

**E&M works for the Development of NMRC Project Office at 2nd floor, Ganga Shopping Complex,
Sector-29, Noida.**



NOIDA METRO RAIL CORPORATION LIMITED

CONTRACT NO: NMRC/Elect (P)/2026/005

**E&M works for the Development of NMRC Project Office
at 2nd floor, Ganga Shopping Complex,
Sector-29, Noida.**

VOLUME-3

SCOPE OF WORK, TECHNICAL SPECIFICATION

**NOIDA METRO RAIL CORPORATION LTD.
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1.0 Scope of Work

GENERAL

- 1.1.1 The contractor shall execute the work and shall prepare the GFC (Good for Construction) Drawings/Method statements/Progress charts for the approval of the NMRC as per scope of works.
- 1.1.2 The work shall be carried out with contractors own material & labour as per the specification & drawing approved by NMRC.
- 1.1.3 The Brief scope of work is mentioned in BOQ and as per site requirement.
- 1.1.4 The work under this contract shall consist of, but not limited to, all materials, labour, equipment's, tools, plants and necessary machinery as required to completely execute any or/ and following works within NMRC premises/ scope:
- 1.1.5 Planning & Executing the Electrical works for the development of NMRC Project Office at 2nd floor, Ganga Shopping Complex, Sector-29, Noida and submit the detailed drawings/ documents, good for Construction drawings w.r.t. scope of works. The item rates in BOQ are inclusive of all Works.

Scope of Work (Electrical)

- 1.1.6 The work covered in the tender is as per BOQ placed in section of this RFP.
- 1.1.7 The technical specifications are set forth in technical specifications-Section 6 of this Volume-3.
- 1.1.8 The bidder should inspect the work site after receiving NOA and obtain for himself at his own responsibility all the information which may be necessary for the purpose of the successful execution of the contract.
- 1.1.9 The bidder shall also make himself conversant with all the local conditions, means of access to the site of work, nature, extent of transport facilities and character of the work and supply of materials, conditions affecting labour and other matters that may affect his tender.
- 1.1.10 All the work in the BOQ must be done as per instructions of Engineer In charge and also take approval of Make of BOQ items before any purchase.
- 1.1.11 The contractor shall execute the Electrical works and shall prepare the GFC (Good for Construction) drawings/shop drawing, Method Statements, Progress Charts, Testing & Commissioning Procedures for approval of NMRC as per the scope of work and BOQ. Contractor also shall make required changes in Electrical drawing on site as per the instruction of Engineer In-charge.
- 1.1.12 The works shall be carried out using contractor's own materials, labour, tools, tackles, testing instruments, plants, machinery, and supervision as per the specifications, approved drawings, relevant IS standards, and instructions of NMRC/Engineer-in-Charge.
- 1.1.13 Preparation of detailed engineering designs, restoration designs, shop drawings, coordinated services drawings, cable routing drawings, schematic diagrams, single line diagrams (SLD), as-built drawings, and Good for Construction drawings with respect to the scope of work. The item rates in BOQ shall be inclusive of all design and drawing works.
- 1.1.14 **Following works are also included as mentioned below:**
 - a) Internal and external LT power/control cabling works. Electrical wiring works including conduit, copper cables, switches, sockets, lighting fixtures, power points, and associated

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accessories, Distribution Boards (DBs), MCCBs, MCBs, RCCBs, isolators, and related accessories.

- b) LT Panels, with switchgear components, Diesel Generator (DG) Sets including associated works, UPS systems along with battery banks, cable trays, raceways, trunking, conduits, Earthing and cable management systems.
- c) Fire Detection & Alarm System including Fire Suppression Systems, sprinkler systems, hydrant systems, extinguishers, Public Address (PA) System including speakers, amplifiers, piping and accessories as required.
- d) HVAC systems including indoor & outdoor, ducting, insulation, ventilation systems, control cabling, thermostats, and associated electrical works.
- e) Integration and interfacing of Electrical, HVAC, Fire Alarm, Fire Fighting, DG, UPS, and PA systems for coordinated operation.
- f) Any other new Electrical, E&M, Fire Safety, HVAC, or allied system work as directed by Engineer-in-Charge.

1.1.15 The contractor shall plan and execute the work in such a manner that the work proceeds smoothly without disruption to existing services and to the satisfaction of the Engineer-in-Charge.

1.1.16 The Contractor shall attend regular coordination meetings convened by the Employer/Engineer for interface management and shall adhere to decisions taken during such meetings.

1.1.17 The equipment including the accessories shall be covered under warranty period/defect liability period. During this period the successful bidder shall replace all defective parts and attend to all repairs / breakdowns. The cost of spare parts for all replacements has to be borne by the successful bidder during the period of warranty/DLP. All warranty cards must be submitted with last bill.

1.1.18 These Specifications contained herein shall be read in conjunction with other tender documents.

1.1.19 The contractor will execute the work as per the tender drawing and shall prepare the Method statements/Progress charts for the approval of the NMRC as per scope of works.

1.1.20 Absence of terms such as providing, supplying, laying, installing, fixing etc in the descriptions does not even remotely suggest that the Contractor is absolved of such providing, supplying etc unless an explicit stipulation is made in this contract. The Owner shall bear no costs of materials, labour, equipment, duties, taxes, royalties etc.

1.1.21 The work under this contract shall consist of, but not limited to, all materials, labour, equipment's, tools, plants and necessary machinery as required to completely execute any or/ and following works within NMRC premises/ scope:

- a) The bidder should inspect the work site after receiving NOA and obtain for himself at his own responsibility all the information which may be necessary for the purpose of the successful execution of the contract.
- b) The bidder shall also make himself conversant with all the local conditions, means of access to the site of work, nature, extent of transport facilities and character of the work and supply of materials, conditions affecting labour and other matters that may affect his tender.
- c) There is a requirement of removal work of the left over Electrical utilities at the 2nd Floor of Ganga Shopping Complex. Bidder must inspect the site properly and ensure proper methodology prior to carry out the removal work.
- d) All the work in the BOQ must be done as per instructions of Engineer In charge and also take approval of Make of BOQ items before any purchase.

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e) Volume 5 contains indicative drawing that shall be subjected to be amended as per the On-site/field requirement and approved by Engineer In-Charge.

Contractor to Provide:-

The Contractor shall provide and maintain at site throughout the period of works the following at his own cost and without extra charge, Except for the items specified in the Bill of Quantities the cost being held to be included in the Contract Rates:

- I. General works such as setting out, site clearance before setting out and on completion of works.
- II. All labour, materials, plant, equipment and temporary works, Overhead charges as well as general liabilities, obligations, insurance and risks arising out of GCC, required to complete and maintain the works to the satisfaction of the Engineer
- III. Adequate lighting for night work, and also whenever and wherever required by the Engineer
- IV. Temporary fences, barricades, guards, lights and protective work necessary for protection of workmen, supervisors, engineers, General public and any other persons permitted access to the site. Contractor shall provide proper signage as directed.
- V. All equipment, instruments, labour and materials required by the Engineer for checking alignment, levels, slopes and evenness of surfaces measurements and quality etc.
- VI. Design mixes and testing them as per relevant clauses of specifications giving proportion of ingredients, sources of aggregates and binder along with accompanying trial mixes. Test results to be submitted to the Engineer for his approval before adoption on works.
- VII. Cost of Preparation and compliance with provision of a quality assurance control program.
- VIII. Cost of safe guarding the environment.

2.0 MATERIALS

2.1 Quality Assurance & Quality Control

- The work shall conform to high standards of design and workmanship, shall be structurally sound and aesthetically pleasing. The Contractor shall conform to the Quality standards prescribed, which shall form the backbone for the Quality Assurance and Quality Control system.
- At the site, the Contractor shall arrange the materials, their stacking/storage in appropriate manner to ensure the quality. The Contractor shall provide all the necessary equipment and qualified manpower to test the quality of materials, assemblies etc., as directed by the Engineer. The tests shall be conducted at specified intervals and the results of tests properly documented. In addition, the Contractor shall keep appropriate tools and equipment for checking alignments, levels, slopes and evenness of the surfaces.
- The Engineer shall be free to carry out such tests as may be decided by him at his sole discretion, from time to time, in addition to those specified in this document. The Contractor may provide the samples and labour for collecting the samples. Nothing extra shall be payable to

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the Contractor for samples or for the collection of the samples.

- The test shall be conducted at the Site laboratory that may be established by the Contractor or at any other Standard Laboratory selected by the Engineer.
- The Contractor shall transport the samples to the laboratory for which nothing extra shall be payable. In the event of the Contractor failing to arrange transportation of the samples in proper time the Engineer shall have them transported and recover two times the actual cost from the Contractor's bills.
- All testing shall be performed in the presence of Engineer. Testing may be witnessed by the Contractor or his authorized representative if permitted by the Test House. Whether witnessed by the Contractor or not, the test results shall be binding on the Contractor.
- The Engineer shall have the right at all times to inspect all operations including the sources of materials, procurement, layout and storage of materials, all equipment including the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged and the Engineer's approval obtained prior to starting of the particular item of work. This shall however, not relieve the Contractor of his responsibilities. All materials which do not conform to these specifications shall be rejected and shall be removed from the site immediately. The Engineer shall have the powers to cause the Contractors to purchase and use materials from any particular source, as may in the Engineer's opinion be necessary for the proper execution of work.

2.2 Rejection

- Any material found not to conform to the specifications shall be rejected forthwith and shall have to be removed from the site by the contractor at his own cost.
- Any work not to the satisfaction of the engineer or his representative will be rejected and same shall be rectified, or removed and replaced with work of required standard of workmanship at no extra cost.

3.0 TIME SCHEDULE

- **The Contractor shall complete field work within 4 weeks. This schedule is to be within the overall completion period of 04 months.**

4.0 Section 6: Technical Specifications

Specifications of Electrical and other works

This section covers specification of Distribution Boards (DBs) suitable for operation on 415 V 3 Phase 4 wire 50 Hz supply feeding final lighting and power sub circuits.

4.1 Standards and Codes.

Updated and current Indian Standards, IEC Standards, Codes of Practice, Rules, Regulations, and Statutory Requirements applicable at the time of execution shall govern the design, manufacture, testing, supply, installation, commissioning, operation, and maintenance of all equipment and works covered under this contract.

In addition, the provisions of the Electricity Act, 2005, the Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations, 2023, the latest edition of the National Building Code of India (NBC 2016 with amendments), the National Electrical Code of India (SP 30:2023), and all relevant Fire and Life Safety Codes issued by BIS shall be applicable.

Wherever Indian Standards are not available, the latest applicable IEC Standards shall apply. In case of conflict, the more stringent requirement shall govern.

The equipment and installation shall generally conform to the latest editions/amendments of the following standards:

Sl. No	Standard	Standard description
A.	ISO Standard	
1.	ISO 9001	Quality systems- model for quality assurance in design/development, production, installation and servicing
B.	IEC Standard	
1.	IEC 60947-6-1/EN 60947-6-1 (2021 Third Edition)	Specification for low-voltage and control gear Multiple function equipment. Automatic transfer switching equipment.
2.	IEC 61008	Residual current operated circuit-breakers without integral over current protection for household and similar uses (RCCBs)
3.	IEC 60947-2/EN 60947-2	Specification for low-voltage switchgear and control gear circuit breakers
4.	IEC 60947-1	Specification for low-voltage switchgear and control gear. Contactors and motor-starters. Electromechanical contactors and motor-starters.
5.	IEC 61439-3/EN 61439-3	Specification for low-voltage switchgear and control gear assemblies. Particular requirements for low voltage switchgear and control gear assemblies intended to be installed in place.
6.	IEC 61439	Specification for low-voltage switchgear and control gear assemblies
7.	IEC 62262:2002+AMD1:2021 CSV	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)

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8.	IEC 61641	Enclosed low-voltage switchgear and control gear assemblies - Guide for testing under conditions of arcing due to internal fault
9.	BS EN IEC 61869-1:202	Instrument transformers - Safety requirements of instrument transformers for high voltage applications
C. IS Standard and Other Relevant Standards & Codes		
1.	IS 694	Polyvinyl chloride insulated sheathed and unsheathed cables with rigid and flexible conductor for rated voltages up to and including 450/750 V
2.	IS 732	Code of practice for electrical wiring installations (third revision)
3.	IS/ IEC 62305	Protection Against Lightning Part 1 General Principles
4.	IS 5831	PVC insulation and sheath of electric cables (first revision)
5.	IS 8130	Conductors for insulated electric cables and flexible cords (second revision)
6.	IS 13779	ac Static Watt-hour Meters, Class 1 and 2
7.	IS 13947-5-2	Low-Voltage Switchgear and Control gear, Part 5: Control Circuit Devices and Switching Elements, Section 2: Proximity Switches
8.	IS 13947-5-1	Low-Voltage Switchgear and Control gear, Part 5: Control Circuit Devices and Switching Elements, Section 1: Electromechanical Control Circuit
9.	IS 13947-4-1	Low-Voltage Switchgear and Control gear: Part 4 - Contractors and Motor-Starters Is
10.	3947-3	Low voltage switchgear and control gear, part 3: switches, disconnectors, switch-disconnectors and fuse combination units
11.	IS 13947-2	Low-Voltage Switchgear and Control gear, Part 2: Circuit Breakers
12.	IS 13947-1	Low-voltage switchgear and control gear, Part 1: General rules IS 5553 Reactors – Specification
13.	IS 5553	Reactors – Specification
14.	IS 3043	Code of Practice for Earthing (Second Revision)

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15.	IS 7098 (Part 1)	Specification For Crosslinked Polyethylene Insulated PVC Sheathed Cables Part 1 For Working Voltages Up to and Including 1100 Volts
16.	IS 5838 (Part 1)	Specification For PVC Insulation and Sheath of Electric Cables
17.	IEEE 80	IEEE Guide for Safety in AC Substation Grounding
18.	Indian Electricity Rules	IE Rules
19.	Indian Electricity Act	IEA Rules
20.	National Building Code	NBC 2016
21.	American Society for Testing and Materials	ASTM
22.	National Electrical Code	NEC SP-30
23.	National Electrical Manufacturers Association	NEMA
24.	National Fire Protection Association	NFPA
25.	American National Standards Institute	ANSI
26.	Chief Electrical Inspector to Government Noida/ Greater Noida (Uttar Pradesh)	CEIG
27.	Central Pollution Control Board	CPCB
28.	National Lighting Code	NLC-SP 72
29.	Noida/ Greater Noida Fire Services	Noida/ Greater Noida FS
30.	Uttar Pradesh/ Noida/ Greater Noida Public Works Department	PWD, Uttar Pradesh/ Noida
31.	Uttar Pradesh/ Noida/ Greater Noida Power Supply Utilities	
32.	Uttar Pradesh/ Noida/ Greater Noida Administration	
33.	Municipal Corporations of Noida/ Greater Noida (Uttar Pradesh)	
34.	Standardization-of-Specifications-for-Electrical-and-Electromechanical-Systems-of-Metro (MoHUA Guidelines)	
35.	Other relevant Codes and General engineering practice required at the time of Design.	

4.2 Distribution Boards

- DBs shall be wall mounting, recessed/surfaced type, totally enclosed, 16 SWG, dust and vermin proof.
- DBs shall be double door type. Access to the wiring shall be possible without removing the outer hinged door. The door shall be earthed with insulated copper braded flexible wires.
- Components forming a part of the DBs shall comply with the relevant Standards and Codes of the Bureau of Indian Standards.
- Detachable plate with Knock out holes shall be provided at the top/bottom of board. Complete board shall be factory fabricated. The box and cover shall be fabricated from 1.6 mm sheet steel, properly pre-treated, phosphatized with powder coated finish.

Where specified it shall be out double door construction provided with hinged cover in the front.

4.3 Name Plates and Labels

- Suitable engraved white on black name plates and identification labels of metal for all Switchboards and Circuits shall be provided. These shall indicate the feeder number and feeder designation.

4.4 Cable Tray/Raceway

(a) Cable Trays

- Cable tray is manufactured to comply with the specifications of National Electrical Code (NEC), relevant IS and National Electrical Manufacturer's Association (NEMA).

(b) Ladder type Cable tray

- Cable trays shall be ladder type fabricated out of mild steel/slotted angles and flats of required width as per design.
- Bends shall be prefabricated. The cable tray shall be hot dip galvanized or primed and painted with powder coating as asked for in BoQ or as approved by Owner/Consultant.
- The minimum weight of the zinc coating shall be 610 gm/sq.m and minimum thickness of coating shall not be less than 80 microns.

(c) Perforated Cable tray

The perforated cable trays are fabricated out of 2.0 mm thick CRCA sheet steel having minimum 50mm depth or as called for in BOQ, hot dip galvanized or epoxy coated of approved shade.

- Perforations are maximum 10mm spaced at maximum 20mm distance. The cables shall be tied with the cable tray with nylon strip/aluminium clamps/M.S. clamps as per requirements.
- Suitable provision shall be made where a tray crosses expansion joints. The width of the tray shall allow for a suitable separation between cables the design shall allow for adequate bending radius for the sizes of cables.
- No sharp bend to be allowed in cable tray. Joints between sections shall be bolted.
- The tray shall be suspended from the surface of the concrete slab by means as specified by the manufacturer. Suitable bushes shall be provided where cables pass through apertures in the tray.
- Cables must be securely fixed to the tray with clamps or cable ties. In routing necessary barrier and spacing shall be maintained for cables of different voltages in case they lie side by side.

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- Telephone cables shall cross the power cables only at about right angle and these two shall not run in close proximity.
- Full details of the tray shall be approved by the Site Engineer before fabrication. Earth continuity shall be maintained between each section of cable tray and each total run of tray shall be effectively bonded to the nearest earth continuity 0 conductor.
- All nuts and bolts used shall be of galvanised steel.
- Depending on the size of cable trays space of 20-25% has to be maintained for future expansion.
- Hot Dip Galvanizing Process for Mild Steel Used for Earthing, Cable Trays or Junction Boxes for Electrical Installation.

4.5 Testing of Cables

Cables shall be tested at works for the following tests before being dispatched to site by the project team.

- Insulation Resistance Test.
- Continuity resistance test.
- Sheathing continuity test.
- Earth test.(in armoured cables)
- Hi Pot Test.

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. On completion of cable laying work, the following tests shall be conducted in the presence of the NMRC site representative.

- Insulation Resistance Test (Sectional and overall)
- Continuity resistance test.
- Sheathing continuity test.
- Earth test.

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 site representative.

4.6 Floor Cable Trunking

(a) General

- Cable trunking and accessories shall comply with BS EN 50085 series or equivalent applicable Indian/IEC standards and shall be manufactured from galvanized steel conforming to IS 277 (latest edition).
- Trunking shall be top accessed. Inverted trunking is not acceptable.
- All multi-compartment trunking systems shall maintain the stated segregation throughout, including all accessories.
- Trunking shall be manufactured using pre-galvanised sheet steel. Trunking shall be spot welded & arc welded throughout its length for better impact resistant and to prevent concrete seepage during installation.
- Manufacturer's standard fittings shall be used for all connections and changes of direction. All vertical bends, Crossover boxes, access outlets, and junction boxes shall be

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of the same manufacturer as the trunking. Trunking shall not be cut or bent to form bends, flanges or attachments. Gusset bends shall be used wherever necessary to provide sufficient bending radius for the cables. Site fabricated items shall not be accepted.

- All inside edges of trunking shall be smooth and provision shall be made to prevent abrasion at bends.
- Trunking shall be adequately supported throughout its length. Trunking support and channel shall be quick-fixing type and shall be such as to space the trunking a minimum of 13mm from any part of the wall or bulkhead.
- A minimum of two fixings shall be provided between joints in the trunking except where the distance between is less than the maximum spacing.
- Where trunking is cut or drilled, the cut edges of the trunking shall be smoothed to prevent abrasion of the cables and shall be painted with anti-corrosion paint like aluminium coating, to the same colour as the adjacent surfaces, such painting to be carried out as the work proceeds. In no circumstances will rough screw edges and nuts be allowed in the interior of the trunking.
- The space factor for cables installed in trunking shall not exceed 35% as per IEE regulations.
- All lengths of vertical run trunking in excess of 3000mm shall contain cable supports made of insulating, non-hygroscopic, non-combustible material. The spacing between such supports shall not exceed 1800mm.
- An additional support shall be provided at the top of all vertical runs exceeding 3000mm, to support the weight of the cable and distribute the cables within the trunking to prevent undue compression of the installation.
- Where trunking crosses expansion joints, a trunking fitting shall be used which shall allow for expansion and maintain earth continuity.
- Trunking installed externally shall be manufactured from galvanized sheet steel in accordance with relevant standard.
- Connections to multiple boxes, switchgear and distribution boards shall be made with multi compartment vertical access boxes. Expansion joints in long continuous runs shall be provided as recommended by the manufacturer.

(b) Access Outlets

- Access Outlets are made of very high quality materials to withstand heavy load and corrosion.
- Manufactured from high-pressure die cast material for strength & durability.
- The trap frame & trap are made of flame retardant Engineering Plastic - ABS & Polyamide ratchet for strength & durability.
- The Trap Frame can be easily removed by pulling either one of the Nylon Bars to detach & remove the unit for servicing or installation of accessories to save installation & servicing time.
- Patented screw less ratchet bar level adjusting system to match with screed / floor height. The trap lid is self-adjustable to any floor finish thickness.
- Trap cover must be reinforced with a 2.5mm thick pre-galvanized steel plate to provide rigidity & added strength. Trap lid to have a screw less knob-hinged design for quick mounting on to the frame requiring minimum maintenance.

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- The Trap cover must have 8 mm recessed for installation of carpet and tiles.
- Trap trim design to protect carpet from damages and give the floor area added aesthetics.
- Strong and durable trap lifting handle on the trap cover is made of similar color material and has special design for easy lifting, even with large fingers.
- Cables are guided by Cable Retainers through generous cable outlet which open automatically and lock into position when cables are present.
- Access Outlet should carry service plates for providing services i.e.: Power, Data & Telecom. The Access outlets must accommodate to have three compartments to run Mains Voltage & Extra Low Voltage cables.
- The system must have Positive Double Earthing connections.
- Earth wire connector should be provided in all the boxes, and complies with the requirement of current IEE regulation.
- Access outlets are tested to a load bearing of 2 tons on the trap lid for heavy traffic areas
- Four side blanks are made with removable perforations to suit ducts installation.
- Standards & Approvals – The system must comply with the relevant specification, IS standard & IEC 61084 standards.

(c) Crossovers/Junction Boxes

- Cross Overs/Junction boxes are made of very high quality materials to withstand heavy load and corrosion.
- Manufactured from high-pressure die cast material for strength & durability.
- The trap lid is self-adjustable to any floor finish thickness using the levelling screws on all the four corners.
- The Trap cover is made of 2.5mm thick pre-galvanized steel plate to provide rigidity & added strength.
- The Trap covers to have flexibility for quick mounting on to the base box requiring minimum maintenance.
- The Trap cover must have 8mm recessed for installation of carpet and tiles.
- The system must accommodate to run Mains Voltage & Extra Low Voltage cables.
- The trap cover screws must be made from Stainless Steel for extra protection.
- The system must have Positive Double Earthing connections.
- Earth wire connector should be provided in all the boxes, and complies with the requirement of current IEE regulation.
- The complete system must have excellent protection against rust.
- Standards & Approvals – The system must comply with the relevant specification & IS standard, IEC 61084 standards.

(d) Vertical Access Boxes

- Vertical access boxes are made of very high quality materials to withstand heavy load and corrosion.

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- Vertical access boxes facilitate the connectivity of floor raceways to the equipment on the wall like the distribution boards, so the product should be designed as —LII shaped
- The Vertical access boxes should have provision to carry Power, Data & Telecom services
- The vertical access boxes should have the duct entry knockouts of up to 38mm and also provision for carrying the conduits to the wall
- The vertical access boxes are made of electrostatic polyester epoxy coating to prevent the rust accumulation.

4.7 Light Fixtures

(a) Light Fittings and LED Standards

- Latest revision of all codes and standards are to be followed wherever specified otherwise for installation and requirements, Indian standards codes of practice or the relevant British Standard codes of practice is to be followed, in absence of any standards.
- Environmental Conditions as per local Condition: Delhi NCR.
- During the execution stage, NMRC may conduct the Test on any type of fixture to ensure the quality of material supplies. If any of the samples fail in the test, the cost of the test along with the complete replacement of whole lot shall be borne by the Contractor.
- If contractor represents, two random samples from the failed Lot shall be collected by the contractor in the presence of NMRC representative and after duly sealing the samples will be send to two different NABL accredited labs (as approved by Engineer In-charge) for conducting all those re-tests, which were conducted on the failed sample. Cost of the testing including the collection of sample and transportation of sample will be borne by the contractor.
- If both the samples pass all the Tests, supplied lot will be deemed as accepted by NMRC, but in case of failure of any of the samples collected by the contractor, complete lot will be deemed as rejected and contractor will replace the whole Lot.
- The delay, if any for the procurement of the replacement material due to failure, shall be considered as non-compliance and applicable penalty shall be imposed on the contractor.

(b) Criteria for Acceptance:

- The lumen output of the tested fixture for each Type of light fixture shall not be less than 70% of the declared value, at the time of approval. If more than 50% of sample of particular type of light fixture fails in testing, the proportionate amount BG will be forfeited. The decision of Engineer-in-charge in this regard will be final.
- Apart from above, Engineer-In-charge reserves the right to test any other type of supplied luminaries.
- The tolerances in the wattage / efficacy / harmonics and other parameters shall be as per the latest IEC / IS.
- The light fittings or its paint shall not emit toxic / corrosive gases in case of fire and shall be non-combustible and fire-resistant type.
- The emergency lighting installation shall fully comply with NBC or other relevant safety standards.
- Each luminaire and driver should be BIS certified and related “R” Number of BIS should be printed on the Luminaire / driver.

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- The lighting fixtures and accessories shall give continuous trouble free operation during the defined life and their performance, shall not deteriorate with time.
- NMRC reserves the right of testing of products for its conformity in accordance with mentioned specifications.
- Driver of luminaire shall be preferably in separate compartment other than luminaire compartment. Mock-up of fixture and driver installation maintenance shall be given by OEM.
- Out of total light fixtures installed, at least 30% of the total lights, all uniformly distributed shall be connected to emergency power source i.e. UPS/DG Set supply.

(c) LED Make and Specifications

- The approved makes for the LED chips are Nichia, Philips-LumiLEDs, Osram and Cree or as approved by NMRC. The LED Chip manufacturers should have registered office In India. The OEM should provide letter of undertaking from LED supplier indicating the LED make, type and quantity supplied for the lot to be delivered.
- LED shall have an SDCM (standard deviation in colour maintenance) of less than or equal to 5.
- The LED efficacy shall be more than 85% at a junction temperature. OEM shall provide relevant test certificates for approval of the Engineer.
- Manufacturer shall submit the TM 21 report and LM-80 report for test duration of minimum 9000 hrs along with relevant documents for each type of LED used in Luminaires to be supplied.

(d) LED Driver and Control Circuit Specifications

- LED driver shall be marked as per latest Standards.
- The LED driver shall be constant current type.
- Potted driver with silicon based compound shall be provided for Type A-Suspended/ Surface mounted LED trunk fixture and all outdoor luminaires. The potting material should have atleast thermal conductivity of 0.8 W/mK. It should be moisture resistance and should be fire retardant. An un-potted sample of the driver also needs to be submitted at time of inspection. MSDS of potting material to be submitted.
- For the balance type of luminaires, which do not have potted drivers, the PCB should have conformal coating complying to IEC 61086.
- Over temperature protection / Thermal fold back should be provided in all luminaires drivers.
- Industrial grade or higher grade components should be used for manufacturing of driver.
- The driver shall have under voltage, over voltage and short circuit protection and auto recovery mode.
- Output current ripple content shall be less than or equal to 10% on load. Supplier shall substantiate this with documentary evidence and same shall be tested during the Acceptance tests.
- Output current regulation shall be +/- 5% of the rated current. Supplier shall substantiate this with documentary evidence and same shall be tested during acceptance tests for specified input voltage range.
- Output voltage ripple shall be within 3%. Supplier shall substantiate this with documentary evidence and the same shall be tested during the Acceptance tests.

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- Total harmonic distortion shall be less than or equal to 10%. Supplier shall substantiate this with documentary evidence and the same shall be tested during the Acceptance tests.
- The driver shall have an efficiency > 85% at rated nominal voltage and at full Load.
- It shall have a power factor > 0.95 at rated nominal voltage and full Load
- It should give consistent performance in the input voltage range of 165V-270V at 50 Hz. The driver should have nominal voltage of 240 V. The output voltage of the driver shall be designed to meet the power requirement for the
- The driver shall be able to withstand 440 V for 8 hrs for all luminaires. After the application of high voltage, the performance parameters namely THD, PF, regulation and efficiency should not deteriorate.
- The OEM shall submit damp heat test report confirming to IEC 60068/2/78 or IS 9000 / Part (IV) for all types of drivers.
- The driver should have facility for cut off at over voltage.
- The driver shall have inbuilt inverse polarity protection.
- The driver should be designed for ambient temperature, $T_a = 40$ degree celsius and the life of the driver shall be 50000 hrs (at full load and failure rate of less than 10%). Accordingly T_c (case temperature) is to be decided by OEM.
- Measurement of T_c to be recorded during inspection after placing luminaire in ON condition in thermal chamber at $T_a=40$ OC, after temperature has stabilization. T_c should not be more than specified value.
- Driver should be paired with luminaire that uses 20% less wattage than the maximum rated wattage of the driver.

(e) LED Luminaire Specifications

- The system luminous efficacy (Actual lumen coming out of LED Luminaires) of the LED luminaires (of the system) shall be more than 140 lumens.
- The product shall be available in the colour temperature range of 4000K-6500K.
- Manufacturer has to submit the LM-79, L70 and TM-21 test report along with relevant documents and IES file of all luminaires.
- It shall have CRI> 80 for indoor applications and CRI> 70 for outdoor applications.
- The fixture shall be surface suspended or recessed type depending on the application area.
- The housing & diffuser shall be robust and conforming to relevant standards and shall have UV and corrosion resistance protection.
- The luminaires shall have a high quality clear toughened glass or non-yellowish polycarbonate or PMMA diffuser with diffused reflection having a maximum transmissivity of 85% with fire retardant feature.
- For the outdoor applications it shall have a clear toughened glass. The housing of the indoor fixtures should be extruded aluminum/standard alloy housing,
- It shall have a proper thermal management to dissipate heat.
- The fixture shall be suitable to work in diverse atmospheric condition like humidity, dust, corrosive etc.

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- The fixture shall have a minimum ingress (IP) and impact protection (IK) rating depending upon the area of application as per E/I.
- The power factor of the overall system shall be > 0.95 at full load
- Manufacturer shall have in-house laboratories for carrying out acceptance tests and shall have NABL accreditation for in-house laboratories to perform all applicable photometric tests.
- Provision shall be made in the fixture for incoming and outgoing power supply termination, preferably directly at the back of housing.
- All the internal wiring of the fixture shall be of FRLS/FRLSZH type, copper conductor. Contractor shall submit a test report in support of FRLS/FRLSZH type conductor as per recommendation of NMRC.
- All screws should be SS 304 or higher grade.
- Connectors used for input AC and output DC connections must be screw type connector.
- The solder shall be RoHS compatible for being environment friendly. LED / LED PCB shall be mechanically fixed (not to be glue fixed).
- Extruded aluminium housing shall be robust, heavy duty & anodized and shall have minimum thickness of 1.1 mm (preferably ribbed).
- Luminaire shall be embossed or screen printed with manufacturer Name and logo. Also the following information shall be marked on durable adhesive sticker as per IS code:
- Type of fitting/Manufacturer name/ Manufacturing year and month /wattage /Lumen/ Efficacy/ R number/IP/IK/ambient temp/CCT/CRI.
- The lumen maintenance of the LED fittings (of the system not chip) shall not be less than 70% after 50000 hrs.
- The luminaire should be tested as per IS 10322/IEC 60598 standards and following test reports should be submitted: Heat Resistance Test, Thermal Test, Ingress Protection Test, Electrical / Insulation Resistance Test, Endurance Test, Humidity Test.
- Should be compliant to LM-79-8/IS 16106: approved method for the Electrical and Photometric Measurements of Solid-State Lighting Products LM-79 testing of the complete luminaire.
- Should be compliant to LM-80 IESNA: Approved Method for Measuring Lumen Maintenance of LED Light sources and LED lumen depreciation time to L70 based on LM-80 data to estimate lifetime based on performance data collected from IESNA LM-80.

4.8 Wiring

General

- Technical Specifications in this section cover the Internal Wiring Installation in concealed/surface conduit/raceways pertaining to:
- Lights and fans
- Convenience socket outlets
- Submain wiring
- Standards and codes

Updated and current Indian Standards, Codes of Practice, Rules, Regulations, and Statutory Requirements applicable at the time of execution shall govern the design, manufacture,

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supply, installation, testing, and commissioning of all equipment and works covered under this section.

In addition, the provisions of the Electricity Act, 2003, the Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations, 2023 (as amended from time to time), the National Building Code of India (NBC 2016 with latest amendments), National Electrical Code of India SP 30:2023, and all applicable Fire and Life Safety Standards shall apply. Wherever Indian Standards are not available, the latest applicable IEC/BS EN Standards shall govern.

- The works and materials shall generally conform to the latest editions/amendments of the following standards:
- PVC insulated cables and flexible cords up to and including 1100 V – IS 694 (latest edition)
- Conduit systems for cable management – IS/IEC 61386 Series
- Accessories for conduit systems – IS/IEC 61386 Series
- Flexible conduit systems for electrical installations – IS/IEC 61386 Series.
- Switches for household and similar fixed electrical installations – IS/IEC 60669-1
- Plugs and socket-outlets for household and similar purposes – IS 1293 (latest edition)
- Luminaires – General requirements and tests – IS 10322 (Part 1) / IEC 60598-1
- Boxes and enclosures for electrical accessories – Relevant provisions of IS/IEC standards and manufacturer's specifications
- Danger notice plates – IS 2551 (latest edition)
- Fire safety of buildings – General principles – IS 1641 (latest edition)
- Fire safety of buildings – Code of practice for fire safety of electrical installations – IS 1646 (latest edition)
- Code of practice for electrical wiring installations – IS 732 (latest edition)
- Guide for safety procedures and practices in electrical work – IS 5216 (latest edition)
- Low-voltage electrical installations – IS 732 and relevant IEC standards.

All materials, workmanship, testing, inspection, and commissioning shall comply with the latest revisions/amendments of the above standards in force on the date of submission of bid.

4.9 Wiring materials (conduits & accessories)

(a) MS Conduits

- All conduits shall be of heavy gauge solid drawn ERW welded manufactured out of 16 (1.6mm) gauge MS Sheet up to 32mm dia and of 14 (2 mm) gauge for sizes higher than this. Both inner and outer surfaces shall be smooth without burrs, dents and kinks. Conduits shall be black stove enameled inside and outside. The cross section of conduit shall be uniform throughout. Conduit shall conform to specifications of IS: 9537 (Part-II) and the capacity of conduits shall be in accordance with the standards and shall never be exceeded. The minimum size of the conduit shall be 20mm dia. Care shall be taken to ensure that all conduits are adequately protected while stored at site prior to erection and no damaged conduit shall be used.

(b) Joints

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- All jointing shall be subject to the approval of the site representative. The threads and sockets shall be free from grease and oil, Connections between screwed conduit and GI boxes shall be by means of hexagon brass check nut, fixed outside and brass bush from inside the box. The joints in conduits shall be free of burrs to avoid damage to insulation of conductors while pulling them through the conduits.

(c) Recessed or Exposed conduit

- All conduits shall be as per Schedule of Quantities.

(d) Flexible Conduit

- Wiring for short extensions to outlets in hung ceiling or to vibrating equipment, motors etc. shall be installed in flexible conduits. Flexible conduits shall be formed from a continuous length of spirally wound interlocked wire steel with a fused zinc coating on both sides. The conduit shall be provided with approved type adaptor. A separate and accessible earth connection shall bond across the flexible conduit.

(e) Conduit Accessories.

Standard accessories

- Heavy duty black enamel painted / galvanized standard conduit fittings and accessories like standard/extra-deep circular boxes, looping in boxes, junction boxes, solid /inspection elbows , solid/inspection tees, couplers, nipples, saddles, check nuts, earth clips, ball socket joints, bushes etc. shall be of superior quality and of approved makes. Heavy duty covers screwed with approved quality screws shall be used. Samples of all conduits fittings and accessories shall be got approved by Engineer-in-Charge before use.

(f) Fabricated accessories

- Wherever required, outlet/junction boxes of required sizes shall be fabricated from 1.6 mm thick MS sheets excepting ceiling fan outlet boxes which shall be fabricated from minimum 3 mm thick sheets. The outlet boxes shall be of approved quality, finish and manufacture. Suitable means of fixing connectors etc., if required, shall be provided in the boxes. The boxes shall be protected from rust by zinc phosphate primer process. Boxes shall be finished with minimum 2 coats of enamel paint of approved colour. A screwed brass stud shall be provided in all boxes as earthing terminal.

(g) Outlet Boxes for Light Fittings.

- These shall be minimum 75mm x 75mm x 50mm deep and provided with required number of threaded collars for conduit entry. For ceiling mounted florescent fittings, the boxes shall be provided 300 mm off centre for a 1200 mm fitting and 150 mm off centre for a 600 mm fitting so that the wiring is taken directly to the down rod. 3 mm thick perspex/hylam sheet cover of matching colour shall be provided.

(h) Outlet Boxes for Ceiling Fans

- Outlet boxes for ceiling fans shall be fabricated from minimum 3 mm thick MS sheet steel. The boxes shall be hexagonal in shape of minimum 100 mm depth and 60 mm sides. Each box shall be provided with a recessed fan hook in the form of one 'U' shaped 15 mm dia rod welded to the box and securely tied to the top reinforcement of the concrete slab for a length of minimum 150 mm on either side. 3 mm thick Perspex/hylam sheet cover of matching colour shall be provided.

(i) PVC Conduit and Accessories

- Conduits and accessories shall conform to latest edition of IS-9537 part 3 and shall be heavy duty with minimum wall thickness of 2.0 mm rigid tubes which are unscrewed without coupling and with plain ends. All sections of conduit and relevant boxes shall be

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properly cleaned and glued by using epoxy resin glue and the proper connecting pieces. All conduits used shall be ISI-marked and shall not be less than 20 mm diameter.

- PVC conduit shall be used for all concealed / embedded installation.

(j) PVC Conduit Accessories

- Accessories used for conduit shall be of an approved brand and type complying with relevant IS code.
- All accessories used shall be of standard white or black colour, identical to conduit used.
- Plain conduits shall be joined by slip type of couplers with manufacturer's standard sealing cement.
- All conduit entries to outlet boxes, trunking and switchgear are to be made with adaptors female thread and screwed male bushes.
- PVC-switch and socket boxes with round knockouts are to be used. The colours of these boxes and the conduits shall be the same.
- 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.
- Samples of accessories shall be submitted for approval prior to installation.
- All jointing of PVC conduits shall be by means of adhesive jointing. Adequate expansion joints shall be allowed to take up the expansion of PVC conduits.

(k) Bends in Conduit

- Where necessary, bends or diversions may be achieved by means of bends and / or circular cast iron inspection boxes with adequate and suitable inlet and outlet screwed joints. In case of recessed system each junction box shall be provided with a cover properly secured and flush with the finished wall surface. No bends shall have radius less than 7.5 cms or three times the outside diameter of the conduits. No run of conduit shall have more than four right angle bends from outlet to outlet. Bends in multi runs of conduits shall be parallel to each other and neat in appearance, maintaining the same distance as between straight runs of conduits.

(l) Conduit Installation

a. System

- The whole conduit system shall be installed to comply fully with relevant provision in Indian Standard Specifications, Indian Electricity Rules and IE wiring regulations. Conduits shall be laid either recessed in walls and ceilings or on surface on walls and ceilings or partly recessed and partly on surface, as required. Same rate shall apply for recessed and surface conduiting in this contract. Stranded copper conductor insulated wire of size as per schedule of quantities shall be provided in entire conduiting for loop earthing. Steel wire of suitable size to serve as a fish wire shall be left in all conduit runs to facilitate drawing of wires after completion of conduiting.

b. Installation

- Conduits shall be laid before casting in the upper portion of a slab or otherwise, as may be instructed or in accordance with approved drawings, so as to conceal the entire run of conduits and ceiling outlet boxes. Vertical drops shall be buried in columns or walls. Wherever necessary, chases will be cut by the contractor with the help of chase cutting m/c or by hand. Nothing extra shall be paid to the contractor on this account. In case of exposed brick/ rubble masonry work special care shall be taken to fix the conduit and

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accessories in position along with the building work. Sufficient depth of the chases will be made to accommodate the required number of conduits. The chase will be filled with cement, coarse sand mortar (1:3) and properly cured by watering for one week.

- If a chase is cut in an already finished surface the contractor shall fill the chase and finish it to match the existing finish. Contractor must not cut any iron bars to fix conduits. Conduits shall be kept at a minimum distance of 100mm from the pipes of other non-electrical services. Where the conduit is to be embedded in a concrete member it shall be adequately tied to the reinforcement to prevent displacement during casting, conduits in chases shall be held by steel hooks of approved design at maximum of 100 cm centres. The embedding of conduits in walls shall be so arranged as to allow at least 12mm plaster cover the same. All threaded joints of conduit pipes shall be treated with some approved preservative compound to secure protection against rust.
- Suitable expansion joints fittings of approved make and design shall be provided at all the points where the conduit crosses the expansion joint in the building.
- Separate conduit shall be used for:
 - Normal light, fan, call bell
 - 6 A power outlets
 - Emergency Light Point
 - Fire alarm System
 - Computer Outlets
 - P.A System
 - Telephone system
 - TV Network
 - Or any other services not mentioned here.
- Conduit runs on surfaces shall be supported with metal 1.2 mm thick saddles, which in turn are properly secured on to GI spacer to the wall or ceiling.
- Cross cover of conduits shall be minimum and entire conduit installation shall be clean and with good appearance. For surface work, the boxes shall be raised back pattern type, designed for use with distance saddles to give clearance of 6mm between the back of conduit and the fixing surface.
- Where conduits are run on steel work, they will be fixed by means of purpose made GI Caddy clips in manner meeting with the approval of the Engineer prior to the installation being carried out. Other methods of fixing may be agreed in special circumstances, but approval must first be obtained from the site engineer.
- The spacing of saddles shall be not more than 600mm centers for up to 32mm diameter conduits and at 750mm for conduit sizes of 40mm diameter and above in case of MS conduit and not more than 600 mm for PVC conduit. In addition, saddles shall be fixed at each side of any bend/Tee, or set at a distance of 200mm from the bend/Tee.
- Particular care shall be taken during the progress of the work to prevent the ingress of dirt and rubbish such as plaster droppings into erected conduits. Conduit which has become so clogged shall be entirely freed from these accumulations or will be replaced.
- All conduit installations must be completed and erected in their totality before they are wired and must be fully rewirable from outlets to distribution boards or trunking systems etc. to which they connect. No wiring of any part of the installation shall be commenced

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until instructions are received to do so by the Engineer-in-charge at such time as he is satisfied that the wiring will not be damaged due to building operations.

- Conduits shall be installed so that they are self-draining in the event of ingress of moisture due to condensation or any other reason. A suitable drainage hole shall be drilled at the bottom of the lowest conduit box in every 9-meter of horizontal run.
- PVC bush of good quality shall be used in each conduit termination in a switch box, draw box, lighting fixtures and circular junction boxes.
- Exposed conduits running above false ceilings shall be suitably clamped independently along with the dropped ceiling. Perforated straphangers or twisted attachment shall not be acceptable. In no case shall raceways be supported or fastened to other pipe for repair and maintenance. They shall be arranged symmetrically and in the most compact design, in no way unduly criss-crossing each other. Proper spacing shall be maintained when two or more conduits run side by side. The layout of the pipes shall be coordinated with other services if any. The junction boxes and conduits used in hazardous areas shall be flameproof type with cast iron construction complete with threaded covers.
- The conduit of each circuit or section shall be completed before conductors are drawn in. The entire system of conduit after erection shall be tested for mechanical and electrical continuity throughout and permanently connected to earth conforming to the requirements by means of special approved type of earthing clamp efficiently fastened to conduit pipe in a workman like manner for a perfect continuity between the earth and conduit.
- The conduit system shall be so laid out that it will obviate the use of tees, elbows and sharp bends. No length of conduit shall have more than the equivalent of two-quarter bends from inlet to outlet. The conduit itself being given required smooth bend with radius of bends suiting to the site conditions but not less than 6 times overall diameter.
- Outlet boxes shall be of heavy-duty sheet steel installed as to maintain continuity throughout. These shall be so protected at the time of laying that no mortar finds its way inside during concrete filling or plastering.
- Draw boxes of ample dimensions shall be provided at convenient points to facilitate pulling of long runs of cables. They shall be completely concealed with MS covers flush with plasterwork painted to match the wall.

(m) Switch outlets and junction boxes

- All outlet boxes for switches, sockets and other receptacles shall be rust proof and shall be of 2 mm thick mild steel sheets with HOT dipped galvanizing (or as specified in BOQ), having smooth external and internal surfaces to true finish. All outlet boxes for receiving plug sockets and switches shall be fabricated to approved sizes. All boxes shall have adequate number of knock out holes of required diameter and earthing terminal screws. Outlet boxes shall be of a maximum depth of 65 mm.

(n) Inspection boxes

- Inspection boxes of 50 mm dia of cast iron shall have smooth external and internal finish to facilitate removal and replacement of wires, where required.

(o) Fish wire

- For drawing of wires in the conduit, GI fish wires of 2.0 mm (14 SWG) shall be provided along with the laying of recessed conduit.

(p) Conductors

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- PVC insulated, Flame Retardant Low Smoke (FRLS) wires shall be single core unsheathed in voltage grade 1100 V as per IS 694 – 1990 with 99.97% pure electrolytic grade bright annealed stranded bare copper conductors. Special parameters of FRLS PVC insulation like critical oxygen index, temperature index, smoke density and flammability test shall conform to relevant IEC and ASTM Standards. Coil packing shall be ISI marked as stipulated in IS 694

(q) Bunching of wires

- Wires carrying current shall be so bunched that the outgoing and return wires are drawn into the same conduit. Wires originating from two different phases shall not run in the same conduit. All wires shall have ferrules for identification. Lighting and power circuits shall be separate.

(r) Drawing conductors

- The drawing and jointing of PVC insulated copper conductor wires shall be executed with due regard to the following precautions. While drawing wires through conduits, care shall be taken to avoid scratches and kinks which may cause breakage of conductors. There shall be no sharp bends. Wire reel stands to be used for pulling of wires to avoid kinks.
- Insulation shall be removed by insulation stripper only. Strands of wires shall not be cut for connecting terminals. The terminals shall have sufficient cross sectional area to take all strands and connecting brass screws shall have flats ends. All looped joints shall be connected through terminal block/connectors. The pressure applied to tighten terminal screws shall be just adequate, neither too much nor too less. All light points shall be terminated through a connector.
- All light points will terminated through a connector. Conductors having nominal cross sectional areas exceeding 10 sq.mm shall always be provided with cable sockets. At all bolted terminals brass flat washer of large area and approved steel spring washer shall be used. Brass nuts and bolts shall be used for all connections.
- Only licensed wiremen (Before doing the work or before appointing him on site contractor has to submit his wiring license to NMRC) and cable jointers shall be employed to do jointing work. All wires and cables shall bear the manufacturer's label and shall be brought to site in original packing.
- For all internal wiring. PVC insulated wires of 1100 volts grade shall be used. The sub-circuit wiring for point shall be carried out in loop system and no joints shall be allowed in the length of the conductors. No wire shall be drawn into any conduit until all work of any nature that may cause injury to wire is completed. Care shall be taken while pulling out the wires so that no damage occurs to conduits/wire itself, the conduits shall be thoroughly cleaned of moisture, dust, dirt or any other obstruction. The minimum size of PVC insulated copper conductor wires for all sub-circuit wiring for light points shall be minimum 2.5 sq.mm copper Separate neutral to be pulled for each circuit.

(s) Joints

- All joints shall be made at main switches, distribution boards, socket outlets, lighting outlets and switches boxes only. No joints shall be made in conduits and in junction boxes. Conductors shall be continuous from outlet to inlet.

(t) Load balancing

- Balancing of circuits in three phase installation shall be planned by the Consultants and shall be checked by the contractor before the commencement of wiring and shall be strictly adhered to.

(u) Colour code of conductors

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- Colour code for normal supply – Red, Yellow, Blue for three Phases, Black for Neutral and Green for Earth – shall be maintained for the electrical wiring installation
- Colour code for UPS supply – Red/white, Yellow/white, Blue/white for three Phases, white for Neutral and Green/yellow for Earth

4.10 Switches, receptacles (modular)

(a) SWITCHES

- All switches shall be enclosed type flush mounted suitable for 240 volts AC. All switches shall be fixed inside the switch boxes on adjustable flat M S strips/plates with tapped holes and brass machine screws, leaving ample space at the back and sides for accommodating wires.

(b) WALL SOCKET OUTLET

- Wall socket outlets shall be of the three pin. An earth wire shall be provided along with the circuit wires and shall be connected to earthing screw inside the box. The earth terminal of the socket shall be connected to the earth terminal provided inside the box. All sockets shall be shuttered type.
- Every socket outlet shall be controlled by an individual switch unless mentioned otherwise.
- The switch controlling the socket outlet shall be on the 'Live' side of the line.
- 6 amps and 16 amps socket outlet shall normally be fixed at any convenient height above the floor level based on request of E/I/Interior designer. The switch for 6 and 16 amps, socket outlet shall be kept along with the socket outlet.
- Each circuit shall have not more than 800 Watts connected load. However, in case of LED Points where load per point may be less, number of points may be suitably increased but not more than 20 light points.
- In an earthed system of supply, a socket outlet and plug shall be of three pin type, the third terminal shall be connected to earth.

(c) Measurement of wiring

- Wiring for lights, fans and convenience socket outlets shall be measured and paid for on Point Basis as itemized schedule of quantities and as elaborated as below (unless otherwise stated).
- Average wiring Length.
- The point wiring basis for wiring for lights, fans and convenience socket outlets shall assume average wiring length and average conduiting length per point based on parameters stipulated in below. The average wiring length and average conduiting length forming the basis of point wiring payment, shall take the electrical layouts of the entire project into consideration.

(d) Point wiring for Lights – Primary and Secondary Light Points.

- In respect of group control of lights (more than one light controlled by one switch or MCB), wiring up to the first light in the group shall be measured and paid for as a primary light point. Wiring for other lights looped in one group for switch controlled as also MCB controlled lights shall be measured and paid for as secondary light points. Primary light points for switch controlled lights shall include the cost of control switch whereas primary light points controlled by MCBs shall not include the switch cost. The cost of MCB

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controlling such lights shall not be included in the primary light point rate since the MCB shall be paid for in the item of DB. Primary light points shall include the cost of circuit wiring (wiring from DB terminal to the first switch in the sub circuit)

(e) Design Parameters

- Wiring shall be carried out as per following design parameters in recessed/ surface conduit/conduit cum raceway system.
- Only looping system of wiring shall be adopted throughout. No joints excepting at wiring terminals shall be permitted.
- All accessories shall be flush type unless otherwise stated.
- For estimation of load, following loads per point shall be assumed.

(f) Scope of Point Wiring

Wiring for Lights, Ceiling Fans, Exhaust Fans Etc. are as per CPWD norms and definition. Measurement of the same shall be done accordingly.

(g) Wiring for Convenience Socket Outlets

- Wiring for 6 amps socket outlets on work tables shall be carried out partly in MS conduits and partly in MS raceways as indicated in electrical layout drawings. Wiring for socket outlets (6 amps as well as 16 amps) in locations other than workstations shall be carried out in MS conduits only.

(h) Routine and completion tests

Installation Completion Tests

1. At the completion of the work, the entire installation shall be subject to the following tests: **i. Wiring continuity test ii. Insulation resistance test iii. Earth continuity test iv. Earth resistivity test**
2. Besides the above, any other test specified by the local authority shall also be carried out. All tested and calibrated instruments for testing, labour, materials and incidentals necessary to conduct the above tests shall be provided by the contractor at his own cost.
3. **Wiring Continuity Test**
 - All wiring systems shall be tested for continuity of circuits, short circuits, and earthing after wiring is completed and before installation is energized.
4. **Insulation Resistance Test**
 - The insulation resistance shall be measured between earth and the whole system conductors, or any section thereof with all protection in place and all switches closed and except in concentric wiring all lamps in position of both poles of the installation otherwise electrically connected together, a direct current pressure of not less than twice the working pressure provided that it does not exceed 1100 volts for LT circuits. Where the supply is derived from AC three phase system, the neutral pole of which is connected to earth, either direct or through added resistance, pressure shall be deemed to be that which is maintained between the phase conductor and the neutral.
 - The insulation resistance measured as above shall not be less than 50 mega ohms divided by the number of points provided on the circuit the whole installation shall not have an insulation resistance lower than one mega ohm.
 - The insulation resistance shall also be measured between all conductors connected to one phase conductor of the supply and shall be carried out after removing all metallic connections

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between the two poles of the installation and in those circumstances the insulation shall not be less than that specified above.

(i) Testing of earth continuity path

- The earth continuity conductor including metal conduits and metallic envelopes of cable in all cases shall be tested for electric continuity and the electrical resistance of the same along with the earthing lead but excluding any added resistance of earth leakage circuit breaker measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation shall not exceed one ohm.

(j) Testing of polarity of non-linked single pole switches

- In a two wire installation a test shall be made to verify that all non-linked single pole switches have been connected to the same conductor throughout, and such conductor shall be labelled or marked for connection to an outer or phase conductor or to the non-earthed conductor of the supply. In the three or four wire installation, a test shall be made to verify that every non-linked single pole switch is fitted to one of the outer or phase conductor of the supply. The entire electrical installation shall be subject to the final acceptance of the Engineer-in-Charge as well as the local authorities.

(k) Performance

- Should the above tests not comply with the limits and requirements as above the contractor shall rectify the faults until the required results are obtained. The contractor shall be responsible for providing the necessary instruments and subsidiary earths for carrying out the tests. The above tests are to be carried out by the contractor without any extra charge.

(l) Tests and test reports

- The Contractor shall furnish test reports and preliminary drawings for the equipment to the Engineer-in-Charge for approval before commencing supply of the equipment. The Contractor should intimate with the tender the equipment intended to be supplied with its technical particulars. Any test certificates etc., required by the local Inspectors or any other Authorities would be supplied by the Contractor without any extra charge. All test reports shall be approved by the Engineer-in-Charge prior to energizing of installation.

4.11 Low Voltage Electrical Panel (Type Tested Panel)

- The manufacturing , testing , installation and commissioning of complete 415 V, 3 phase, 4 wire and 50 Hz low voltage main switchboard is as defined in IS/IEC 61439-1 & 2 or IEC/EN 61439-1& 2, built up from compartments to house busbars , terminal blocks, internal and control wiring, instrumentation, relays, interlock and padlocking facility, emergency push buttons, equipment for BMS/RS 485/Ethernet/ Mod bus connectivity of communicable ACB, Meters etc. interface, indication lamps, control and auxiliary switches, contacts, control power supply, air circuit breaker, MCCB, MCB, CTs and PTs, APFCs and any other items considered necessary to deliver the functions of incoming and outgoing power supply as detailed in BOQ and drawing.

- **The equipments installed in each of the Electrical Panel are defined in the BOQ.**

(a) Governing Specifications

- Electrical Panels along with equipments shall conform to the latest standard or harmonize as per the respective standard as given below or specified along with the equipment in the specification.

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- In case of any conflict between specifications & the standards, the instructions/decision of the Engineer' or Employer's authorized representative shall be binding.

(b) General and Technical Requirements of Electrical Panels

- The Electrical Panel shall be same as low- voltage switchgear and control-gear assemblies defined in IEC 61439-1 or EN 61439-1 or IS/IEC 61439-1 built up from compartments housing circuit breakers, control gear, relays, bus bars, controls and other equipment as defined in BOQ. IEC 61439 and IEC 60947, is mentioned in the specification or BOQ, should be read as "IEC 61439 or IS/IEC 61439" and "IEC 60947 or IS/IEC 60947", respectively. Further, latest update of IEC standard shall be applicable for design and testing requirements. Type tests reports for compliance of IEC 61439 from accredited and independent testing laboratory shall be submitted.
- All the panels should be factory built and of proven design duly approved by the original manufacturer (i.e. original manufacturer as per clause 3.10.1 of IEC 61439-1), and the requirements related to type test for each of the panel should comply to IEC 61439.
- Compliance to requirement for all types of Type Test for the purpose of Design verification shall be in accordance with Clause 10 and Annexure D of IEC 61439-1.
- Type tests reports for compliance of IEC 61439 from accredited and independent testing laboratory shall be submitted.
- For each type of complete panel for which the type test report is being submitted to the user (i.e. party who will specify, purchase, use & or operate the assembly, or someone acting on their behalf, which is NMRC in this contract), the contractor should clearly communicate / specify to the user the details of the original manufacturer (i.e. original manufacturer as per clause 3.10.1 of IEC 61439-1, which is the organisation that had carried out the original design and associated verification of an assembly in accordance with relevant assembly standard) as well as the ASSEMBLY manufacturer (i.e. the organisation taking responsibility of the completed assembly as per clause 3.10.2 of IEC 61439-1 and as per note mentioned in this clause, the ASSEMBLY manufacturer can be same or different organisation to the original manufacturer). In context of above, it shall be noted that the contractor shall be required to submit the approval to the design & drawings for each type of complete panel (which is being supplied to the user) of above mentioned original manufacturer of the corresponding panel (i.e. the panel whose type test report is being submitted by the contractor to comply to contractual requirements related to various type tests).
- Manufacturing Quality Plan (MQP) with clear mention of quality hold points is also required to be submitted for approval of the Engineer, so that stage inspection (if required) may be conducted by the user.
- The Contractor shall also submit the FAT (Factory acceptance test) protocol for approval of the Engineer submitting details of all such tests which shall constitute the FAT, with clarity on the acceptance /rejection criteria in co-relation to relevant standards.
- The Contractor shall also submit the SAT (Site acceptance test) protocol for approval of the Engineer submitting details of all such tests which shall constitute the SAT, with clarity on the acceptance / rejection criteria in co-relation to relevant standards.
- The Electrical Panel shall pass the internal arc fault containment tests in accordance with IEC 61641 for fault current ratings as defined in BoQ .
- The degree of Ingress Protection for Electrical Panels shall be IP 54 unless otherwise specified in BOQ.
- The Electrical Panels and the associated equipment, including switchgear and control gear assemblies shall be certified for the category of duty specified as per Annex A of IS/IEC 60947-1.

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- The main circuit as defined in vide clause 3.1.3 of IEC 61439-1 shall have an insulation voltage of 1000 V A as specified in the BOQ.
- The ambient temperature and ambient humidity for Electrical Panel shall be as per IEC 61439-1 (Clause 7.1.1 and 7.1.2 of IEC 61439-1) and Switch gear shall be as per IEC 60947 (Clause 6.1.1 and 6.1.3 of IEC 60947).
- The Electrical Panel shall have a rated short time withstand current of 70 kA, 65 kA, 50 kA, 35 kA, 25kA etc. as per BOQ.
- **The Electrical Panels shall be a minimum of Form 4b Type 5 in accordance with BS EN 61439-2/IEC 61439-2&Eiema's Guide to Forms of Separation.**
- All materials like busbar supports etc. used in the panels shall be Low Smoke Zero halogen and Thermosetting type.

(c) Electrical Panel Construction

- The panels shall be of the approved design to suit local conditions. The Electrical Panel (other than DB) shall be designed for indoor use in the form of free standing, floor mounting extendible, self-contained, flush fronted cubicles and sectionalized as necessary to face easy transportation and erection, containing all the equipment indicated on the Drawing, BOQ and specified hereinafter.
- The cubicle section shall be constructed of angle iron types frames or folded sheet steel or fully welded/bolted construction with all necessary removable covers. Removable lifting lugs shall be provided on the top of the cubicles. Cubicle sections shall be provided with bolts or devices for insuring that they are correctly aligned when being coupled together. The bus bar chamber shall be fitted with removable end cover plates secured by mild steel captive screws.
- It shall be finished to provide a rigid shell type of enclosure in accordance with BS EN 10025.
- The load bearing parts and other parts of the entire electrical panel assembly shall be 2 mm CRCA thick sheet.
- The Electrical Panels shall be mounted on a robust base frame made up of steel channel with a minimum height of 100mm and the maximum height of Electrical Panel shall as per E/I as per available space at site including base frame. The base frame shall be able to withstand the static and dynamic loads of the Electrical Panels. The steel channels shall be painted with epoxy polyester paint. The main contractor shall ensure that the maximum height of the Electrical Panel at the site of installation shall not exceed 2.65meter including foundation if any.
- Electrical panel shall have provision for top/bottom in-coming and bottom/top out-going to suit site conditions of cable entries.
- Aluminium / Non-magnetic gland plates of not less than 5 mm thick of suitable size shall be provided at the top and bottom of the LV main switchboards for the termination of incoming and outgoing power cables of size 120 sq. mm or more or bus ways and 3 mm thick for cables of size less than 120 sq. mm. Where armoured multi-core cables terminate inside the switchboard enclosure, glanding plates or glanding brackets shall be provided for securing the cables to the switchboard.
- Glanding plates, glanding brackets and extension boxes shall be removable and shall be of adequate size for the particular cables to be terminated. The cables shall not put any stress on to the glanding plate and shall be secured adequately.
- All relays and indicating instruments shall be at least 300 mm and not higher than 1.8 m from base frame. The clearance in front, back and side of all assemblies of switchgear and control gear shall be as per latest IE rule.

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- Various units comprising a complete Electrical Panels shall be grouped in a multi-tier arrangement including a cabling and wiring chamber of ample dimensions to accommodate terminal blocks, cable boxes and gland plates.
- The equipment shall be arranged within each compartment such that all normal maintenance can be carried out through hinged access doors or removable covers, and where possible from the front.
- Adequate maintenance access shall be provided to equipment within the Electrical Panels. Demountable panels shall be provided at the back of the Electrical Panels that can be handled by a single person. Every demountable panel shall be provided with a pair of handles for easy removal and fixing.
- Front access door shall be fixed with concealed hinges and interlocked with the switch mechanism. The door panel can be opened only if the switchgear is in the "OFF position" or the switchgear should switch off if the panel door is opened. Each openable door of the panel shall be double earth with braided flexible copper wire of minimum cross section 2.5 sq mm.
- Ventilating louvers along with G3 grade filter with minimum 80% filtering efficiency, where required, shall ensuring compliance of IP requirement shall be provided. It shall be provided in such a way that it is easily accessible for cleaning or self cleaning filters shall be provided.
- Anti-condensation touch proof DIN rail mounted heaters shall be provided at the rate of 100 W for each vertical of the Electrical Panels, in case the volume is greater than 1 cubic meter of one vertical then 150 W heater shall be provided. The heaters shall be of an enclosed tubular pattern, each separately fused/ MCBs and switch. Each heater shall be controlled by means of a step adjustable humidistat. Cable alley shall be having the provision of industrial grade LED fixture of 1000 lumens, controlled by limit switch.
- Adequate arrangements for air circulation shall be made within each compartment of the Electrical Panels. Adequately sized thermostatically controlled cooling fan with filter, if required shall be provided. The Contractor shall ensure that the internal temperature of the Electrical Panels will be well within the operating ranges as specified by IEC 61439-1 of all electric components including switchgear, control gear, bus bars, relays, wiring and timers inside the Electrical Panels.
- All the incoming/outgoing terminations in panel shall be extended Aluminium into a separate termination chamber adjacent to the switchboard. When busbars are used between switchboards, the internal busbars of the switchboard shall be of Aluminium Bars for panels. Sizes of Bus bar shall be as per tested design. No linking of bus bar or incoming/outgoing terminals with switch gears/functional units shall be permitted with cable except in case of MCCBs/MCBs below or equal to 100 Amps rating.
- The switchgear assembly/sub-assemblies or panels shall be termite and rodent proof.
- The switchboard shall have sufficient space to house all electrical equipment allowing spare space capacity for the future expansion if specifically asked in BOQ.
- Spare feeder shall be provided as per BOQ. Any Panel which comprises an assembly of similar modules shall be constructed such that further similar modules can be added at either end.
- All similar items of the Electrical Panels and their component shall be interchangeable. Spare parts shall be manufactured to originals and shall fit all similar items of the Electrical Panels. Where machining may be needed before fitting renewable parts, the machining fits and the associated tolerances shall be shown on the drawings accompanying the instruction manuals.
- The Electrical Panel shall operate without excessive vibration and with a minimum of noise as per best of engineering practice and shall also operate without excessive temperature rise at the rated load conditions.

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- The style and finish of the workmanship shall be consistent throughout the Works. Unless otherwise specified, Engineer shall decide the final colours for all paintwork and other finishes to be applied to the Electrical Panels.

(d) Electrical Panel Earthing and Safety Arrangement

- All non-current carrying metallic components shall be permanently connected to earth.
- Material used for the earthing busbar shall be same as the main busbar.
- Bare Aluminium earthing busbar inside the panel shall have minimum cross-sectional area as per provisions of IEC 61439-1
- A continuous earthing busbar shall be provided along the whole length of each Electrical Panels and shall be provided with terminals for connection to the metal housing of incoming busways, cable trunking and cladding or armouring of all incoming and outgoing cables and to the substation earth.
- Switchboards shall be provided with two earthing terminals, one at each end, for the connection of external earth conductor for earthing. The earthing bars shall be fixed at rear interior bottom portion throughout the length of the switchboard, bonding all gland plates, and other component parts of the switchboard to a main earth point adjacent to the intake position in accordance with BS 951 and BS 7430.
- All terminals, connections, relays and other components which may remain live when access doors are open shall be screened. It shall not be possible to obtain access to an adjacent cubicle when any door is opened.
- Where several outgoing circuits occupy a common cabling chamber, all busbarwork, cable lugs, terminations and terminal blocks shall be fully segregated by compartmentation to enable work on any one circuit to be carried out with other circuits remain live.
- Protection against shock in normal service shall be achieved by the provision of barriers or enclosures both vertical and horizontal and between adjacent units to ensure segregation and prevent accidental contact with live parts, or by complete insulation of all live parts Control cables shall be segregated from primary conductors.
- The protective earthing configuration shall be TN-S unless otherwise specified.
- Equipment Installed Inside Electrical Panels
- Electrical panels consist of Low Voltage Switchgear, control wiring and all other parts which are defined below.

(e) BUSBAR

- Busbars shall be of rectangular section hard drawn high conductivity high strength bare aluminium alloy (Grade 63401 WP, formerly 91E) conforming to IS 5082 as per BOQ, adequately rated for designed value and fault level of load as per BOQ and supported by non-tracking moulded insulators spaced at suitable intervals. The complete assembly shall be capable of withstanding the maximum mechanical stresses to which it may be subjected to under fault conditions.
- Sizing of the busbar shall comply with IEC 60890 for temperature rise assessment by extrapolation.
- Bus bar rating shall be same throughout the length of panel and shall be as per BOQ type tested design and recommendation of IEC 61439. The bus bar shall be designed for easy extension in future at either end.

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- Busbars and busbar connections shall be constructed in accordance with the requirements of IEC 61439-1. The short-time withstand current rating shall be as mentioned in seconds as in BOQ at 415 V.
- Connection in Bus bars shall be made as approved and proven design of original manufacturer.
- The maximum temperature of the bus bars and the bus connections shall be as per IEC 61439 standard.
- The main busbars shall be so positioned and arranged that all busbar risers and droppers can be brought onto the main busbars without undue bending. Busbars shall be and supported with appropriate clearances in air to the requirement of providing full insulation.
- Busbar chambers of similar rating shall be capable of coupled together using busbar coupling links, in accordance with the manufacturer's recommendation. Coupling links shall be approved by the Engineer before use.
- Interconnecting conductors between busbar chambers and switchgear shall be as per rating of switchgear and type tested design.
- Switchgear shall be joined to busbar chambers by means of properly designed busbar chamber connection flanges or conduit couplers and male bushes. Connection flanges shall be manufactured from galvanized sheet steel or CRCA and finished grey.
- Busbars shall be coloured for phase identification at location of bus inspection points with the approval of site Engineer. The material for phase identification shall be non-fading colour of proven design to be decided by the Engineer and use of adhesive label shall not be acceptable.
- The front cover and end plates of busbar chamber shall be removable and normally held in position by non-ferrous metal screws.

(f) Polarity

- The polarity of all apparatus shall be arranged as follows when viewed facing the front of the Electrical Panels:
- For two pole apparatus, phase pole and neutral pole when reading from top to bottom or left to right; and
- For three or four pole apparatus, red, yellow and blue phases and neutral when reading from top to bottom or left to right.
- All cables shall be so connected within the Electrical Panels such that the correct sequences are preserved throughout.

(g) Control Supply

- The control circuit shall be separated from other auxiliary circuits, i.e. indicating circuit, heater and lighting circuits, with dedicated circuit protective devices.
- 240V Volt sensing relay with volt free contacts shall be provided for sensing the control supply for local and remote indication.

(h) Instrumentation

- The display for meters i.e. ammeter, voltmeters or multifunction meter shall be auto-ranging type. The display for single meter i.e. ammeter or voltmeter shall be 3.5 digits as specified in BOQ.
- Selector switches shall be inbuilt in Voltmeter such that voltmeters can read voltages between phase and phase and between phase and neutral.

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- Ammeters shall normally be suitable for 5A secondary of current transformers
- Voltmeter circuits shall be provided with protection through MCB as required.
- Separate current transformers for a feeder shall be provided for protection device and for instrumentation.
- All Panels shall be provided with surge protection device of rated equivalent to design fault level of Panel.

(i) Current Transformers (CTs) and Voltage Transformers (VTs)

- CTs and VTs shall comply with IEC 61869/BS EN 61869 and CTs shall be of the epoxy resin encapsulated ring type. The ratings specified in BoQ are indicative only and it shall be contractor/manufacturer's responsibility to ensure that the ratings offered are adequate for the relays/meters provided considering lead resistance, etc.
- Current transformers shall comply with approved standard and shall be compatible with and provide the necessary accuracy, over current factors, characteristics, performance and VA rating for the satisfactory operation of the relevant protection devices, instruments and meters.
- All CTs shall have a short-time current rating as specified in IEC 61869-2.
- CTs for protection shall be compatible with the protection relays to ensure that the CTs will not be saturated up to the maximum prospective fault current.
- CTs designed for unit protection schemes shall be able to withstand a stability of not less than the maximum through-fault of the units.
- In balanced circuits, the spill current with maximum stability conditions shall not exceed one quarter of the operating current of the relay.
- CTs for use in conjunction with protection relays shall be of class 5P accuracy or better. CTs for use in conjunction with measuring instruments should have better or matching accuracy with the accuracy of energy meters. The product of rated accuracy limit factor and rated output of the protection CTs shall not be less than 20 times the total rated burden of the trip circuit including the relay, connection leads and O/C release where applicable.
- All CTs shall have output ratings adequate to cater for the burden connected to them. The Contractor shall demonstrate to the satisfaction of the Employer representative. By calculation or by test, that each group of the CTs, when installed and having the secondary burden connected, is capable of operating the relays and other measuring instruments in accordance with the manufacturer's published characteristics and the requirements of the system, with a reasonable margin of safety.
- Measuring CTs shall be connected to test terminal block. The test blocks shall be provided with easily removable links and designed to facilitate connection of testing instruments on load without open-circuiting the CTs.
- The secondary circuit of each set of CTs shall be earthed at one point only through a disconnectable copper link at a readily accessible position for testing.
- Multi-ratio CTs (where used) shall have a label clearly indicating the connections required for the alternative ratios. These connections shall be shown on panel wiring diagrams.
- Identification labels shall be fitted, mentioning type, ratio, rating, output and serial numbers.
- VTs, where ever required as per BOQ, shall be provided with adequately rated primary and secondary fuses.
- Instruments shall be similar in appearance throughout the whole of the Electrical Panels. All instruments, meters shall be of flush pattern, dust and moisture proof, suitable for the environment in which they are installed.

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- All instruments and meters shall be completely segregated in instrument compartments. Compartments containing these devices shall not contain any terminals or equipment operating at higher voltages with the approval of site Engineer.
- The housing shall be of steel or phenolic mould. Design and manufacture of meters shall ensure prevention of fogging of instrument glass. Selector switches shall be provided for ammeters and voltmeters used in three-phase system. This selector shall be of built-in type with meters.

(j) Relays

- The relays are having in-built function with protective gears such as ACB, MCCB and MCB and MPCB etc. In case any relay is required for additional protection as stated in BOQ or otherwise, the same shall be provided to ensure full protection to the system.

(k) Emergency Push Button (EPB)

- Emergency lock and key type push buttons shall be installed wherever required or specified in BOQ to de-energize the Electrical Panels in the event of an emergency. The EPB shall be button type with flat surface protection guard ring and pressed-in design with key reset so that accidental triggering and vandalism shall be avoided as far as possible. Transparent hinged cover shall be provided in front. The button design and the installation details shall be submitted for approval.
- Interlock And Padlocking Facilities
- Mechanical key interlocks shall be provided wherever applicable or as specified in BOQ and shall be so designed as to avoid mal-operation at the point of manual application. The scheme shall be such that attempts to remove a captive key shall not result in tripping or opening of the device.
- The tripping of the ACB(s) shall be via local hard wiring control and in Signal(s) shall also be generated from circuit breaker(s) upstream of the corresponding Electrical Panels and the switchboard interconnected section ACB.
- Electrical interlocks on with drawable equipment shall be so arranged that if the equipments are withdrawn, the complete operation of the withdrawn equipment shall be independent of the remote interlocking contacts. In addition, interlocks shall not be defeated leading to damages or unsafe operations of Electrical Panels due to the withdrawing of equipment.
- Locking facilities shall be provided where appropriate for switches and isolators in order that they may be locked in the open position. Switchgear cubicle access doors shall be equipped with integral type locks, preferably incorporated in the handles of the equipment.
- Where locking facilities are of the integral barrel type, the key for each lock shall be unique to the associated lock unless otherwise specified.
- Two keys shall be provided for every lock supplied. The keys shall be fitted with rings with identification labels, and cabinets with glazed front- opening doors shall be provided. The cabinets shall be adequate in size and equipped with hooks to house all keys when not in use, and shall be mounted in positions to be decided.

(l) Internal and Control Wiring

- All equipment shall have adequate provision for the entry and termination of all associated power and auxiliary cables.
- Cable entry shall in all cases, except where otherwise specifically approved, and be at the base of the equipment. All cabling and wiring within the Electrical Panels shall be neatly run and fitted in or upon such cable trays, trunkings and conduits as may be appropriate to the layout and equipment. Cable trays, trunkings, conduits and cleats shall be non - metallic and

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shall be of the low smoke halogen free material. Metallic cleats is acceptable with the approval of the site Engineer.

- All Internal power cables shall be of FRLSH copper conductor wires rated at 450/750 V complying with BS 50525-3-41 rated at 1100 V. All control wiring within the Electrical Panels shall be with single core minimum 2.5 mm² for CT and balance as per approved manufacturer design. Insulation shall have a glossy finish, be resistant to oil and be incapable of supporting combustion.
- Wiring from the fixed part of the switchboard to the movable part such as hinged door shall be enclosed by flexible tubing made of Fire Retardant Low Smoke Halogen material . Exposed live terminals shall be suitably shrouded or covered.
- Wiring passing out to fully accessible positions shall be run in non-metallic low smoke halogen free flexible tubes or conduits.
- All internal wiring shall be neatly run and securely fixed in non-metallic cleats in such a manner that, wherever practicable, wiring can be checked against diagrams without removal of the cleats.
- Access opening shall be fitted with a suitable long life grommet where inter-panel wiring passes through panel side sheets etc.
- Bus-wires shall be fully insulated. Bus-wires terminals shall be fully accessible from the point of entry to each enclosure. MCB and links shall be provided to enable all control circuits within the Electrical Panels to be isolated from the bus-wires.
- All control circuits shall be protected by a MCB.
- There shall be no joint in conductors between terminal points.
- Terminations for terminals shall be of the crimped-on ring type. Terminations of stranded conductors to clamp type terminals shall be of the crimped-on solid rod type.
- No more than one core of either internal or external wiring shall terminate on any outgoing terminal. Where duplication of terminal blocks is necessary, suitable solid bonding links shall be incorporated in the design of block selected.
- Wiring for all known future equipment shall be provided and all wires shall be terminated.
- All wires between the terminals of two equipment shall be given a unique number according to an approved system. In the interests of uniformity, the wire-numbering system shall be approved by the Engineer.
- Identification markers shall be fitted to all wires and multicore cable tails within enclosures in accordance with the diagram for apparatus concerned. Cable and core makers shall be of insulation material, colored according to the wire numbering system with a glossy finish, be resistant to oil and be incapable of supporting combustion. Numbers shall not be duplicated unless the corresponding wires are directly in series or parallel
- Different insulation colours shall be provided to distinguish the various circuits. All wiring shall conform to the colour and ferrule codes to be approved by Engineer.

(m) Terminal Blocks

- Both incoming and outgoing cable shall have top or bottom entry depending on site requirement.
- Each terminal block compartment shall have not less than 20 % or 4 spare terminals whichever is greater.
- Terminal blocks for low voltage wiring shall be moulded from high-grade non-hygroscopic melamine, comprise bank of rail-mounted blocks with all live parts fully shrouded, screw-

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clamp, spring loaded insertion, solder-lug or stud type terminals as appropriate to the design and duty of the cables to be terminated. Pinch-type screws, where the screw is in direct contact with the conductor, shall not be used.

- Each terminal shall be provided with claw-type washers, crimp lugs or other approved means for connection of the wires. Plain and spring washers, nuts and lockouts shall be electro-tinned.
- Terminals shall be assembled in banks and each terminal shall be complete with marking tags to fit into moulded tag slots.
- Terminals for final connections for indication, instrumentation and metering circuitry shall have test probe facilities and an integral disconnecting device to facilitate testing.
- Terminations shall be grouped according to function and no more than two wires Connected to one terminal. Labels shall be provided adjacent to the terminal block to identify the function and voltage of each group.
- All terminals to which 240 V or 415 V AC circuits are connected, where they are in individual terminal blocks, shall be provided with a transparent insulated cover which in addition to any other form of identification and shall have a label engraved suitably indicating the voltage.
- Terminals for the control supply which may be still alive when the main equipment is isolated from the mains supply shall be suitably labelled to reduce the risk of accidental contact.
- All terminals shall bear a permanent identification number or letter.
- Indicating Lamps
- Indicating lamps shall be multiple LED type. All indicating lamps shall be suitably rated so that the indication is clearly visible from the side and front at a distance of not less than 3 m in a room.
- The colours of indicating lamps for red, yellow, blue phases, ACB on, off and trip shall be red, yellow, blue, red, green and amber respectively.

(n) Low Voltage Switchgear

Air Circuit Breakers

- ACB should be mechanically robust of compact design, air break horizontal and withdrawable type, confirming to IS/IEC 60947-2 and EN 60947-2.
- Air Circuit Breaker is to be provided as essential/semi-essential circuit breaker as defined in BOQ.
- Manual charging as well as by 240 V AC motor with charged spring closing mechanism complete with anti-pumping relay, discharge resistor, auxiliary switch, etc.
- An under-voltage relay or release, when associated with a switching device, shall operate to open the equipment even on a slowly falling voltage within the range between 70% and 35% of its voltage as per clause 7.2.1.3 of IEC 60947-1. The under-voltage relay or release shall be provided only is selected ACBs as per the requirement of project and as detailed in BOQ.
- 240 V A.C shunt-trip coil shall be operable, within operational voltage range of 70% to 110% of rated voltage as per Clause 7.2.1.4 of IEC 60947-1.
- The operating mechanism shall be trip-free.
- Maximum number of circuit breaker auxiliary switches, spare auxiliary switches to be equally divided between normally open and normally closed. At least 4 spare pairs of N.O. and N.C. volt free contacts shall be provided.

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- Indicating lamps for on, off, tripped on fault and trip supply healthy with all necessary push buttons, panel wiring, bus wiring, terminals, fuses, etc.
- Power and control cable terminals with undrilled gland plates for outgoing power cables and multi-core cables.
- Electrical connection between the breaker and switchboard shall be of plug and socket type with automatic screening shutters. An interlock to prevent withdrawal when the breaker is closed.
- Number of Poles shall be as per BOQ.
- Local/auto control selector switch shall be lockable in all positions. The automatic control shall be defeated when the selector switch is put at local or OFF position as per drawing and BOQ.
- Remote indication and alarm facilities shall be provided for Circuit-breaker open, Circuit-breaker closed, Circuit Breaker is ready to close, Circuit-breaker tripped on fault, and Switch position of local/remote control selector switch.
- Control switch for air circuit breakers shall be as follows:
- Air Circuit breakers shall be fitted with operative switches of the pistol grip type. The handles of control switches for air circuit breakers shall turn clockwise for closing and anti-clockwise for tripping.
- The control switch shall be clearly labelled as CIRCUIT BREAKER OPEN - NEUTRAL - CLOSE, with spring return to the neutral position. Mechanical interlock shall be fitted to prevent repetitive closing without moving first to the trip position, and shall be capable of padlocking in the neutral or trip position.
- Set of terminals wired to provide for connection to the following:
- Automatic changeover and interlocking as shown on the drawing
- Operation of emergency push button as per requirement or as per BOQ.
- Signal cables wired to terminal block for remote monitoring to SCADA.
- Electrical Characteristics:
- Rated Insulation Voltage: 1000 V
- Rated Frequency: 50 Hz
- Rated ambient temperature: As per Clause 6.1.1 and 6.1.3 of IEC 60947
- Current Ratings shall be as follows:
- Rated short-time withstand current (Icw): 70/65/50 kA for 1 second (minimum)
- Rated ultimate short circuit breaking capacity (Icu): 50/35/25 kA based on actual fault level or as per BOQ.
- Rated service short-circuit breaking capacity (Ics): 100% of Icu, and Rated short-circuit making capacity: shall be atleast 2.1 times of ultimate short circuit breaking capacity at 0.25 power factor or as per BOQ.

Protection

ACB shall have microprocessor based protection releases for type of faults with selective over current (long time, short time & instantaneous) & earth fault protection, measurement of electrical parameters and with communication capability with remote system and any other additional protection as mentioned in BOQ. ACB shall have an LED/LCD display to show true RMS current in all the three phases and highest current among these phases. The release shall be equipped with self-diagnostic feature with indication and inbuilt Ethernet

port. The release shall be capable for communication through Ethernet TCP/IP as per the requirement of design or as defined in BOQ. The overload and short circuit characteristics should be front adjustable and password protected.

- The release should have an internal fault indication for faster fault diagnosis/self-diagnostic feature is required.
- The release should have fault indications by which discrimination of fault is possible.
- Control relays and wiring for automatic changeover interlocking and other breaker operation as shown on the Drawings.
- Fire resistant/retardant transparent covers shall be provided over ACB's to achieve IP-54 protection if so desired and door interlock so that ACB access door shall not open if ACB is ON otherwise it will automatically OFF if Door is opened.
- Electrical interlock for the two incoming circuit breakers and interconnector bus - section circuit breaker to prevent paralleling of different power supply sources at any one time as shown on the Drawings
- Following shall be provided for ACB connected to the main incomer:
- Four or Five Protection Current Transformers (three/four in panel, one in loose to be mounted in transformer neutral), for Restricted Earth Fault Relay and Standby Earth Fault relay as specified in the interface with high voltage switchgear. The final requirement to be confirmed by interface with HT contractor.
- Inter-tripping provision shall be provided by interfacing with the Power Supply Contactor.
- Voltage sensing relay and associated relays for automatic changeover and interlocking operation as detailed on the Drawings.

(o) Interlocks and Test Operation Facilities

All ACBs shall be provided with interlocks to ensure that:

The ACB cannot be plugged in or isolated while it is closed,

- The ACB cannot be closed until it is fully plugged in or completely isolated
- The ACB cannot be closed in the service position without completing the auxiliary circuits between the fixed and moving portions.
- With manual charged and motor charged spring mechanisms the springs cannot be discharged until they have been fully charged and until the means for charging has been removed or disconnected,
- Facilities shall be provided for testing the ACB operation when in the isolated and withdrawn positions by the normal means as in service, and
- Where control circuits are provided and interlock circuits are broken via plugs on withdrawal of the ACB, a minimum of one jumper lead and plug assembly of each size and type shall be provided to facilitate testing in the withdrawn position.
- The neutral shall be rated for 100%.

(p) Safety Shutters

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- A set of shutters with padlocking facilities shall be provided to cover each three phase group of stationary isolating contacts. The shutters shall be independent and operated automatically by a positive drive from the ACB withdrawal mechanism
- In order to prevent unauthorized operation, the withdrawable air circuit breakers shall be provided with padlock facilities to secure them in their connected, test and isolated positions.
- The Arc chutes on each pole shall be designed to permit rapid dispersion, cooling and extinction of arc. It should be possible to remove arc chutes. The insulation material shall conform to Glow wire test as per IEC 60695-2.

(q) Type Test Certificates

- ACB shall be CE marked and shall be type tested and certified from NABL / International lab accredited testing laboratories for compliance to IS / IEC 60947-2. Supplier shall submit combine sequence test in the type test report for vendor approval.

(r) Moulded Case Circuit Breakers

- MCCBs shall comply with and be type-tested to IS/IEC 60947-2 or EN 60947-2. Each MCCB shall be of fixed or withdrawable type, as specified in the BOQ and have all the mechanical and live parts completely enclosed in an insulated moulded case. Withdrawable pattern circuit breakers shall be designed that their electrical equipment can be safely disconnected from or connected to the main circuit whilst the circuits are live.
- MCCB shall be suitable for isolation as per Annexure 7.1.2 of IEC 60947-2
- MCCBs shall meet the following requirements:
- Number of poles: double-pole, triple-pole or four poles as specified on the Drawings or Design or BOQ
- Rated operational voltage: 240 / 415 V AC, as per drawing or BOQ
- Rated insulation voltage: 750 V AC, higher voltage acceptable
- Rated uninterrupted current (In): as shown on the BOQ, but after taking into account the installation conditions and temperature deration.
- Rated frequency: 50 Hz,
- Rated short-circuit making capacity (Icm): shall be at least 2.1 times of ultimate short circuit breaking capacity at 0.25 power factor,
- Rated ultimate short-circuit breaking capacity (Icu): 65/50/35 kA (or as per BOQ),
- Rated service short-circuit breaking capacity (Ics): 65/50/35 kA (as per BOQ) Further, Ics must be equal to 100% Icu for the selected breaker,
- Utilization category: A or B as appropriate,
- Degree of protection: IP 3X to IEC 60529 or EN 6029, and
- Rated ambient temperature: As per IEC 60947-2
- Impulse Withstand Voltage - 8KV or as per latest applicable standard.

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- All MCCB's should have front adjustable microprocessor based releases with adjustment in the range of 40 - 100% for nominal overloads and adjustable setting for short circuit fault currents and time delays. MCCB's for network/feeder Protection shall have releases with earth Fault Protection features, wherever and as indicated in Bill of quantities or drawings.
- In case of 4 pole MCCB, neutral shall be defined and capable of offering protection upto full rating with possibility of adjustment at site in the neutral setting.
- Mechanical endurance shall be as specified in latest IEC standard.
- MCCB's shall have an electrical endurance operation cycles as per latest IEC standard 60947.
- All MCCB's shall be arranged for padlocking in OFF positions with lock provided. A shunt trip coil shall be provided to facilitate automatic tripping and local manual tripping. The manual trip device shall be fitted with the means of padlocking. The shunt trip coil shall be suitable for operation within a voltage range of 70% to 110% of the rated AC power supply voltage.
- Electronic trip units shall comply with the requirements as specified in Appendix F (EMC /EMI Compatibility) of IEC 60947-2 or EN 60947-2.
- The time delay on overload tripping shall be inversely proportional to the over current up to a threshold value of approximately six to seven times the rated current at rated working temperature.
- Handle position shall give positive indication of 'ON' 'OFF' or 'TRIPPED', thus qualifying to disconnection as per IEC 60947-3 indicating true position of all the contacts.
- The operating mechanism of MCCB's shall be Independent of the operating speed of the over centre toggle and the MCCB shall be of current limiting type and comprise of Quick make and Quick break switching. Contacts shall be non-welding type. The operating mechanism should be trip-free and provided with mechanical "ON", "OFF" and "TRIPPED" indicator. The MCCB shall be designed for both vertical and horizontal mounting, without any adverse effect on electrical performance.
- Remote closing and tripping coil should be of suitable duty cycle. Motorized MCCB (as per requirement of project or as specified in BOQ) shall be provided to meet the requirement of remote controlling/interlocking.
- MCCB's shall have common field fittable auxiliaries for the entire range and above 100 A the accessories like copper spreaders and phase barriers should be the integral part of the MCCB's.

(s) Miniature Circuit Breakers (MCB)

- MCBs shall comply with and be type-tested to IEC 60898 or EN 60898.
- MCBs shall meet the following requirements:
- Number of poles: single-pole, double-pole, triple-pole or four-pole as specified in the BOQ or Drawings
- Protection against external influences: Enclosed-type,
- Method of connection: Bolted type or clip-on type,

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- Rated operational voltage and frequency 240 / 415 V AC and 50 Hz.
- Rated current: 6 A, 10 A, 16 A, 20 A, 25 A, 32 A, 40 A, 63 A, as shown on the drawings. Above 63A, MCCB as specified above must be used.
- Range of instantaneous tripping current: MCB's shall be current limiting Type Class 3 with range of instantaneous tripping current B, C or D type as appropriate or as specified,
- Rated short-circuit breaking capacity: not less than 10 kA (M3) unless otherwise specified in BOQ
- I²t characteristic: suitable for load and circuit being protected,
- Degree of protection: IP-20 for MCB's
- Reference ambient temperature: as per IEC 60898.
- MCB's shall have minimum power loss (Watts) per pole as per the IEC and should be proven by published value by manufacturer.
- The load handling contacts shall be silver/tungsten or proven material and the contacts and operating mechanism shall be designed so as to give a wiping action both at make and break. The breaker operating mechanism shall be of trip-free type. The breaker operating dolly shall be clearly indicated for the "ON" and "OFF" positions. It should be of Quick make and Quick break type.
- Circuit protection against overload and short-circuit conditions shall be provided by means of thermal-magnetic device. Double-pole, triple-pole, and four pole MCBs shall be integral units and interlocked internally so that an over current through any pole shall trip all the poles of the MCB simultaneously. An assembly of two or three or four single-pole units mechanically strapped together is not acceptable.
- Housing shall be heat resistant and having high impact strength. All DP, TP and FP circuit breaker shall have a common trip bar and should be mechanically coupled through a pin. It shall have an electrical endurance of the order of 10000 operation cycle for current rating of up to 63A.

(t) Residual Current Circuit Breaker (RCCB)

- RCCBs shall be double pole or four-pole current-operated, housed in a totally enclosed moulded case, manufactured and tested in compliance with IEC 61008 or EN 61008.
- RCCBs shall meet the following requirements:
- Number of poles: double-pole or four-pole as specified on the Drawings,
- Rated current (I_n):
- Rated residual operating current: 30 mA or 100 mA or 300 mA as shown on BoQ or as per approval of the Engineer.
- Rated voltage: 240/415 V AC,
- Rated frequency: 50 Hz,

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- Rated short-circuit capacity: not less than 6 kA unless otherwise specified in BOQ.
- Operating characteristics in case of residual currents with DC components: as specified,
- Method of mounting: distribution board type,
- Method of connection: connection shall be made with proper size of thimbles and number ferruling for circuit identification,
- I^2t characteristic: suitable for equipment and circuit being protected
- Degree of protection: IP 2X to IEC 60529 or EN 60529, and
- Reference ambient temperature: As per IEC 60898.
- The tripping mechanism shall be of trip-free so that the unit cannot be held closed against an earth fault. Tripping devices utilizing electronic amplifiers or rectifiers are not acceptable.
- Provision shall be made for testing the automatic earth - leakage tripping by an integral test device. A device shall be fitted for prevention against reclosing after the device has tripped on earth leakage.

(u) RCBO (if applicable) (RESIDUAL CURRENT CIRCUIT BREAKER WITH OVER-CURRENT) PROTECTION)

- RCBOs shall be double pole or four-pole current-operated, housed in a totally enclosed moulded case, manufactured and tested in compliance with IEC 61009 -1, IS 12640(part 2) 2008 and ISI marked.
- RCBOs shall meet the following requirements:
- Number of poles: double-pole or four-pole as specified on the Drawings,
- Rated current (I_n): as shown on the Drawings,
- Rated residual operating current: 30 mA or 100 mA or 300 mA as shown on drawings or as per approval of the Engineer.
- Rated voltage: 230/415 V AC,
- Rated frequency: 50 Hz,
- Rated short-circuit capacity: 10kA
- Operating characteristics in case of residual currents with DC components: as specified,
- Method of mounting: distribution board type,
- Method of connection: connection shall be made with proper size of thimbles and number ferruling for circuit identification,
- I^2t characteristic: suitable for equipment and circuit being protected
- Degree of protection: IP 2X, and
- Reference ambient temperature: As per IS 12640-1

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- The tripping mechanism shall be of trip-free so that the unit cannot be held closed against an earth fault. Tripping devices utilizing electronic amplifiers or rectifiers are not acceptable.
- A mechanical flag indicator on RCBO for faster identification of fault trip condition i.e. earth leakage or over-current for faster fault diagnosis and preventive measures, shall be provided.

(v) Discrimination

- Selection of ACB, MCCB and MCB shall be of same make. Total discrimination up to the design fault level must be available between the various elements of switchgear (ACB, MCCB, MCB etc) selected. Supplier must provide test certificates from acceptable, accredited and reputed laboratories or submit published discrimination charts/tables to prove the same. In view of Standardization and Uniformity, mixing of two series of switchgear (even from the same manufacturer) for either MCCB or ACB will not be permitted.
- In case higher frame sizes rating of switchgear (than those specified In the BOQ) is required to be provided to achieve the above requirement, due to selection of a particular make, the same shall be provided at no extra cost if other makes are able to achieve the same with the specified frame size.

4.12 Auto load management, auto synchronizing / auto load sharing panel

- It covers Supply, installation, testing and commissioning of auto load management, auto synchronizing / auto load sharing panel based on demand feedback for two DG sets having different capacity, Genset controller with load management PLC shall collect demand feedback from MFM in panels / transformer incomers & necessary wiring & communication from meter to PLC, auto change over, interlocking DG control and operation programmable logic controller (PLC) based logic panel cubicle type.
- Panel shall be Suitable for 2 Nos DG Set. (320KVA & 160 KVA) complete with all measuring instruments, protective devices, alarm, etc. as required, PLC with required digital & analogue input & output modules, input/output racks, power supplies and communication with Power Monitor. Gas Flooding system- clean agent based shall be provided.
- This panel scheme is PLC based type tested panel. The panel has incomers from two nos. of DG sets of different capacity power supply. The same is required to be designed and interlocked in such a way when main power supply gets off DG-1 (320kVA) integrated with PLC shall act as Master and 160 kV DG set will act as a slave. if total load exceeds 80% of Master DG then PLC close the Bus coupler and start DG-2. Thereafter, both DG sets shall operate in parallel and share the load as per the programmed load-sharing logic. When the load decreases to a level that can be adequately supplied by a single DG set, the PLC shall automatically de-synchronize and stop one DG set based on the predefined operating logic, and the remaining DG set shall continue supplying the load in compliance to the latest IS and IES standard.
- Panel shall be designed and fabricated as per the details mentioned above.

a) The panel shall be provided with:

- Continuous earth bus.

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- Two external earthing terminals.
- Door bonding arrangements.
- All metallic parts shall be effectively earthed.

b) Testing

- The panel shall be factory tested and site tested.
- Routine Tests
- Visual Inspection
- Wiring Verification
- Insulation Resistance Test
- High Voltage Test
- Functional Test
- PLC Logic Verification
- Communication Test
- Alarm Test
- Site Tests
- DG Start/Stop Test
- Auto Synchronization Test
- Load Sharing Test
- Load Transfer Test
- Protection Test
- Fire Suppression System Test

c) Applicable Standards

- The complete system shall conform to the latest editions of:
- IEC 61439 – Low Voltage Switchgear Assemblies
- IEC 60255 – Protection Relays
- IEC 61131 – PLC Systems
- IEC 60529 – Degrees of Protection (IP)
- IEC 60947 – LV Switchgear and Controlgear
- IS 8623 / IS 61439
- IS 732
- IS 3043
- IS/IEC 60034 (Generators)
- Relevant Central Electricity Authority (CEA) regulations
- Applicable Indian Electricity Rules (IER)

d) Documentation

The supplier shall submit:

- GA Drawings
- SLD
- Control Schematics
- PLC Logic Diagrams
- Cable Schedule
- Bill of Materials
- Type Test Certificates
- FAT Reports
- SAT Reports
- O&M Manuals
- As-Built Drawings
- The panel shall be supplied complete in all respects for satisfactory operation, testing and commissioning of the Auto Load Management, Auto Synchronizing and Auto Load Sharing System for 320 kVA and 160 kVA DG Sets.

e) Current Limiting & Coordination

- 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 all. It shall be responsibility of Panel builder & OEM to carry out the discrimination study at the time of drawing approval.

f) Spare Provision

- 25% spare cubicles/space shall be provided in all switchboards to cater for future use.

g) Drawout Features

- Air Circuit Breakers shall be provided in fully drawout cubicles, unless otherwise stated. These cubicles shall be such that drawout is possible without disconnection of the wires and cables. The power and control circuits shall have self-aligning and self-isolating contacts.
- The fixed and moving contacts shall be easily accessible for operation and maintenance. Mechanical interlocks shall be provided on the drawout cubicles to ensure safety and compliance to relevant Standards. The MCCB's shall be provided in fixed type cubicles.

h) Instrument Accommodation

- Instruments and indicating lamps shall not be mounted on the Circuit Breaker Compartment door for which a separate and adequate compartment shall be provided and the instrumentation shall be accessible for testing and maintenance without danger of accidental contact with live parts of the Switchboard.

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- For MCCB's instruments and indicating lamps can be provided on the compartment doors.
- The current transformers for metering and for protection shall be mounted on the solid copper/aluminium busbars with proper supports.

i) Wiring

- All wiring for relays and meters shall be with PVC insulated copper conductor wires. The wiring shall be coded and labelled with approved ferrules for identification. The minimum size of copper conductor control wires shall be 2.5 sq. mm.
- Wiring shall be terminated with ferrules on terminal block. CTs shall be provided with shorting facilities

j) Cable Terminations

- Knockout holes of appropriate size and number shall be provided in the Switchboard in conformity with the location of incoming and outgoing conduits/cables.
- The cable terminations of the Circuit Breakers shall be brought out to terminal cable sockets suitably located in the cable chamber
- The cable terminations for the MCCB's shall be brought out to the rear in the case of rear access switchboards or in the cable compartment in the case of front access Switchboards.
- The Switchboards shall be complete with tinned brass cable sockets, tinned brass compression glands, gland plates, supporting clamps and brackets etc. for termination of 1100 volt grade aluminium conductor XLPE cables.
- Removable gland plates shall be provided for power and control cables. The gland plates shall be 3 mm thick and for single core cables shall be of non-magnetic material.

k) Space Heaters

- Anti- condensation heaters shall be fitted in each cubicle together with an ON/OFF isolating switch suitable for electrical operation at 230 volts A.C 50 Hz single phase of sufficient capacity to raise the internal ambient temperature by 5O C. The electrical apparatus so protected shall be designed so that the maximum permitted rise in temperature is not exceeded if the heaters are energized while the switchboard is in operation. As a general rule, the heaters shall be placed at the bottom of the cubicle.

l) Ventilation Fans

- The Switchboard shall be provided with panel mounting type ventilation fans in each panel with switchgear rated for 2500 amp and above. The fan shall be interlocked with switchgear operation. If ventilation fans cannot be provided for maintaining the required degree of ingress protection, the design of switch board cubical shall incorporate suitable measures like decreasing current density of conductors, increasing cubical volume for effective heat dissipation etc. in order to restrict temperature rise to within the required limit.

m)Earthing

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- Continuous internal copper earth bus sized for prospective fault current to be provided with arrangement for connecting to SYSTEM earth at two points. Hinged doors / frames to be connected to earth through adequately sized flexible braids.

n) Steel Treatment And Painting

- Sheet steel used in the fabrication of switchboards shall undergo a rigorous cleaning and surface treatment seven tank process comprising of alkaline degreasing, descaling in dilute sulphuric acid and a recognised phosphating process after which a coat of primer paint compactively with the final paint shall be applied over the treated surface. Final paint coat of oven baked powder coating, of minimum 50 micron thickness, of sheet approved by E/Is/Owners shall then be provided.

o) Name Plates And Labels

- Suitable engraved white on black name plates and identification labels of metal for all Switchboards and Circuits shall be provided. These shall indicate the feeder number and feeder designation.

p) Local Authorities Requirement

- All other requirements by the local Authority that are imposed in course of execution of the work, particularly those listed below shall be provided.

a) Danger Signs

b) Rubber floor mat of 10 m thickness and 1 m width provided for the full length of the switchboard.

c) A dry chemical type fire extinguisher of 9 kg capacity with approved label

d) Framed single line diagram with minimum A1 size

e) First Aid Demonstration sign.

q) CPRI Testing

- Switchboard configurations offered shall be CPRI tested. Copies of the CPRI test certificates shall be submitted with the tender.

Testing at works

- Copies of type test carried out at ACB/MCCB manufacturers works and routine tests carried out at the switchboard fabricators shop shall be furnished along with the delivery of the switchboards. E/Is/Owners reserves the right to get the switchboard inspected by their representative at fabricators works prior to dispatch to site to witness the routine tests

r) Installation

- The foundations prepared as per the manufacturers drawings shall be levelled, checked for accuracy and the Switchboard installed. All bus bar connections shall be checked with a feeler gauge after installation. The cable end boxes shall be sealed to prevent entry of moisture. The main earth bar shall be connected to the SYSTEM earths.
- Antistatic rubber matting of approved make conforming to IS 5424 – 1983, of minimum 1000 mm width 10 mm thickness shall be provided in front of and along the

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full length of the Switchboard. The rubber mat shall withstand 15 KV for 1 minute and leakage current shall not exceed 160 mA/sq. metre.

- After installation the Switchboard shall be tested as required prior to commissioning.

s) Testing At Site

- Pre-commissioning tests as required and as per manufacturers recommendations shall be carried out on each switchboards at site before energizing the switchboards including but not restricted to the following.

a) Physical checking of the switchboards including checking alignment of panels, interconnection of Bus bars, tightness of bolts/connections and evidence of damage/cracks in any components.

b) Physical checking and inspections of Inter panel wiring

c) Checking free movement of ACBs/MCCBs/SFUs

d) Checking of operation of breakers

e) Insulation tests of bus bar supports and control wiring etc. with 1.1 kV megger.

f) Primary & secondary injection tests of relays and CTs.

g) Checking of Interlocking function.

t) Metering Equipment

- General
- This section covers specifications for Protection and Control Relays for breakers, Instrument Transformers, Measuring Instruments, Push Buttons, and Indicating Lamps etc. required in LT and HT switchboards.

4.13 Specifications for Manually Operated Fire Detection and Alarm System

General description:

Scope

This specification covers the supply, installation, testing and commissioning of the Fire Alarm Systems and generally comprise

1. Provision of Manual Call Points
2. Repeater Panel
3. Fire Zone Mimic Panel
4. Response Indicator
5. Provision of Hooters
6. Local Control Unit for the System
7. Wiring between MCP, Hooter and Control Units to make the complete System

a) Standards and codes

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- All equipment and the installation shall be as per the relevant Indian Standards Specifications. Where these Standards do not exist, the relevant British Standards or any other internationally accepted Standard shall apply.

b) Manual call points

- Manual Call Points shall consist of a push button switch housed in a dust tight sheet steel enclosure of 1.5 mm thick sheet to manually initiate audio visual alarms. The front shall be sealed with a breakable glass cover fixed in such a way that the actuating push button is kept depressed as long as the glass is intact and released automatically when the glass is broken. The front face of the Manual Call Box shall have an area not less than 5000 sq mm and the element shall have an exposed area of not less than 1600 sq mm in the shape of a square or a rectangle. A small steel hammer shall be attached to the assembly with a steel chain to facilitate breaking of the glass front. The Manual Call Box shall be suitable for surface or recessed mounting as required. The words "IN CASE OF FIRE BREAK GLASS" 5 mm high shall be painted in red on the front face.

c) Hooter

- Electronic audio alarm sirens shall be suitable for operation on the DC supply of the System and will be actuated from the Main Control Panel in the event of a fire. These shall have a two tone modulated alarm signal for continuous service with an output of 89 dB at a distance of 3 meters.

d) Main control panel

- General
- The Main Control Panel (MCP) shall be located at entrance and shall form the nerve centre of the total System.
- The MCP shall be metal enclosed, sheet steel cubicle pattern, dead front, floor/wall mounting type as required and suitable for indoor mounting. The MCP shall be dust and vermin proof. Synthetic rubber gaskets shall be provided on all covers and doors to render the joints dust and vermin proof. All doors shall be lockable. The MCP shall be fabricated from 2.0 mm CRCA thick sheet steel and shall be folded and braced to provide a rigid support. Joints shall be seam welded.

e) Repeater Panels

Remote repeater panels for repeating all alarm status indication with 640 character Touch screen LCD/LED/coloured TFT backlit alpha numeric display shall be provided at the specified location and shall be Delhi Fire and Emergency Services approved. LCD display shall be viewable through the panel door.

The repeater panel shall be fully standalone complete with power supply, charger/batteries. Repeater Panel will have its own micro- processor, software, and memory capabilities and provide indication for alarmed and troubled/faulted condition in each loop. All software (i.e., Programs and data system configuration) will be held in non-volatile ROM / EPROM.

The repeater panel shall be provided with warning buzzer which shall activate when an alarm occurs in the fire control room and a push switch shall be provided for

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silencing the warning signal. Lamp test control switch shall also be provided in the panel.

The Repeater housing shall have minimum protection rating of IP 54 or equivalent NEMA-1 or UL listed as per NFPA-72. rating.

The repeater panel enclosure shall be flush mounted and all electronics shall be contained in the enclosure. Access to the repeater panel switches shall be protected by key-switch.

The panel construction shall be as per Specification. One repeater panel has to be provided at THE ENTRANCE.

f) Response Indicator

- Response indicator of LED type shall be provided for above false ceiling and below false floor detectors and these shall be mounted outside/ inside the rooms wherever asked for by the Contractor/Employer representative for indication of fire through detector in the room. The design & colour shall be as per the standard.

g) Clean agent gas flooding system

- The clean agent gas flooding system shall be designed as per the NFPA 2001.
- The contractor has to submit the detailed design calculation for choosing the cylinder capacity and other design requirement for each panel/application as per the NFPA 2001 guidelines.
- The installation and commissioning of the system should be by Manufacturer or their authorised channel partner. The final connections between equipment and system detection tubing should be under direct supervision of factory trained and certified representative of manufacturer.
- The clean agent gas flooding system shall have 1 years replacement warranty from the date of operation of site and the Contractor shall submit the **UNDERTAKING** before completion of DLP period for the remaining guarantee/ warrantee period left.

h) Technical and Installation Requirements

- The system shall be a clean agent pre-engineered automatic indirect Fire Suppression System and shall be UL & FM Approved products and approval by Local Fire Authority.
- The system shall be self-contained and have its own non-electric automatic detection system, which when actuated shall automatically release the suppression agent into the transformer cabinet.
- The system shall be complete in all respects. It shall include agent storage container, detection tubing, discharge nozzles, pressure gauge, end of line adapter, fittings manual release, abort stations, audible and visual alarm devices, and any other operations necessary for a functional Clean Agent suppression system.

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- The System shall detect, control and extinguish the fire and also simultaneously give audio visual indication on the control panel. Interfacing shall be done with Fire Alarm and BMS.
- Storage containers shall be located as near as possible to hazard area but shall not be exposed to fire.
- Storage containers shall be carefully located so that they are not subjected to mechanical, chemical or other damage.

i) System Operation

- The system must operate automatically, and its operation shall be as per following sequence:
- When the temperature of detection tube installed inside the Cabinet will increase to above 100 degree C or the detection tube comes in the direct contact of flame, the tube shall burst and initiates ILP Valve which allows the diffusion of extinguishing medium which is Clean Agent gas through strategically placed pipes & nozzles.
- The system shall be designed for In Direct discharge of extinguishing agent through the pipes and nozzle when the tube rupture occurs. The diameter of tube for direct discharge shall be as per calculations and manufacturer recommendations but shall not be less than 6mm under any condition.
- The Contractor shall design & submit the piping isometric design layout along with calculation to validate the storage cylinders capacity requirements. The appropriate fill density to be arrived at basis of the same.
- The design & calculation shall be checked & certified by manufacturers trained design engineer. The calculation is the only guarantee that the system shall work, provided the system is installed exactly as per the design.
- These documents shall be prepared by a fully experienced person and qualified in the design of gas-based fire suppression system.

j) Equipment Specifications

- Cylinder
- Design, fabricate, certify and stamp containers in accordance with the requirements of NFPA (DOT). Containers shall be standard model and size of ease of replacement and addition.
- Discharge Hose
- The Discharge Pipe should be high pressure braided hose with heavy duty adopters. The nozzle should be made of Brass/Gun Metal and should have 180-degree discharge pattern.
- The System will be UL/FM approved product.
- Clean Agent should be used with below mentioned properties.
- The Clean Agent should have Zero Ozone Depletion Potential. (ODP = 0).
- The Clean Agent should not have Global Warming Potential of more than 1.
- The Clean Agent should be a low-pressure agent.

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- The detection tube shall be manufactured from specially processed polymer material to achieve the desired heat detection and delivery characteristics. The tube shall be capable of working even when contaminated with oil, dust and debris as long as the contamination will allow the heat to pass through the tube.

k) Internal wiring

- All internal wiring shall be with 1.5 sq mm PVC insulated copper conductor wires colour coded and labelled with ferrules for easy identification. The wiring shall be properly bunched and harnessed. The wiring shall be done in a manner such that it is readily accessible from the front for maintenance.

4.14 Specifications for HVAC/ VARIABLE REGRIGERANT FLOW SYSTEM:

a) scope of work

The scope of work related to Variable Refrigerant Flow Air-conditioning System shall generally comprise of but not limited to the following:

- a) Manufacturing
- b) Testing at manufacturer's works
- c) Supply and storage
- d) Installation at station
- e) Site testing and commissioning
- f) Training of NMRC staff

b) Anti-corrosive coating for Indoor, Outdoor , Refrigerant piping and Split AC

- To offer an inhibiting as well as sacrificial protection of metals against corrosion, Sulphur and other chemical contaminants present in the air. Coating should be done at manufacturing stage only in presence of OEM representative. The coating shall be carried-out by the certified applicator of coating manufacturer. The coating should be in consultation of OEM, so that there is no effect on equipments ISEER. OEM shall provide technical documents of coating and applicator details to engineer in-charge for approval before application of coatings.

c) The VRF type air-conditioning system shall generally consist of:

- a) Outdoor and Indoor units along with refrigerant piping, its insulation with aluminium cladding and control cables. Each refrigerant circuit from Outdoor Unit to Indoor Unit will run on cable tray. Refrigerant piping of each circuit shall be provided with proper tagging (engraved aluminium Tag) at regular interval for easy identification. Identification mark (in red colour) to be done at each joints of refrigerant pipe.
- b) Air distribution system, Drain Piping, Electrical & control works.
- c) Materials and components not specifically stated in the specifications and/or bill of materials or noted on the drawings but which are necessary for satisfactory installation and operation of the system. No separate payment is to be made for such items.

d) Governing Specifications

The VRF type air-conditioning system shall comply with standards mentioned particularly in the table below unless otherwise stipulated in the specifications. The

latest version of standards shall be applicable.

ASHRAE latest standard and guidelines.
UL-94- V0
Indian Electricity Rules- 2005
ASTM B280
ISHRAE Guidelines for Testing and Rating of VRF systems

e) Requirements

The VRF system shall be designed to meet the minimum requirements on the design parameters mentioned in drawing.

f) Functional Requirements

The Variable Refrigerant Flow (VRF) System should be air cooled, consisting of modular condensing outdoor units connected to multiple indoor units. Each indoor unit shall have the capability of individual set point control. Each modular condensing unit should have inverter compressors to obtain 10% to 100% step less capacity control to match the air-conditioning load.

The VRF unit shall be capable of operating within a wide range of temperatures in cooling mode. The condensing units should be capable of working at ambient temperature up to 52 deg. C DB. The system shall be designed for automatic cyclic operation for a bank of VRF units with settable time feature including providing all related microprocessor, cabling. The refrigerant used should be environmental friendly and latest. The manufacturer shall take a note of the ambient air pollution prevailing in Delhi/NCR region and shall provide proven protection against corrosion to all the components of VRF module like copper coils, fins and other electronic components. The VRF air conditioning system shall consist of the following sub-systems:

g) OUTDOOR UNIT

The outdoor unit shall be a factory assembled unit housed in a sturdy weather proof casing constructed from rust-proofed mild steel panels coated with a baked enamel finish. There should be no scaling, corrosion or any other physical deformation on the body of Outdoor unit. The outdoor unit shall be modular in design and thickness of the sheet used for manufacturing the body shall be such that it shall not deform during handling and may use corrugation to strengthen the body structure. It should be possible to place the ODU's side by side. The ODU must deliver the rated capacity at 42.2 °C outside condition and 24°C inside condition within the acceptable tolerance of $\pm 5\%$. The minimum ISEER and COP as per BOQ shall include deration due to Anti corrosion coating, if any.

h) Compressor

The compressor shall be highly efficient 100 % inverter based hermetically sealed scroll/Twinrotary design and capable of capacity modulation with inverter technology.

i) Heat Exchanger

The heat exchanger shall be constructed with copper tubes mechanically bonded to aluminium fins to form a cross fin coil. The heat exchanger and condenser fins,

coils and joints must be coated with Anti-corrosive treatment referred above.

j) Fan Motor Speed Control

The condensing unit fan motors to have at least two speed operations to maintain constant head pressure control at all ambient temperatures and modes of operation. The fan should have external static pressure of minimum 4mm WG for cowl duct extension.

k) Refrigerant Circuit

The refrigerant circuit shall include an accumulator, liquid and gas shut off valves and a solenoid valves or pulse width modulation valve. The equipment must have inbuilt refrigerant stabilization control for proper refrigerant distribution.

l) Oil Recovery System

Each unit shall be equipped with an oil separator to ensure stable operation with long refrigerant piping.

m) Unit Control Board

- a) The Units shall be provided with surge protection device suitable for minimum 8KV Impulse.
- b) There should be no ingress of water in control board enclosure during wet maintenance.
- c) All electronic PCBs shall comply to IEC 60571/EN 50155 for dry heat test, dust & sand test etc, compliance documents shall be submitted for approval. Also, all electronic PCBs shall have protection against direct spikes & surges in the power supply inbuilt as defined in IEC 60571.

n) INDOOR UNIT

- a) Indoor unit shall be Wall mounted/Ceiling mounted/floor mounted (as per requirement) with metallic body except cassette units, each complete with coil, pre-filter, etc. including necessary steel supporting structure. Indoor unit should have flexibility for duct extension (if required). CFM shall be as below:

CEILING SUSPENDED IDU Capacity	CFM (Minimum)
1.5TR	600
2.0 TR	800
2.5 TR	1000
3.0 TR	1200
4.0 TR	1350
CEILING MOUNTED IDU (Cassette Type)Capacity	CFM (Minimum)
2.0 TR	600
2.5 TR	800
3.0 TR	1000

Note: The CFM of indoor units may vary as per actual equipment's ADP, meeting the design requirements.

- b) It shall have electronic control valve to control refrigerant flow rate in response to load variations of the room. The fan shall have highly efficient BLDC (Brushless Direct Current) motor and statically and dynamically balanced direct driven DIDW multi-blade type blowers, to ensure low noise and vibration free operation or the latest and highly efficient.

- c) The system should be designed such that in case of failure/ trip of one indoor unit, the working of ODU and other indoor units should not be affected. The indoor unit fan shall be direct driven. The indoor unit casing shall be fully insulated and sealed to prevent condensation. Each indoor unit shall have the capability of individual set point control.
- d) All the ceiling suspended indoor unit's body & parts should be of metallic construction. The cassette type indoor units having some parts in non-metallic construction must be UL-94- V0 certified.
- e) The indoor unit should be provided with corded remote control as a standard accessory. The address of the indoor unit shall be set automatically in case of individual and group control. In case of centralized control, centralized remote controller shall set it. The fins, copper coil, joints of the IDU shall be coated with Anti corrosion coating referred above.

o) Electronic Expansion Valve

Each indoor unit shall be fitted with an electronic expansion valve to control the refrigerant flow in response to the load variations in the room. The electronic expansion valve is to be controlled via a sensing the return air temperature, refrigerant inlet and outlet temperatures. During the cooling operation the electronic expansion valve shall control the refrigerant superheat degree at the evaporator.

p) Cooling Coils

Shall be direct expansion, constructed from copper tubes expanded into aluminium fins to form a rigid mechanical bond.

q) Unit Control Board

The indoor unit shall have a printed circuit board complete with, address switches for a variety of operation controls, emergency operation switch and fault / operation indication LED's. The fan motors shall be thermally protected. All electronic PCBs shall comply to IEC 60571/EN 50155 for dry heat test, dust & sand test etc, compliance documents shall be submitted for approval. Also, all electronic PCBs shall have protection against direct spikes & surges in the power supply inbuilt as defined in IEC 60571.

r) REFRIGERANT PIPEWORK

- I. All interconnecting pipe-work between the condensing unit & indoor units shall have quality seamless copper tubes with brazed connections and the appropriate distribution joints and headers shall be used. The piping should be routed at site in such a manner, that brazed joints in the Refrigeration Piping are kept to a minimum. All interconnecting piping joints and U bends shall be painted with two coats of coating for protection against corrosion from ambient air pollution.
- II. Each coat shall have dry film thickness of minimum 25micron of coating material as referred. The coating shall be strong, flexible and durable. It shall have good adhesive and abrasion resistance. It shall be resistant to moisture, UV, acid alkali and other chemicals.
- III. All suction & liquid lines of the Refrigerant pipe work shall be insulated with Nitrile rubber pipe sections as specified to avoid condensation.
- IV. The exposed piping insulation shall be Aluminium clad with minimum 0.63mm thickness. The refrigerant pipe shall be thermally insulated by proven materials having low thermal conductivity, high mechanical strength, non-combustible, resistance to Fungi, ozone, UV and any other environmental pollutant.

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Moulded joints of thermal insulating material shall be used at bends y-joints, T-joints etc.

- V. The refrigerant piping shall be extendable up to minimum 165 m with 50 m level without any oil trap. Distribution refrigeration pipe joints and headers shall be installed in an appropriate orientation to enable correct distribution of refrigerant. The Distribution joints shall be factory/site insulated. All pipe-work must be kept clean and free from contamination to prevent breakdown of the system. All pipe ends shall be kept sealed until immediately prior to making a joint.
- VI. Refrigerant charge must be calculated based on the actual length of the refrigerant pipe work. The refrigerant charging process must be carried out with an appropriate charging station and under supervision of manufacturer/OEM or his representative.
- VII. The insulated refrigerant piping and control wiring (in conduit) shall run on GI tray properly supported by GI rods. The exposed tray shall be covered by openable GI covers.
- VIII. Bend of copper piping shall be done by proper mechanical bending machine.
- IX. The copper tubes shall be of two types: Soft Annealed (O) and Half hard (1/2 H). The chemical composition will confirm to grade C12200 designated as "Phosphorus Deoxidized High Residual Copper" grade having minimum Copper % of 99.9 % with Phosphorus % of 0.015 to 0.040%.
- X. The Mechanical properties should also as per the ASTM B280.
- XI. The OD & wall thickness of copper refrigerant piping shall be as follows:

Size	Thickness	Tolerance (Thickness)	Tolerance (Dia)	Specification
6.35 mm (1/4 in)	0.762 mm	± 0.08 mm	± 0.051 mm	C12200T-O(ANNEALED)
9.52 mm (3/8 in)	0.813 mm	± 0.08 mm	± 0.051 mm	C12200T-O (ANNEALED)
12.70 mm (1/2 in)	0.813 mm	± 0.08 mm	± 0.051 mm	C12200T-O (ANNEALED)
15.9 mm (5/8 in)	0.889 mm	± 0.11 mm	± 0.051 mm	C12200T-O (ANNEALED)
19.1 mm (3/4 in)	1.07 mm	± 0.11 mm	± 0.025 mm	C12200T-1/2 H (HALF-HARD)
22.3 mm (7/8 in)	1.14 mm	± 0.11 mm	± 0.025 mm	C12200T-1/2 H (HALF-HARD)
25.40 mm (1 in)	1.27 mm	± 0.13 mm	± 0.038 mm	C12200T-1/2 H (HALF-HARD)
28.6 mm (1 1/8 in)	1.27 mm	± 0.13 mm	± 0.038 mm	C12200T-1/2 H (HALF-HARD)
34.9 mm (1 3/8 in)	1.40 mm	± 0.14 mm	± 0.038 mm	C12200T-1/2 H (HALF-HARD)
41.3 mm (1 5/8 in)	1.52 mm	± 0.15 mm	± 0.051 mm	C12200T-1/2 H (HALF-HARD)

- XII. The size of the pipe may vary depending on the site conditions/OEM recommendation.
- XIII. The copper tubes shall be supplied with end Caps at both ends.
- XIV. The copper tubes must be packed & sealed to protect them from any atmospheric degradation/contamination.
- XV. All copper tubes shall be 100% eddy current tested.
- XVI. All the Tubes shall be RoHS (Restriction of Hazardous Substances) complied and each lot of supply shall be provided with routine test certificate.

Testing (PPM)	Max. Permissible Content Limit
Cadmium(Cd)	100 ppm

Lead(Pb)	1000 ppm
Mercury(Hg)	1000 ppm
Chromium	1000 ppm

s) DRAIN PIPING

The indoor units shall be connected to vertical insulated PVC drainage pipe. The vertical pipes shall be concealed in the wall & drop down up to floor level and connected to the horizontal pipe running in the floor. The pipes shall be laid in proper slope for efficient drainage of condensate water. Drain pipes carrying condensate water shall be insulated with 6 mm Nitrile rubber insulation as specified. The joints shall be properly sealed with synthetic glue to ensure proper bonding of the ends.

t) NOISE LEVEL

The Noise level of outdoor unit shall not be more than 68 dB(A) at normal operation. The Noise Level of indoor unit shall not be more than 42 dB(A) for non ductable and not more than 49dB(A) for ductable units. The noise level shall be measured at a distance of 1m away (horizontally) and 1.5m above ground.

u) INPUT VOLTAGE & FREQUENCY

All the outdoor unit shall be suitable for operation with 415 V $\pm 10\%$, 50 $\pm 3\%$ Hz, 3Ph 4 wire AC supply, whereas all indoor units should be with 230 V $\pm 10\%$, 50Hz $\pm 3\%$ Single Phase supply.

v) ADDITIONAL REQUIREMENTS

- a) The control/communication cable between indoor and outdoor units shall run in GI conduits.
- b) The insulated refrigerant piping and cable between indoor and outdoor unit shall run in a Galvanized Steel raceway/Cable tray with proper supporting arrangement. The exposed refrigerant pipe near ODU's shall run in covered cable tray or in raceway.
- c) All galvanized support beams, galvanized legs, galvanized hangers, anchor bolts, vibration isolators, and ductworks shall be provided for the installation of the units, assembly and its sub-assembly.
- d) The VRF type air conditioning units shall be mounted on vibration isolators and installed in accordance with the manufacturer's recommendation such that no disturbing vibration or noise is being transmitted to the nearby structure.
- e) The centralized system Controller shall be located in a properly sized box with lock and key facility along with its battery/adaptor unit. The power supply cable for the controller shall be taken in a conduit from the nearest 230V socket. A guidance manual of the controller shall be located in this unit.
- f) Joints in refrigerant piping should be minimized. Half Hard/Hard copper pipes upto dia 18 mm should be bended and not use elbow at the locations having bends of 90 deg.

w) SAFETY

All necessary safety devices shall be provided in the indoor and outdoor units to ensure the safety operation of the system. The design of the safety system shall be such that the equipment is protected and defect of one unit shall not lead to

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consequential damage to any other units. The safety and protection design shall be submitted with the offer and shall be a part of the training course to NMRC official.

The following safety devices shall be part of the outdoor unit:

- a) High Pressure Switch
- b) Low Pressure Switch
- c) Fan Motor Safety thermostat
- d) Over Current Relay
- e) Fuse
- f) Overload protection
- g) Protection for indoor fan motor.
- h) All the material used in the manufacturing of VRF system shall be fire retardant. The indoor unit shall be in conformance to UL-94 guidelines. The manufacturer shall submit UL compliance certificate with the offer.

x) ENERGY EFFICIENCY

- a) Only the best manufacturing practices and as per mentioned in the BOQ i.e. the units with maximum ISEER as per ISHRAE will be accepted. The contractor shall study the best available design and offer the best ISEER available in industry. However, the VRF unit should provide a minimum ISEER as mentioned above.
- b) The vendor shall provide the model no. of the proposed units and provide the actual capacity of same units at AHRI and site condition also. The Minimum EER & IEER Value should also comply as per ASHRAE.

y) MAINTENANCE AND LIFE

- a) The service life of the VRF system shall be at least minimum 10 years.
- b) The manufacturer shall submit the list of those items whose life does not match with the service life of VRF. The life of such spares shall be advised with a certificate from the original manufacturer of the spares. The firm shall supply purchase specification of these items.
- c) The CAMC will cover all components, all consumables including refrigerant and oil, electronic and electrical parts, rubber and plastic parts, wires, displays, connectors, controller hardware / software, PCBs, condense coil, compressors, anti corrosion coating everything including preventive maintenance and breakdown servicing.
- d) The CAMC will also cover all defects arising out of Atmospheric corrosion and all this must be rectified / replaced by Vendor at their cost including prevention and treatment related to atmospheric corrosion, transport, handling, lifting shifting, labour, consumables, and all re-commissioning activities if any are needed.

z) TESTING

The unit shall be tested for capacity and ISEER as per ISHARE conditions at manufactures premises or at an accredited laboratory. The capacity of ODU and IDU's shall be as per the BOQ and rated 100% capacity within the acceptable tolerance of +5 % at design condition i.e. at minimum 42.2 °C outside condition. The OEM shall also submit the unit's actual capacities at AHRI condition for the same unit.

The COP of proposed units ,including the deration due to anti corrosion coating

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and shall be used for demonstrating the ISEER.

The manufacturer shall also submit the deration graph for different ambient conditions in the performance of their VRF system starting from the maximum ambient temperature conditions as tested.

The refrigerant piping system shall be pressure tested using dry nitrogen gas prior to insulating the joints at a pressure of 4.0 MPaG (580 PSIG). Pressure of 4.0 MPaG (580 PSIG) shall be maintained in the system for at least 24 hours for test of leakage.

After satisfactory testing, the refrigerant pipe shall be evacuated and dehydrated to (-755 MM HG) and held for one to four hours depending on the pipe length. When the gauge indicator does not rise, the test will be considered successful. If the gauge indicator rises, there may be moisture remaining or a leak in the circuit.

After completing the vacuum drying, the refrigerant shall be charged in a liquid state. Digital scale shall be used for measuring the additional refrigerant quantity.

The FAT plan for VRF equipment shall be as per Annexure-A.

aa) TRAINING

The contractor shall ensure training of NMRC staff as decided by NMRC at NMRC workplace or at his workplace as considered necessary.

On completion of installation, the manufacturer shall supply two sets of well bound handing over manuals duly approved by Consultants/Engineer-in-charge. Each set shall include:-

- a) As Built Drawings.
- b) Do's and Don'ts for the maintenance and operating staff.
- c) Working details of VRF system.
- d) Operating manual.
- e) Extracts of the warrant/DLP.
- f) Details of service center.
- g) List of staff trained on the said design of the VRF.
- h) The first page of the booklet shall be signed by the manufacture, contractor and NMRC Engineer.
- i) Soft copy of the entire documents.

bb) ANNEXURE-A

FAT PLAN FOR VRF EQUIPMENT (MINIMUM PARAMETERS)

PHYSICAL PARAMETERS TO BE CHECKED				
	COMPONENT	PARAMETER	Requirement	Remarks
1.	OUTDOOR UNIT	Casing	Weather proof casing constructed from rust-proofed mild steel panels coated with a baked enamel finish	
2.	INDOOR UNIT	Component	Electronic Expansion Valve	
		Insulation	fully insulated and sealed	

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3.	HEAT EXCHANGER	Construction	The Condenser fins must be coated with Anti-corrosive treatment.	
4.	REFRIGERANT CIRCUIT	Component	Accumulator	
		Component	Liquid and gas shut off valve	
		Component	Solenoid valves	
5.	OIL RECOVERY SYSTEM	Component	Oil Separator	
6.	SAFETY DEVICES	Component	High Pressure Switch	
		Component	Low Pressure Switch	
		Component	Fan Motor Safety Thermostat	
		Component	Over Current Relay	
		Component	Fuse	
7.	FAN MOTOR	Component	Thermal protection relay.	

TECHNICAL PARAMETERS TO BE CHECKED			
COMPONENT	PARAMETER	REQUIREMENT	REMARK
OUTDOOR UNIT	Cooling capacity	100% cooling capacity at Outdoor ambient temperature as per ISHRAE (within the acceptable tolerance as specified ISHRAE Guidelines for Testing and Rating of VRF systems)	
	Noise level	68 dB(A) at normal operation measured horizontally 1m away and 1.5m above ground.	
	COP/ISEER	As per ISHRAE Guideline Conditions	
	Maximum temperature operating test	As per ISHRAE Guideline Conditions	
	Operation	The unit operation at maximum outdoor temperature of 52°C.	
INDOOR UNIT	Noise level	NOISE Level < 42dB for non ductable type and <49 dB for ductable unit	
REFRIGERANT PIPING	Length	Extendable minimum 165 m with 50 m level without any oil trap.	
FAN MOTOR	Speed Control	At least two speed operation to maintain constant head pressure control at all ambient temperatures	
CENTRALIZED REMOTE CONTROLLER	Operation	Starting/ Stopping of Air-conditioners as a zone or group or individual unit	
	Operation	Temperature setting for each indoor unit or zone	
	Operation	Switching between temperature control modes	

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	Operation	Switching of fan speed	
	Operation	Control direction of air-flow	
	Operation	Enabling/disabling of individual remote controller operation	
	Operation	Monitoring of Operation status	
	Operation	Maintenance information	
	Operation	Trouble Shooting information	
	Operation	Temperature setting of individual indoor units	

cc) COMMISSIONING

After installations are completed, all air-conditioning system shall undergo test run. During test at site, a report forms to contain following minimum data listings shall include design and actual conditions for each Item mentioned below:

- a) Date and time of test.
- b) Outside conditions (DB and WB)
- c) Air-conditioning unit make, type, name and serial number.
- d) Fan rpm.
- e) Fan motor amperage
- f) Rated motor amperage, starter number and ampere rating.
- g) Fan CFM
- h) Entering air coil conditions (mixing) (DB and WB)
- i) Leaving air coil conditions (DB and WB)
- j) Room temperature & Humidity (DB and RH %)
- k) Settings to be checked of centralized controller after power supply failure.
- l) Running condition of each circuit after switching-off of one indoor unit from MCB in each circuit.
- m) During test run, the air filters of testing sets shall be used.

Note: Additional tests may be conducted based on the requirement of the employer's representative.

dd) SPLIT AIR CONDITIONERS

GENERAL

- a) The contractor shall supply and install split system air conditioner with highly efficient inverter compressor. The system shall be complete in all respects and comply with the specifications as given.
- b) All split units shall be eco-friendly type.
- c) All electronic PCBs shall comply to IEC 60571/EN 50155 for dry heat test, dust & sand test etc, compliance documents shall be submitted for approval. Also all electronic PCBs shall have protection against direct spikes & surges in the power supply inbuilt as defined in IEC 60571.

In all applications, conformal coating as per IEC 61086 suitable for Class 3C2 (IEC 60721), shall only be used. Contractor shall submit the compliance documents along with test report as defined in IEC 60721 and IEC 61086 to NMRC for approval.

CONDENSING UNITS

- a) Each condensing unit shall be complete unit with high EER hermetic inverter type scroll/rotary compressors, air cooled condenser, condenser fans with motors, internal piping, switches and internal wiring and shall be enclosed in weather proof outdoor type housing.
- b) The compressor shall be hermetic, with enclosed gas cooled motor. The compressors shall be suitable for R410A/R32.
- c) The condenser coil shall be air cooled type with aluminium sine wave fins and copper tubes and necessary refrigerant connections. The copper tubes shall not be less than 1/4" O.D.
- d) The condenser air fans shall be propeller type direct driven, each complete with motor. The air quantity and area of the condenser shall be adequate for working in the specified outdoor conditions.
- e) The casing shall be fabricated from galvanized steel and finished with powder coated paint. The casing shall make the whole unit fully weather proof. Suitable for outdoor installation.
- f) The unit shall include a remote control assembly with thermostat and starter and speed switches.
- g) The necessary charge of refrigerant gas and lubricated oil shall be provided to run the system.
- h) The fins, copper coil, joints of the IDU/ODU must be coated with Anti-corrosive treatment referred in above clause E. 05.3.1.3

COOLING UNIT

- a) Indoor unit shall be Wall mounted/Ceiling mounted (as per requirement) with metallic body except cassette units. The cooling unit shall be matched to the respective condensing unit and shall consist of cooling coil, blower, filters, outer casing, drain pan, accessories etc.

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- b) The cooling coil shall have copper tubes of not less than 1/4" O.D. and continuous aluminium sine wave fins with integral collars. The tubes shall be staggered in the direction of the air flow.
- c) The fan section shall comprise of 1 Nos. statically and dynamically balanced centrifugal blower, motor, drive package, mounting arrangement etc.
- d) The unit casing shall be made of galvanized steel, the casing shall be insulated to lower the noise level and eliminate condensation. The Cassette type indoor units having some parts in non-metallic construction must be UL-94-Vo certified.
- e) CFM requirement shall be as follows.

Unit Capacity	CFM (Minimum)
1.5TR	600
2.0 TR	800

Note: The CFM of the indoor units may vary as per actual equipment's ADP, meeting the design requirements.

REFRIGERANT PIPING

The condensing unit and evaporator unit shall be interconnected by type 'L' seamless refrigerant liquid and suction lines using flared or brazed fittings. Necessary accessories shall be incorporated in the circuit:

- a) The suction and liquid line shall be insulated with 13 mm thick Nitrile rubber insulation and the discharge/gas line shall be insulated with 19 mm thick insulation.
- b) Necessary chases and holes in walls and floor etc. for laying the piping work shall be done by contractor, after completion of work necessary repair work shall be done by contractor and brought to its original finish to the satisfaction of Engineer-in-charge.

MISCELLANEOUS

- a) The unit shall have control panel, housing the starting switches, contactor, relays etc. Isolation pads shall be provided under the units.
- b) Insulated drain line shall be provided from indoor unit up to drain trap. (To be priced separately).
- c) Suitable galvanized M.S. channel supporting frame shall be provided for the condensing unit and supporting arrangement for the indoor units.
- d) Interconnecting power and control cabling shall be provided between condensing unit and evaporator unit.
- e) Aluminium cladding of 0.63 mm shall be provided to cover the insulated refrigerant piping and electrical cabling from indoor to outdoor units.
- f) Compressor current should not flow through indoor unit.
- g) Inbuilt protection in indoor unit against electric fault to be provided.

INSTALLATION

The split type air conditioner shall be mounted on vibration isolators and installed in accordance with the manufacturer's recommendation such that no disturbing vibration or noise is being transmitted to the nearby structure.

- a) Refrigerant pipes that exposed to outdoor shall be cladded with 0.63 mm thick Aluminium cladding.
- b) Anti-corrosion protective coating on refrigerant pipes, Bents, Joints of indoor & outdoor unit to be done to avoid leakages.

All galvanized support beams, galvanized legs, galvanized hangers, anchor bolts, vibration isolators, duct works and shall be provided for the installation of the units.

TESTING AND COMMISSIONING

After installations are completed, all air-conditioning system shall undergo test run. Any adjustments that are needed shall be made to assure that all air-conditioning system will operate at therequired performance. Report forms to contain following minimum data listings shall include design and actual conditions for each Item mentioned below:

- a) Date and time of test.
- b) Air-conditioning unit make, type, name and serial number.
- c) Fan rpm.
- d) Fan motor amperage
- e) Rated motor amperage, starter number and ampere rating.
- f) Fan CFM
- g) Outside conditions (DB and WB)
- h) Entering coil conditions (mixing) (DB and WB)
- i) Leaving coil conditions (DB and WB)

During test run, the air filters of testing sets shall be used.

MAINTENANCE AND LIFE

- a) The manufacturer shall submit the list of those items whose life does not match with the service life of Split AC. The life of such spares shall be advised with a certificate from the original manufacturer of the spares. The firm shall supply purchase specification of these items.
- b) The manufacturer should also submit Annual Maintenance cost rates for the full service life of the system.
- c) The manufacturer shall provide free service and guarantee for 24 months from the date of taking over.
- d) The CAMC will cover all components, all consumables including refrigerant and oil, electronic and electrical parts, rubber and plastic parts, wires, displays, connectors, controller hardware / software, PCBs, condense coil, compressors, anti-corrosion coating everything including preventive maintenance and breakdown servicing.
- e) The CAMC will also cover all defects arising out of Atmospheric corrosion, and all this must be rectified / replaced by Vendor at their cost including prevention and treatment related to atmospheric corrosion, transport,

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handling, lifting shifting, labour, consumables, and all re-commissioning activities if any are needed.

Air Distribution

- (For Ducts Fabricated In Factory as Per “SMANCA” Standards)

Scope

The scope of this section comprises supply fabrication, installation and testing of all sheet metal / aluminium ducts, supply, and installation, testing and balancing of all grilles, registers and diffusers. All to be in accordance with these specifications and the general arrangement shown on the Drawings.

- Duct materials

Raw materials: Galvanizing shall be Class VII – light coating of zinc, nominal 120gm/sq. m surface area and Lock Forming Quality prime material along with mill test certificates. In addition, if deemed necessary, samples of raw material, selected at random by owner's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

Duct construction

- All ducts shall be fabricated and installed in workmanlike manner, conforming to relevant SMACNA codes. a. Ducts so identified on the Drawings shall be acoustically lined and insulated from outside as described in the section —Insulation and as indicated in schedule of Quantities. Duct dimensions shown on drawings, are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in Schedule of quantities. The fabricated duct dimensions should be as per approved drawings and care should be taken to ensure that all connecting sections are dimensionally matched to avoid any gaps.
- Ducts shall be straight and smooth on the inside with longitudinal seams shall be airtight and at corners only which shall be either Pittsburgh or snap button as per SMACNA practice, to ensure air tightness.
- All ducts up to 75cms width within conditioned spaces shall have C&S/approved connector. The internal ends of slip joints shall be in the direction of airflow. Care should be taken to ensure that Cleats are mounted on the longer side of the duct and Cleats on the shorter side. Ducts and accessories within ceiling spaces, visible from air-conditioned areas shall be provided with two coats of mat black finish paint.
- Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Airturms (vanes) shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.
- Ducts shall be fabricated as per details shown on Drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or angles, of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.
- All sheet metal connection, partitions and plenums, required to confine the flow of air to and through the filters and fans, shall be constructed of 18 gauge GSS / 16gauge aluminium/ as per E/I, thoroughly stiffened with 25mm x 25mm x 3mm galvanized

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steel angle braces and fitted with all necessary inspection doors as required, to give access to all parts of the apparatus. Access doors shall be not less than 45cm x 45cm in size.

- Plenums shall be shop/site fabricated panel type and assembled at site. Fixing of galvanized angle flanges on duct pieces shall be with rivets heads inside i.e. towards GS sheet and riveting shall be done from outside.
- Self-adhesive Neoprene rubber / UV resistant PVC foam lining 5mm nominal thickness instead of felt, shall be used between duct flanges and between duct supports in all ducting installation.

Installation practice

All ducts shall be installed generally as per tender drawings, and in strict accordance with approved shop drawings to be prepared by the Contractor:

- The Contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent of these Specifications and Drawings. The work shall meet with the approval of site representative in all its parts and details.
- All necessary allowances and provisions shall be made by the Contractor for beams, pipes, or other obstructions in the building, whether or not the same are shown on the drawings. Where necessary to avoid beams or other structural work, plumbing or other pipes, and conduits, the ducts shall be transformed, divided or curved to one side (the required area being maintained) all as per the site requirements.
- If a duct cannot be run as shown on the drawings, the contractor shall install the duct between the required points by any path available in accordance with other services and as per approval of owner's site representative.
- All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with hangers formed of galvanized steel wire ropes and galvanized steel angle/channel or a pair of brackets, connected by galvanized steel wire hangers under ducts, rigid supports may be provided at certain interval if need be. The spacing between supports should be not greater than 2.4 meter/ as per the gudliance/standard/E/I. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates or Toggle end wire fixing left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the wire rope hanger shall be welded to the plates. Trapeze hanger formed of galvanized steel wire rope using Gripple shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/anchor fastener driven into the concrete slab by electrically operated gun. Wire rope supports shall hang through the cleats or wire rope threaded studs can be screwed into the anchor fasteners.
- Alternatively, if mentioned in the BoQ, all ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with trapeze hangers formed of galvanized steel rods and galvanized steel angle/channel or a pair of brackets, connected by galvanized steel rod under ducts. The spacing between supports should be not greater than 2.0 meter. All vertical ductwork shall be supported by

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structural members on each floor slab. Duct supports may be through galvanized steel insert plates left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the hanger rods shall be welded to the plates. Trapeze hanger formed of galvanized steel rods shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/anchor fastener driven into the concrete slab by electrically operated gun. Hanger rods shall then hang through the cleats or fully threaded galvanized rods can be screwed into the anchor fasteners.

- Ducting over furred ceiling shall be supported from the slab above, or from beams after obtaining approval of site representative. In no case shall any duct be supported from false ceiling hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other contractor's work in the building.
- Where ducts pass through brick or masonry openings, it shall be provided with 25mm thick insulation around the duct and totally covered with fire barrier mortar for complete sealing.
- All ducts shall be totally free from vibration under all conditions of operation. Whenever ductwork is connected to fans, air handling units or blower coil units that may cause vibration in the ducts, ducts shall be provided with a flexible connection, located at the unit discharge. Flexible connections shall be constructed of fire retarding flexible heavy canvas sleeve at least 10cm long securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting ductwork rigidly held by independent supports on both sides of the flexible connection. The flexible connection shall be suitable for pressure at the point of installation.
- Duct shall not rest on false ceiling and shall be in level from bottom. Taper pieces shall taper from top.

Dampers

Dampers: All duct dampers shall be opposed blade louver dampers of robust 16 G GSS construction and tight fitting. The design, method of handling and control shall be suitable for the location and service required.

Dampers shall be provided with suitable links levers and quadrants as required for their proper operation. Control or setting device shall be made robust, easily operable and accessible through suitable access door in the duct. Every damper shall have an indicating device clearly showing the damper position at all times.

Dampers shall be placed in ducts at every branch supply or return air duct connection, whether or not indicated on the Drawings, for the proper volume control and balancing of the air distribution system.

Pressure relief dampers: Pressure relief dampers shall be constructed with 18G Aluminium construction with parallel blade construction. Leafs shall be 100% air tight upon closure. Leafs shall be loaded with spring pressure of stiffness (k value) corresponding to set point pressure.

Non return damper (Back draft damper): Non return damper shall be constructed out of 16G GSS. Blades shall ensure 100% air leak proof performance on closure. Design shall ensure that no rattling noise is produced at design duty.

The electric actuator shall be energized either upon receiving a signal from smoke detector installed in AHU room supply air duct / return air duct. Electric Actuator of suitable Torque and as approved by UL shall be factory mounted and tested. In

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addition actuator shall have elevated temperature rating of 250 deg.F. Electric Actuator shall have been energized hold open tested for a period of at least one year with no spring return failure. Each fire/smoke damper shall be equipped with a heat actuated release device which shall allow controlled closure of damper rather than instantaneous to prevent accident. (Electrical fusible link). The EFL shall allow the damper to reopen automatically after a test, smoke detection or power failure condition. The damper shall be equipped with a device to indicate OPEN and CLOSE position of Damper blades through a link mounted on the damper blade.

Each damper shall be provided with its own control panel, mounted on the wall and suitable for 240 VAC supply. This control panel shall be suitable for spring return actuator and shall have at least the following features:

- a. Potential free contacts for AHU fan ON/ Off and remote alarm indication.**
- b. Accept signal from external smoke / fire detection system for tripping the electrical actuator.**
- c. Test and reset facility.**
- d. Indicating lights / contacts to indicate the following status:**
- e. Power Supply On**
- f. Alarm**
- g. Damper open and close position**

Actuators shall be mounted on the sleeve by the damper supplier in his shop and shall furnish test certificate for satisfactory operation of each Motor Operated Damper in conjunction with its control panel. Control panel shall be wall mounted type.

It shall be HVAC Contractor's responsibility to co-ordinate with the Fire Alarm System Contractor for correctly hooking up the Motor Operated Damper to Fire Detection / Fire Management System. All necessary materials for hooking up shall be supplied and installed by Contractor under close co-ordination with the fire protection system contractor.

Contractor shall demonstrate the testing of all Dampers and its control panel after necessary hook up with the fire protection / fire management system is carried out by energising all the smoke detectors with the help of smoke.

Contractor shall provide Fire retardant cables wherever required for satisfactory operation and control of the Damper.

Contractor shall strictly follow the instructions of the Damper Supplier or avail his services at site before carrying out testing and installation at site.

Fire/smoke damper shall be provided with factory fitted sleeves; however, access doors shall be provided in the ducts within AHU room in accordance with the manufacturer's recommendations.

The Contractor shall also furnish to the Owner, the necessary additional spare actuators and temperature sensor (a minimum of 5% of the total number installed) at the time of commissioning of the installation.

Fire dampers

1. Whenever a supply duct crosses from one fire zone to another, it shall be provided with approved fire damper of at least 1½ hour fire rating as per UL555/1995 tested by CBRI. This shall be curtain type fire damper.

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1. Fire damper sleeves and access doors shall be provided within the duct in accordance with the manufacturer's recommendation.
2. The contractor shall also furnish to the Owner, the necessary additional fusible links (spares), as recommended by the manufacturer, at the time of commissioning of the installation.

Supply air registers

Supply air registers shall be of either steel or aluminium sections as specified in schedule of quantities. Steel construction registers shall have primer Coat finish whereas extruded aluminium registers shall be either Anodised or Powder Coated as specified in Schedule of Quantities. These registers shall have individually adjustable louvers horizontal /vertical. Supply air registers shall be provided with key operated opposed blade extruded aluminium volume control damper anodised in matt black shade. The registers shall be suitable for fixing arrangement having concealed screws as approved by E/I. Linear continuous supply cum return air register shall be extruded aluminium construction with fixed horizontal bars at 15 Deg. inclination & flange on both sides only (none on top & bottom).

The grilles shall be suitable for concealed fixing. Volume control dampers of extruded aluminium anodised in black color shall be provided in supply air duct collars. For fan coil units horizontal fixed bar grilles as described above shall be provided with flanges on four sides, and the core shall be & suitable for clip fixing, permitting its removal without disturbing the flanges.

All registers shall be selected in consultation with the E/I. Different spaces shall require horizontal or vertical face bars, and different width of margin frames. These shall be procured only after obtaining written approval from E/I for each type of register.

All registers shall have a soft continuous rubber/foam gasket between the periphery of the register and the surface on which it has to be mounted. The effective area of the registers for air flow shall not be less than 66 percent of gross face area.

Registers specified with individually adjustable bars shall have adjustable pattern as each grille bar shall be pivotable to provide pattern with 0 to +45 degree horizontal arc and up to 30 degree deflection downwards/ as per E/I. Bars shall hold deflection settings under all conditions of velocity and pressure.

All volume control dampers shall be anodised aluminium in mat black shade.

Supply and return air diffusers

Supply and return air diffusers shall be as shown on the Drawings and indicated in Schedule of Quantities. Mild steel diffusers/dampers shall be factory coated with rust-resistant primer. Aluminium diffusers shall be powder coated & made from extruded aluminium section as specified in schedule of quantities.

Rectangular Diffusers shall be steel/ extruded aluminium construction, square & rectangular diffusers with flush fixed pattern for different spaces as per schedule of quantities These shall be selected in consultation with the E/I.

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Supply air diffusers shall be equipped with fixed air distribution grids, removable key-operated volume control dampers, and anti-smudge rings as required in specific applications, and as per requirements of schedule of quantities. All extruded aluminium diffusers shall be provided with removable central core and concealed key operation for volume control damper.

Linear Diffuser shall be extruded aluminium construction with removable core, one or two way blow type. Supply air diffusers shall be provided with volume control/ balancing dampers within the supply air collar. Diffusers for different spaces shall be selected in consultation with the E/I, and provided as per requirements of schedule of quantities. All diffusers shall have volume control dampers of extruded aluminium construction anodised in mat black shade.

Slot Diffuser shall be extruded aluminium construction multislot type with air pattern controller provided in each slot. Supply air diffusers shall be provided with Hit & Miss volume control dampers in each slot of the supply air diffusers. Diffusers for different spaces shall be selected in consultation with the E/I and provided as per requirement of Schedule of Quantities.

Data centers shall be provided with floor grilles. Grilles shall be of nominal size of 600mm x 600mm and shall be fitted in floor tile of false floor. Grille shall be with dampers for flow control.

Grill shall be heavy duty 16G Aluminium and shall take care of human traffic load. Damper shall be operable in situ without requirement of removal of grille.

Support

All static mechanical, electrical and HVAC services shall be suspended as per standard/ OEM guidance/E/I.

Insulation

The scope of this section comprises the supply and application of insulation conforming to these specifications.

Elastomeric Nitrile Rubber

- **Insulation Material:** Duct and pipe insulation shall be **closed-cell elastomeric nitrile rubber (NBR)** and It shall be fire rated **Class 0 (BS 476 Part 6)** and **Class 1 (BS 476 Part 7)**.
- **Moisture & Thermal Stability:** Water vapour permeability shall be with stable thermal performance over ageing, tested for long-term durability equivalent to **minimum 5 years ageing performance** in accredited labs.
- **Fire, Smoke & Hygiene:** Smoke density shall not exceed and material shall be non-toxic under fire conditions. It shall be **anti-microbial** and resistant to fungus and mould growth
- Insulation material for Duct Acoustic Lining shall be elastomeric Nitrile rubber.
- Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer's test certificate for thermal conductivity values, density, water vapour permeability and fire properties. Samples of insulation material from each lot delivered at site may be selected by Owner's site representative and gotten tested for thermal conductivity and density at Contractor's cost. Adhesive used

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for sealing the insulation shall be non-flammable, vapour proof adhesive strictly as per manufacturer's recommendations.

Duct acoustic lining

Insulation material for Duct Acoustic Lining shall be elastomeric Nitrile rubber. Material shall be engineered Nitrile Rubber open cell foam. The material should be fibre free. The density of the same shall be within 140-180 Kg/m³. It should have antimicrobial product protection, and should pass Fungi Resistance. Thickness of the material shall be as specified for the individual application. The insulation should be installed as per manufacturer's recommendation. The adhesive shall be specially formulated for the Duct insulation application and supplied by insulation manufacturer. The adhesive shall be Solvent based rubber insulation adhesive, free from benzene.

Installation Procedure

The inside surface for the ducts shall be covered with adhesive recommended by the manufacturer. Cut Foamed sheets into required sizes apply adhesive on the foam and stick it to the duct surface.

Duct insulation

External thermal insulation shall be provided as follows:

The thickness of nitrile rubber shall be as shown on drawing or identified in the schedule of quantity.

Following procedure shall be adhered to: Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying out insulation work.

Measurement of surface dimensions shall be taken properly to cut closed cell elastomeric rubber sheets to size with sufficient allowance in dimension. Cutting of nitrile rubber sheets shall be done with adjustable blade to make 90° cut in thickness of nitrile rubber sheet. Hacksaw or blades are not acceptable tools for cutting the insulation.

Material shall be fitted under compression and no stretching of material shall be permitted. A thin film of adhesive shall be applied on the back of the insulating material sheet and then on to the metal surface.

When adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond. All longitudinal and transverse joints shall be sealed by providing 6 mm thick 50 mm wide nitrile rubber tape. The adhesive shall be strictly as recommended by the manufacturer.

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Bidder Needs to submit after receiving of work order			
Model			
Power Supply		V~,Hz,Ph	
Cooling	Capacity	kW	
	Input	kW	
	Current	A	
	EER	W/W	
Heating	Capacity	kW	
	Input	kW	
	Current	A	
	COP	W/W	
Max. Current		A	
Max. Input Consumption		kW	
Circuit breaker		A	
DC Inv. Compressor	Quantity		
	Type		
	Brand		
Outdoor Fan Motor	Type		
	Brand		
	Output Power	W	
Air Flow Volume		CFM	
		m³/h	
Noise Level		dB(A)	
Dimension(W×D×H)	Net	mm	
	Packing	mm	
Weight	Net	kg	
	Gross	kg	
Refrigerant type/Quantity	Type		
	Charged Volume	kg	
Design Pressure		MPa	
Refrigerant Piping	Liquid Side	mm	
	Gas Side	mm	
	thickness	mm	
	Max. Length	m	
	Max. Height	m	
Ambient Temp (Cooling/Heating)		°C	
Wiring specification	Power wiring (ODU)	mm²	
	A.B signal wiring (ODU)	mm²	
	A.B signal wiring (toIDU)	mm²	
Stuffing Quantity	20/40/40H	Unit	

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The scope of the work under SITC of VRV includes the following:-

- Immediate attendance of breakdown, if any.
- Repairing of leakage, refrigerant Gas charging, if necessary.
- Replacement of parts viz. Compressor, fan, Fan Motor, Belts, radiator fins, PCB, Magnetic Switch, Transformer, gas leak, pipe welding, control panel and other electrical parts of AC etc. restore the A.C. functioning.
- The setting of the central controller whenever required.
- Cleaning as per OEM of Air Filter, Sheet Metal parts, Evaporator coils, Condenser Coil Circuit Breaker, Front grill assembly / plastic cover/panel, Circuit Breaker (MCB), Remote Handset, and Voltage stabilizer. If any such part requires replacement then the same must be replaced within the timelines specified below.
- It shall be the responsibility of the contractor to hand over the awarded VRV/VRF HVAC system to NMRC in working condition at the expiry of the Contract period.
- During any break down which requires replacement of part which is not on the stock of the contractor and is expected to take more than 24 hours then standby replacement for that part should be provided and fixed by the contractor within 24 hours.
- The received complaint should be attended within 24 hours by the contractor. Nature of the complaint can be two type minor fault or major fault.
- In case of minor fault,
- Fail to attend the complaint within 24 hours the penalty of Rs. 2500/- will be imposed plus the work will be carried by other agency at the risk and cost of contractor and amount will be deducted from bill.
- Minor complain should be rectified within 24 hours. Fail to do so the penalty of Rs.500 per day till 5 days. After that penalty of 2500/- will be imposed plus the work will be carried by other agency at the risk and cost of contractor and amount will be deducted.

4.15DG SETS

a) SCOPE OF WORK

- The scope of work should cover Design, Manufacture, Supply, Installation, testing and commissioning including Integral testing & commissioning with systems of Diesel Engine Alternator sets including AMF Panel, Power and Control Cabling from DG set to AMF Panel (with necessary cable end terminations), all the necessary meters & Relays, Control wiring, earthing, Day Oil Fuel Tank along with fuel piping, Exhaust Piping, Silencer(s), Sound proof Enclosure and Fire Safety system, etc.
- Models of DG sets offered should be strictly as per the DG sets set installed in NMRC office and latest CPCB norms (latest prevalent at the time of supply of the DG sets). The compliance to all requirements with regards to statutory laws on emission and noise to be ensured by vendor and NMRC to be indemnified for that.

b) Scope of work under this tender will include: -

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- Design, Manufacture, Supply, including all transportation, arranging access to site, storage, loading/unloading, insurance, installation, testing, commissioning, including Integral testing & commissioning with systems and safe custody till handing over of the following of each sound attenuated Diesel Generator set: -
- Sound attenuated weather proof enclosures.
- Ventilation and illumination system for acoustic enclosure.
- Alternator and Engine with Radiator.
- Residential / Critical / Hospital grade silencer.
- Bank of starting batteries along with battery charger for trickle and boost charging of battery bank.
- Auto – Mains Fail (AMF) Panel for DG set operation.
- Power cable from Generator to AMF Panel (with necessary cable end terminations).
- All necessary control wiring from Generator to AMF Panel.
- Anti-vibration mounting pads.
- All piping system between engine and radiator.
- Piping system for fuel line from Engine to Day Oil fuel tank. The pipes shall be Mild Steel (MS) pipes of 25 mm dia. with two coats of primer & two coats of paint or braided flexible (If Required, As per BOQ item).
- Calibrated Day Services Tank minimum capacity of 990 liters or as per CPWD norms for operation of DG sets. The tank shall be made out of 14 SWG thick MS sheets with all accessories such as oil level indicator, drain plugs, manhole and painting etc. complete as required by Indian Explosive Rules and Regulations. (If Required, As per BOQ item).
- Provision of making two independent earth stations for Neutral Earthing as per IS 3043:2018 & IEEE-80 (Ground Enhancement Material) / NBC-2016 complete in all respect including masonry enclosure, and connecting the Earth strips to the Earth stations / Station Earthing as per Earthing specification.
- Provision of making cable trenches / or supplying and laying of GI / HDPE pipes to accommodate all cables, earthing strips and fuel pipe lines as utility to DG set.
- Supply and fixing of hot air exhaust duct of 22 SWG GI sheet with DG canopy to remove hot air (if required).
- Exhaust piping system including MS pipes, bends, flanges, reducers etc. connection to silencers and lagging the exhaust pipe as per specifications.
- All the MS supports for the Exhaust pipe should be bolted type instead of being welded, so as to facilitate easy removal / replacement.
- As per the CPCB guidelines the Chimney / Stack height has to be higher than the building height, therefore suitable Lightning protection system on the Exhaust pipe has to be provided which should be duly approved by Engineer In-charge.
- All wiring and connections including but not limited to between: -
- Engine control panel and AMF Panel.

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- Starting battery bank and engine control.
- Engine mounted alternator to static battery charger.
- Electrical panel etc.
- Battery charger to batteries.
- All necessary wirings & connections to make DG Set system fully functional.
- Supply laying and commissioning of earthing from Earth stations made for DG to D.G. Body and neutral and AMF panel separately by GI earthing Strips. The fixing arrangement of Earth strips should ensure all safeguards against vandalism and theft.
- Alarms and Protection system should be got approved from employer. It should include all parameters for safe operation and safety of equipment & personnel. AMF should be PLC or microprocessor based with suitable interface for monitoring and recording of all parameters by BMS / SCADA.
- Interfacing with Building Contractor
- Testing and commissioning (including arranging suitable consumables and testing equipment) of the DG sets at site.
- All other work, not specifically mentioned but required for satisfactory completion of work.
- Automatic Gas flooding of AMF Panel, using linear heat sensing tubes- Fire trace or equivalent.
- The contractor should go through all the site conditions of the DG set installation before submitting the installation approval of the section/schedule. The contractor has to make arrangements along with all the approval requirements as per the required place of installation of the DG sets.

c) Tender Conditions, Specification and Schedule

- For any discrepancy between Technical Specifications and Bill of Quantities, provision of Bill of Quantities shall prevail.
- Any item shown in Bill of Quantities and not called for in the Specifications or vice versa shall be provided as if called for in both.
- Wherever it is mentioned that the Contractor shall perform certain work or provide certain facilities, it implies that the Contractor shall do so at his cost.
- Wherever the Technical Specifications stipulate requirements in addition to those contained in the applicable Indian Standard Specifications/Codes- these additional requirements shall also be satisfied, the Contractor shall do so at his cost.
- DG set Contractor is required to provide signals for the remote operations. All signals (digital as well as continuous/analogue) should be available from PLC of AMF panel or microprocessor through RS – 485 ports. All the information should be compatible with MOD – BUS protocol. All energy related parameters shall be made available through a RS 485 port.
- DG sets are expected to run at light load / No load. The DG set offered, shall be suitable for operation under light load / No load, without any adverse impact on the service performance or life of the equipment. These are provided with independent

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reliable sources for power supplies and DG sets would be required to operate for a very small duration and after large period of idling. DG set should be designed to work satisfactorily even after prolonged idling period.

- Approximately 60 percent of the load shall be non – linear, DG set should be designed to operate under non – linear load environment. DG set should be so designed that the ripples are not created in the energy generated and EMI and RFI are within acceptable limit, specified by standards.
- Requirements of EMI / EMC due to Single – phase A.C. traction should be taken care.
- During the Integrated, Testing and Commissioning of the DG set, the set will be tested for the actual linear and non – linear loads at site and the test report furnished.
- Equipment offered shall comply with latest pollution norms as notified by the Government and other statutory bodies at the time of delivery of the DG sets at the site.
- All drawings and other documentation including design calculations shall be submitted in hard copy format as well as in soft copies in latest version of MS word latest version and PDF formats.

d) Following test acceptance criteria shall be applicable.

The tests shall include the following minimum requirements:

- Verification of the suitability of the system, its efficiency, etc.
- Performance testing of DG set for 8 hours.
- Capacity testing of the DG set.
- Any additional testing as required as per relevant standards.
- Fuel consumption of the DG set.
- Complete functional tests.
- Testing of the Sound Acoustics enclosures.
- Fault Simulation and testing of control & protection devices.
- Copies of all the documents of routine tests & type test certificates of the equipment carried out at the manufacturer premises shall be furnished to the Engineer In charge along with the supply of the equipment and these are as below:
- Routine Test: -
 - Engine separately
 - Alternator Separately
 - DG Set
 - Type test certificates.
 - Engine.
 - Alternator.
 - Pumps.
 - Meters.

- Governors.
- All major components.

e) OPERATING CONDITIONS

- The Engine Alternator is to be installed in Delhi / National Capital Region and shall be capable of working at any ambient temperature between 0°C and 50°C and relative humidity up to 95%.

f) PERFORMANCE REQUIREMENT

- The working kVA rating at site condition after accounting for derating shall be obtained at 0.8 power factor.
- Period of Operating: - The set may be idle for a long period except for routine test periodically. When there is an electrical supply failure it will be required to work continuously at variable load with average load factor of 70% as per ISO 8528.
- Overload: - The set shall be capable of taking 10% overload for a period of one hour during any 12 hours period while operating as per above conditions.
- Shaft Speed: - Rotational speed shall not exceed 1500 rpm.
- Loads: - The set shall be capable of operating in conjunction with non-linear and harmonics generating electronic loads including the UPS System.

g) STANDARDS

STANDARDS	DESCRIPTIONS
BS: 5514, BS: 649, ISO 3046	Diesel Engines
IS: 4722	Alternator
IS: 8183	Sound Insulation
BS: 4552	Fuel Filters
BS: 7226	Air Filters
IS: 3043	Earthing System
ISO 8528	Genset
Latest CPCB norms for Noise Level, Height of Stack / Chimney & Emission levels	
The set shall conform to following standards with latest amendments.	

h) DIESEL ENGINE:

Construction

- The Engine shall be internal combustion type direct injection, cold start suitable for diesel fuel, 1500 rpm, turbocharged, with electronic governor suitable for auto synchronization, 4- stroke of suitable rating with provision of 10% overload for 1 hour in every 12 hours of running. Engine shall be multi-cylinder of “in – line” or “V” configuration and complete with basic accessories.

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- Engine shall be built to comply with BS 5514 The engine shall be complete with cooling fan drive, lubricating oil filters, air cleaners, starter motor / exciter, fuel injector, fuel control solenoid, fuel lift pump, engine speed adjustment, other standard / operational accessories and protective devices including Genset controller.
- The Diesel Engine is designed for operation on HSD oil Grade a conforming to IS – 1460. DG sets will be operated on Diesel, commercially available in the NCR region, this aspect should be duly taken care in the DG sets being offered and any variation in the performance of DG set on account of this should be clearly indicated / brought out.
- The engine shall be fitted with a heavy, dynamically balanced flywheel suitable for constant speed generator duty to meet the cycle variation requirements. An electronic speed governor shall be fitted to maintain engine speed at all conditions of load in line with the requirements of BS: 5514.
- Cylinder Housing and heads shall be provided along with other accessories.
- Crankshaft shall be truly balanced.
- Pistons shall be of aluminium alloy and provided with necessary compression and scrapper rings and a fully floating gudgeon pin.
- Connecting rods shall be H-section steel stampings. Camshaft shall be gear driven (fly-wheel end) and easily removable.
- Lubrication system shall be complete with necessary gear pump, piping and drilled oil passage strainer, oil cooler and relief valve, etc.
- DG set shall be able to start automatically even in cold condition without any adverse effect on its performance and capable to take full load within 30 seconds (wake up time) of failure of normal supply.
- DG set shall be designed for low specific fuel consumption. Specific fuel consumption at rated load should not be more than as per ISO 3046 / BS 5514. During testing of DG set, consumption will be checked and recorded at 25%, 50%, 75% and 100% of rated loads.
- The DG set shall be suitable for continuous operation inside the acoustic enclosure under all the ambient conditions up to 50 degree C ambient without any adverse effect on its performance.
- The AMF panel shall be connected & provided with suitable interlocking arrangements to ensure automatic starting of the DG set in case of failure of supply from both the sources and interlocking arrangement to avoid any incident of paralleling of normal power supply with DG set supply. **And make the connection suitable for Auto-Load Management /Sync. Panel/Auto Load sharing panel**

i) Cooling

- The engine shall be complete with suitable radiator for cooling the machine in tropical ambient temperatures of 50 degree C, with engine-driven blower type heavy duty cooling fan and radiator core.
- Water cooled with fan and radiator, with engine driven circulating water pump, thermostat, and temperature gauge with high temperature alarm / trip. Cooling water circuit shall be fitted with corrosion inhibitors and coolant supplied by manufacturer.

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Need of corrosion inhibitors shall be examined during design stage, based on recommendations of Engine Manufacturer.

- A thermostatic valve should by-pass the coolant in the primary circuit until a pre-set operating temperature is reached.
- The design shall take into account compensation for possible ingress of dirt, which may normally clog the fins. The choice shall take into account the place of installation and the flexibility available for locating cooling system, air circulation and smoke exhaust.

j) Filtration

- The engine shall have replaceable fuel oil filters. Lube oil filtration, air filtration shall also be through replaceable filters.

k) Fuel Filters

- A supply line fuel filters shall be fitted and shall be of twin replaceable elements type.
- Air filters
- The engine shall be fitted with dry type air filters with replaceable elements.
- Twin heavy-duty air intake filters in accordance with BS 7226 suitable for operating in dust- laden atmospheres shall be fitted. Breathers shall be fitted with washable filters, which are easily accessible for maintenance.

l) Engine Exhaust

- The engine exhaust piping shall be amply sized for minimum back pressure and connected to the engine manifold through flexible connection or an expansion joint on one side and to a silencer on the other side along with pipe. The silencer shall be package type with adequate attenuation for urban use, constructed from heavy gauge galvanized steel.
- The sound absorbent infill shall be non-hygroscopic, vermin proof, non-combustible material. Engine shall be provided with Residential / critical / hospital – grade silencers so as to achieve sound attenuation of more than 25 DBA from the DG set as per CPCB norms.
- The exhaust piping from the silencer onward shall be laid up to the specified / approved level and discharged through a rain cowl. Entire exhaust piping and silencer shall be Class 'Medium' MS pipe and shall be rock wool insulated with 50 mm thick 64 Kg / cum density. The insulation shall be held in position with 0.63 mm dia, 20 meshes, galvanized steel wire mesh and finished neatly with 24SWG Aluminium cladding.
- The generator set shall be provided with an exhaust system incorporating residential / critical / Hospital – grade silencers. If possible, the silencers shall be contained entirely within the Generator building / on acoustic enclosure.
- As per the CPCB guidelines for DG sets the Stack Height / Height of Chimney shall be worked out as per the formula given below: -

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- $H = h + 0.2 \times \text{SQROOT (KVA)}$.
- H = Total height of Stack in meter.
- h = Height of the building in meters where the generator set is installed.
- KVA = Total Generator capacity of the set in KVA
- In case of any different regulation by the state Pollution Control Board, the more stringent of norms shall be applicable at no extra cost payable to the contractor.
- Similarly, for higher KVA ratings a stack height can be worked out using this formula.
- The Exhaust Pipe is to be provided keeping in view the CPCB guidelines. Nothing extra shall be paid on account of the suitable support structure to be provided for the Exhaust pipe (suitable support structure should be part of DG set exhaust pipe item).
- Flanged connection to the silencer and between pipe sections shall be made. Minimum wall thickness of pipes and the silencer shall be 3 mm. A stainless-steel bellows unit shall be provided for connection onto the engine.
- Exhaust pipes within the building shall be lagged and guarded to prevent accidental contact up to a height of 2.5 m. No part of any exhaust system installed outside the building shall be less than 3 m from ground level. Passage of exhaust pipes through walls or the roof shall be sleeved and shall be shrouded to prevent ingress of rain or of vermin. Exhaust emission control shall have suitable provisions to control pollution from DG Sets as per extant NGT/CPCB norms (latest prevalent at the time of supply of DG Sets).
- Exhaust piping shall be fabricated from class 'Medium' MS pipes conforming to IS 1239 of size suitable to limit backpressure to within permissible limit. The insulation thickness stipulated in the schedule of quantities shall be checked by the tenderers to achieve a maximum temperature of 60°C on the outside surface of the insulated pipe and supporting calculations for back pressure shall be furnished, the measurement of the back pressure will be checked during proto type testing.
- Flanged joints in the exhaust piping shall be covered with removable insulation at suitable intervals for permitting access to the joint, as and when required. All flanged joints shall have sprung high temperature gasket. The piping shall be installed with necessary thermal expansion facility as required. Exhaust piping shall be connected to the engine by means of flexible section or an expansion joint and shall also be graded to a drain pocket inside the building. The pocket shall be fitted with a drain cock.

m)Retro-fit Emission Control System

- DG set shall have retro-fit emission control system as per Statutory Authorities recommendations to achieve minimum specified particulate matter capturing efficiency of 70%.
- Retro-Fit emission control system shall be tapped in Exhaust stack and shall have dual outlet with pressure relief valve, by-pass valve and other safety precautions to ensure no damage to the engine operations under any circumstances. The retro-fit emission control system to be closely coupled with the engine exhaust so that 100% of the exhaust passes through it.

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- Exhaust coming out from the DG set will be routed through the pipe towards the oxidation chamber for oxidation of pollutants like particulate matter etc. This device shall aid passive regeneration of particulate matter (PM) trap. This system shall capture soot particle or particulate matter and then release exhaust air. This trap is designed to ensure back pressure are kept in limit and required PM reduction efficiency is met.
- Safety system to be provided to safeguard engine from higher back pressure and any malfunction.
- Technology of retro-fit emission control system shall be tested by one of the CPCB approved institutions / labs with at least 70% Particulate Matter capturing efficiency.
- Any amendment in emission limits by Statutory Authorities at the time of vendor approval shall be binding upon the Contractor.
- Life of the product should be at least minimum 10,000 operational hours.
- Retrofit emission control device manufacturer & contractor should interface with DG set manufacturer during installation of Retrofit device and during installation, Testing & Commissioning of DG set for successful installation testing and commissioning of this device with DG set.

n) Sound attenuating acoustic enclosure

Design

- The sound attenuation enclosure should be designed keeping into account the latest norms of the CPCB as applicable at the time of Delivery.
- Sound Attenuating Acoustic Enclosure should have pleasant and aesthetic looks and should be designed to achieve the Final sound level of 75 dB (maximum) at a distance of one meter from the Acoustic enclosure as per ISO 8528 part 10 (The latest CPCB guidelines prevalent at the time of supply of DG Sets will have to be complied, during the execution of the contract). For testing, the measurement of dB shall be done at different points all along the enclosure and then averaged as per ISO 8528 part 10 mentioned in CPCB compliance procedures.
- The sound attenuating enclosure shall be meticulously designed and its design, construction etc. should be decided based on ventilation requirement and should be completely weather proof.
- In design, proper care should be taken for engine heat rejection in order to have safe working temperature inside the enclosure by provision of fans etc., as required. The design aspect should ensure free and uninterrupted flow of suction and exhaust air in order that the temperature rise of the enclosure with respect to the ambient is less than 7°C.

o) Construction features

- **STRUCTURE:** Enclosure shall be made in modular design and can be dismantled / assembled at site. It shall be made out of heavy gauge mild steel sections and reinforced with fabricated structure; the supporting frame work shall be of 2.0 mm thickness. Outside covers & doors shall be fabricated in 1.6 mm thick CRCA sheet. Inside cover or perforated sheet should be used. The base of Acoustic Enclosure shall be made from suitable size of M.S. sheet / Channel. There should be provision

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of lifting-hooks on the enclosure to ensure easy lifting. "CAP – ON" type Acoustic Enclosure shall not be accepted.

- **ACCOUSTIC INSULATION** (walls, Roof and Doors): Fire retardant Foam / rock wool slab of minimum density & thickness confirming to IS 8183 and covered by fire resistant fiber tissue confirming to AWWA C – 203 specifications.
- For DG sets up to 250 KVA Fire Retardant Foam can be used & above 250 KVA Mineral Rock wool can be used as per the requirement, and confirming the Latest CPCB norms as applicable at the time of delivery.
- **AIR INLET & AIR OUTLET:** Specially designed sound attenuators at Suction & Exhaust ends.
- **PAINTING:** Outer surface of Acoustic Enclosure shall be painted with Polyurethane paint or powder coated but painting should be done after corrosion treatment of sheet by 7 tank treatment process (or latest available) & synthetic enamel paint on the internal surface. All nuts & bolts shall be zinc coated. The colour of the Enclosure should be got approved from the Employer. Enclosure should be suitably coated to withstand arduous temperature conditions of Delhi region.
- **WIRING AND LIGHTING:** Suitable lighting arrangement with integrated door interlocking limit switch to be provided in all compartments of Sound attenuating Acoustic Enclosure i.e. ENGINE / ALTERNATOR set, AMF Panel with PVC FR copper wire of minimum 2.5 mm², 1100 V grade concealed in flexible conduit / channel & MCB.
- **EXHAUST OF ENGINE:** The Engine Exhaust shall consist of suitable dia. 'Medium' class M.S pipe (Insulated) along with smooth bends & supported. This pipe shall be suitably brought out at the top of enclosure with suitable arrangement at the outer end for preventing water to enter in pipe as required. The Exhaust Muffler with insertion loss of 25 dB shall be provided. For the Engine Exhaust detailed specifications as per clause E24.8.5E23.8.5. Are to be complied. Rain cowl should be provided to prevent entry of rain water, birds etc.
- **PROVISION FOR NEUTRAL / BODY EARTHING:** Suitable bus bars have to be provided outside sound Attenuating Acoustic Enclosure for neutral / Body earthing separately. The neutral terminals shall be connected to the neutral of Alternator with flexible copper wire insulated braided strip. All the Equipment's inside the Acoustic Enclosure shall be connected together with suitable size strip / flexible braided wire and then connected to the Body Earthing bus bars. DG canopy door to be connected with suitable size braided wire for Earthing
- **VENTILATION & AIR CIRCULATION:** The system shall be designed to provide air inlet / exhaust acoustic louvers for efficient air circulation under all loading conditions. The ventilation may be natural / forced cooling. The temperature rises of the enclosure with respect to the ambient should be less than 7°C. In case of forced ventilation there should be specially designed circuitry to ensure that the fan(s) starts when the Genset is in operation and when the Genset has been switched off the fan(s) automatically switches over to main supply and runs for 5 – 15 minutes (programmable) before stopping to ensure that set is ready to start in case of another failure.

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- SPECIAL FEATURE: Fuel tank shall be provided at suitable place (nearest to ENGINE / ALTERNATOR set) outside the sound attenuating enclosure. Provision should be there to fill this tank from outside as in automobiles and this should be with a lockable cap.
- The batteries shall be accommodated in the sound attenuating enclosure in battery tray.
- Engine Control Panel as well as engine instruments panel shall be inside the sound attenuating enclosure with free frontal access.
- AMF panel should be located inside in the DG room, the equipment layout for each DG room is to be got approved from the Employer, prior to the execution of work. As far as possible the control panel shall be placed adjacent to the enclosure to have minimum length of cable.
- The sound attenuating enclosure shall be provided with residential / critical / hospital – grade silencers insulated from inside with rock wool having minimum insertion loss as specified in the Latest CPCB norms.
- The sound attenuating enclosure should be as compact as possible with good aesthetic look.
- From continuous running of engine, the temperature inside the sound attenuating enclosure shall be maintained within 7°C of ambient and canopy shall be provided with temperature safety device to shut down engine if canopy temperature exceeds 60°C.
- The measurement of difference of temperature shall be as per the prescribed procedure specified by the C.P.C.B.
- The sound attenuating enclosure shall be complete with ducting & radiator bellow.
- The sound attenuating enclosure shall have built in receiving tray at base of the Genset for any oil spillage.
- The sound attenuating enclosure shall have provision of emergency shutdown from outside the container.
- The sound attenuating enclosure door shall be gasket with high quality EPDM gaskets to avoid leakage of sound. The door handles should be provided with durable weather – proof locking system.
- All the doors of the sound attenuating enclosure shall be lockable and theft proof.

p) Safety systems

Governor

- The performance of the governor under load conditions shall be to Class A1 in accordance with BS 5514: Part 4 (ISO 3046).
- The governor shall meet the following performance requirements:
- Steady state speed band: + 1% or + 0.25% of nominal speed,
- Transient frequency changes on application or rejection of 60% load: $\pm 5\%$,
- Recovery time to steady state speed band on application of 60% load: 10 seconds,

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- Maximum speed drop: 5%
- The electrical over speed trip provided shall operate at 120% of the rated speed and shall be reset only by hand.
- Other safety controls and indicating instruments shall be as shown in Data Sheet.

q) Engine starting

- The starting system shall comprise a 12 / 24 V heavy duty suitable capacity high discharge lead acid battery of reputed make as required, and electric starting motor. The battery shall be sized to give not less than ten consecutive starts of the engine at 0°C to 50°C.
- The starting system shall be complete with necessary relays, solenoid valves for fuel, control and indicating panels as specified and required.
- A main powered battery charger shall be provided, with sufficient capacity to maintain the battery in a condition to fulfil the starting requirements.
- The mains powered charger shall be suitable for operating on 240 V, single phase, 50 HZ supply and shall be complete with the following indications and features:
 - Battery charge / discharge current,
 - Boost charge / trickle charge selector, On / off switch
 - Fault indication,
 - Protection Auto cut off feature to safeguard batteries from over charging,
 - DC ammeter and voltmeter,
 - Annunciation panel for battery charging indication.
- The input voltage to battery charger may vary between 180 V to 240 V; therefore, the battery charger should be capable of charging the battery to the desired voltage level with the above input Voltage range.
- The battery charger shall have a selector switch by which the rate of charging the batteries can be selected.
- If the equipment does not start within three starting cycles with appropriate interval between each attempt, the starting circuit shall be locked and audio-visual alarm shall be given.

r) Mounting and installation

- The engine shall be complete with suitable radiator for cooling the machine in tropical ambient temperatures, with engine-driven blower type heavy duty cooling fan and radiator core.
- A common rigid bed plate shall be provided for the engine and alternator which shall be directly coupled. The coupling must be done after ensuring proper alignment of generator and engine shafts.
- The entire set shall be housed in sound attenuating enclosure mounted on suitable Rubber- in-shear type vibration mounts with 6 mm static deflection for isolating the building floor / foundation. A nominal base concrete pad (if required) shall be provided over which the engine set with its own base frame and vibration mounts shall be

mounted. It is to be ensured that minimum vibrations are transmitted to the surface on which set is resting.

s) Radio Interference

- All equipment's, provided under the scope, shall be so designed that they shall not cause interference with radio equipment. In the event of the inherent characteristics of the equipment being such that radio interference is possible, efficient devices to nullify the same shall be provided.

t) Alternator

Type & Rating

- Alternator shall be 3 phase, 4 wire 50 cycles 415 volt, totally enclosed, brush-less screen protected drip proof with self-contained excitation system and self-regulating and conforming to IS 4722 & continuously rated. The alternator should have the rated capacity at 0.8 PF. The alternator shall be designed to suppress radio interference in conformity with BS 800. It shall be of heavy-duty single / double bearing design, adaptable for direct coupling with diesel engine including excitation system, automatic voltage regulator, voltage adjusting potentiometer [to adjust nominal voltage over a range of approximately (+) or (-) 5%] and low speed protection, to reduce voltage proportional to the driven speed in order to protect both alternator and V / F sensitive loads.
- The supply interlocks shall be provided to supply the electricity after stabilization only. The excitation system shall provide an exceptionally rapid response to load change and alternator shall be designed for high motor starting capabilities.
- The alternator shall be tropically insulated with H class insulation and windings shall be impregnated with thermo setting insulated varnish to use in tropical climates. Ample ventilation shall be provided by shaft mounting fan as per manufacturer design.
- The neutral point shall be brought out separately and earthed permanently.
- The band of voltage regulation shall be + / - 0.5% from no load to full load and under varying load conditions.
- The overload short circuit capacity shall be 150 – 300 % for 10 seconds limitation, if any, shall be highlighted by the manufacturer.
- The Alternator shall be suitable for taking unbalanced load, limitation, (if any), shall be highlighted by the manufacturer.
- The alternator shall be of fabricated steel construction conforming to minimum IP-23 class specified (test certificates conforming to the specified IP class should be produced by the contractor), dynamically balanced rotor with single / two bearings and damper windings. The unit shall be with a large terminal box for outgoing cable connections specified. Necessary adapter box shall be provided if the terminal box is not adequate to receive the cables.
- Alternator rotor shall be salient pole type with a damper cage and dynamically balanced. Insulation shall be to class 'H' (BS 2757 / 1957). All winding shall be fully impregnated for tropical climates with high quality or epoxy varnish.
- Ventilation to the alternators shall be by means of fans fitted on the rotor.

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- It shall handle 10% overload in one hour in every 12 hrs. of operation without exceeding the permissible possible temperature rise for the class of insulation provided.

u) Excitation system

- The main exciter shall receive power from a permanent magnet generator orthrough separate auxiliary windings on stator via Automatic Voltage regulator. The AVR shall be of solid-state circuitry and shall provide regulated voltage to the exciter compensating for all normal variations. The main exciter output is fed to the main motor windings via a rotating 3-ph bridge rectifier assembly which shall be protected from voltage surges, short circuit, and overload and diode failures. The AVR and control gear shall be mounted in a component box on the side of the machine. Electrical connections to the AVR shall be taken through a multi way plug and socket.
- Voltage regulation shall be within half percent under all conditions of load, power factor and temperature including cold to hot variation. There shall be no radio or television interference. Line voltage wave form shall be as true as possible with a total harmonic distortion not exceeding 3% on 3-Ph load.
- The excitation system and engine governor should be such that the alternator is capable of starting up induction motors having a starting KVA of not less than 1.8 times the alternator rated KVA. Manufacturer should indicate the voltage dip and duration under such conditions as required under equipment data.
- The neutral of each generating set shall be earthed solidly to ground with facility for isolation.

v) Automatic Mains Failure (AMF) operation

- The AMF panel shall be capable of starting the DG set automatically in the event of unhealthy conditions of the main power supply including power (mains) failure, single phasing or voltage going below 85% or 360 V at the bus bar of MDB or Essential power panel and shall switchover essential load from the main supply to DG set. The voltage on both the incoming mains shall be continuously monitored through adjustable voltage monitor on all the three phases. AMF shall be of at least IP 54.
- To avoid unnecessary frequent starting and stopping of the DG set caused by momentary unhealthy condition, an adjustable timer with setting 1 to 10 seconds shall be incorporated in the control system. The DG set shall start automatically within 30 seconds of main supply failure. It shall be idle for three minutes after making change over from DG set supply to main supply, to ensure that the main supply has stabilized. The manufacturer shall specify the adjustable range in both the cases.
- The DG set Contactor or breakers shall have 4 poles (3 phase and 1 neutral) electrically interlocked. The interlock logic will be got approved from NMRC and necessary interfacing with E&M contractor will be done by DG set contractor.
- The AMF logic must be achieved through a PLC or microprocessor-based circuitry to monitor engine controls with an Online mimic giving status of Engine running, voltage built up & other status as required & specified. AMF shall have 3 modes of operations viz. automatic, manual & test. The set shall be capable of starting and taking up the load within the time stipulated in the data sheets.
- The sequence of Automatic Mains Failure (AMF) operation shall be as follows:

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- Upon main power failure, the generator shall receive 3 kick-starts and the generator breaker shall close only after building up of requisite voltage.
- Hold the Mains Contactor or Breaker open.
- On restoration of power, AMF logic should make change over from DG set to main supply and trip the engine after a present time delay.
- The AMF Panel should therefore comprise:
- 4 Pole MCCBs, contactor of adequate rating to be electrically and mechanically interlocked.
- Battery charger with normal and trickle charging facility and an isolating switch. Over load and E / F protection for the generator set.
- For DG sets of UG station, outgoing breakers as per BOQ shall be provided for UPS panels and Fire Fighting Panel.
- AMF panel shall have Ethernet communication port for BMS system for providing the controlling and monitoring the parameters.

w) PROTECTION / ANNUNCIATION

- Protection and annunciation system conforming to latest standards like BS / IEC or IS with soft control and touch resets shall be designed and provided comprising of following but not limited to: -
- Overload and short circuit trip for main in-comer
- Overload and short circuit trip for the DG set
- Over and under voltage protection
- Over and under frequency protection
- High temperature for cooling water trip
- Alarm in case the DG set is not run for one week at a stretch.
- Earth fault
- Loss of sensing
- Low battery voltage
- Fault indication alarm through suitably designed Annunciator with inbuilt hooter
- High Temperature in Canopy / DG room
- Over speeds Trip
- Field overload
- Over current
- Any other alarm as specified.
- METERS AND INDICATORS AS FOLLOWS
- Meter Generator as given in Specifications and data sheets
- Battery Charger

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- 0 - 24V Voltmeter
- 0 - 5A Ammeter for charge
- 0 - 75mA ammeter for trickle charge
- Indication and Alarm annunciation
- Engine side as given in Specifications and data sheets
- Auto Manual Selector Switch

Start-Stop Reset	Buttons
Alarm Reset	Buttons
Lamp testing	Buttons

x) Battery System

- There shall be a 12/24V lead acid stationary battery with an AH capacity suitable for 10 (ten) cranking attempts of (10 seconds each) (suitable design to be submitted by the firm for the given capacity of DG set and to be got approved from NMRC) plus all indicating lamps and alarm before the cell voltage goes down by 1.8V. Battery shall be complete with necessary angle iron stand and multi strand flexible copper leads. The battery charger in the AMF Panel shall be capable of floating the battery with quick and trickle charging facility to maintain a cell voltage of 2 Volts. The battery stand and the canopy failure should be provided with suitable safeguards against battery Acid.

y) Control System

- The control system shall work on suitably supplied DC / AC operated system with provision of alarm and operation status available on auxiliary terminal board so as to enable it to extend alarm and operation status to operation control centre & station control centre. The metering system shall be based on digital indication with status on auxiliary contacts. The control system and metering panel shall provide for the following:
- Metering / Indication
- Voltmeter
- Phase sequence indication
- Ammeter
- KW meter, kWh meter, Frequency, Power factor meter or Multifunction Meter
- Battery Voltmeter
- Common Fault Alarm Signal
- ON, OFF, TRIP for all incoming and outgoing feeders.
- Counters
- Hours Run Counter
- Controls

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- Emergency Stop Button
- Run / Off-Reset / Auto Control Switch
- Lamp Test / Reset Push Button
- 3 Attempt Start Timer
- Terminals for Remote / Emergency Stop
- Interface to Remote Annunciator
- Voltmeter Phase Selector Switch,
- Ammeter Selector Switch

Note: For Metering, Indication and Control, above or equivalent system shall be designed & provided as per the latest industrial standards, after getting explicit approval of the Employer.

z) FINISH

- The generator shall be thoroughly cleaned and primed with two coats of industrial primer and finished in two coats of industrial high gloss paint.

aa) Testing & Commissioning

- The complete Diesel generator set shall be thoroughly checked for correct operation and load tested in supplier works before dispatch. All fluid seals, faults, control functions and site load conditions shall be simulated, checked, and proved.
- After installation DG set shall be tested and the specific fuel oil consumption will be checked. The values of the oil consumption noted at the time of proto type testing will be verified at site. On the successful commissioning DG set shall be run for a minimum period of 30 minutes continuously on no load. On satisfactory completion of the no-load run the set shall be run for a period of 6.5 hours at 100% full load and followed by 60 minutes operation at 10% overload. All consumables including fuel, lubricating oil and load banks required for commissioning the set shall be supplied by the contractor. Test readings together with an hourly log of the running test shall be furnished.
- The trial shall be conducted in the presence of the Employer Representative and the test results shall be recorded in an approved format. Any abnormal condition occurring during trial run of the DG set shall also be recorded. Test results shall be recorded at 30 minutes intervals. All facilities, labour, instruments, materials, and consumables including fuel and lubricating oil required for the test shall be provided by the contractor at his cost.
- Tests proving the satisfactory performance of all operating gear, safety functions and controls shall be carried out.
- Contractor shall be required to carry out any further tests / trials that the NMRC Engineer-In charge may desire to satisfy themselves that the Generator Sets and Associated equipment fully comply with the conditions as set out in these Specifications. Co-ordination with EIG for inspection shall be the responsibility of contractor.
- DATA Sheet AMF PANEL

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Sector-29, Noida.**

1.	SYSTEM	415V 3 Ph 4W effectively earthed neutral system
2.	BUSBARS	Aluminum
3.	LOCATION & TYPE	Indoor cubicle dead front
4.	ENCLOSURE	IP 54 (IEC)
5.	Circuit Breaker Panels	
5.1	Usage	Generator Breaker
5.2	Number	1(One)
5.3	Type	MCCB / ACB
5.4	Pole	4P
5.5	Closing	With 12V / 24V DC
5.6	Opening	Closing Coil 12 / 24V DC shunt trip coil
5.7	Current rating (A)	as applicable
5.8	Breaking Capacity (KA)	As specified in BoQ
5.9	Meters	As Applicable
5.10	Kilowatt hour meter (kW hr)	1-3Ph 4 wire unbalanced load
	Voltmeter, Ammeter	0-500V as per rating of DG sets and with suitable rating CT's
	Power factor meter	Lag 0-1-0 lead (Digital type)
	Protection	
	O / C & EF Type	2# O / C & 1# REF (Restricted Earth Fault) IDMT 1.3 Sec. or static relay (Electric Numerical Relay)
	Setting range Auxiliary	OC: 50-200%, REF: 10-40%, Under Voltage Relay, Alarm Relay
	Instrument Transformers	
	CT's for measurement	Set of 3
	Burden Ratio	15 VA
	Class	CI-0.5
	CT's for Protection	As per the ratings of DG sets.

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	Burden Ratio Accuracy / Class CT Numbers	15VA 5P10 4+1 Neutral CT
	Phase indication lamp Sundry Fittings ON-OFF-TRIP LED Indicating lamps	1 No. for Each R-Y B 1 No. for Each for ON, OFF, Trip

bb) -Check schedule include following items:

- Lube oil
- Oil filter
- Fuel Filter
- By-pass filter
- Water Separator
- Air Filter
- Radiator Cleaning
- Any other test suggested by OEM

Note:

1. Vendor is required to read clearly and Load management panel / Sync. Panel shall be integrated with new DG set as mentioned above as (BOQ) well as installed DG set of 160 KVA KOEL make.
2. Vendor shall strictly follow the make of DG sets for equipment's and integration as specified above.

4.16UPS SYSTEM:

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- Specification as per BOQ.
- The UPS shall include a Rectifier, inverter, battery bank suitable for 30 minutes back up (Battery VAH capacity shall not be less than 1600 VAH per KVA of UPS rating per Hour backup time) on full load and Static Bypass switch along with provision for manual bypass, suitable isolation transformer for additional protection against neutral faults etc.
- UPS shall have inbuilt phase sequence correction. The UPS systems offered are to be of the latest technology with Digital Control Microprocessor based for reliable operation using Insulated Gate Bipolar Transistor (IGBT)'s both for the rectifier & inverter (3 Level) with PWM (Pulse Width Modulation).
- The operating efficiency of the UPS systems shall be >96% while operating on battery mode and delivering quality power to the 100% non-linear loads. Current total harmonic effect(ITHD) on the input grid shall be < 5% at 50 %load.
- Required battery racks and interconnecting copper conductor cables of suitable size and connectors and all required accessories are inclusive of the cost).
- The Specification shall in any case not specify standards which, in the Engineer's opinion, are less than or inferior to those described in the Technical Specifications contained in the Tender Documents.
- Contractor will have to develop strong service network and should have well qualified trained UPS and battery installation team for installation, testing and commissioning of UPS system.
- The UPS installation team should be well equipped with requisite tools and testing instruments to install and check the functionality & performance of the system.
- Any material which is of inferior quality and make are liable to be rejected out rightly without any prejudice. Decision of NMRC Engineer shall be final and binding in this regard.
- The location of service centre & store would be well notified by the contractor to NMRC and authorized representative of NMRC will have full authority to inspect service centre and the store for inspection of availability of required spares, consumables, tools and testing instruments. The testing instruments and measuring instruments should be calibrated.
- Contractor will have to maintain sufficient stock of all type of spares and consumables in stock to ensure smooth execution of work and work should not be hampered due to unavailability of materials.
- Any damage/breakage to the NMRC properties during the execution of works will be at the risk & cost of the contractor and in this regard, decisions of NMRC will be final & binding regarding amount of damage/breakage etc. the amount will be deducted from Contractor's bills.
- Engineer representative at site shall check the spare parts and related documents.

a) Initial Treatment

- Precautions to be taken:-
- Use safety wear such as gloves, shoes and eye protectors.

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- Always work with the battery ungrounded.
- Ensure the charger is turned off before making or breaking electrical connections between the battery and the load.
- Ensure that all connections are firmly tightened before the charger is switched on.
- Connect battery positive terminal to charger positive terminal and battery negative terminal to charger negative terminal.

Preparing electrical contacting surfaces

- Electrical contacting surfaces shall be free from dust, remove the hardware and clean off terminal surfaces with brass wire brush followed by dry cotton cloth to ensure lowest electrical contact resistance.
- Inter cell/ Inter module connection
- Assemble lead plated inter cell connectors/flexible copper cable in a module.
- Inter stack connections
- Assemble lead plated inter cell connectors/flexible copper cables between cell belonging to different stacks.

b) Connection integrity

- After connecting all the cells, check the open circuit voltage (OCV) of the system. Total system OCV should be equal to the sum of all the individual cell OCV's.

c) Technical Specifications

- These batteries conform to the concern standards as mentioned below:
- **IEC 60896-21** – Methods of test for VRLA stationary batteries.
- **IEC 60896-22** – Requirements for VRLA stationary batteries.
- **IS 15549:2004** (or latest revision) – Stationary Lead Acid Batteries, Valve Regulated Type.
- **IS 1651** (latest revision) – Stationary Cells and Batteries, Lead Acid Type (general requirements and testing, where applicable)

S.No.	Parameter	Requirement
1	Battery Type	Sealed Maintenance Free (SMF) VRLA Battery
2	Nominal Voltage	12 V DC
3	Rated Capacity	42 Ah at C10 rate
4	Boost Charge	2.40 V/Cell $\pm 1\%$ for 16 hours (14.4 V for 12 V battery)
5	Float Charge	2.27 V/Cell $\pm 1\%$ for 72 hours (13.62 V for 12 V battery)
6	Equalizing Charge Voltage	2.40–2.45 V/Cell, if permitted by manufacturer
7	Maximum Charging Current	0.25 C10 (10.5 A maximum)

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8	Recommended Charging Current	0.1–0.2 C10 (4.2–8.4 A)
9	Logic for Float to Boost Changeover	Automatic on battery discharge or when battery voltage falls below 12.0–12.2 V.
10	Logic for Boost to Float Changeover	Automatic after 16 hours of boost charging or when charging current reduces below 2–5% of rated capacity.
11	Low Voltage Disconnect (LVD)	10.5 V $\pm$ 0.2 V
12	High Voltage Disconnect (HVD)	15.0 V $\pm$ 0.2 V
13	Temperature Compensation	–3 mV/°C per cell from reference temperature of 27°C
14	Design Life	Minimum 10 years at 27°C

4.17 Earthing

Scope

- This section covers specifications for earthing systems comprising of earth electrodes, earth leads and loop earthing conductors.
- Separate earthing systems shall be provided for neutral earthing (of transformers and generators) and body earthing.
- All the non-current carrying metal parts of electrical installations including metal conduits, trunkings, cable armour, switchboards, DBs, light fittings and all other non-current carrying parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system.
- All three phase equipment shall have two separate and distinct body earths and single phase equipment shall have a single body earth.
- Separate earth leads of appropriate size shall be provided for.
 - a. Main switchboards
 - b. UPS system earth bus
 - c. Computer system earth bus
 - d. Telephone system earth bus
- Wherever so specified the earth lead shall be PVC sheathed to provide a clean earth.
- All metallic components and pipes within bathrooms, toilets and kitchens shall be connected to the earthing system by means of minimum 4 sq mm PVC insulated (green/yellow) copper conductor wires.

a) Standards

- The earthing system shall be carried out in conformity with the updated and current edition of IS 3043: 1987. In addition, relevant clauses of Indian Electricity Act 2003, India Electricity Rules 1956 and IEE Wiring Regulations (16th edition), as amended up-to-date, shall also be applicable.

b) Earth Electrodes

- Plate Earth Electrodes: The plate electrodes shall be of copper or GI as called for in the schedule of quantities. Minimum dimensions of the electrodes shall be 600 mm x 600 mm. Thickness of copper electrodes shall not be less than 3 mm and of GI electrodes not less than 6 mm.
- Pipe Earth Electrode: Pipe electrode shall be fabricated from a 40 mm dia 4500 mm long class B (medium) GI pipe. The GI pipe shall be tapered at the bottom and shall be provided with 12 mm dia holes drilled at every 75 mm.
- Galvanizing: Galvanizing of Earth Electrodes and Earthing Conductors shall conform to class – IV of IS 4736: 1986.

c) Earth Pit

- For plate electrodes: Plate electrode shall be buried in ground with its face vertical and top not less than 500 mm below ground level. The depth shall be increased if required so that permanently moist soil level is reached. The electrode shall be surrounded by alternate layers of charcoal and salt. A 20 mm dia class B GI pipe shall be provided for watering of the soil surrounding the electrode. The watering pipe shall have a watering funnel attachment with a wire mesh which shall be housed in the masonry inspection chamber. Main earth lead shall be securely terminated at the electrode by means of 2 bolts, nuts, checknuts and spring washers.
- The earth lead from the electrode up to the test link in masonry chamber shall be drawn in a suitable diameter class B GI pipe for mechanical protection. The GI pipe shall be provided with a coat of bituminous paint or bituminized jute wrapping for additional corrosion protection. The lead shall terminate in a test link provided in the inspection chamber to enable the earth electrode to be isolated for measuring earth resistance.
- For pipe electrodes: Pipe electrode shall be installed with its stop not less than 200 mm below ground level. The top shall be provided with a 40 mm x 20 mm reducer to fix watering funnel with mesh on top. The entire length of pipe below the inspection chamber shall be surrounded by alternate layers of charcoal and sand. Earth lead shall be provided as for plate electrode and shall be terminated using a though bolt, nuts, check nuts, spring washers etc.
- Masonry inspection chamber: The watering funnel arrangement as also earth test links shall be accessible and shall be housed in a 400 mm x 400 mm x 400 mm deep masonry inspection chamber having a lockable 10 mm thick cast iron hinged cover plate attached to a galvanized steel frame work embedded in the chamber walls. The hinged cover shall be suitably marked on top so that it is conspicuously identifiable as an earth station.
- Location of earth electrodes: Location of earth electrodes shall be based on following guidelines.
 - a. Minimum distance between any electrode and building structure shall be 1.5 m.
 - b. Minimum distance between two adjacent electrodes shall be 2 m.
 - c. Electrodes shall be located in accessible locations. Entrances, pavements and roads shall not be used for locating earth electrodes.

d) Earthing Conductor

- Main Earth Lead
- Interconnections between earth bus provided on the main switchboard inside the building for body earthing / neutral terminals of transformers / generators for neutral earthing and test link provided in the earth electrode inspection chamber shall be laid at minimum 300 mm depth below ground (minimum 600 mm below road crossings and paved pavements).
- For small installations where this lead is by means of GI / copper wire, the earth lead shall be drawn in a 15 mm dia class B GI pipe. For larger installations the GI pipe size shall be suitable for drawing the earth strip. GI pipe shall be provided with a coat of bituminous paint on the outside for minimizing corrosion. In locations where GI pipe protection cannot be provided, the earth conductor shall be wrapped with bituminous jute wrapping.

e) Earthing conductors

- Earthing conductors shall be connected to form the earthing network throughout the installation for earthing of all non-carrying metal parts as below. Materials and sizes shall be as per schedule of quantities.
 - a. Main earthing conductors shall be taken from the earth connections at the main switchboards to all other switchboards in the network.
 - b. Sub-mains earthing conductors shall run from the main switchboard to the sub distribution boards and to the final distribution boards.
 - c. Loop earthing conductors shall run from the distribution boards and shall be connected to any point on the main/sub-main earthing conductor, or its distribution board or to an earth leakage circuit breaker.
 - d. Conduiting systems and cable armouring shall be earthed at the ends adjacent to switchboards at which they originate, or otherwise at the commencement of the run by separate loop earthing conductors in effective electrical contact with cable armour, switch boxes, accessories, lighting fitting etc. Installation and Jointing of earthing conductors.
- Earthing conductors shall be provided in longest possible unbroken length to minimize jointing of the conductors in between terminations.
- Strip conductors shall be secured to the building walls etc. with appropriate size of saddles at intervals not exceeding 900 mm. The saddle shall be gun metal for copper and GI for GI strips.
- Copper earth strips shall be joined by butt welding /brazing or the mating surfaces shall be tinned, riveted and soldered.
- GI earth strips shall be joined by GI bolts, nuts, checknuts and spring washers of appropriate size.
- All exposed joints shall be provided with 2 coats of anti-corrosive paint.
- Wires shall be joined by means of lugs of appropriate size connected by bolts, nuts, checknuts and washers. If the connection is on a painted surface, the paint shall be

thoroughly removed and the metal exposed for making effective electrical contact. Lugs and bolts shall be of brass for copper wires and for GI wires.

f) Prohibited Connections

- Neutral conductor, sprinkler pipes, or pipes conveying gas, water, or inflammable liquid, structural steel work, metallic enclosures, metallic conduits and lighting protection system conductors shall not be used as a means of earthing an installation or even as a link in an earthing system.

g) Resistance To Earth

- No earth electrode shall have a greater ohmic resistance than 3 ohms as measured by an approved earth testing apparatus. In rocky soil the resistance may be up to 5 ohms.
- The electrical resistance measured between earth connection at the main switchboard and any other point on the completed installation shall be low enough to permit the passage of current necessary to operate circuit breakers, and shall not exceed 1 ohm.

h) Maintenance Free Earthing Electrode System/ Chemical Earthing

- In maintenance free earthing copper bonded earthing rod electrode shall be of minimum 14.35 mm in diameter and 3 meter length. The rod shall be placed in a 150 mm dia augured hole in the ground and then surrounded by ground enhancement material in either a dry form or premixed in a slurry. Once set, ground enhancement material becomes hard and as such holds positively to the rod as well as surrounding ground. Earth rod offered shall have passed the test required of BS7430/ ANSI/ UL467 and confirm to the adhesion of the copper coating to the steel core (Design feature that prevents the ingress of moisture and subsequently the integrity of the rod).
- Minimum 0.25 mm thickness of copper shall be deposited over the steel core as per BS 7430/ UL 467. Average life of the ground rod shall be 30 years in most soil.
- Ground enhancement material shall be as per IEEE-80 clause 14.5d with a resistivity of less than 0.12 ohm-meter. The ground enhancement material shall be permanent and not leach any chemicals into the ground.
- Minimum 30 Kg of ground enhancement material shall be provided for each earth electrode.
- Inspection chamber shall be of 400 x 500 mm with concrete base CI manhole cover with frame painted with bitumastic paint. 2 Nos. of 50 x 6 mm cross section & 300 mm long copper strip to be clamped with copper clad rod electrode have sufficient nos (But not less than 4 Nos.) of 10mm GI nuts & bolts for connection to the equipment / interconnection to the other pits to form equip-potential bonding.

i) Testing At Site

- Testing Of Earth Continuity Path: The earth continuity conductor including metal conduits and metallic envelopes of cable in all cases shall be tested for electric continuity and the electrical resistance of the same along with the earthing lead but excluding any added resistance of earth leakage circuit breaker measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation shall not exceed one ohm.

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- Earth Resistivity Test: Earth resistivity test shall be carried out in accordance with IS Code of Practice for earthing IS 3043.

5. Approved makes for Electrical, Fire-fighting and other works

S. No.	Details of Materials / Equipment	Manufacturer's Name
A	Medium Voltage Equipment	
1	Power Distribution Panel	Ambit, Neptune, Advance, C&S, L&T, Application, NMRC approved vendor or equivalent
2	Distribution Board	Siemens, Schneider, C&S, ABB, Legrand, NMRC approved vendor or equivalent
3	Moulded Case Circuit Breaker (MCCB)	Siemens, Schneider, C&S, ABB, L&T, Legrand, NMRC approved vendor or equivalent
4	Miniature Circuit Breakers	Siemens, Schneider, C&S, ABB, L&T, Legrand, NMRC approved vendor or equivalent
5	Residual Current Circuit Breaker (RCCB)	Siemens, Schneider, C&S, ABB, L&T, Legrand, NMRC approved vendor or equivalent
6	Power/Aux. Contactor	Siemens, Schneider, C&S, ABB, L&T, Legrand, NMRC approved vendor or equivalent
7	Control Transformer/Potential Transformers	Newtek Electricals, Schneider Electric, Siemens, ABB, CG Power, Eaton, Automatic Electric Ltd. (AEL), Trutech Products, BCH Electric, Lauritz Knudsen (L&T), NMRC approved vendor or equivalent
8	Current Transformer (Epoxy Cast Resin)	Newtek Electricals, Schneider Electric, Siemens, ABB, CG Pow-er, Eaton, Automatic Electric Ltd. (AEL), Trutech Products, BCH Electric, Lauritz Knudsen (L&T), NMRC approved vendor or equivalent
9	Protection Relay (Numeric Type)	ABB, Schneider, C&S Electric, L&T, Siemens or equivalent
10	Indicating Lamps LED type and Push Button	Schneider Electric, Siemens, ABB, Eaton, C&S Electric, Legrand, NMRC approved vendor or equivalent
11	Overload relays with built in Single Phase preventer	ABB, C&S Electric, Larsen & Toubro Mitsubishi Electrical Schneider Electric Siemens or equivalent
12	Electronic Digital Meters (A/V/PF/Hz/KW/KWH) with LED Display	Schneider Electric, Siemens, ABB, Socomec, Secure Meters, L&T Schneider Electric, , C&S Electric, or NMRC approved vendor or equivalent
13	Static Power Meter & Logger (SPML)With RS 485 port	Schneider Electric, Siemens, ABB, Socomec, Secure Meters, L&T Schneider Electric, , C&S Electric, or NMRC approved vendor or equivalent

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14	PVC insulated XLPE aluminum/copper conductor armoured MV Cables upto 1100 V grade	KEI Industries, Universal Cables, Havells, Gloster Cables, NMRC approved vendor , and equivalent
15	LT Jointing Kit / Termination	Birla-3M, Raychem, 3M, Cellpack, Brugg Cables, Cembre, Dowells, Denson, Elcon, EMC, NMRC approved vendor , and equivalent
16	Cable Glands Double Compression with earthing links	Dowells, stokes, HMI, Hex, Gripwell, EMC, Axis Electrical Components, Jainson, Braco, NMRC approved vendor , and equivalent
17	Bimetallic Cable Lug	Comet Cosmos, Dowells, stokes, HMI, Hex, Gripwell, EMC, Axis Electrical Components, Jainson, Braco, NMRC approved vendor , and equivalent
18	PVC insulated copper conductor stranded flexible wires (FRLS)	KEI Industries, Universal Cables, Havells, Gloster Cables, NMRC approved vendor , and equivalent
19	Metallic / GI Conduit (ISI approved)	AKG, BEC Conduits, RMCON, Jindal, NMRC approved vendor , and equivalent
20	PVC Conduit & Accessories (ISI approved)	AKG, BEC Conduits, RMCON, Jindal, NMRC approved vendor , and equivalent
21	Lead Coated Flexible GI Conduit	AKG, BEC Conduits, RMCON, Jindal, NMRC approved vendor , and equivalent
22	Switch & Socket	ABB, C&S, Schneider Electric, Legrand, Havells, NMRC approved vendor , and equivalent
23	Industrial Socket Splash Proof	ABB, C&S, Schneider Electric, Legrand, Hansel, Havells, NMRC approved vendor , and equivalent
24	Industrial Socket Metal Clad	ABB, C&S, Schneider Electric, Legrand, Hansel, Havells, NMRC approved vendor , and equivalent
25	Ceiling/wall Fan	Crompton, Orient, Havells, Bajaj, Usha, NMRC approved vendor , and equivalent
26	Lighting Fixture LED	Jaquar Lighting, Surya, Philips, Wipro Lighting, Panasonic, NMRC approved vendor , and eq
27	UPS	Riello, APC Schneider, Hitachi, Emerson Network Power ABB Socomec or equivalent
28	Battery	HBL, Exide, Amaron, Amara or equivalent
29	Lighting & Surge Voltage Protection	ABB, DEHN, Furse (ABB), JMV LPS Ltd., Yes, Varun Electrodes or equivalent

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30	230/12 V Step Down Transformer with BUILTIN Isolation Transformer	Schneider Electric, Siemens, ABB, Legrand, Eaton, Automatic Electric Ltd. (AEL), Servokon Systems, NMRC approved vendor , and eq
31	Energy saving Units	Schneider Electric, Siemens, ABB, C&S, Secure Meters, Socomec, Eaton, L&T and NMRC approved vendor , and equivalent
32	Exit Signage's	NMRC approved vendor , and equivalent
33	Cable tray	Rmcon, AKG, BEC, Advance, NMRC approved vendor , or equivalent
34	Raceway	Rmcon, AKG, BEC Advance, NMRC approved vendor , and equivalent
35	VRV/VRF	Mitsubishi Electric, Hitachi, oshiba, LG, and equivalent approved make.
36	Split /Tower/ Window AC	Daikin, Mitsubishi Electric, Hitachi, Carrier, LG Electronics, O General or equivalent approved make.
37	Grille / Diffuser / Dampers	Pineaire, Systemair Ruskin Titus Mapro or equivalent approved make.
38	Insulation	
39	Microban Closed Cell Elastomeric nitrile rubber (with protective coating of 7 mill black woven fiberglass as required)	Armacell (Armaflex) K-FLEX, Aeroflex, Superlon, ZOTEFOAMS (T-FIT), Huamei, Thermaflex, NMC Insulation, and equivalent approved make.
40	Acoustic insulation Nitrile Rubber with antimicrobial property	Armacell (Armaflex) K-FLEX, Aer-oflex, Superlon, ZOTEFOAMS (T-FIT), Huamei, Thermaflex, NMC Insulation, and equivalent approved make.
41	Copper Pipe & fittings	Mueller Streamline, Wieland, Mandev Tubes, Rajco Metal Industries, Mehta Tubes, Cerro Flow, Halcor, KME Germany, Lawton Tubes, and equivalent approved make.
42.	uPVC Drain Pipe	Astral Supreme AKG Supreme Industries, Prince Pipes, Ashirvad Pipes, Jain Irrigation, Captain Pipes, and equivalent approved make.
	Fire Hydrant and accessories	
43	Fire Alarm Equipments	As per installed make of FACP at site
44	Butterfly/Non Return Valve (CI)	Kirloskar, Sant, Exflame Audco/ Advance/ Kartar/ Zoloto and equivalent approved make.
45	Landing Valves (CI)	Omex/ Suprex/ Newage/ Getech/ Safeguard/ Padmini/Exflame/ and equivalent approved make.
46	Fire Brigade Inlets	Omex/ Suprex/ Newage/ Getch/ Safeguard/ Padmini/Exflame/ and equivalent approved make.
47	Hose Reel (Drum and Bracket)	Suprex/ Newage/ Getch/ Safeguard/Omex/Padmini/Exflame/ and equivalent approved make.

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48	Thermo Plastic Water Hose Textile Reinforced	Kesra/ Maitra (ISI Marked)
49	Gun Metal/Bronze Gate/Global/Check/Ball	Leader/ Exflame/ Zoloto/ Sant and equivalent approved make.
50	R.R.L Hose	Newage/ Getch/ Safeguard (ISI marked)/ Omex/ Padmini/ Superx/ Exflame/ Fire Guard and equivalent approved make.
51	Hose Couplings/Branch Pipe & Nozzels	Omex/ Exflame/Padmini/ Superx/ Safex/ Newage/ Minimax/Safeguard/ and equivalent approved make.
52	Pressure Switches	Indfoss/ Switzer/ Exflame/ system Sensor/ Plotter/ and equivalent approved make.
53	Sprinklers	UL approved
54	Sluice Valves	Zoloto/ Kartar/ Exflame/ Kirloskar/ and equivalent approved make.
55	Pressure Gauges	Danfoss/ Exflame/H-Guru/ Fiebig/ and equivalent approved make.
56	Deluge Valve	HD/ Exflame and equivalent approved make.
57	Expansion Bellows	Easy Flex / Exflame/ Resistoflex/ and equivalent approved make.
58	Installation control Valve	Newage/ HD Fire/ Padmini/ Exflame/ and equivalent approved make.
59	Portable Fire Extinguishers	Minimax/ Exflame/Ceasefire / Superex/ Fire Guard/ Kanex Fire,/ and equivalent approved make.
60	Water Meter	Kranti / Crescent/ and equivalent approved make.
61	DG	KOEL, Sudhir, Jackson and equivalent approved make but must be able to synchronize with existing DG set at site
62	MS pipe	Jindal Steel, APL Apollo, Tata Steel Tube and equivalent approved make.

NOTE:

The makes tabulated above are indicative and intended as a reference. Equivalent makes may be considered subject to compliance with the project specifications and approval at the sole discretion of the Engineer In charge (E/I).