breaker manufacturer's instructions.
   b. Each circuit breaker shall be drawn out of its cubicles, closed manually and its insulation resistance measured from phase to phase and phase to ground.
   c. All adjustable direct acting trip devices shall be set using values given by the consultant/ manufacturer.
   d. The dielectric strength of insulating oil wherever applicable shall be checked. Before switchgear is energized, the following tests shall be performed on each circuit breaker in its test position.
   e. Close and trip the circuit breaker from its local control switch push button or operating handle. Switchgear control bus may be energized to permit test operation of circuit breaker with A.C. closing with prior permission of the client / consultant.
   f. Test tripping of the electrically operated circuit breaker by operating mechanical trip device.
   g. Test proper operation of circuit breakers latch, check carriage limit switch if provided. Test proper operation of lockout device in the closing circuit. Wherever provided by simulating conditions which would cause a lockout to occur.
   h. Trip breaker either manually or by applying current or voltage to each of its associated protective release.
   i. Before switchgear is energized, the tests covered above shall be repeated with each breaker in its normal operating position.
   j. Capacitor banks shall be tested as per manufacturer's instructions. In addition, test for output and/or capacitance, insulation resistance test and test for efficiency of discharge device shall be carried out.
   k. All electrical equipment alarms shall be tested for proper operation by causing alarms to sound under simulated abnormal conditions.

4. INSPECTION OF DB'S :

a. The DB's shall be inspected and checked as per inspection manual of the DB manufacturer.

b. Various electrical components and accessories of the DB's shall be checked as per the drawing for the respective DB's.

c. The DB's shall be checked for rigid mounting, earthing connection, proper rating & size of components, internal wiring, etc.

d. All mechanical fasteners and electrical connections shall be checked and tightened before installation.

5. INSTALLATION OF DB'S :

a. The DB's shall be assembled and aligned together and be installed at site as per installation manual / instruction of the DB manufacturer.

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b. The DB shall be installed in surface manner at the various location.

c. All minor electrical and mechanical work required to be attended to on the DB shall be completed in an applicable after installation but before energizing the DB's.

d. The M.S. angle/channel iron frame used for installation of D.B. shall be hot dip galvanized (816 g / m²).

e. The DB shall be mounted on angle / channel frame with Anchor fastening only. Civil grouting is not acceptable.

6. TEST OF DB's :

Prior to commissioning of the DB's following tests shall be carried out.

a. Mechanical endurance test shall be carried out by closing and opening of all the MCB's, switches etc.

b. Insulation resistance test shall be carried out between phases and between phase to earth bus, keeping the isolating switch in open position. Similar test shall be carried out keeping the isolating switch in closed position.

c. All the interlocks, controls and tripping mechanism of the switch gears shall be tested for their proper functioning.

3.1.7. PROFORMA FOR LT PANELS, ENCLOSDED SWITCHGEAR, DB'S, CONTROL PANEL TEST :

Circuit breaker or contactor module designation / bus no.

Insulation resistance test (contacts open, breaker racked in position)

between each phase of bus	:	Mega ohm
between each phase and earth	:	Mega ohm
DC and AC control and auxiliary circuits	:	Mega ohm
between each phase of CT / PT and between CT & PT circuit if any	:	Mega ohm

CT checks :
- CT ratio
- CT secondary resistance
- CT polarity check

Check for contact alignment and wipe.
Check / test all releases / relays.
Check mechanical interlocks.
Check electrical interlocks.
Check switchgear / control panel wiring.
Check breaker / contactor circuit for :
- Closing - local & remote (wherever applicable)
- Tripping - local & remote (wherever applicable)

Opening time of breaker / contactor.
Closing time of breaker / contactor.

[This Proforma shall be jointly signed by the CLIENT / CONSULTANT and the contractor in duplicate].

3.1.8. FIELD QUALITY CONTROL :

1. Prepare for acceptance tests as follows:
   a. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
   b. Test continuity of each circuit.

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c. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

- Inspect switchgear, wiring, components, connections, and equipment installation. Test and adjust components and equipment.
- Remove and replace malfunctioning units and retest.

3.1.9. CLEANING :

Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.1.10. DEMONSTRATION :

1. **General:** Manufacturer's factory-authorized service representative to train the Employer's personnel in the operation of the Unit.
2. **Equipment:** Check operation of each unit with Owner's personnel present and before Substantial Completion. Determine that operational systems and devices are functioning properly.
3. **Instruction:** Instruct the Employer's personnel in proper use, maintenance, adjustment, and repair of each system.

3.1.11. VFD'S INSTALLATION :

1. EXAMINATION :

a. Examine areas, surfaces, and substrates to receive VFDs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.

b. Examine VFD before installation. Reject VFDs that are wet, moisture damaged, or mold damaged.

c. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.

d. Proceed with installation only after unsatisfactory conditions have been corrected.

2. HARMONIC ANALYSIS STUDY :

a. Perform a harmonic analysis study to identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible operating scenarios, including recommendations for VFD input filtering to limit TDD and THD(V) at each VFD to specified levels.

b. Prepare a harmonic analysis study and report complying with IEEE 399 and these contract documents.

3. INSTALLATION :

a. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

b. Wall-Mounting Controllers: Install VFDs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural steel channels bolted to wall.

c. Floor-Mounting Controllers: Install VFDs on 4-inch nominal thickness concrete base. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

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d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded. Install anchor bolts to elevations required for proper attachment to supported equipment.

e. Roof-Mounting Controllers: Install VFD on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.

4. CONNECTIONS :

Tighten joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values.

5. FIELD QUALITY CONTROL :

a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

b. Acceptance Testing Preparation:

c. Test insulation resistance for each VFD element, bus, component, connecting supply, feeder, and control circuit.

d. Test continuity of each circuit.

e. Tests and Inspections:

f. Inspect VFD, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.

g. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.

h. Test continuity of each circuit.

i. Verify that voltages at VFD locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify the Employer’s Representative before starting the motor(s).

j. Test each motor for proper phase rotation.

k. Perform each electrical test and visual and mechanical inspection stated in IS.

l. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

m. VFDs will be considered defective if they do not pass tests and inspections.

n. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each VFD, Remove front and rear panels so joints and connections are accessible to portable scanner.

6. ADJUSTING :

a. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

b. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload relay pickup and trip ranges.

c. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes

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7. CLEANING :

Vacuum dirt and debris; do not use compressed air to assist in cleaning.

8. PROTECTION :

Provide final protection to ensure that moisture does not enter bus assembly.

9. DEMONSTRATION :

a. General: Manufacturer's factory-authorized service representative to train the Employer's personnel in the operation of the Unit.

b. Equipment: Check operation of each unit with the Employer's personnel present and before Substantial Completion. Determine that operational systems and devices are functioning properly.

c. Instruction: Instruct the Employer's personnel in proper use, maintenance, adjustment, and repair of each system.

d. All the switches, contactors, push button stations, indicating lamps shall be distinctly marked with a small description of the service installed. The following capacity contactors and overload relays shall be provided for different capacity motors or as per manufacturer's recommendation.

e. Two speed motors when specified, shall be provided with DOL starter irrespective of it rating.

10. EMERGENCY START/ STOP PUSH BUTTON :

a. Shall be provided with 2No positive action N/C contacts.

b. Shall be provide with 1 No N/O contacts

c. Housing material shall be Plastic

d. Enclosure rating shall be IP 65

e. Connection type (contacts) shall be Screw connection

f. Mounting diameter shall be a minimum of 22 mm

g. Mechanical life shall be a minimum of 50.000 switching cycles

h. Ambient operating temperature shall be from–40 °C to +70 °C

i. Protection class II

j. Usage category shall comply with IEC 947-5-1 AC-15/DC-13

k. Rated insulation voltage Ui 600 V

l. Minimum switching voltage 5 V DC

m. Minimum switching current 1 mA

n. Connection type (contacts) Screw connection

o. Maximum connection cable cross-section 2.5 mm²

p. LED indicator lamps shall be provided.

3.2. L.V. BUSDUCT, BUSBARS & ACCESSORIES :

3.2.1. SCOPE :

The scope of work shall include Transporting, loading / unloading the LT Busduct & LT Plug-in busbar trunking to project site, storing, handling, shifting, installing, testing and commissioning of all the items reflecting in Bill of Quantities & layouts.

3.2.2. INSTALLATION :

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1. Support bus assemblies independent of supports for other elements such as equipment enclosures at connections to panel boards and switchboards, pipes, conduits, ceilings, and ducts.
2. Design each fastener and support to carry load indicated by seismic requirements and to comply with seismic-restraint.
3. Design each fastener and support to carry 100kg lb or 4 times the weight of bus assembly, whichever is greater.
4. Support bus assembly to prevent twisting from eccentric loading.
5. Support bus assembly with not less than 3/8-inch steel rods. Install side bracing to prevent swaying or movement of bus assembly. Modify supports after completion to eliminate strains and stresses on bus bars and housings.
6. Install expansion fittings at locations where bus assemblies cross building expansion joints. Install at other locations so distance between expansion fittings does not exceed manufacturer's recommended distance between fittings.
7. Complete installation will be in the scope of Seller as per the approved drawings & standards. Fully detailed installation manuals shall be supplied by the manufacturer describing topics such as handling, storage, installation, energizing and maintenance.
8. All the parts, sections and accessories of the bus riser shall be tagged w.r.t the Building and floors for the ease of Installation. A complete set of any special tools required for the installation, operation, maintenance and testing of the Bus duct shall be provided. The Contractor/ Vendor shall provide a list of special tools, individually priced. A suitable storage box or wall mounted rack shall be provided.
9. Busbar supports shall be Spring supports and inertia supports.
10. Construct rated fire-stop assemblies where bus assemblies penetrate fire-rated elements such as walls, floors, and ceilings.
11. Install weather seal fittings and flanges where bus assemblies penetrate exterior elements such as walls or roofs.
12. Coordinate bus-assembly terminations to equipment enclosures to ensure proper phasing, connection, and closure.
13. Tighten bus-assembly joints with torque wrench or similar tool recommended by bus-assembly manufacturer. Torque test to be performed prior to energization.

3.2.3. FIELD QUALITY CONTROL :

1. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
2. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
3. Perform tests and inspections and prepare test reports.
4. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

3.2.4. TESTS & INSPECTIONS :

1. Perform each visual and mechanical inspection and electrical test stated in IS.
2. Remove and replace units that do not pass tests and inspections and retest as specified above.
3. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of bus assembly including joints and plug-in units.

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4. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
5. Perform 2 follow-up infrared scans of bus assembly, one at 4 months and the other at 11 months after Substantial Completion.
6. Prepare a certified report identifying bus assembly checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
7. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed Satisfactory Test" label to tested component.
8. Busduct / Plug-in Busbar Trunking shall be tested upon installation with a 500 V meggar and the following readings established:
   a. Continuity of all phases
   b. Insulation resistance
      - between conductors
      - all conductors and ground
   c. Temperature rise test

   All test readings shall be recorded.

3.2.5. CLEANING :

Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.2.6. PROTECTION :

Provide final protection to ensure that moisture does not enter bus assembly.

3.2.7. DEMONSTRATION :

1. General: Manufacturer's factory-authorized service representative to train Owner's personnel in the operation of the Unit.
2. Equipment: Check operation of each unit with Owner's personnel present and before Substantial Completion. Determine that operational systems and devices are functioning properly.
3. Instruction: Instruct Owner's personnel in proper use, maintenance, adjustment, and repair of each.

3.3. L.V. POWER & CONTROL CABLES IT/ TELCOM & TV CABLES :

3.3.1. SCOPE :

The scope of work shall include Transporting, loading / unloading the LT cables & Terminations to project site, storing, handling, shifting, installing, testing and commissioning of all the items specified in Bill of Quantities.

Cable network shall include power, control and external lighting cables which shall be laid in underground trenches, cable trays, G.I. pipes, or on building structures as detailed in the relevant drawings, cable schedules or as per the client / consultant's instructions. Supply & installation of cable trays, G.I. pipes / conduits, cable glands and sockets of both end isolators, junction boxes, remote push button stations, etc. shall be under the scope of the contractor.

3.3.2. ERECTION OF CABLES :

1. Not- withstanding the cable routes indicated on the Drawings the Contractor shall be entirely responsible for the supply of correct lengths of the cables to be installed and for all

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allowances for connecting and terminating the cables to the switchgears and transformers respectively

2. The Electrical Contractor to confirm all sub main and fire circuit cable lengths prior to ordering the cables for installation as this will affect the protective device disconnection time and the cable size. This will give time to verify the cable size prior to purchase preventing an embarrassing situation of pulling additional cables to address volt drop, earth loop impedance or changing the MCCB or MCB prior to practical completion.

3. The Contractor shall submit proposed cable routes including details of supports for the cables for approval before installation. The cable shall not be run in places other than corridor, passageway, electrical riser or other designated areas subject to the Employers Representative approval. The cost of all cable containment supports shall be included by the Contractor. The Contractor shall allow minimum clearance distance between all other MEP services such as water and gas lines in accordance with local code and the MEP service design criteria.

3.3.3. CABLE PULLING :

1. Winching of cables through ducts / pipes shall only be carried out with the approval of the Employers Representative in which event a pulley eye shall be attached to the conductors. Cable shall be run in neat and orderly manner to allow space for future cabling and maintenance. Under any circumstances the cable shall not run diagonally across a room, cable basement, corridor, etc.

2. A cable sheath stocking may be employed or cables where no undue stress in the sheath is likely to occur.

3. Care shall be taken to ensure that the draw strain is applied to the armouring and protected during drawing against damage. All cable pulling shall be carried out using self anchoring cable rollers/ sleeves to prevent damage to the oversheath. Any damaged cable shall be replaced by the Contractor with new cable with no extra cost or time variation to the works.

4. Cable roller shall be placed at every 1.5 meters & guide roller shall be placed at all the diversion change in direction.

3.3.4. CABLE LAYING :

1. The cable drum shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming links. At all changes in directions in horizontal & vertical places, Contractor shall follow bending radius as per manufacture's recomendation. Multiple banking of cables shall not be permitted and the Contractor shall verify the cable tray spatial allowance permits this and any discrepancies shall be highlighted within the bid process.

2. The cable of 1.1KV grade shall be laid not less than 750mm below ground level in a trench (throughout). Where more than one cable is to be laid in the same trench, the width of the trench shall be increased such that the inter axial spacing between the cables except where otherwise specified is at least 150mm minimum or as per site requirements or as approved by the Engineer-in-charge. Where single core cables are used in multiphase systems, the cables shall be installed in trefoil. The cables shall be tied together using low smoke and fume fire resistant cable ties of a steel or plastic construction.

3. In case the cables are laid in vertical formation due to unavoidable circumstance the depth per tier shall be increased by 200 mm (minimum). Cable shall be laid in reasonably straight line, where a change in direction takes place a suitable curvature shall be i.e. either 20 times the dia meter of the cable or the radius of the bend shall not be less than twice the diameter of the cable drum or whichever less is.

4. Greater care shall be exercised in handling the cable in order to avoid forming 'Kinks'. The cable drum shall in-verbally convey on wheels and the cable unrolled in right direction as indicated on the drum by the manufacturer. The cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains.

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5. Cables laid in trenches in single tier formation, 10 cms all-around sand cushioning is provided below and above the cable before a protective cover is laid. For every additional vertical tier. The 30 cm of sand cushion is provided over the initial tier. The cable shall be protected by 2nd class brick of size not less than 230 x 115 x 75mm, stone tiles / RCC curved channel be placed on top of the sand breadth wise for the full length of the cable and where more than one cable is to be laid in the same trench the brick shall cover all cables and project at least 8 cms over the outer sides of the end cables.
6. Filling of trenches shall be done after sand cushioning and tiles or bricks lying and inspection is carried out by the Employers Representative (Refer drawing). Back fill for trenches shall be filled in layer not exceeding 150 mm. Each layer shall be properly rammed & consolidated before laying the next layer.
7. RCC Hume pipes complying to IS standard shall be provided on all road crossing. The size of the pipe shall be above the size of the cable. Sizes of pipes as indicated in the layout are to be provided. The pipe shall be laid in ground with special arrangement and shall be cement jointed and concreting of 1:5:10 shall be provided as per relevant IS with latest amendment. Nothing extra shall be paid on this account. Cable route markers at interval of 30 meters and at the point of direction change shall be provided to indicate cable path. Aluminium strip cable tag of 20mm wide with engraved tag no. shall be provided at both ends of cable.
8. Where the cables are laid in ducts (trenches) inside the building, they will be laid on cable ladder / cable trays cantilever supported on trenches walls. Cables passing through floors shall be protected from mechanical damage by steel channel to a height of one meter above the floor. Metal sleeves shall be provided in the wall for crossing of cables.
9. Where the cables are laid in open (in building) along walls, ceiling or above false-ceiling, cable rack (ladder type) or cable tray shall be provided. The size of the cable tray or rack shall depend on the number of cables to pass over that rack. Cable tray/rack shall be properly supported through wall/ceiling according to the site conditions. Cable laid on tray & riser shall be neatly dressed & clamped at an interval of 1000 mm & 750mm for horizontal & vertical cable run respectively either side at each bend of cable. All power cables shall be clamped individually & control cables shall be clamped in groups of three or four cables. Clamps for multi core cables shall be fabricated of 25x3 GI flats and shall be fastened at both ends to suit the profile of the cables. All power cables above 120mm² cross sectional area shall be secured by additional cleats every 1200mm on the vertical rise. The cleats shall be fire resistant low smoke and fume of a plastic or metal construction. Single core power cable shall be laid in trefoil formation & clamped with trefoil clamps made of PVC/fiber glass.
10. Cable openings in wall/floor shall be sealed by the contractor suitably by Hessian tape & fire stop compound or by any other proven material to prevent the ingress of water and shall be suitably fire stopped.
11. After the cables are laid, shall be tested as per IS and the results submitted to the Employer's Representative and in case the results found unsatisfactory, all the repairing/ replacing of cables will be done by the contractor free of charge.

3.3.5. FIRE SEAL SYSTEM :

1. All the floor/wall openings provided for cable crossing shall be sealed by fire seal system. Sealing shall be both around containment and within containment.
2. The fire proof sealing system shall fully comply with the requirements of relevant IS/ ISO 834, ISO 1182, ISO 1716, ISO 3008, ISO 3009, ISO 3261, ISO 4736. The fire proof seal system shall comply to the fire rating of the area as per the fire compartmentation plan drawings/architectural intent layouts.
3. The fire proof seal system shall be physically, chemically, thermally stable and shall be mechanically secured to the masonry concrete members. The system shall be completely gas and smoke tight, ant rodent and anti-termite.

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4. The material used in fire proof seal system shall be non-toxic and harmless to the working personnel.
5. Type of fire proof seal system shall be mortar type or flame mastic type compound or approved equivalent. All fire stopped openings shall be checked and certified by fire stop material vendor for the integrity of the fire stop. Where cables pass through non fire rated floors or non-fire rated walls they shall be protected by a short length of heavy gauge pipe bushed with lead or hard wood at each end. When rising through a floor the protecting barrel shall project to a height of approximately 1200mm.
6. After laying and jointing work is completed, high voltage test should be applied to all cables to ensure that they have not been damaged during or after the laying operation and that there is not fault in the jointing.

3.3.6. TESTING :

1. Finished Cable Tests at Manufacture's Works:

The finished cables shall be tested at manufacturer's works. Following routine tests for each and every length of cable and copy of test results shall be furnished for each length of cable along with supply. If specified, the cables shall be tested in presence of client's representative.

2. Voltage Test for LT Cables:

Each core of cable shall be tested at room temperature at 3 KV A.C. R.M.S. for duration of 5 minutes.

3. Conductor Resistance Test:

The D.C. Resistance of each conductor shall be measured at room temperature and the results shall be corrected to 20°C. to check the compliance with the values specified in IS 8130 - 1976.

4. Cable Test Before & After Laying of Cables at Site:

a. Insulation Resistance test between phases and phase to Neutral and phase to earth.
b. Continuity test of all the phases, neutral and earth continuity conductor.
c. Sheathing continuity test.
d. Earth resistance test of all the phases and neutral.
e. Polarity test.
f. Hot pot test.
g. All site test for the FS cable for FS properties as per IEC-811

All tests shall be carried out in accordance with relevant Indian Standard Code of practice and Indian Electricity Rules. The Vendor shall provide necessary instruments, equipments and labour for conducting the above test and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the client and results shall be recorded in the prescribed forms.

3.3.7. FIELD QUALITY CONTROL :

1. Perform the following field tests and inspections and prepare test reports:
   a. Perform each visual and mechanical inspection and electrical test stated in IS, and under the specifications. Certify compliance with test parameters.

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b. After installing cables and before electrical circuitry has been energized, test for compliance with requirements.

2. The Contractor shall supply all necessary testing equipment for site testing. When required, these testing equipments shall be calibrated at the expense of the Contractor at a recognized national laboratory.

3.3.8. IT/ TELECOM CABLING SYSTEM :

1. WIRING METHODS :

a. Install cables in conduits and cable trays

b. Conceal conductors and cables in walls and floors unless otherwise agreed with the Employer's Representative.

c. Wiring within Enclosures:

- Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
- Install lacing bars and distribution spools.
- Install conductors parallel with or at right angles to sides and back of enclosure.

2. INSTALLATION OF CABLES :

a. General Requirements for Cabling:

- Comply with TIA/EIA-568-B.1.
- Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
- Install 110-style IDC termination hardware unless otherwise indicated.
- MUTOA shall not be used as a cross-connect point.
- Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors:

  i. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
  ii. Locate consolidation points for UTP at least 15 m from communications equipment room.

- Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
- Cables may not be spliced. Secure and support cables at intervals not exceeding 750 mm and not more than 150 mm from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
- Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
- Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
- Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
- In the communications equipment room, install a 3m long service loop on each end of cable.

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- Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

b. UTP Cable Installation:

a. Comply with TIA/EIA-568-B.2.

b. Do not untwist UTP cables more than 12 mm from the point of termination to maintain cable geometry.

c. Group connecting hardware for cables into separate logical fields.

d. Separation from EMI Sources:

- Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
- Separation between open communications cables or cables in nonmetallic containment and unshielded power conductors and electrical equipment shall be as follows:

i. Electrical Equipment Rating Less Than 2 kVA: A minimum of 150 mm.
ii. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 300 mm.
iii. Electrical Equipment Rating More Than 5 kVA: A minimum of 600 mm.

- Separation between communications cables in grounded metallic containment and unshielded power lines or electrical equipment shall be as follows:

i. Electrical Equipment Rating Less Than 2 kVA: A minimum of 65 mm.
ii. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 150 mm.
iii. Electrical Equipment Rating More Than 5 kVA: A minimum of 300 mm.

- Separation between communications cables in grounded metallic containment and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

i. Electrical Equipment Rating Less Than 2 kVA: No requirement.
ii. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 75 mm.
iii. Electrical Equipment Rating More Than 5 kVA: A minimum of 150 mm.

- Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 1200 mm.
- Separation between Communications Cables and Fluorescent Fixtures: A minimum of 150 mm.

3. FIRE STOPPING :

2 Hour fire stopping to be provided through all penetrations through fire rated partitions.

4. GROUNDING :

a. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

b. Comply with J-STD-607-A.

c. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 50-mm clearance behind the grounding bus bar. Connect grounding bus bar with a minimum 16mmsq grounding electrode conductor from grounding bus bar to suitable electrical building ground.

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d. Bond metallic equipment to the grounding bus bar, using not smaller than 16mmsq equipment grounding conductor.

e. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

f. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by the Employer.

g. Cable and Wire Identification:

- Label each cable within 100 mm of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

i. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
ii. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 4.5 m.
iii. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

- Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
- Label each unit and field within distribution racks and frames.

iv. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
v. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.
vi. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.
vii. Cables use flexible vinyl or polyester that flex as cables are bent.

5. FIELD QUALITY CONTROL :

Perform the following tests and inspections:

a. Visually inspect UTP jacket materials for certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.

b. Visually confirm Category 3 (Multi-stranded, Twisted Pair Telephone cable) and Category 5e marking of outlets, cover plates, outlet/connectors, and patch panels.

c. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

d. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

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- Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

e. UTP Performance Tests:

Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:

- Wire map.
- Length (physical vs. electrical, and length requirements).
- Insertion loss.
- Near-end crosstalk (NEXT) loss.
- Power sum near-end crosstalk (PSNEXT) loss.
- Equal-level far-end crosstalk (ELFEXT).
- Power sum equal-level far-end crosstalk (PSELFEXT).
- Return loss.
- Propagation delay.
- Delay skew.

f. **Final Verification Tests:**

- Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.

i. **Voice Tests:** These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.

ii. **Voice Tests:** These tests assume that the EPABX tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. Test each intercom point to ensure interphone communications. Test if STD calls are permitted from intercom.

iii. **Data Tests:** These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

- Document data for each measurement. Data for submittals shall be printed in a summary **report** that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- End-to-end cabling will be considered defective if it does not pass tests and inspections.
- Prepare test and inspection reports.

6. DEMONSTRATION :

Engage a factory-authorized service representative to train the Employer's maintenance personnel in cable-plant management operations, including changing signal pathways for

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different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets.

3.3.9. TV CABLING SYSTEM :

1. INSTALLATION :

Install signal line surge suppressors on coaxial.

2. FIELD QUALITY CONTROL :

a. Perform tests and inspections.

b. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

c. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.

d. Tests and Inspections:

- Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements.
- Replace malfunctioning or damaged items.
- Retest until satisfactory performance and conditions are achieved.
- Prepare television equipment for acceptance and operational testing.
- Use an agile receiver and signal strength meter or spectrum analyzer for testing.

e. Test Schedule: Schedule tests after pretesting has successfully been completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.

f. Operational Tests: Perform tests of operational system to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

g. Distribution System Acceptance Tests:

- **Field-Strength Instrument:** Rated for minus 40-dBmV measuring sensitivity and a frequency range of 54 to 812 MHz, minimum. Provide documentation of recent calibration against recognized standards.
- **Signal Level and Picture Quality:** Use a field-strength meter or spectrum analyzer, and a standard television receiver to measure signal levels and check picture quality at all user-interface outlets.
- **Signal-to-Noise-Ratio Test:** Use a field-strength meter to make a sequence of measurements at the output of the last distribution amplifier or of another agreed-on location in system. With system operating at normal levels, tune meter to the picture carrier frequency of each of the designated channels in turn and record the level. With signal removed and input to corresponding headend amplifier terminated at 75 ohms, measure the level of noise at same tuning settings. With meter correction factor added to last readings, differences from first set must not be less than 45 dB.
- **Qualitative and Quantitative Performance Tests:** Demonstrate reception quality of color-television program transmissions at each user interface from each designated channel and source. Quality shall be equal to or superior than that obtained with performance checks specified below, using a standard, commercial, cable-ready, color-television receiver. Level and quality of signal at each outlet and from each service and source shall comply with the following Specifications when tested according to 47 CFR 76:

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i. RF video-carrier level.
ii. Relative video-carrier level.
iii. Carrier level stability, during 60-minute and 24-hour periods.
iv. Broadband frequency response.
v. Channel frequency response.
vi. Carrier-to-noise ratio.
vii. RF visual signal-to-noise ratio.
viii. Antenna combiner insertion loss.
ix. Signal power splitter loss.
x. Cable connector attenuation.
xi. RF FM carrier level.
xii. FM frequency response.
xiii. FM carrier-to-noise ratio.

h. Prepare test and inspection reports.
i. Cap all unused connectors and seal weather tight.

3. DEMONSTRATION :

Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain MATV equipment.

a. Train Owner's maintenance personnel on procedures and schedules for troubleshooting, servicing, and maintaining equipment.
b. Demonstrate methods of determining optimum alignment and adjustment of components and settings for system controls.
c. Demonstrate programming and tuning of satellite receivers.

3.4. WIRING DEVICES & ACCESSORIES :

3.4.1. SCOPE :

The scope of work shall include Transporting, loading / unloading the wires/ conduits/ junction box/ pull boxes to complete the point wiring to project site, storing, handling, shifting, installing, testing and commissioning of all the items reflecting in Bill of Quantities & layouts.

3.4.2. INSTALLATION :

1. Comply with IS / IEC & IE rules, including the mounting heights listed in that standard, unless otherwise noted.
2. Coordination with Other Trades:
   a. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes. The Contractor shall be responsible for their part of installation and protection of the same. In case any damages are caused due to interface with other trades the Contractor shall arrange to repair the damages without any extra cost.
   b. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   c. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is flush with the face of the wall.

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d. Install wiring devices after all wall preparation, including painting, is complete.

e. All devices and circuit tagging shall be done with lamicod engraved/laminated stickers with black letter on white background after testing & commissioning of the board.

i. Conductors:

- Do not strip insulation from conductors until just before they are spliced or terminated on devices.
- Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire. Under no condition during execution contractor is allowed to cut strands to suit the termination.
- The length of free conductors at outlets for devices shall be in line with NBC/NEC requirements, without pigtails.

ii. Cable terminations to equipment shall be made one of the following methods:

- Sweated lugs of the appropriate sizes for the cable used.
- Compression type lugs.
- Pinch type screw terminations of the type that do not spread the conductors.
- Clamp type conductors.

iii. Existing Conductors:

- **Cut** back and pigtail, or replace all damaged conductors.
- Straighten conductors that remain and remove corrosion and foreign matter.
- **Pig** tailing existing conductors is permitted provided the outlet box is large enough.

iv. Device Installation:

- Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
- Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
- Do not remove surface protection, such as plastic film and smudge covers, until the last **possible** moment.
- Connect devices to branch circuits using pigtails that are not less than 6 inches in **length**.
- **When** there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
- **Use** a torque screwdriver when a torque is recommended or required by the manufacturer.
- **Tighten** unused terminal screws on the device.
- When mounting into metal boxes, remove the fibre or plastic washers used to hold **device** mounting screws in yokes, allowing metal-to-metal contact.

v. Receptacle Orientation:

- Install ground pin of vertically mounted receptacles up down, and on horizontally mounted receptacles to the right.
- Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

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3.4.3. LUMINAIRE CONNECTION :

1. In the case of fluorescent luminaires, two such conduit boxes shall be provided at appropriate fixing centres. A heat resisting flexible cord shall be connected from the terminal block to the fitting. Care shall be taken to ensure that the metalwork of the fitting is effectively earthed.
2. Final connection to each bulkhead luminaire shall be by a standard circular conduit box as per manufacturer recommendation and site requirement, mounted immediately adjacent to the wiring. Wiring of sub-circuit cables through luminaires shall not be allowed unless otherwise stated.
3. The Contractor shall ensure that all ceiling recess, fixed or plug-in, shall be accessible for maintenance and testing purposes.

3.4.4. POSITION OF LIGHTING SWITCHES :

1. Particular attention shall be given to the position of switches with reference to the hanging of doors.
2. The Employers Representative attention shall be drawn to locations where switch positions are at variance with drawings, consistent with the following conditions:-
   a. Single doors: Switches shall be located adjacent to closing style.
   b. Unequal two- Switches shall be located adjacent to leaf doors: hanging style of narrower portion of doors.
   c. Equal two-Switches shall be located adjacent to the leaf doors: left hand side of the doors on entering.
   d. Switches shall not be installed within1.5m of any water tap, wash basin or sink.

3.4.5. FUSED CONNECTION UNITS :

1. Fused connection units shall be of the switched or unswitched type, incorporating flex outlet facilities, complete with a red neon indicator light and positioned as indicated on the Tender drawings and/or Specification Section.
2. Each outlet shall be manufactured in accordance with respective codes as specified in section 1.4. Each unit shall be complete with a sheet steel box adjustable top grid and plate finished to match the lighting switches.
3. White moulded inserts and fuse holders shall be fitted to each unit, together with an appropriately rated cartridge fuse to IS 60127.
4. Where fused connection units serve remote items the Contractor shall include for the supply of an independent flex outlet with each unit. The flex outlet shall be located adjacent to the terminals of equipment being supplied.

3.4.6. 20 AMP DOUBLE POLE SWITCHES :

1. 20 amp rated double pole switches shall be provided where shown and shall be suitable for use on 240 volt 50 Hz supply.
2. Each 20 amp DP switch shall be manufactured in accordance with respective codes. Each unit shall be either flush mounting complete with recessed pressed steel box or surface mounting, as appropriate, with front plate matching the local lighting switch and small power outlets.
3. The switch plate shall incorporate, where shown, on the drawings flex outlet and/or indicator light units in addition to the 20 amp double pole switch assembly. Switches for use with water heaters shall have the plate engraved water heater.
4. Wiring terminals shall each be capable of accepting a minimum of 2 No. 4mm sq conductors.

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3.4.7. FLEX OUTLET PLATES :

1. Flex outlet plates shall be suitable for flush or surface mounting, as required, and be complete with pressed steel box and cover plate. The flex outlet plates shall be finished to match the local lighting switch and small power outlets, as indicated.
2. Each unit shall be fitted with three pairs of terminals, each being able to accommodate the required size of conductor.
3. A cord grip shall be fitted into each unit.
4. Where flex outlets are to be installed in exposed, damp or similar areas the outlets shall be of a galvanised steel pattern or other heavy duty protection

3.4.8. FILED QUALITY CONTROL :

1. Perform tests and inspections and prepare test reports.
   a. Test Instruments: Use instruments that comply with IS code.
   b. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.
   c. Perform earth loop impedance test on the power sockets on ring ckt.
2. Tests for Convenience Receptacles:
   a. Line Voltage: Acceptable range 240 ± 10%.
   b. Percent Voltage Drop: Maximum 5.8% acceptable at outlet
   c. Ground Impedance: Values of up to 2 ohms are acceptable.
   d. GFCI Trip: Test for tripping values specified in NEC 2011
   e. Using the test plug, verify that the device and its outlet box are securely mounted.
   f. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

3.5. CABLE TRAYS, TRUNKING & CONDUITS :

3.5.1. SCOPE :

The specifications are given below to enable the Design as per Form & type specified, Manufacture, Testing and Supplying of the number of panel boards appearing in the schedule of quantities.

The scope of work shall include Transporting, loading / unloading the Cable trays / Cable Ladder/ conduits to project site, storing, handling, shifting, installing, testing and commissioning of all the items reflecting in Bill of Quantities & layouts.

3.5.2. CONDUIT INSTALLATION :

1. LAYOUT :

a. Where conduits are run embedded in slab, the contractor shall agree all routing, spacing and installation details with the Structural Engineer prior to submission of shop drawings. Installation at site shall follow agreed layout exactly.

b. The conduit layout and conduit routes shall be submitted for approval. Allowance for adjustments due to site conditions shall be made at no extra cost.

c. Conduit routes shall be chosen for easy, straight runs with minimum bends and crossings. Generally they shall follow the structure of building, running at right angles or

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in parallel to floors and ceilings. Conduits shall be kept within 300 mm of floors and ceilings when running parallel to them.

d. Outlet boxes for housing accessories shall be used as draw boxes. The total number of draw boxes shall be kept to a minimum and shall be provided so that conduit runs do not exceed 12 m or have more than two right angle bends.

e. All conduits shall be kept clear of gas and water pipes. In particular, conduits shall be at least 150 mm away from gas pipes. Where proximity to these pipes is unavoidable, they shall be effectively segregated e.g. using rubber or other insulating material to prevent appreciable voltage differences at possible points of contact. Segregation from extra low voltage circuits and telecommunication circuits shall also apply unless these are wired to the same voltage requirements as lighting and power circuits.

f. Conduits from different distribution boards shall not be connected to the same junction box. Each run of conduit shall be assembled complete with draw-in-wires.

2. JONITS & TERMINATIONS :

a. Electrical and mechanical continuity shall be maintained throughout all conduit joints and terminations. Conduit threads shall be thoroughly cleaned and tightly screwed. The conduit system shall be watertight after installation.

b. Conduits shall be connected using couples or via boxes. With a coupler, the ends of the conduit shall butt close together and the running coupler is screwed tightly on and tightened by a locknut.

c. Conduits terminating into boxes provided with spouts shall be threaded so that there are no exposed threads. For boxes with no spouts, the termination shall be made using a brass bush and a coupler. The conduit is pushed through the knockout or drilled entry and the bush is screwed tightly onto its end. The coupler is screwed to butt firmly against the exterior wall of the box.

d. Where conduits are not jointed or terminated in boxes, they shall be terminated in a screwed brass bush.

e. In all joints and terminations, conduit threads shall not be exposed. Where this cannot be avoided as in a running coupler, the exposed threads shall be coated with red lead paint to seal against the ingress of water.

f. Where noted on the Contract documents conduits are to be installed with expansion joints across building expansion line joints.

g. Additional Supports for expansion joints shall be provided by the contractor as per OEM recommendations.

`At each expansion joint a suitable flexible connector is to be provided across joints to allow for expansion/contraction of at the joint. Only OEM approved jointing to be used. Contractor is deemed to have included for the same.

3. BENDS :

a. Conduits shall only be bent cold with an approved type of bending block or bending machine, without altering the dimensions of their sections.

b. All conduit bends shall be such as to permit compliance to the requirements for bends in cables to as stated in the respective codes as specified in section 1.4.

c. Bends shall be made with as large a radius as the position of the conduit within the building permits. Where the bend is more than 90 degree, circular or rectangular junction boxes are to be used for connecting conduits.

4. CABLING :

a. The conduit system must be installed free of obstructions and sharp corners before any cables are drawn in. Conduits shall be thoroughly swabbed to remove moisture and dirt immediately prior to the drawing in of cables.

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b. Cables shall be drawn without crossing each other and shall not be pulled against the walls of the draw boxes. Slack cables shall left in all draw boxes.

c. Cables shall be continuous throughout conduit lengths and no joints are permitted. There shall be no kink in cables, neither any cut, abrasion or chink in the cable insulation.

d. The same conduit shall carry the lead and return conductors bunched together. However, the same conduit shall not house cables from different distribution boards.

e. Cables for power and lighting circuits and extra low voltage systems shall not be drawn into the same conduit. Lighting and power circuits shall run in separate conduits except, where an adapter box is employed as final distribution point, a number of final circuits are grouped together in larger conduits between the distribution board and the adapter box provided that all final circuits in one conduit are of the same phase. In the case of three phase circuits, all three phases including neutral, if any, shall be drawn into the same conduit.

f. Conduits shall not constitute the earth continuity path for the electrical circuit. A separate circuit protective conductor shall be installed within the conduit. The whole conduit system shall be effectively earthed.

g. Flexible conduits shall have a separate earthing conductor installed within the tubing and connected at conduit ends. Flexible conduits in general shall not be used for more than 3m length.

h. Maximum number of PVC insulated 650/1100 V grade/copper conductor cable that can be taken in Rigid Metallic or Rigid Non metallic conduit shall be as per NBC 2005, Part 8 Building Services – Section 2 Electrical and Allied Installation ,Table -1 Clause 6.10.1 and 6.10.3.2

5. ACCESS AND DRAINAGE :

a. The conduit system shall be rewirable, that is, draw boxes must be accessible for the purpose. Where boxes are concealed, their covers shall be flushed with the finished surface.

b. The need for accessibility notwithstanding, the conduit system shall be protected against the ingress of water and impurities. When installed, conduits shall be kept dry and free of debris with approved pipe plugs or caps. Such plugging is especially essential prior to pouring concrete for concealed installation. As for boxes, they shall be covered by steel plates prior to concreting.

c. When installed outdoor, and in situations liable to condensation of moisture, conduits shall be arranged to be self draining, so that water may drain to low points which are fitted with a drain plug. Conduits laid under concrete floors shall have watertight floor-traps of approved detail for access of these drainage points.

d. Conduits run on surfaces other than structural steel members shall be secured using galvanized space bar saddles and brass fixing screws. Spacing of saddles shall not exceed 1.2 m for conduit sizes up to and including 25 mm and 1.8 m for sizes 32 mm and above.

e. Conduits run on structural steel shall be secured using girder clips or an approved clamp. These conduits and those run in the vicinity of structural steel shall be bonded to the steelwork using an efficient and permanent metallic connection. The conduits shall not in any way be under mechanical stress.

f. All conduit boxes except loop-in patterns shall be fixed direct to the building structure in addition to the support provided by the conduits.

g. Conduits terminating into surface boxes shall be secured by a minimum of 3 saddles at not less than 32 mm, 150 mm and 300 mm respectively from the box.

h. Conduits shall be painted with an approved paint to blend with visual environment. A zinc rich undercoat shall be provided before painting the final coat.

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3.5.3. CABLE TRAY :

1. Cable tray shall be perforated type and construction with minimum 2.0 mm hot dipped galvanized mild steel for outdoor damp condition, and heavy-duty hot dipped galvanized hot rolled mild steel for indoors. All cable trays shall be installed in a straight run parallel to walls where possible.
2. Cable trays shall be supported by electro-galvanized 'U' channel with galvanized threaded rod for indoor suspended tray and hot-dipped galvanized for area subject to weather.
3. All hangers shall be installed at 1 meter interval and shall be applied primer and painted to match with the surrounding building finish approved by the Employers Representative-in-charge.
4. The cable trays those are exposed to the weather, a hot-dip galvanized cover of 1.5mm gauge steel, flush fixing type with gasket, shall be installed on top of the tray.
5. Depending on the size of cable trays spare space of 25% shall be maintained for future expansion.
6. Copper earth link bar shall be fixed at every joint of the cable tray run.
7. Expansion joint to be provided of maximum 100mm at the places of structural expansion joint and specification of material shall be same as of cable tray.

3.5.4. CABLE LADDER :

1. All cable ladders and accessories installed indoors shall be heavy-duty hot dipped galvanized hot rolled mild steel. All cable ladders installed outdoors shall be heavy-duty hot dipped galvanized hot rolled mild steel. Thickness of the mild steel shall not be less than 2 mm.
2. Cable ladder shall have a 150 mm high longitudinal side member for ladders width of 800 mm or above and 120 mm high longitudinal side member for ladder width less than 800 mm.
3. The rugs shall be at least 50 mm wide, with slots of 25 mm x 10 mm at 25 mm intervals covering the length of the rugs. The rugs shall be space at 300 mm apart along straight lengths of the ladder.
4. All nuts, bolts and washers for clips and brackets shall be zinc plated. Each cable ladder shall be in standard manufacturer's length and supplied complete with coupling sets consisting of fishplates, spine bolts, and nuts and locking washers.
5. The complete cable ladder installation shall be provided with all necessary proprietary factory-made elbows, risers, reducers, tees, crosses, drop-outs, etc. and any site fabricated items will not be permitted.
6. Separate flexible earth continuity connectors of at least 16mm2 copper jumpers shall be installed between the ladder sections.
7. All cables ladders shall be supported from the ceiling concrete slab, steel structures or sidewalls using a frame system, with overhead hangers, support channels, hanger rods or angle brackets, beam clams and ceiling brackets.
8. Fixings and supports shall be installed at regular intervals not exceeding 1000 mm and 150 mm from all bends, tees, inter-sections and risers.
9. When cable ladder is refined to install across structure expansion joints, the ladder shall be in two sections between supports installed on either side of the expansion joint.
10. The ladder sections shall than be jointed with expansion joint fishplates, bolts, nuts and washers install in elongated holes permitting a lengthwise movement of 25 mm from the initial fastening position.
11. For cable ladder that are exposed to the weather, hot-dip galvanized cover of 1.5mm gauge steel, flush fixing type with gasket, shall be installed on top of the ladder.
12. Copper earth link bar shall be fixed at every joint of the cable ladder run.

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3.5.5. CABLES TRUNKING :

1. All trunking shall have removable lids extending over their entire lengths. Lids shall be fixed at interval not exceeding 1 meter by means of brass steel screws which and protected against corrosion by a finish of zinc coating or equivalent to zinc coating.
2. Factory-made bends, joints, elbow, riser, tee, reducer and accessories with same material shall be provided throughout the installation for trunking.
3. Trunking space factor shall be in compliance with latest IS standards.
4. Copper earth link bar shall be fixed at every joint of the cable trunking run.
5. For connection detail from embedded conduit to trunking, contractor to refer to the standard detail sheet.

3.5.6. CONNECTIONS :

1. Ground cable trays according to manufacturer's written instructions / Dwg & Standards.
2. Install an insulated equipment grounding conductor with cable tray, in addition to those required by IS 732, IS 3043 and NBC.

3.5.7. FIELD QUALITY CONTROL :

After installing conduit, cable trays, trunking and after electrical circuitry has been energized, survey for compliance with requirements. Perform the following field quality-control survey:

1. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in conduit cable tray, trunking. vibration, and thermal expansion and contraction conditions, which may cause or have caused damage.
2. Verify that the number, size, and voltage of cables in conduit, cable tray, and trunking do not exceed that permitted by NBC/NEC. Verify that communication or data-processing circuits are separated from power circuits by barriers.
3. Verify that there is no intrusion of such items as pipe, hangers, or other equipment that could damage cables.
4. Remove deposits of dust, industrial process materials, trash of any description, and any blockage of tray ventilation.
5. Visually inspect each conduit, cable tray, trunking joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and re-torque in suspect areas.
6. Check for missing or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
7. Perform visual and mechanical checks for adequacy of conduit, cable tray, trunking grounding; verify that all take off raceways are bonded to conduit cable tray & trunking.

3.5.8. PROTECTION :

Protect installed conduit, cable trays & trunking.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touch up coating recommended by manufacturer.
3. Install temporary protection for cables in open trays to protect exposed cables from falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials until the risk of damage is over.

3.6. EARTHING SYSTEM :

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3.6.1. SCOPE :

The scope of work shall include Transporting, loading / unloading the Earthing pit material, Strips/ cables/ wires for equipotential bonding etc. to project site, storing, handling, shifting, installing, testing and commissioning of all the items reflecting in Bill of Quantities & layouts

3.6.2. APPLICATIONS :

1. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
    a. Install bus on insulated spacers 50mm minimum from wall, 300mm above finished floor unless otherwise indicated.
    b. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.
2. Conductor Terminations and Connections:
    a. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
    b. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
    c. Connections to Structural Steel: Welded connectors.
3. It shall be noted that wherever conductors pass through walls or floors etc., they shall do so via an insulated sleeve provided and installed under this Contract.
4. It shall also be noted that all trunking or trays containing ELV, communication or data/CCMS signals shall be electrically continuous and bonded at one single point (at the start of the run). Earthing arrangements shall not form networks or loops along the trunking or tray such that induced circulating currents can flow.
5. All cable glands shall be complete with a proprietary earthing tag from which a bond shall be extended to the panel earth bar. The earthing system shall be installed in accordance with all sections of the specification and as indicated on the drawings.
6. Typical details are indicated on the typical earthing drawing. Installation to comply with requirements of specification and local supply authority. Provide dedicated CPC for every main, sub-main and final circuit conductor. All conductors to shall be banded indicating which items they serve.
    a. An equipotential bond shall emanate from each main LV earth bar to bond incoming services, structure and main building services engineering systems (i.e. whole project services) etc. and bonded at each floor level or area onto the distribution centre for that floor or area where these distribute through the building.
    b. The equipotential bonds to building services engineering systems shall emanate from the substation or main LV intake panel, i.e. ladder rack, trunking, tray, water main, fire/sprinkler main, gas and oil pipework, steam etc.
    c. Where services emanate from plant areas i.e. ductwork, HWS, DHS, chilled water, etc., the equipotential bond shall be made to the earth bar of the switchgear or motor control panel serving that area. The cable shall terminate in a tag, in turn clamped to the metallic ductwork or pipework.
    d. If not indicated on the drawing, conductor sizes shall be a minimum of 25x3mm GI tape for equipotential bond and 6 sq.mm. braided Cu cable for supplementary bonds. Equipotential and Supplementary bonds shall also be provided in any generator area.
    e. The main equipotential bonding conductors shall be PVC sheathed with copper/Aluminium conductors, sheathing coloured green and yellow. The bonding connection to the mechanical services being with sweated or crimped lugs onto a purpose made connection point on ductwork or the like or purpose made GI clamp to pipework. Main equipotential bonding conductors shall conform with NEC 2011.

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f. This Contract shall include for the installation of all supplementary bonding in wet areas, etc. necessary to comply with NEC 2011.

g. All metal sinks, work surfaces (in kitchens etc.), tanks, exposed pipework, etc., shall be supplementary bonded under this Contract to the earth terminal of an adjacent socket outlet or accessory on a power circuit using green/yellow PVC insulated cable in accordance with the NEC 2011. The earth wire shall be installed in flush conduit terminating at low level with 50.8mm fixing centre conduit box fitted with a bushed dome lid. The supply and installation of all necessary bonding terminals to the sinks, tanks, etc., shall be included in this Contract.

h. Other Items shall be bonded or earthed as applicable, unless otherwise stated. The Contractor shall include for the testing for earth continuity of all extraneous conductive parts where work has been undertaken under this Contract.

i. The Contractor shall include for all continuity links between services run on tray and conduits to the final outlet points. The Contractor shall include for bonding all equipment. The Contractor shall include for bonding the LV intake earth bar to the lightning protection installation. Any Functional Earths provided shall be coloured cream to BS.6736C and sized in accordance with their intended application.

3.6.3. EQUIPMENT GROUNDING :

1. Install insulated equipment grounding conductors with all feeders and branch circuits.
2. Install insulated equipment grounding conductors with the following items, in addition to those required by IS 732 and IS 3043:
   a. Feeders and branch circuits.
   b. Lighting circuits.
   c. Receptacle circuits.
   d. Single-phase motor and appliance branch circuits.
   e. Three-phase motor and appliance branch circuits.
   f. Flexible raceway runs.
   g. Armoured and metal-clad cable runs.
   h. Bus way Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on bus way.
   i. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power distribution units.
3. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 230 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
4. Isolated Grounding Socket Circuits: Install an insulated equipment grounding conductor connected to the Socket grounding terminal. Isolate conductor from raceway and from panel board grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
5. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panel board grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

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6. Signal and Communication Equipment: In addition to grounding and bonding required by IS 732 and IS 3043, provide a separate grounding system complying with requirements of communication system.
    a. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
    b. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
7. Metal and Wood Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.7. LIGHTNING PROTECTION SYSTEM :

3.7.1. SCOPE :

The scope of work shall include Transporting, loading / unloading the material as GI Strips/ cables/ Stainless steel lugs / Cu wires for equipotential bonding, lighting strike pads, lightning rods etc. for lightning protection system to project site, storing, handling, shifting, installing, testing and commissioning of all the items reflecting in Bill of Quantities & layouts

3.7.2. INSPECTION :

Examine conditions where lightning protection system is to be installed. Notify the Employers Representative in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.7.3. INSTALLATION :

1. Install lightning protection system as per approved scheme from client & consultant & indicated, in accordance with manufacturer's written instructions, and in accordance with local authority requirements to ensure that installation complies with requirements and serves intended function.
2. Coordinate as necessary to interface installation of the lightning protection system with the building architecture, Façade, structure, roof equipment and earthing.
3. Install conductors with more than one direct path from air termination to earth connections avoiding sharp bends and narrow loops. Conceal all conductor drops to earth within building structure as indicated. Provide flush cable support boxes with gaskets and bolted cast covers, finish as directed by the Employer’s Representative.
4. Properly guard and protect all work installed in accessible locations.
5. Install all material in a manner to prevent electrolytic action under the presence of moisture. Bond metallic projections on every roof. Route perimeter conductors on the set back roofs as required. Connect perimeter conductor/air terminal systems to steel reinforcing column system as indicated on the drawing / manufactures requirement/ site requirement.
6. Make all roofs, wall or other penetration in a manner to prevent the ingress of water or moisture.
7. Install lightning protection system so that completed work is unobtrusive and does not detract from the building's appearance.
8. Make installation in a manner to eliminate possibility of displacement and subsequent maintenance.
9. Make all connections mechanically and electrically sound and clean all bonding surfaces just prior to attachment.
10. Conductors

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a. Tape on flat roof areas shall be run exposed. Fasteners shall be fixed in accordance with Standard specified in section 1.4 and manufacturer's recommendations. Color of tape sheath and fasteners to be white and agreed with the Employer's Representative.

3.7.4. FIELD QUALITY CONTROL :

1. Upon completion of lightning protection system, test system to demonstrate compliance with specifications. When possible, field-correct defective equipment, then retest to demonstrate compliance. Replace equipment which cannot be satisfactorily corrected at no additional cost to the Employers Representative.
2. Check continuity of entire system.
3. Inspect all connections prior to concealing same and ensure compliance with all applicable standards.
4. Perform an earth resistance test immediately after driving earthing (ground) rods and furnish test results to Employers Representative.
5. Install equipment under direct supervision of the equipment manufacturer's factory representative.
6. Fully test the complete lightning protection system in the presence of the Employers Representative to demonstrate continuity of all conductors. Submit a written test report in format approved by Employers Representative.

3.7.5. CORROSION PROTECTION :

1. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
2. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.7.6. CLEANING & PROTECTION :

1. Upon completion of the Work, remove unused materials, debris, containers and equipment from the project site.
2. Protect the Work during the construction period so that it will be without any indication of use or damage at the time of acceptance.

3.7.7. TRANSIENT-VOLTAGE SURGE SUPPRESSION :

1. EXAMINATION :

Examine elements and surfaces to receive switchgear for compliance with requirements for installation tolerances, required clearances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

2. INSTALLATION :

b. Install TVSS devices at service entrance on load side, with ground lead bonded to service entrance ground.

c. Install TVSS devices for panel boards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

d. Provide multiple, circuit breakers as a dedicated disconnecting means for TVSS unless otherwise indicated.

3. CONNECTIONS :

Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values.

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4. FIELD QUALITY CONTROL :

a. **Testing Agency:** Engage a qualified testing agency to perform tests and inspections.

b. **Manufacturer's Field Service:** Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

Verify that electrical wiring installation complies with manufacturer's written installation requirements.

c. Perform tests and inspections.

Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

d. Tests and Inspections:

Perform each visual, mechanical inspection and electrical test stated in Standards.

After installing TVSS devices but before electrical circuitry has been energized, test for compliance with requirements.

Complete startup checks according to manufacturer's written instructions.

e. TVSS device will be considered defective if it does not pass tests and inspections.

f. Prepare test and inspection reports.

5. CLEANING :

Vacuum dirt and debris; do not use compressed air to assist in cleaning.

6. PROTECTION :

Provide final protection to ensure that moisture does not enter bus assembly.

7. DEMONSTRATION :

a. General: Manufacturer’s factory-authorized service representative to train Owner’s personnel in the operation of the Unit.

b. Equipment: Check operation of each unit with Owner’s personnel present and before Substantial Completion. Determine that operational systems and devices are functioning properly.

c. Instruction: Instruct Owner's personnel in proper use, maintenance, adjustment, and repair of each system.

3.8. INVERTER BASED EMERGENCY LIGHTING SYSTEM :

3.8.1. SCOPE :

The scope of work shall include Transporting, loading / unloading the inverters along with battery Bank & Battery rack to project site, storing, handling, shifting, installing, testing and commissioning of all the items reflecting in Bill of Quantities & layouts,

3.8.2. STATIC INVERTER UNIT :

1. INSTALLATION :

a. Install freestanding equipment as per site condition.

b. Examine areas and conditions, with Installer present, for compliance with requirements for conditions affecting performance of the Inverter.

c. Proceed with installation only after unsatisfactory conditions have been corrected.

2. EXAMINATION :

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d. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions, Client equipment layout and IS/IE Standards.

e. Connections: Interconnect system components. Make connections to supply and load a circuit according to manufacturer's wiring diagrams unless otherwise indicated.

3. FIELD QUALITY CONTROL :

a. **Testing Agency:** A qualified testing agency to perform tests and inspections.

b. **Manufacturer's Field Service:** Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

c. **Perform tests and inspections**.

- Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

d. Tests and Inspections:

- Comply with manufacturer's written instructions.
- Inspect interiors of enclosures, including the following:
  i. Integrity of mechanical and electrical connections.
  ii. Component type and labelling verification.
  iii. Ratings of installed components.
- Inspect batteries and chargers according to OEM requirements.
- Test manual and automatic operational features and system protective and alarm functions.
- Test communication of status and alarms to remote monitoring equipment.
- Load the system using a variable-load bank to simulate kilovolt amperes, kilowatts, and power factor of loads for unit's rating. Use instruments calibrated within the previous six months according to NIST standards.
  i. Simulate malfunctions to verify protective device operation.
  ii. Test duration of supply
  iii. Test remote status and alarm panel functions.
  iv. Test battery-monitoring system functions.

4. DEMONSTRATION :

a. General: Manufacturer's factory-authorized service representative to train the Employer's personnel in the operation of the UPS systems.

b. Equipment: Check operation of each unit with the Employer's personnel present and before Substantial Completion. Determine that operational systems and devices are functioning properly.

c. Instruction: Instruct the Employer's personnel in proper use, maintenance, adjustment, and repair of each system.

3.8.3. BATTERIES :

1. GENERAL :

Batteries shall be contained in an enclosure or rack mounted as indicated and colour coded.

Where batteries are not in an enclosure, insulating covers shall be provided over all cell terminals and inter-connections. All leads shall be insulated and colour coded.

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Batteries shall be maintained in a good condition on site with all necessary precautions being taken to prevent deterioration; they shall be handed over at the completion of the works, fully charged.

Batteries shall be stored as recommended by the supplier.

The unit shall usually operate in a normal ambient of 40°C.

2. INSTALLATION :

a. The overall system shall be installed to the manufacturers recommendations and comply with BS 5266.

b. Emergency lighting wiring shall not be drawn into the same conduit, trunking compartment or ducting compartment as cables of other Category 3 circuits (NEC 2011). The cores of emergency lighting circuits shall not be contained within the same multi-core cable, flexible cable or flexible cord as cores of any other circuits.

c. Wiring for emergency lighting circuits shall be carried out using normal fire retardant PVC wires in embedded Heavy Mechaical Strength (HMS) type PVC conduits. This includes all wiring between emergency distribution boards and final circuit wiring.

3. EMERGENCY LIGHTING SYSTEM :

a. All outgoing circuits from the final distribution boards shall not exceed 200 metres in length.

b. The system design shall be such that, when a normal Utility Power Supply fails the dedicated emergency fittings shall be powered from the inverter supply without the power break-up.

c. Red coloured rock roses and final termination to emergency lights to be provided.

d. Distribution cables from the output of the Central Inverter system to the sub-circuit and final circuit emergency lighting distribution boards shall all be Fire Retardant PVC cables/wires.

4. CONNECTIONS :

Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values. Provide tabulated tightening values after installation and include calibration certification for torque tightening wrench. As required part/complete process shall be witnessed by the Employer’s Representative.

5. FIELD QUALITY CONTROL :

Prepare for acceptance tests as follows (All process to be witnessed by the Employer’s Representative):

a. Full after-dark emergency illumination testing. Contractor to provide calibrated light meter with calibrated sensitivity to 0.1lux – 100lux. To avoid shadowing the meters head shall be on 1m chord. Contractor to produce meters calibration certification prior to each testing exercise.

b. 30 minutes partial discharge of the system (and automatic reinstatement)

c. 90 minutes full discharge of the system (and automatic reinstatement)

d. Test continuity of each circuit.

e. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

- Inspect wiring, components, connections, and equipment installation.
- Remove and replace malfunctioning components, connections and equipment and retest.

6. CLEANING :

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Vacuum dirt and debris; do not use compressed air to assist in cleaning.

7. DEMONSTRATION :

a. General: Manufacturer's factory-authorized service representative to train the Employer's personnel in the operation of the Unit.

b. Equipment: Check operation of each unit with the Employer's personnel present and before Substantial Completion. Determine that operational systems and devices are functioning properly.

c. Instruction: Instruct the Employer's personnel in proper use, maintenance, adjustment, and repair of each system.

8. THE FOLLOWING BEFORE HANDING OVER:

a. All Technical Schedules duly filled-in and signed.

b. O&M MANUAL WITH BELOW DETAILS

- Outline General Arrangement, Sectional and Detail drawings for equipment.
- Drawings showing the construction of the equipment and terminal arrangements with details of all accessories.
- Single Line Diagram showing all the auxiliary devices and their connection
- Details of Cable termination and fittings
- Details of anti-corrosion protection and painting specification
- Setting up Commissioning and Operating Instructions
- Maintenance Instructions including Schedules for preventive maintenance & Trouble Shooting Procedure
- Detailed Technical Specification & Catalogue
- Testing Schedule Procedures & All Test results duly signed off by the Employer's Representative. Complete recommended Spare part List including manufacturer's name and Catalogue Number with all required re-ordering information.
- A set of required maintenance tools.

3.9. HANGERS & SUPPORT FOR ELECTRICAL SYSTEM :

3.9.1. SCOPE :

The scope of work shall include Transporting, loading / unloading the hanger & support system to project site, storing, handling, shifting, installing, testing and commissioning for all the items reflecting in Bill of Quantities & layouts,

3.9.2. APPLICATION :

1. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NEC 2011 and relevant IS codes. Minimum rod size shall be 1/4 inch in diameter. Supports shall be selected based on loading as per manufacturers recommendation. Support for busduct including sway movement, seismic and expansion joint.
2. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
3. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2inchand smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

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3.9.3. SUPPORT INSTALLATION :

1. Raceway Support Methods: In addition to methods described in relevant IS / NBC codes supports may be supported by openings through structure members (any such proposal must be first submitted by the Contractor as a technical submittal for approved by the project Structural engineer.
2. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lbs (91 KG).
3. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
    a. To Wood: Fasten with lag screws or through bolts.
    b. To New Concrete: Bolt to concrete inserts.
    c. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
    d. To Existing Concrete: Expansion anchor fasteners.
    e. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
    f. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
    g. To Light Steel: Machine screws.
    h. To GI steel: GI screws shall be permitted.
    i. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
    j. To Light Steel: Sheet metal screws.
    k. Items Mounted on Hollow Walls and Non-structural Building Surfaces: Mount cabinets, panel boards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
    l. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.9.4. INSTALLATION OF FABRICATED METAL SUPPORTS :

1. Comply with installation requirements for site-fabricated metal supports.
2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
3. Field Welding: Comply with AWS D1.1/D1.1M.

3.9.5. CONCRETE BASES :

1. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
2. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."
3. Anchor equipment to concrete base.

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a. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

b. Install anchor bolts to elevations required for proper attachment to supported equipment.

c. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.9.6. PAINTING :

1. **Touch up:** Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting.
2. **Galvanized Surfaces:** Clean welds, bolted connections, and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

3.10. IDENTIFICATION FOR ELECTRICAL SYSTEM :

3.10.1. SCOPE :

The scope of work shall include Transporting, loading / unloading the identification products to project site, storing, handling, shifting, installing, checking for all the items reflecting in Bill of Quantities & layouts,

3.10.2. INSTALLATION :

1. Verify identity of each item before installing identification products.
2. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
3. Apply identification devices to surfaces that require finish after completing finish work.
4. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
5. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
6. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 20 maximum intervals in straight runs, and at 10m maximum intervals in congested areas.
7. Aluminium Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
8. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
   a. Outdoors: UV-stabilized nylon.
   b. In Spaces Handling Environmental Air: Plenum rated.

3.10.3. IDENTIFICATION SCHEDULE :

1. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Provide safety labelling
2. Accessible Raceways, Armorer and Metal-Clad Cables, More Than 600 V: Self-adhesive vinyl labels. Install labels at 10m maximum intervals.
3. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 240 V to ground: Identify with self-adhesive vinyl label. Install labels at 10m maximum intervals.

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4. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
   a. Emergency Power.
   b. Power.
   c. UPS.
5. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and hand holes, use color-coding conductor tape to identify the phase.
   a. **Color-Coding for Phase and Voltage Level Identification, 600 V or Less:** Use colors listed below for ungrounded service feeder and branch-circuit conductors.
      - Color shall be factory applied.
      - Colors for 415V / 240-V Circuits:
      - To IS code
      - Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for minimum distance of 150mm from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
   b. **Power-Circuit Conductor Identification, More than 600 V:** For conductors in vaults, pull and junction boxes, manholes, and handholes, use write-on tags.
      - Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
      - Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.
   c. **Auxiliary Electrical Systems Conductor Identification:** Identify field-installed alarm, control, and signal connections.
      - Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
      - Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
      - Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the
      - Operation and Maintenance Manual.
   d. **Locations of Underground Lines**: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
      - Limit use of underground-line warning tape to direct-buried cables.
      - Install underground-line warning tape for both direct-buried cables and cables in raceway.
   e. **Workspace Indication:** Install floor marking tape to show working clearances in the direction of access to live parts. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
   f. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
      - Comply with NBC/ NEC 2011 / respective codes as specified in section 1.4 for signage requirements
      - Identify system voltage with black letters on an orange background.

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- Apply to exterior of door, cover, or other access.
- For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
  i. Power transfer switches.
  ii. Controls with external control power connections.
  iii. Insert items.

g. **Operating Instruction Signs:** Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

h. **Emergency Operating Instruction Signs:** Install instruction signs with white legend on a red background with minimum 10mm - high letters for emergency instructions at equipment used for power transfer and generation.

i. **Equipment Identification Labels:** On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

j. Labeling Instructions:

- Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 12mm - high letters on 40mm - high label; where two lines of text are required, use labels 50mm high.
- Outdoor Equipment: Engraved, laminated acrylic or melamine label.
- Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
- Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

k. Equipment to Be Labelled:

- Panel boards: Typewritten directory of circuits in the location provided by panel board manufacturer. Panel board identification shall be engraved, laminated acrylic or melamine label.
- Enclosures and electrical cabinets.
- Access doors and panels for concealed electrical items.
- Switchgear.
- Switchboards.
- Emergency system boxes and enclosures.
- Motor-control centre's.
- Enclosed switches.
- Enclosed circuit breakers.
- Enclosed controllers.
- Variable-speed controllers.
- Push-button stations.

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- Power transfer equipment.
- Contactors.
- Remote-controlled switches, dimmer modules, and control devices.
- Battery-inverter units.
- Monitoring and control equipment.
- UPS equipment.

3.11. HANDING OVER / TAKING OVER:

After completion of works and tests specified above, the various installations of the project can be taken over by the employer as and when these are ready in all respects. The defect liability period of 12 months shall start from the date, when all the installations of the project have been executed, tested as described above, successfully commissioned and handed over.

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SECTION – C & D

SCHEDULE OF TECHNICAL REQUIREMENTS AND INFORMATION REQUIRED FROM TENDERER

BUROHAPPOLD ENGINEERING

P0	09.10.2015	Electrical Tender	JV			LODHA
Rev	Date	Revision	Prepared By	Checked By	Approved by	Client

SECTION - C & D "Schedule of Technical Requirements & Information Required From Tenderer"

LT & CONTROL CABLES

Sr. No.	Content	TENDER SPECS	Vendor Data.	Remarks / Deviations if Any
1	**General**			
1.1	Voltage Grade	1.1 KV grade		
1.2	No. of Conductors & Size of Conductors.	As Specified in the Tender Package		
1.3	Cable Type	As Specified in the Tender Package		
1.4	Operating Frequency	50 Hz		
2	**Construction Details**			
2.1	Conductor			
2.2	Material	Vendor to furnish		
2.3	Construction	Vendor to furnish		
2.4	No. & Dia of wires per Core	Vendor to furnish		
2.5	Conductor Screen			
2.6	Material	Vendor to furnish		
2.7	Thickness	Vendor to furnish		
2.8	Insulation			
2.9	Material	Vendor to furnish		
2.10	Thickness	Vendor to furnish		
2.11	Core identification Method	Vendor to furnish		
2.12	Insulation Screen			
2.13	Material	Vendor to furnish		
2.14	Thickness	Vendor to furnish		
2.15	Inner Sheath			
2.16	Type & Material	Vendor to furnish		
2.17	Thickness	Vendor to furnish		
2.18	Armouring	Vendor to furnish		
2.19	Type & Material	Vendor to furnish		
2.20	Diameter of wire / Strip Thickness	Vendor to furnish		
2.21	Outer Sheath	Vendor to furnish		
2.22	Material	Vendor to furnish		
2.23	Thickness	Vendor to furnish		
3	**Electrical Data**			
3.1	Continous current raring when laid in Air at 40 deg C.	Vendor to furnish		
3.2	Continous current raring when laid in Ground at 30 deg C..	Vendor to furnish		
3.3	Short Circuit Current For 1 sec.	Vendor to furnish		
3.4	Resistance At Operating Temp. (Ohm / KM)	Vendor to furnish		
3.5	Reactance At 50 C/S (Ohm/KM)	Vendor to furnish		
3.6	Capacitance (F/Km)	Vendor to furnish		
3.7	Insulation Resistance	Vendor to furnish		
3.8	Recommended temperature below which installation of cable should not be carried out.	Vendor to furnish		
3.9	Maxi unsupporte run of cable both horizontally & vertically.	Vendor to furnish		
3.10	Derating of cable for following Ambient temperature.	Vendor to furnish		
3.11	a) Ground :	Vendor to furnish		
3.12	i) at 30°C	Vendor to furnish		
3.13	ii) at 35°C	Vendor to furnish		
3.14	iii) at 40°C	Vendor to furnish		
3.15	iv) at 45°C	Vendor to furnish		
3.16	v) at 50°C	Vendor to furnish		
3.17	b) Air :	Vendor to furnish		
3.18	i) at 30°C	Vendor to furnish		
3.19	ii) at 35°C	Vendor to furnish		
3.20	iii) at 40°C	Vendor to furnish		
3.21	iv) at 45°C	Vendor to furnish		
3.22	v) at 50°C	Vendor to furnish		
3.23	c) Duct :	Vendor to furnish		
3.24	i) at 30°C	Vendor to furnish		
3.25	ii) at 35°C	Vendor to furnish		
3.26	iii) at 40°C	Vendor to furnish		
3.27	iv) at 45°C	Vendor to furnish		
3.28	v) at 50°C	Vendor to furnish		
3.29	Group factor for following No. of cables laid in Trefoil.	Vendor to furnish		
3.30	a) Touching :	Vendor to furnish		
3.31	i) 3 numbers	Vendor to furnish		
3.32	ii) 4 numbers	Vendor to furnish		
3.33	iii) 5 numbers	Vendor to furnish		
3.34	iv) 6 numbers	Vendor to furnish		
3.35	b) 2 x dia centre to centre apart :	Vendor to furnish		
3.36	i) 3 numbers	Vendor to furnish		
3.37	ii) 4 numbers	Vendor to furnish		
3.38	iii) 5 numbers	Vendor to furnish		
3.39	iv) 6 numbers	Vendor to furnish		
4	**Mechanical Data**			
4.1	Overall diameter of Cable	Vendor to furnish		
4.2	Weight Of Cables Per KM	Vendor to furnish		
4.3	Minimum Bending Radius	Vendor to furnish		
4.4	Maximum Pulling Tension	Vendor to furnish		

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SECTION - C & D "Schedule of Technical Requirements & Information Required From Tenderer"				
LT & CONTROL CABLES				
Sr. No.	**Content**	**TENDER SPECS**	**Vendor Data.**	**Remarks / Deviations if Any**
4.5	Standard Drum Length	Vendor to furnish		
4.6	Tolerance On Drum Length	Vendor to furnish		

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SECTION - C & D "Schedule of Technical Requirements & Information Required From Tenderer"

LT PANELS

Sr. No.	Content	TENDER SPECS	Vendor Data.	Remarks / Deviations if Any
1	**CONSTRUCTION**			
	Sheet Steel Thickness			
	a) Door	1.6 mm		
	b) Frame	2 mm		
	c) Others	1.6 mm		
	Lifting Lugs	Required		
	Cable Entry			
	a) Incoming – Bottom / Top	Top (Bus Duct) & Top (Cables)		
	b) Outgoing – Bottom / Top	Top		
	Interpanel Barrier	Vendor to furnish		
	Switchboard Construction	Bolted Type (Shipping Section) Form 4, Type 6		
	a) Maximum No. of ACB and SFU Feeders in one Panel	Vendor to furnish		
	b) Depth-Uniform or different depth	Uniform		
	c) Extensibility at both ends of Panel	To be Provided		
	Painting			
	a) Type	Epoxy Powder coated		
	b) Shade	As per specifications		
	Dimension and General Arrangement Details			
	a) Overall Dimension for	Vendor to furnish		
	b) Number of Panels	Vendor to furnish		
	c) G.A. Drawing with internal control wiring details, Panel foundation details and front face layout	Vendor to furnish		
	Degree of Protection	**As per SLDs**		
2	**BUSBARS**			
	Main Busbar Chambers Position	Top		
	Material	As per specifications		
	Current Rating	As per SLDs		
	Size – Main Busbars			
	a) Phase	Vendor to furnish		
	b) Neutral (100%) same as that of Phase.	Vendor to furnish		
	Fault Level (sym.)	As per SLDs		
	Access to Main Busbar Chamber for Maintenance	Sides		
3	**BUSDUCT DETAILS**			
	Entry	From Top		
	Busbar Crossover – in Switchgear or Outside	Vendor to furnish		
	Busbar Flange details for Busduct connection	Vendor to furnish		
4	**COMPONENTS**			
	Breakers			
	a) Make	As per approved makes		
	b) Rating	As per SLD		
	c) Type Ref. No.	Vendor to furnish		
	d) Drawout / Fixed Type	Drawout		
	e) Spring Charging - Manually Operated / Motor Operated	Motor Operated .		
	f) Shunt Trip Coil	Required		
	g) Closing Coil	Required		
	h) Anti-Pumping			
	- Electrical	Required		
	i) Releases	Required for outgoing feeder		
	j) Castell Key Interlock	As per SLD		
	k) 4 Pole / TP + NL	As per SLD		
	Protective Relays	As per SLD		
	a) Drawout / Fixed Type	Drawout		
	Meters/ Switches/Fuses/ Contactors			
	Digital meters			
	a) Type and Make	As per approved makes		
	b) Rated for 1 Amp. CT Secondary / 5 Amp. CT Secondary	**As per SLD**		
	Voltmeter			
	a) Type and Make	As per approved makes		
	b) Rated for Volts	415 Volts		
	c) Range	0 – 500 Volts		
	Switches			
	a) Type and Make	Double break type		
	b) Heavy Duty / Motor Duty (AC-23)	Heavy Duty AC-23 Only		
	c) Interlocking with Door + Defeat Interlocking facility	Required		
	d) Padlocking in OFF Position	Required		
	e) Shrouding of Incoming Terminal	Required		
	Fuses			
	a) Type – Link / Dised	Link Type		
	b) Rupturing Capacity	Vendor to furnish		
	c) Control Fuse Make	As per approved makes		

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SECTION - C & D "Schedule of Technical Requirements & Information Required From Tenderer"

LT PANELS

Sr. No.	Content	TENDER SPECS	Vendor Data.	Remarks / Deviations if Any
	Contactor	Min. rating shall be 16 Amp.		
	a) AC3 Rating	Vendor to furnish		
	Indicating Lamps			
	a) Type	Clustered LED Type		
	b) Series Resistance	Built-in Resistance		
	c) Voltage	230V AC for Breaker Feeder		
	Control Transformer	PRECISE / INDCOIL		
	For winding Heating (415/240V)			
	VA rating	Vendor to furnish		
	Control Supply for each module (415/240V)	Shall be Tapped before breaker / SFU		
5	**EARTHING**			
	a) Earth Bus Size	Vendor to furnish (Based on Fault Level)		
	b) Material	**Copper**		
	c) Location	Bottom		
	d) Provision for Connection to Grid	Earth Bus shall be brought out at Two opposite ends		

Note: Vendor has to Confirm following Details along with the Data Sheet.

1	Complete Panels shall be compartmentalized in convenient sections suitable for		
2	All the cable entries shall be from Top with Sufficient space for Glanding.		
3	Height of the panel shall not exceed more than 2100mm.		
4	The panels shall be with Mounting Base frame. & with Operating Height (Min)		
5	The Gland plate shall be of 3mm thick MS. removable type without Knockouts.		
6	All the panels shall have 100% section for neutral compared to phase.		
7	All the C.T's shall be of cast Resin type and not Tape wound.		
8	The Earthing Bar should be mounted on Insulated supports.		
9	No hylim supports are accepted anywhere.		
10	All the breakers should have Ics as 100% of Icu.		
11	All the Incoming & outgoing Cable terminations should be provided with Phase		
12	Al. anodized engraved Panel nameplates with I/C & O/G feeder's details shall be		
13	All the panels should consist of Door Earthing.		
14	All the MCCB's shall be provided with the operating handles.		
15	All the breakers should have 2 sets of Potential free contacts.		
16	Connections of all the CT's should be proper with suitable Connectors & shorting		

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PLOT C SALES GALLERY, INFRA WORKS

SECTION – E

SCHEDULE OF DEVIATIONS FROM TECHNICAL SPECIFICATION

BUROHAPPOLD ENGINEERING

P0	09.10.2015	Draft Electrical Tender	SG			LODHA
Rev	**Date**	**Revision**	**Prepared By**	**Checked By**	**Approved by**	**Client**

SECTION E – SCHEDULE OF DEVIATIONS-TECHNICAL

NOTE FOR TENDERER:-

The Tenderer shall carefully study all the requirements of the specifications and drawings and indicate all deviations from technical specifications and Tender Drawings in this section only. Deviations indicated elsewhere in the package or bid will not be considered for evaluation.

SR.NO	REFERENCE CLAUSE	DESCRIPTION	DEVIATION DETAILS

We confirm that all the deviations from Technical Specifications and Tender Drawings are listed as above.

Seal of the Tenderer **Name:**

Designation:

END OF SECTION

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SECTION – F

SCHEDULE OF DEVIATIONS FROM GENERAL & SPECIAL CONDITIONS OF CONTRACT, BOQ/SCHEDULE OF PRICES

BUROHAPPOLD ENGINEERING

P0	09.10.2015	Electrical Tender	JV			LODHA
Rev	Date	Revision	Prepared By	Checked By	Approved by	Client

SECTION F – SCHEDULE OF DEVIATION-GENERAL

NOTE FOR TENDERER:-

The Tenderer shall carefully study all the requirements of the general & special conditions of contract and BOQ / Schedule of prices & indicate all deviations in this section only. Deviations indicated elsewhere in the package or bid will not be considered for evaluation.

Sr.No.	Reference Clause	Description	Deviation Details

We confirm that all the deviations from general & special conditions of contract and BOQ / Schedule of prices are listed as above.

Seal of the Tenderer

Name:

Designation:

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RFI Format

Where Requests for Information are to be raised the Contractor shall use the format advised below:

Lodha Kolshet RFI				
Date			**Company Name**	
Sr.No.	**Reference Section and Clause Number**	**Page Number**	**Description**	

Seal of the Tenderer

Name:

Designation:

END OF SECTION

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PLOT C1 SALES GALLERY, INFRA WORKS

SECTION – G

LIST OF APPROVED MAKES

BUROHAPPOLD ENGINEERING

P0	09.10.2015	Electrical Tender	JV			LODHA
Rev	Date	Revision	Prepared By	Checked By	Approved by	Client

1.1 GENERAL

Sr. No.	Description of Materials / Equipment	Approved Manufacturer's/ Makes
1.0	**L.V. Panels, Enclosed Switchgear, DB's, VFD's , Control Panels, & Starters**	
a.	Cubicle LV Panels Main Distribution Boards (MDB), Sub-Main Distribution Boards (SMDB), Distribution Boards (DB)	Siemens Schneider-Merlin Gerin ABB GE L&T CPRI Approved panel builder
b.	ACBs (electronic protection)	Seimens - SENTRON 3WL Schneider-Merlin Gerin - Masterpact NW ABB - Emax L&T - C-Power GE - EntelliGuard G
c.	MCCB (electronic protection)	Siemens – SENTRON 3VL Schneider –COMPACT NS ABB - Isonmax L&T-D SINE GE - Record Plus
d.	Switch Fuse Units	Siemens L&T ABB
e.	Automatic Transfer Switches Electromechanical Interlocks.	ASCO SOCOMEC
f.	ELCB, MCB, RCCB & DBs	Siemens Schneider-Merlin Gerin Legrand L&T ABB
g.	Capacitors with Harmonic Filters	Siemens- EPCOS ABB DUCATI L&T
h.	Contactors & Timers	Siemens Schneider Telemechanic ABB L&T G.E
i.	Variable Frequency Drive	Siemens ABB Allen Bradley Danfoss Schneider Electric GE
j.	Programmable timer	Siemens Schneider ABB L&T

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Sr. No.	Description of Materials / Equipment	Approved Manufacturer's/ Makes
k.	Auxiliary relays	Siemens AREVA ABB Schneider GE L&T
.	Measuring Instruments	Schneider Electric AREVA ABB L&T
l.	Panel Accessories	Siemens Teknic Rishab BCH
m.	Protective relays	Siemens ABB AREVA L&T G.E
n.	Control Fuses with base	Siemens G.E ABB Schneider L&T
o.	CTs/ PTs	AEI Kappa Pragati Gilbert & Maxwell
p.	Selector switch	Siemens Salzer L&T BCH KAYCEE
q.	Push Buttons (different colours)	Tecnik Siemens L&T Vaishnav
r.	Indicating Lamps – LED type	Tecnik Siemens L&T
s.	Terminal strip	Obo Bettermann Wago Connectwell Phoneix Elmex
2.0	**L.V. Busduct, busbars & accessories**	
a.	Busducts / Bus riser & Accessories (Bends, Tees, Elbows, Flexible joints etc).	Siemens EAE Zucchini- Legrand Schneider Electric L&T
b.	Fire Stop Material	HILTI 3M India

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Sr. No.	Description of Materials / Equipment	Approved Manufacturer's/ Makes
		KBS Fire Stop PROMAT Specified Technologies
3.0	**L.V. Power & Control Cables, IT/ Telecom & TV Cables**	
a.	Electrical Cables- LV Cables, 1.1kV, , XLPE/PVC/FR	Finolex Polycab AVOCAB AEI Cables Limited Ravin
b.	Electrical Cables - MV Cables 11kV grade	Polycab Finolex CCI AVOCAB Torrent Cables Ltd (TCL) Ducab Unistar Phelps Dodge
c.	Electrical Cables- Fire Survival Cabling standard (PH30) and enhanced (PH120) fire survival cabling 1.1KV grade	Tyco Prysmian Cables & Systems Ltd CAVICEL - FIRECEL AEI Cables Limited INDIA IMPEX
d.	Fire Spray On Cable – Endothermic	KBS Passive Fire HILTI SGS 3M
e.	LV Jointing Kit/Termination	RAYCHEM (Tyco Electronics) 3M India REPL
f.	Cable Glands & Bi-metallic crimping type lug	Comet Dowel Braco HMI Commex Gripwell
g.	Crimping lugs/ Thimbles	Comet Dowell
h.	Copper control Cable	Finolex Polycab AVOCAB Lapp
i.	TV co-axial cable	Finolex Havells Delton Nicco As per IT specialist's requirement.
j.	Telephone cables	Finolex Havells Delton Nicco As per IT specialist's requirement.
k.	Telephone Tag Blocks	Krone ITL

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Sr. No.	Description of Materials / Equipment	Approved Manufacturer's/ Makes
		Delton
I.	Data Cables	Avaya Clipsal Legrand Molex Systemax Beldon Krone Communication
4	**Wiring Devices & Accessories :**	
a.	Electrical Wires- FR/LSZH/FRLS, PVC insulated, multi-stranded, copper wire, 1.1 KV grade	Finolex Polycab AVOCAB Ravin RR Kable
b.	Switch, socket with switch (BOH)	Legrand MK Clipsal Crabtree ABB
c.	Weather Proof/Industrial Socket outlets (poly carbonate body IP67/IP65)	MK Hensel Clipsal Scame Legrand
5	**Cable Trays, Trunking & Conduits**	
a.	Cable Tays / Trunking	Profab Indiana
b.	G.I. Pipes	Jindal (Hisar) Tata
c.	G.I. Conduit pipe & accessories (ISI marked)	B.E.C. NIC AKG BE.
d.	PVC Conduit pipe (ISI marked)	Precision Plastic POLYPACK A-D Technologies : DURALINE DPLAST
e.	PVC Conduit accessories (Excluding Fan Box)	Precision Plastic POLYPACK A-D Technologies : DURALINE DPLAST
6	**Earthing System :**	
a.	Cu. Strip and earthing material	Furse Kingsmill Erico Indiana Bharti
b.	G.I. Strip	ISI/CPRI approved
7	**Lightning Protection System :**	
a.	Surge Arrestors(All Types)	Emerson FURSE DEHN ABB OBO BETTERMANN

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Sr. No.	Description of Materials / Equipment	Approved Manufacturer's/ Makes
b.	Stainless steel Lugs	Jindal tata
c.	Lightning Protection Equipment	Furse ERICO A N Wallis & Co., Ltd. Kingsmill Industries (UK) Ltd
8.	**Inverter Based Emergency Lighting System :**	
a.	Luminaries	Philips Lighting Thorn Lighting Wipro Schreder Zumtobel Erco
b.	Lighting Controls	Lutron Siemens Legrand Helvar Beckhoff ABB
c.	Lamps / Tubes	Philips Osram Crompton GE
d.	Luminaire Ballasts Electronic Non-Dimmable (EEI = A2) Luminaire Ballasts Electronic Digial Dimmable (EEI = A1) Luminaire Ballasts Analogue Dimmable (EEI = A1)	Tridonic Philips OSRAM Lutron Wipro Vossloh Atco Tridonic Philips OSRAM Lutron Wipro Tridonic Philips OSRAM Lutron Wipro
f.	Lighting Poles (Hex, Angular, Ms Tubular, Decorative)	Bajaj Electricals Keselec K-Lite Bombay Tubes & Poles
g.	Battery Charger	Hitachi Amara Raja Mastech
h.	Battery (Lead acid Maintenance Free)	Hitachi Amara Raja

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Sr. No.	Description of Materials / Equipment	Approved Manufacturer's/ Makes
		HBL Nife Exide BOSCH Yuasa
i.	UPS System	Emerson APC CHLORIDE Toshiba Corporation MGE
j.	Inverters	Megatech Microtek Luminous Vivtar Electronics
9.	**Obstruction Beacon Lighting System**	
a.	Aviation Lighting- LED	Orga Aviation BV Cooper BINAY OPTO ELECTRONICS P.LTD Contarnax Europe Limited AVAIDS Technovators Hughey & Phillips
10.	**Hangers & Supports for Electrical System**	
a.	M.S. Steel (Angle. Channel, Strip, sheet)	Tata Sail
b.	Anchor Fastners	Hilti Fischer Arrow

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SECTION – H

PREAMBLE TO BILL OF QUANTITY / SCHEDULE OF PRICES

BUROHAPPOLD ENGINEERING

P0	09.10.2015	Electrical Tender	JV			LODHA
Rev	Date	Revision	Prepared By	Checked By	Approved by	Client

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1.1 GENERAL

A. The Bills of Quantities herein, including all notes and instructions, form an integral part of the Contract Documents. However, the descriptions contained in the Bills of Quantities for each item are not necessarily complete.

B. The rates for each item must be comprehensive and must include for complying with the Specifications, and all obligations under the Contract including all matters and things necessary for the proper construction, completion and maintenance of the Works. No claims for additional payment will be allowed for any error or misunderstanding by the Contractor of the work involved.

C. The rates for each item must allow for all costs and expenses in complying with all general risks, liabilities and obligations set forth in the Drawings, Specifications and Conditions of Contract, including but not limited to the following :

1. Labour, supervision and all associated costs.
2. Materials, goods, consumables and all associated costs.
3. Fitting and fixing materials and goods in position
4. Provision of plant, equipment and tools
5. Restriction of working areas and procedures
6. Temporary works
7. Establishment, administration and overhead charges and profit

D. Where quantities are indicated to be “Provisional” they shall be included in total scope of works. The value of the works shall be paid to the Contractor as per milestones, the milestones works to be assessed by Project manager along with Contractor’s representative, and the Contract Price shall be adjusted accordingly.

E. The prices and rates entered by the Contractor against items in the Bills of Quantities shall apply throughout the duration of the Contract to the execution of these items in any location and, these rates will be used as a basis for evaluating of Variation items provided for, to any additional work ordered by the Client/Consultant.

F. A price or rate is to be entered against each item in the Bills of Quantities and any item left unpriced will be deemed to be included in the total tendered price and hence the rate for that item will be taken as nil.

1.2 METHOD OF MEASUREMENT

A. The quantities in the Bills of Quantities have been prepared generally in accordance with IS 1200 method of Measurement. The description of each item (which description shall imply references to any heading, sub-heading, preamble or other clause of item which shall apply) shall be held to include all claims, materials, workmanship, including all taxes, duties, charges, all Government levies, landing charges, transport, packing, forwarding, insurance, handling, loading, unloading, profit and overheads and all other incidental costs to complete the Works.

B. The Contractor shall not use these Bills of Quantities as a construction programmed or for the purposes of ordering materials or arranging sub-contracts. The references for these activities shall be the Drawings, Specifications and instructions issued by the Client/Consultant.

C. These preambles are to be read in conjunction with the Drawings, Specifications and item descriptions in the Bills of Quantities.

D. As described’ means as described in the Specifications.

1.3 ABBREVIATIONS

A. In the Specification and Bills of Quantities the following abbreviations have the meanings hereby assigned to them :-

Approved /Approval - means approved by or approval of the Client / Consultant in writing
Submitted / Submit - means submitted to or submit to the Client / Consultant in writing

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Accepted / Acceptance	- means accepted by or acceptance of the Client / Consultant in writing
Inspected / Inspection	- means inspected by or inspection of the Client / Consultant
Directed	- means directed by the Client / Consultant in writing
Authorised / Authority	- means authorised by or authority of the Client in writing.
Required	- means required by the Client in writing
Rejected	- means rejected by the Client in writing
In writing	- above shall also mean verbally later confirmed in writing
O.O.E.A.A.	- Means or other equal and approved
Mm	- Millimetre
m	- Linear metre
m^2	- Square metre
m^3	- Cubic metre
Kg	- Kilogram
KN	- Kilo Newton
MPa	- Mega Pascal
No /Nos	- Number
Pc	- Piece or number
T	- Tonne
IR	- Item Rate Only
R.O	- Rate only

1.4 PREAMBLES

A. Rates for all work shall include for protection and provision of samples.

B. All measurements are net and the total price shall include for all laps, waste, working space and trade or traditional allowances.

C. The pricing of materials shall take account of the following :

1. Materials shall be of the quality specified unless otherwise directed by the Client / Consultant.
2. All materials shall be transported, handled, stored and fixed in accordance with the printed instructions or recommendations of their manufacturers or suppliers.
3. Protection of completed work, all casings and temporary coverings and making good, cleaning and polishing and clearing away upon completion.

1.5 PRICING

A. The prices shall be comprehensive and must include for complying in all respects with the Conditions of tender, Conditions of Contract, Specifications and Drawings and for all matters and things necessary for the proper construction, completion and maintenance of the whole of the Works. No claims for additional payment will be allowed for any error or misunderstanding by the Contractor of the Work involved.

B. Tenders shall be on a item rate basis for items/equipment delivered, installed, tested & commissioned at site. During the contract period and till the completion of work in all respects, prices shall remain firm & free from variations due to rise and fall in cost of materials, equipment, labour or any other reason what so ever contractor shall be paid as per erected qty at site.

C. All prices indicated shall be inclusive of the price for design verification, drawings, manufacture, supply, handling at site, installation, testing, commissioning, balancing and handing over, unless otherwise specified.

D. All prices indicated shall be inclusive of all applicable taxes, duties and other levies such as excise duty, sales tax, turnover tax, fabrication tax, works contract tax, octori etc. Packing & forwarding, transportation, insurance, loading, unloading and installation charges (including erection, testing commissioning & handing over) Nothing extra shall be payable except statutory changes in taxes & duties. Any adjustment due to statutory changes in taxes & duties shall be made only in the final bill based on submission of proper authenticate and adequate documentation.

E. Bidder shall fill the enclosed Bill of Quantity only.

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F. The price shall be filled-in ink and no over-writing, rubbing etc. is allowed. If for any reason prices are cut and changed, Bidder shall clearly sign at the respective locations.

G. Bidder shall indicate rates for all the items mentioned under RATE ONLY in the price schedule. These rates shall be applicable if any of the said items are used during the execution of the contract.

H. The Bidder shall furnish all the information called for in Section C, D, E & F of tender Document, failing which the Bid will be treated as incomplete and the Client/Consultant reserves the right to reject the Bid. The Bidder is advised to fill information strictly in the format enclosed.

I. The Bidder shall carefully study all sections and drawings enclosed (if any) with specification and indicate deviations in the Section E & F of the Specification. If no deviations are stated it will be assumed that the offer conforms in all respects to the specification and the Client reserves the right to evaluate the Bid as such without further reference to the Bidder.

J. Lump sums shall not be given where unit rates are applicable.

K. Where the word “allow” is used, the cost of the item shall be the responsibility of the Contractor to allow and include cost of entire scope work.

L. The amounts set against any item of overhead shall include for all costs in connection with letters of credit, bank charges, interest charges and insurance after the materials, come under the control of the Contractor.

M. The rates inserted will be used to determine the amount of the Contractor’s Interim Payments.

N. The Tenderer shall submit the analysis of the “Tender Sum” with a full and detailed rate breakdown of all the BOQ items including spare parts items, together with their tender submission. The breakdown is to show the actual calculations of the General Items, labour, Plant and Materials, Cost for the Works, the build-up of measured rates with on-costs and overheads and any other allowances used to arrive at the Tender Price. In addition the Tenderer/Contractor will be required to provide the Client within 48 hours with a full and detailed breakdown/ any other information if requested.The rates inserted in the Schedule of Day works if any, shall be deemed to be the rates used by the Main Contractor in making up rates for works items in all parts of the Bills of Quantities.

1.6 VARIATIONS

A. Employer’s representative shall have the power from time to time in the execution of work by notice in writing to instruct the Contractor to make any alteration, omission, addition or variation in the work (herein after referred to as ‘Variation’). The difference in cost of such variation shall be added to or deducted from the contract price as the case may be in accordance with the rates applicable in the Contract. In case these rates are not available in the contract, they shall be agreed between the Employer’s representative and the Contractor. If the variation required by the Consultants in the opinion of the Contractor involves a claim for additional payment or prevents him from meeting any of his obligations to guarantees in the Contract, he shall immediately notify the Consultants in writing failing which he shall not be entitled to any modification in his obligation or for additional payment. If Consultants do not admit that the variation required by him involves additional payment to the Contractor or modification in the obligations of the Contractor, the variation required shall nevertheless be carried out and the matter of difference settled between the Employer’s representative and the Contractor.

B. The Consultants shall give a reasonable notice to the Contractor to enable him to make arrangements for variations in work required by him.

C. The Employer’s representative reserves the right to omit or alter some or all the items at any stage of the work and the contract value will be adjusted accordingly.

1.7 SHOP DRAWINGS

A. The rates in the appropriate section shall include for design of the elements as specified in the Contract and for providing Design Verification, working drawings, shop drawings,

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schedules, specifications, calculation, Installation, Testing, Commissioning etc and for obtaining the Employer's representative approval.

1.8 SITEWORK

1. The Bidder is hereby notified that all the BOQ Quantities are indicative and quantities measured as approximate the valuation works as per assessed milestone basis.
2. For excavation work no allowance for increase in bulk or working space.
3. The Bidder shall allow in his rates for excavation for excavating in any material including running silt, running sand and rock, commencing excavation of any depth, excavating below the normal water table, excavating around existing services and mains, supporting the vertical sides of excavations, working space and filling soft spots.
4. Rates for disposal of excavated material shall include for any necessary double handling and the provision of a tip, if necessary, including any charges in connection therewith.
5. Wherever the term 'dispose on site' is stated within the earthworks section of the Bills of Quantities, the quantities of surplus excavated material shall either be required to be used elsewhere in the contract or stockpiled on site in a location approved by the Project Manager.
6. Wherever the term 'filling to make up levels' is stated within the earthworks section of the Bills of Quantities, the additional quantities of fill material required shall either be taken from elsewhere in the contract or from the stockpiles of surplus excavated material located on site.
7. Rates for excavation of trenches for pipes, cables and the like shall include for compaction, disposal, dewatering and filling with selected excavated material, hand and machine compacted as specified.
8. The rates for drains, inspection chambers, etc., are to allow for testing.
9. Rates for drain pipes generally are to include for all short lengths, back stops, wooden plugs and retaining and alignment pegs required in laying and for the extra involved over normal trench excavating in hand packing and tamping selected fine material around the lower half of the pipes to buttress them against the side of the trench. Rates are to include for leaving all pipes clean and clear.
10. Pipes are measured net works as laid and are to include for all drain fittings on all types of drain pipes, extra joints of all types and cutting and waste on all pipes, for laying in trenches of any depth, and building in to sides of inspection chambers.
11. Rates for drain accessories shall include for concrete surrounds and any additional excavation and disposal.

1.9 METALWORK

A. The rates for all steelwork and metalwork shall include for the following :
   1. Ends, angles, intersection, ramps on frames, bearers, bars, rods, angles, channels, I beam etc.
   2. Assembling and jointing together components
   3. The weight of weld metal in welded constructions
   4. Members of any length
   5. Cutting to size and shape and joints in the running length
   6. Notches, holes, slots, mitres, angles, ends and for all drilling and splay cut ends
   7. Grinding welds to a smooth finish, unless otherwise required
   8. Fixing with appropriate non-corroding countersunk screws including holes unless otherwise described.
   9. Riveted and bolted work shall include rivets, bolts and holes and countersunk holes
   10. Approved protection to cut ends or holes in galvanised work or other applied finish
   11. All considerations arising from the Specification

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12. Floor plates, duct covers and the like shall include narrow widths, laying in position, frames and for all holes, slots and the like and making good
13. All preparation, protection coatings and final decoration with the items to which they relate
14. All fittings and fixing required, including grouting in position

B. "Welding" is deemed to be in accordance with the specification and for the material to which it is to be used.

1.10 FITTINGS AND FIXTURES AND ACCESSORIES

A. General
- For the purposes of identification, fittings fixtures and accessories to be measured in accordance with the principles in this section shall be defined as those being specially manufactured or proprietary items not included in other section.
- Unless otherwise described or measured as whole item work in this Bill of Quantities, prices for all items shall include for all necessary straight, raking or circular cutting, pipe fittings, bends, elbows, end caps, pipe supports, concrete thrust-blocks, pipe beddings and surrounds etc. for the completion of the whole of the works as specified and shown on the drawings.

B. Equipment
- Valves, strainers, unions, pressure gauges, thermometers to fittings shall be deemed to be included.
- Taps, mixers shall be deemed to be included with the sanitary fittings.
- Connections to water supply and waste, including necessary waste outlets, traps flexible connections etc., shall deemed to be included with the fixing rate of sanitary fixtures.

1.11 MECHANICAL WORK

A. Sundries
- Rates for the documents shall include for providing design verification, asbuilt drawings and shop drawings, operating instructions and maintenance manuals within the time period as specified.
- Rates for the incidental works shall be deemed to include for cleaning and sterilising.
- Modifications to existing works shall be measured as whole items where appropriate. Making / breaking and remaking surfaces to match/ join the existing shall be deemed to be included.

B. Pipe work and Gutter work
- All necessary fittings to pipe works, irrespective of the diameter of the pipe shall be deemed to be included in the rates of the relevant pipe work item, unless such fittings have been specifically measured.
- Pipe supports and fixings shall be deemed to be included in the relevant pipe work item irrespective of the diameter of the pipe, unless such supports and fixings have been specifically measured.
- Valves or the like shall be enumerated unless otherwise stated.
- Sleeves cover plates matching flanges, rubber gaskets, bolts, nuts, washer's, supports, vibration isolators, flexible connectors and all items necessary and required and as given in the specifications or the like shall be deemed to be included in the rate of the relevant item.

C. Ductwork
- Measurement of ducting will be on the basis of the external surface area of the fabricated/installed ducting including all materials and labour, only measured as whole work, but not as a unit.
- The price include Sleeve, flanges, gaskets for joints, bolts, nuts, duct supports, hangers, vibration isolation pads, suspenders, flexible connections, inspection doors, turning vanes, straight vanes and any other item which will be required to complete the duct installation , external insulation and acoustic lining are measured separately.

  In case of taper pieces, average width and depth will be worked out as follows:
  W1 - Width of small cross section
  W2 - Width of large cross section
  D1 - Depth of small cross section

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D2 - Depth of large cross section
Average Width – (W1 + W2)/2
Average Depth – (D1 + D2)/2

For the special pieces like bends, branches, tees, etc. the same principle of area measurement as for linear lengths will be adopted. The length of bends and elbows will be the average of the lengths of inner and outer periphery along the curvature.

D. Equipment
- Chillers, cooling towers, Tanks, fans, pumps, air-handling units or the like shall be enumerated.
- Valves, strainers unions, pressure gauges and thermometers to equipment shall be deemed to be included.
- Taps, mixers shall be deemed to be included with the sanitary fittings.
- Connections to water supply and waste, including necessary waste outlets, traps flexible connections, etc. shall be deemed to be included with the fixing rate of sanitary fixtures.
- Pressure Switches and Pressure Gauges will not be measured separately shall deemed tobe included in respective pumping sets and shall include all necessary items to complete the work to the satisfaction of Owner/ Architect/ Consultant.

E. Automatic Controls
- Sensing or activating devices, control panels, air compressors and receivers or the like shall be deemed to be included in the respective items.
- Wiring, pneumatic tubing, isolators, starters, relays or the like associated with automatic controls shall be deemed to be included.

F. Connections to Supply Mains
- Connections to supply mains shall be measured as an item.

G. Sanitary Fittings
- Sanitary fittings shall be enumerated. Taps, mixers, waste outlets, traps and the like shall be deemed to be included.

H. Insulation including Linings and Protective Coverings
- Insulation to rectangular ductwork shall be measured by area, calculated as the length taken along the centre line over all fittings times the net girth of nominal dimensions. Additional insulation to flanges or the like shall be deemed to be included.
- An item shall be given for insulation on equipment.
- Insulation boxes around accessories shall be deemed to be included.
- Rates for insulation are to include for cutting and waste, jointing laps and for working around and over ancillaries, fittings, flanges, and other obstructions.

I. Plumbing Works
- Rates for Hot and Cold water pipe work shall include for insulation including (insulation is measured separately) cutting and waste, jointing laps and for working around and over ancillaries, fittings, flanges and other obstructions.
- Rates for all pipe work irrespective of the pipe diameter shall include for assembling and jointing, pipe fixings, pipe supports, pipe sleeves and cover plates and the like, unless such items have been specifically measured.
- Rates for pipe work irrespective of the pipe diameter shall include for all fittings, brackets, hangers and other necessary supports, unless such items have been specifically measured as whole item as lump sum.

J. Excavating Trenches
- Excavating trenches for pipes, irrespective of depth, disposal, backfilling, compacting / grading bottoms, supporting sides of excavation, pipe beds and surrounds, etc. where required whether expressly stated in the item descriptions or not) shall be deemed to be included in the respective lengths for pipes.

K. Beds, Haunchings and Surroundings
- Beds, haunchings and surrounds as specified shall be deemed to be included with the respective item length.

L. Drainage
- Drain accessories (for example gullies, traps) shall be enumerated; supports, concrete surrounds and additional excavation shall be deemed to be included.
- Fittings to drainage pipes shall be deemed to be included with the drainage pipes.

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M. Manholes, Soak ways, Septic Tanks, etc.
- Manholes, soak ways, septic tanks, etc. shall be enumerated.
- Inspection chambers or the like shall be enumerated.
- Manhole covers shall be deemed to be included with manholes.

N. Connections
- Connections to existing pipes or sewers shall be enumerated.

O. Rates for Drainage
- The rates Clauses for other trades shall also apply to this Section where relevant.
- The rates for pipe trenches shall include for excavating as required for pipe alone or for pipe and bed under and shall also include for backfilling with selected excavated material carefully packed around pipes and clearing away any surplus.
- Rates for manholes soak ways, septic tanks and the like shall include for excavation, backfill and removing surplus excavated material from site, for reinforcing concrete and waterproofing as required and for connections to the drain pipe.

1.12 ELECTRICAL WORK

A. Main Circuits
- Cable to distribution boards and the like shall be measured in liner meters.
- Cable terminations shall be separately enumerated.
- Any kind of 'conduit' as defined above shall be deemed to be included with cable / wire.

B. Sub-Main Circuits
- Cables to individual sub-main circuits shall be measured by length stating the cable type and size.
- Terminations to individual circuits as indicated on the drawings shall be separately enumerated.
- Any kind of 'conduit' as defined above shall be deemed to be included with cable / wire.

C. Control Gears
- Rates for all electrical panels shall include for supply and installation of all necessary MCCB's, MCB's, EFR's, ELCB's auxiliary contacts, Volt meters, ammeters, kWh meters, indicator lamps, selector switches, inter connecting copper bus bars, interlocks aligning and grounding the panel, interconnections, internal wiring instrument wiring loops, connecting to switch gears, cable gland lugs, steel channels and necessary hardware fixing and insulating materials with fully enclosed panels and distribution boards where ever necessary and complete as shown in drawing and comply with the specifications, and as per relevant latest standards and regulations and all complete to working order to the approval of the Consultant.
- Rates for all panel boards shall include for making separate compartment for incomer and inter phase barriers.

D. Meter boards
- Rates for meter boards shall include for 20mm thick teak wood board, energy meters, current transformers, MCBs, /MCCBs/ SFUs, sheet steel enclosure, mounting bracket, framework and finishes etc.

E. Small power & lighting installation
- Rates for small power point wiring shall include for supply & installation of sockets, fixtures, face plates, conduits, wires, junction boxes & accessories.
- Rates for lighting point wiring shall include for supply & installation of conduits, wires, junction boxes & accessories, holders, ceiling rose, fixing blocks etc. Lighting switches shall be separately enumerated.
- Special lighting such as aviation lights shall be enumerated. All relevant cabling, conduits, fittings, fixings and control units shall deemed to be included in the lights.
- Rates for lighting fixtures shall include for supports, brackets, mounts, hangers etc.

F. Cable trays
- Rates for cable trays shall include for all fittings and supports.

G. Excavating Trenches for Cables
- Excavating trenches for cables irrespective of the depth shall be deemed to be included in respective item length.
- Disposal, backfilling, compacting and grading bottoms and supporting sides of excavation, etc. shall be deemed to be included, in respective item length.

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1.13 ADJUSTMENT ITEM

A. General
- Where the Amount of Tender is computed by a Tenderer by making a lump sum adjustment to the summed total of the Bill of Quantities or to the summed total of a section of the bill of Quantities, then the lump sum adjustment so made will be deemed to apply proportionally to the individual rates and prices throughout the Bill of Quantities, or throughout that section of the Bill of Quantities respectively.
- Such proportional adjustment shall not be applied to any Provisional Sums given in the Tender Documents.
- Such proportionally adjusted rates and prices shall be those rates and prices used later during the currency of the Contract to assess the value of variations to the Contract and for the valuation of measured work done for interim payments.

1.14 PROPRIETARY MATERIALS

A. Where manufacturers names of proprietary material names are given against certain items in the Bills of Quantities, the rates and prices inserted shall be for those specified material or other similar and approved materials.

1.15 MATERIALS AND WORKMANSHIP

A. Tenderer's are referred to the specification forming part of the contract documents, together with the notes on all the contract drawings for the standard of materials and workmanship to be used in construction.

B. Where not elsewhere defined, standards are to be not less than those specified in relevant British / Indian Standards and Local Authority's Codes of Practice currently in force.

END OF SECTION

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SECTION – I

BH-ZSG-BOQ-E-0002
BILL OF QUANTITY / SCHEDULE OF PRICES

BUROHAPPOLD ENGINEERING

P0	09.10.2015	Electrical Tender	JV			LODHA
Rev	**Date**	**Revision**	**Prepared By**	**Checked By**	**Approved by**	**Client**

SALES GALLERY- EXTERNAL SERVICES ELECTRICAL

ITEM NO.	ITEM DESCRIPTION	UNIT	QTY.	RATE	AMOUNT	
					Rs.	Paise
	BILL NO. 1 - ELECTRICAL ENGINEERING INSTALLATIONS					
1	**LV Panels**					
	Include for the Supply, Installation, Testing and Commissioning of the complete installation as detailed in the Specifications and on the Drawings and to the complete satisfaction and approval of the Engineer and all concerned Statutory Authorities and under the following sections including MDBs and associated protective devices, relays, meters, terminations, isolators, supports, surge protection, accessories, etc., complete					
1.01	Installation, testing and Commissioning of SG-MDB-L0001 - As per Drawing No. BH-ZSG-SLD-E-1100(Sales Gallery LV Schematic) EC to field verify the existing panel on site and make the panel to be in working condition. Check the circuit integrity of the panel and change components necessary for making the panel to use functionally as intended in the drawings. EC to field verify before bidding and accodmodate all the required changes in the quote	No.	1			
1.02	SG-APFCR-L0001 - As per Drawing No. BH-SLD-E-1100 (Sales Gallery LV Schematic)	No.	1			
1.03	SG-ATS-0001 - As per Drawing No. BH-SLD-E-1100 (Sales Gallery LV Schematic)	No.	1			
1.04	SG-EXT-LPDB-L0001 - Incomer : 125 A TPN Isolator RCCB : 30 mA DP / Phase Timer : 1 No. Dual Channel 24x7 Programmable Astronomical Time Switch O/G : 25 Nos. 20 A SP MCB with SP Contactor controlled by Time Switch 03 Nos. 32 A DP MCB Each for Elec. Room, Pump Room & Guard House 05 Nos. 20 A SP MCB 01 Nos. 40 A TPN MCB ISO	No.	1			
2	**SUBSTATION LIGHTING & POWER**					
	Supply, Intallation, Testing and Commissioning of Substation lighting and small power distribution inlcuding DB and other accessories as per drgs and specifications					
2.01	Batten type, suspended type weather proof luminaire including lamps suitable for 2x28W, TL5 fluorescent lamps(TYPE-1)	Nos	6			
2.02	Batten type Corrosion resistant luminaire including lamps suitable for 2x28W, TL8 fluorescent lamps(TYPE-2)	Nos	QR			
2.03	Self contained, Non Maintained, Emergency lighting luminaries suitable for 1x20W FTL with 3 hr backup & sealed rechargeable Ni-Cd batteries (high temperature type) Prolite Make: PEL 120NM/H (TYPE-3)	Nos	3			
	DBs, associated protective devices, relays, breakers, terminations, isolators, supports, surge, protection, accessories, etc., complete,					
2.04	Wall mounted 4-Way SPN Lighitng DB Incomer - 32A DP RCCB 30 mA O/G - 4 Nos .SP 6/10/16/20 A MCB	Nos	3			
2.05	Single phase Switched Socket Outlet 6/16A with Plastic surface box, white cover plate, Switch & socket (For Exhaust Fans).	Nos	5			
2.07	Exhaust Fans (300mm dia)	Nos	2			
2.08	Ceiling Fans 900mm Dia.	Nos	1			
	Point wiring including pvc concealed conduiting with bends, elbow and complete accessories, from DB including termination at the light point, fan point, power points and switch board including installation of wiring accessories (backboxes, switches, sockets, module/faceplate etc. complete) as per the point wiring definition please refer to standard details sheets.					
2.08	TYPE-1	Nos	8			
2.09	TYPE-2	Nos	2			
2.10	TYPE-3	Nos	2			
2.11	Exhaust fan point	Nos	2			
2.12	Ceiling Fan Point with Regulator	Nos	1			
3	**EARTHING**					
	Include for the Supply, Installation, Testing and Commissioning of the complete installation as detailed in the Specifications and on the Drawings and to the complete satisfaction and approval of the Engineer and all concerned Statutory Authorities and under the following sections including earth pits, rods,earth bar & terminal, earth seal, conduits, cables including accessories, terminations, fittings, fixing complete as per codes and guidelines (Refer Earthing Schematics)					
	Note: 1) Earth bars to be mounted on insulators 2) For each earth bar provide for twin disconnection links					
3.01	Maintenance Free Earth Pits(Including overall Earth pit assembly)	Nos.	6			
	Supply and fixing of following bare Al. cables/copper tapes/wires including all necessary fixing accessories and terminations and effecting connections as per specifications.					
3.02	50 x 10 mm2 GI. Strip	M	50			
3.03	32 x 6 mm2 GI Strip	M	20			
3.04	Supply and installation of 50mm x 10mm x 300mm GI Earth busbar mounted on insulators and having 15 nos. holes for terminating flexible cable/ Strip with the entire assembly enclosed in 1.6 mm thick MS enclosure of approved make, design & painted with approved paint shade.	Nos	4			
	Include for the complete Supply, Installation, Testing and Commissioning of the following items as detailed in the tender documents and to the complete satisfaction and approval of the Engineer and all concerned Statutory Authorities and under the following sections.					
4	**CABLING AND TERMINATIONS**					
	XLPE/SWA/PVC/Al. Cabling works including, accessories, support, protection, termination etc. complete					

4.01	4c x 16mm²	M	350			
4.02	4c x 25mm²	M	115			
4.03	4c x 50mm²	M	321			
4.04	4c x 70mm²	M	30			
4.05	4c x 95mm²	M	30			
4.06	4c x 240mm²	M	120			
4.07	4c x 300mm²	M	608			
	Cable Terminations					
4.08	4c x 16mm²	Nos	10			
4.09	4c x 25mm²	Nos	8			
4.10	4c x 50mm²	Nos	10			
4.11	4c x 70mm²	Nos	2			
4.12	4c x 95mm²	Nos	2			
4.13	4c x 240mm²	Nos	8			
4.14	4c x 300mm²	Nos	8			
4.15	SWA Cable Termination to the earth bar - 16mm²	Nos	10			
4.16	SWA Cable Termination to the earth bar- 25mm²	Nos	8			
4.17	SWA Cable Termination to the earth bar- 50mm²	Nos	10			
4.18	SWA Cable Termination to the earth bar- 70mm²	Nos	2			
4.19	SWA Cable Termination to the earth bar- 95mm²	Nos	2			
4.20	SWA Cable Termination to the earth bar- 240mm²	Nos	8			
4.21	SWA Cable Termination to the earth bar- 300mm²	Nos	8			
	PVC/Al. Cabling works including, accessories, support, protection, termination etc. complete					
4.22	CPC Cable - 1c x 16mm²	M	350			
4.23	CPC Cable - 1c x 25mm²	M	436			
4.24	CPC Cable - 1c x 35mm²	M	36			
4.25	CPC Cable - 1c x 50mm²	M	36			
4.26	CPC Cable - 1c x 150mm²	M	QR			
4.27	CPC Cable - 1c x 300mm²	M	QR			
4.28	CPC Cable Termination to the earth bar - 1c x 16mm²	Nos	10			
4.29	CPC Cable Termination to the earth bar - 1c x 25mm²	Nos	18			
4.30	CPC Cable Termination to the earth bar - 1c x 35mm²	Nos	2			
4.31	CPC Cable Termination to the earth bar - 1c x 120mm²	Nos	2			
4.32	CPC Cable Termination to the earth bar - 1c x 150mm²	Nos	QR			
4.33	CPC Cable Termination to the earth bar - 1c x 300mm²	Nos	QR			
5	**DWC SN8 PIPES:**					
	Include for the complete Supply, Installation, Testing and Commissioning of the following items as detailed in the tender documents and to the complete satisfaction and approval of the Engineer and all concerned Statutory Authorities and under the following sections.					
	FOR LV					
	Supply and laying of following sizes of RCC Hume Pipe, Class NP-2/3 (Work shall include excavation, refilling, jointing of collars, sealing of end etc. complete as required)					
5.01	150 mm dia	M	440			
	FOR ELV					
	Supply and laying of following sizes of RCC Hume Pipes, Class NP-2/3 (Work shall include excavation, refilling, jointing of collars, sealing of end etc. complete as required)					
5.02	100 mm dia	M	60			
6	**MAN HOLES:**					
	Include for the complete Supply, Installation, Testing and Commissioning of the following items as detailed in the tender documents and to the complete satisfaction and approval of the Engineer and all concerned Statutory Authorities and under the following sections.					
	Constructing Water tight brick masonry manhole with first class bricks in cement mortar 1:6 (1cement :6 coarse sand), R.C.C. top slab with 1:2:4 mix (1cement :2coarse sand :4 graded stone aggregate 20mm nominal size). Foundation concrete 150mm thick 1:4:8 (1cement :4 coarse sand :8 graded stone aggregate 40mm nominal size), inside plastering 12 mm thick with cement plaster 1:3 (1cement :3 coarse sand) finished with a floating coat of neat cement and making channel in cement concrete 1:3:6 mix, M.S. foot rests including fixing in 20 x 20 x 10cm cement conc. blocks neatly finished, complete with double sealed cover as per standard design and approved drawings. (Price shall include the cost of excavation, back filling, disposal of suplus earth dewatering & water proofing of manholes as directed at site & other associated civil works).					
6.01	750 x 750 x 1000mm Deep	Nos	7			
6.02	600 x 600 x 750mm Deep	Nos	2			
6.03						
7	**SAFETY EQUIPMENTS**					
	Supply of Safety equipment for electrical equipments as per IS and tender document.all complete works.					
	Rubber matting in front of each switchgear					
7.01	1.1 kv grade	Sq.mm	5			
7.02	Shock treatment chart	Nos	1			

	Caution and Danger board					
7.03	11kv system	Nos	-			
7.04	415V system	Nos	1			
7.05	Fiber discharge rod	Nos	-			
	Hand gloves					
7.06	Pair of hand gloves tested for 22kV/11kV	Nos	-			
7.07	Pair of hand gloves tested for 415V	Nos	1			
7.08	CO2 Fire extinguisher : 4.5 Kg	Nos	1			
8	**MISCELLANEOUS WORKS**					
	Contractor shall confirm following miscellaneous items but not limited to are included in above quoted tender	Item				
8.01	Drawings, manuals, approvals from LODHA (Asbuilt drawings, Shop drawing, Material Submittal etc.)	Incl				
8.02	Assistance and documentation to Liasioning Work	Incl				
8.03	Operation & Maintenance Manual	Incl				
8.04	Testing & Commissioning	Incl				
8.05	Sealent (Fire/other) and Protection for equipements.	Incl				
8.06	Identification and Labeliing.	Incl				
8.07	Inspection and getting approval of all the HT equipments and materials at the factory and at site as per the MSEDCL requirements. Preparation and submission of all required documentation is also included.	-				
	TOTAL					