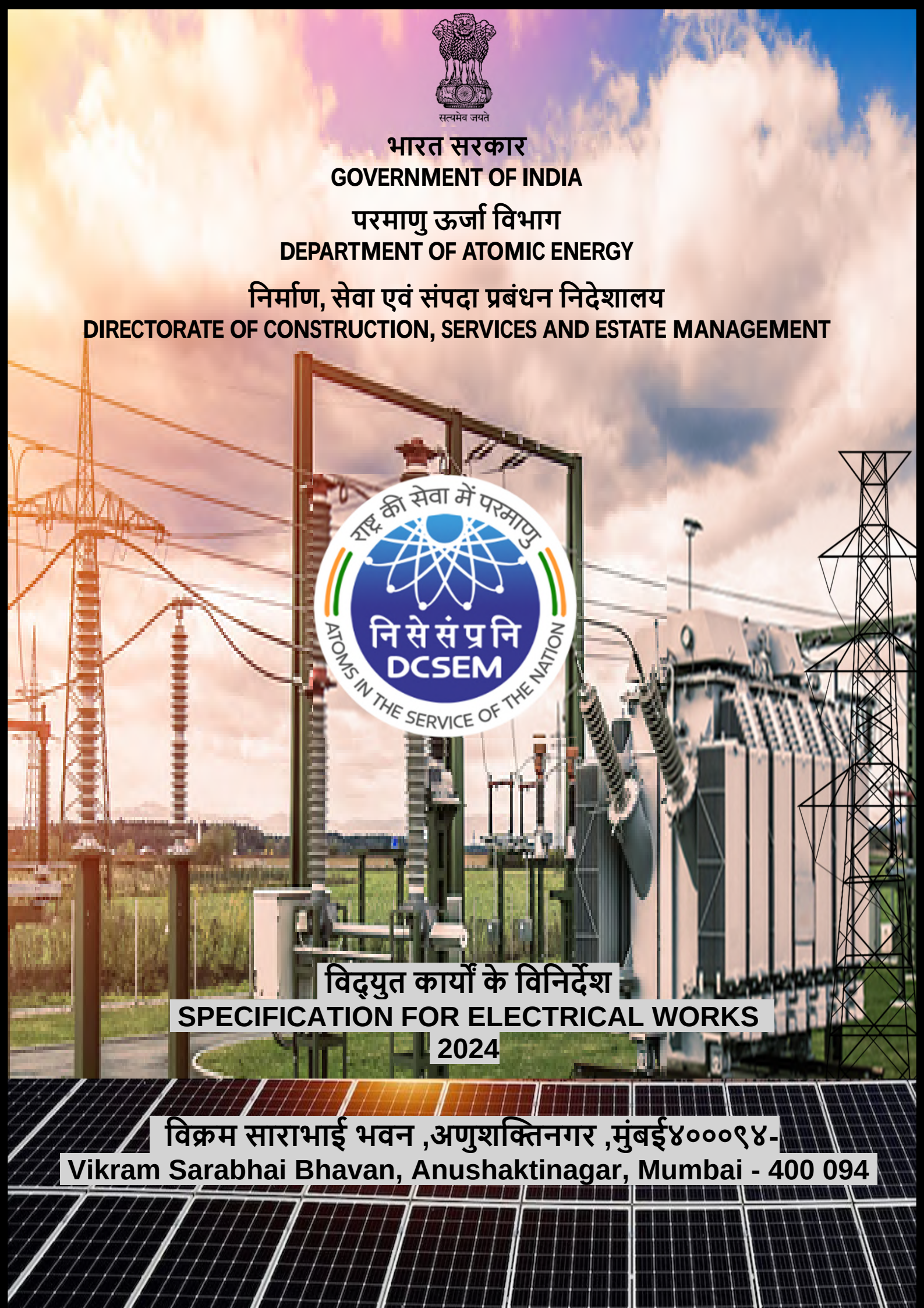

सत्यमेव जयते
भारत सरकार
GOVERNMENT OF INDIA
परमाणु ऊर्जा विभाग
DEPARTMENT OF ATOMIC ENERGY
निर्माण, सेवा एवं संपदा प्रबंधन निदेशालय
DIRECTORATE OF CONSTRUCTION, SERVICES AND ESTATE MANAGEMENT
राष्ट्र की सेवा में परमाणु
नि से सं प्र नि
DCSEM
ATOMS IN THE SERVICE OF THE NATION
विद्युत कार्यों के विनिर्देश
SPECIFICATION FOR ELECTRICAL WORKS
2024
विक्रम साराभाई भवन ,अणुशक्तिनगर ,मुंबई४०००९४-
Vikram Sarabhai Bhavan, Anushaktinagar, Mumbai - 400 094



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विद्युत कार्यों के विनिर्देश
SPECIFICATION FOR ELECTRICAL WORKS
2024

(भीतरी व बाहरी विद्युत कार्य)
(Internal & External Electrical Works)

विक्रम साराभाई भवन ,अणुशक्तिनगर ,मुंबई-४०००९४
Vikram Sarabhai Bhavan, Anushaktinagar, Mumbai - 400 094

PREFACE

1.) DCSEM Specifications for Electrical works 2024 are the revised edition of existing DCSEM Specifications for Electrical Works.

2.) DCSEM Specifications for Electrical works 2024 will replace existing DCSEM Specifications for Electrical works. The specifications of many items have been updated and improved by making them more comprehensive. Many new items using new materials and latest technology have also been added.

3.) The specifications for Electrical works-2024 incorporates following new items / features:

3.1) **List of Indian Standard Codes:** Modified by deleting IS codes discontinued and by adding relevant IS codes.

3.2) **Transformers:** Dry type transformer specifications added.

3.3) **Bus-Duct:** Specifications for compact sandwich type bus-duct / rising mains added.

3.4) **Sub-Station:** Compact sub-station specifications added.

3.5) **Cable trays:** Cable trays & cable management system updated by addition of wire mesh cable tray, floor runway etc.

3.6) **Earthing:** Maintenance free Earthing specifications added.

3.7) **Lightening Protection system**: Specifications for Lightening Protection system updated as per latest IS standards.

3.8) **Solar PV System**: Specifications for Grid tied & Standalone solar PV systems are introduced.

3.9) **Diesel Generator** specifications are updated.

3.10) **Elevators:** The specifications for Elevators (with machine-room & machine-room less) & Dumb Waiters are added.

3.11) Recommended / preferred manufacturer list for materials is modified by deleting names of discontinued makes and by incorporating of new makes.

4.) Due care has been taken to prepare DCSEM Specifications for Electrical works 2024 as correctly as possible. It is, however, possible that some errors might have crept in inadvertently. In case any error or omission is noticed, it may be brought to the notice of the **Head (ED), DCSEM, V. S. Bhavan, Anushaktinagar, Mumbai-400094.**

Suggestions for improvement are always welcome.

के. महापात्रा
K. MAHAPATRA

सत्यमेव जयते
भारत सरकार
Government of India

उत्कृष्ट वैज्ञानिक एवं निदेशक
निर्माण, सेवा और संपदा प्रबंध निदेशालय
Outstanding Scientist & Director
Directorate of Construction,
Services & Estate Management

FOREWORD

The DCSEM Specification for Electrical Works being published by DCSEM is very comprehensive and useful in execution of Electrical Works. This specification serves as guideline to Engineers and Contractors for specification of Materials, Execution of Works and Mode of Measurements.

The Specification for Electrical works has been revised with addition of specification of items as per requirements and current practices.

I wish to place on record, the effective involvement and the efforts of dedicated team of Electrical Engineers led by Shri Sameer Jadhav, Head (ED), Shri D.K. Bajpai, P.E. (Electrical) , Shri K.R. Reddy, Supdt. (ES) & all other Senior Engineers of this Directorate for their valuable inputs in preparing and finalising this Specifications for Electrical Works.

My special thanks to Shri D.Sengupta, Head (MD), Shri A.S.Yadav, Chief Engineer (ESG), Shri. A.K.Jana , Chief Engineer (C1/CQD) and Shri K.Shivaprakasha, Chief Engineer (C2) for their valuable suggestions from time to time.

I am sure that this Specification will be useful for Electrical Works to all concerned units engaged in Building Works in DAE, in general and DCSEM in particular.

(K. Mahapatra)

Place: Mumbai
Date: 29th February, 2024.

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DEPARTMENT OF ATOMIC ENERGY
DIRECTORATE OF CONSTRUCTION, SERVICES AND ESTATE MANAGEMENT
SPECIFICATION FOR ELECTRICAL WORKS: 2024

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Specifications for Electrical Works (General Notes)

i.) The detailed specifications given hereinafter are for the items of works described in the schedule of quantities and shall be guidance for proper execution of work to the required standards.

ii.) It may also be noted that the specifications are of generalized nature and these shall be read in conjunction with the description of item in schedule of quantities and drawings. The work also includes all minor details of construction which are obviously and fairly intended and which may not have been referred to in these documents but are essential for the entire completion in accordance with standard Engineering practice.

iii.) Unless specifically otherwise mentioned, all the applicable codes and standards published by the Bureau of Indian Standards and all other standards which may be published by them before the date of receipt of tenders, shall govern in all respects of design, workmanship, quality and properties of materials and methods of testing, method of measurements etc. Wherever any reference to any Indian Standard Specifications occurs in the documents relating to this contract, the same shall be inclusive of all amendments issued thereto or revisions thereof, if any, up to the date of receipt of tenders.

iv.) In case there is no I.S. specification for the particular work, such work shall be carried out in accordance with the general guidelines of manufacturer/specialized agency subject to full satisfaction and approval of the Engineer-in-Charge.

v.) The work shall be carried out in a manner complying in all respects with the requirements of relevant bye-laws of the Municipal Committee/Municipal Corporation/Development Authority/Improvement Trust under the jurisdiction of which the work is to be executed or as directed by the Engineer-in-Charge and, unless otherwise mentioned, nothing extra shall be paid on this account.

vi.) Samples of various materials, fittings etc. proposed to be incorporated in the work shall be submitted by the contractor for approval of the EIC before order for bulk supply is placed.

vii.) The contractor shall take instructions from the Engineer-in-Charge regarding collection and stacking of materials in any place. No excavated earth or building materials shall be stacked on areas where other buildings, roads, services, compound walls etc. are to be constructed.

viii.) The contractor shall maintain in perfect condition all works executed till the completion of the entire work awarded to him. Where phased delivery is contemplated, this provision shall apply to each phase.

ix.) The contractor shall give a performance test of the entire installation(s) as per standard specifications before the work is finally accepted and nothing extra whatsoever shall be payable to the contractor for the test.

x.) The contractor shall clear the site thoroughly of all scaffolding materials and rubbish etc. left out of his work and dress the site around the building to the satisfaction of the Engineer-in Charge before the work is considered as complete.

to the satisfaction of the Engineer-in Charge before the work is considered as complete.

xi.) Post construction inspection and testing: After completion of the work and during maintenance period liability of the contractor, the work shall also be subjected to 'Post construction inspection and testing'. In case the materials or articles incorporated in the work are found to be inferior, though the sample collected for the same might have been passed at the time of execution, it shall be the responsibility of the contractor to replace the same at his own cost, failing which the Department may rectify the same at the risk and cost of the contractor or Department may accept the work as sub-standard, and cost be adjusted from the outstanding security deposit, as per the terms and conditions of the contract for the work.

xii.) The Chief Engineer, DCSEM, shall be the sole deciding authority as to the meaning, interpretations and implications for various provisions of the specifications and his decision in writing shall be final and binding on all concerned.

xiii.) In case any difference or discrepancy between the specifications and the description in the schedule of quantities, the Bill of Quantitiesshall take precedence. In case of any difference or discrepancy between specifications and drawing, the specifications shall take precedence.

CHAPTER 1

TRANSFORMERS

OIL FILLED TRANSFORMERS

1.) SCOPE:

This Specification is intended for the design, manufacture, assembly, testing, inspection, performance guarantee and delivery to site, installation and commissioning of oil filled outdoor type Transformers complete assembly with accessories mounted and wired up for installation and operation at Substation. The Bidder shall furnish all the guaranteed technical particulars as listed in the specification.

This Specification shall be read in conjunction with **Bill of Quantities (BOQ**).

2.) STANDARDS & CODES:

Except where modified by these Specifications, all materials and equipment's shall conform to the requirements of the following standards (latest editions).

	Outdoor Type Oil Immersed Distribution Transformers Upto and Including 2 500 kVA, 33kV — Specification	:	IS 1180
	Bushings	:	IS/IEC 60137
	Transformer oil	:	IS 335
	Current transformer	:	IS 2705
	Fittings and accessories for power transformers	:	IS 3639
	Degree of protection for control gear	:	IS/IEC 60529
	Routine tests	:	IS 2026
	Buchholz relay	:	IS 3637
	Electrical insulation classified by thermal stability	:	IS 1271
	Specification for on-load tap changers	:	IS 8468
	Dimension for porcelain transformer bushings	:	IS 3347
	Installation & Maintenance of Transformer	:	IS:10028

3.) **CONSTRUCTIONAL FEATURES:**

3.1.) General:

All materials used shall be as per the specifications and in accordance with the specified Indian Standard and shall be new. Similar parts, particularly removable ones, shall be interchangeable.

Screws, studs, nuts and bolts shall be as per Indian Standards.

The design and manufacture of all electrical & mechanical equipment's shall be such that they can be transported and installed without any damage and give satisfactory operation under specified site conditions.

Nuts, bolts, pins used inside the transformers and tap changer compartments shall be locked.

Exposed parts shall not leave pockets where water can collect.

Internal design of transformer shall ensure that air is not trapped in any location. When such air pockets cannot be avoided, they shall be connected to pipe between Buchholz relay and tank. Suitable air release vents shall be provided.

Facility shall be provided for lubrication of bearings and mechanisms. Mechanisms shall be constructed of non-corrodible materials.

Materials. In contact with oil shall be such as not to contribute to the formation of acid in oil. All bolts and nuts shall be galvanized or cadmium coated.

3.2.) Core:

The magnetic circuit shall be of 'Core Type' construction. The core shall be built out of prime grade M4 or better, non-ageing low loss and high permeability, cold rolled grain oriented silicon steel laminations.

After being sheared, the laminations shall be treated to remove all burrs.

The finally assembled core shall be free from distortion. It shall be rigidly clamped to ensure adequate mechanical strength and to prevent vibrations during operations.

The core clamping structure shall be so designed to minimize eddy current loss.

The core shall be provided with lugs suitable for lifting the complete core and coil assembly.

The core and coil assembly shall be so fixed in the tank that shifting will not occur during transport or short-circuit.

All steel sections used for supporting the core shall be thoroughly sand blasted after cutting, drilling & welding.

Core and winding assembly shall be mounted on the bottom of the tank. It shall not be supported from tank cover.

Frame core clamps and core bolts shall be electrically insulated from the core. Class-F insulation shall be used for this purpose.

3.3.) Internal Earthing:

All internal metal parts of the transformer, with the exception of individual laminations, core bolts and their individual clamping plates shall be earthed. Core clamps and core bolts shall be insulated from the core by Class-F insulation unless other Class insulation is approved by the purchaser.

The top clamping structure shall be connected to the tank by a tinned copper strip. The bottom clamping structure shall be earthed by one or more of the following methods.

i. By connection through vertical tie-rods to the top structure.
ii. By direct metal to metal contact with the tank base.
iii. By a connection to the top structure on the same side of the core as the main earth connection to the tank.

The magnetic circuit shall be connected to the clamping structure at one point only, through a link placed in an accessible position beneath an inspection opening on the tank cover. The link shall be on the same side of the core as the main earth connection above.

When the magnetic circuit is sub-divided by oil ducts or insulated barriers above 0.25mm. thick, tinned copper strip bridging pieces shall be inserted to maintain electrical continuity between circuits.

Coil clamping rings of material at earth potential shall be connected to the adjacent core clamping structure on the same side as the main earth connection.

3.4.) Windings:

The coil and winding assembly shall be carried out in a dust free and humidity controlled atmosphere.

Windings shall be subjected to a shrinking and seasoning process, so that no further shrinkage occurs during service. Adjustable devices shall be provided for taking up possible shrinkage in service. HV winding shall be preferably continuous disc type and LV shall be spiral/helical type.

Coils shall be supported at frequent intervals by means of wedge type insulation spacers permanently secured in place and arranged to ensure proper oil circulation. To ensure permanent tightness of winding assembly the insulation spacers shall be dried and compressed at high pressure before use.

Windings shall not contain sharp bends which might damage the insulation or produce high dielectric stresses. No strip conductor wound on edge shall have width exceeding six times the thickness.

Materials used in the insulation and assembly of the windings shall be insoluble, non-catalytic and chemically inactive in the hot transformer oil and shall not be softened, unless otherwise affected under the operating conditions.

All threaded connections shall be locked. Leads from the windings to the terminal board and bushings shall be rigidly supported to prevent injury from vibration. Guide tubes shall be used where practicable.

Windings and connections shall be braced to withstand shocks during transport or short circuit.

The conductors shall be transposed at sufficient intervals in order to minimize eddy currents &. equalize the current and temperature distribution along the winding.

Winding conductor shall be of high conductivity annealed copper only.

Preferably, there shall not be any joint in the copper conductor used for making the coil. Joint shall not be there within drum and joints shall be provided only when essential.

All current carrying bolted connections shall be silver plated to a minimum thickness of 5 microns.

Measures shall be taken to distribute the lightning and switching surges uniformly along the winding.

Unless otherwise specified, uniform insulation to earth shall be provided for windings which are required to withstand highest system voltage. Winding insulation materials shall be Class-A.

Coil clamping rings shall be of steel or of a suitable insulating material built from flat lamination.

Permanent current carrying joints in the windings and loads shall be welded or brazed. Clamping bolts for current carrying parts inside oil shall be made of oil resistant material which shall not be affected by acidity in the oil. Steel bolts, if used, shall be suitably treated.

Terminals of all windings including neutral shall be brought out of the tank through bushings for external connections on the sides only and not from the top cover of the tank.

Pre-compressed press boards shall be used during coiling of the winding assembly.

3.5.) Tank:

The tank shall be made from good commercial grade low carbon steel. All seams, flanges, lifting lugs and other permanent parts attached to the tanks shall be welded, All joints which may have to be opened from time to time in the course of operation shall be of a design to permit them to be easily made oil tight in re-assembly. The tank should be free from distortion.

Tank shall be designed to permit lifting, by crane or jacks of the complete transformer assembly filled with oil. Suitable jacking pads and lifting arrangements should be provided outside the tank.

Tank shall be designed to withstand without permanent distortion the following conditions:

i. A pressure of 80kPA and full vacuum of 500 mm of Hg. for filling with oil by vacuum.
ii. Mechanical shocks during transport.

Suitable guides shall be provided in the tank for positioning the core and coil assembly.

Adequate space shall be provided at the bottom of the tank for collection of sediment.

The transformer top shall be provided with a detachable cover with a bolted flanged gasket joint. Suitable lifting lugs shall be provided for removing the cover.

The material used for gasket shall be PU or cork-neoprene or approved equivalent. Gasket joints for tank and manhole cover bushings and other bolted attachments shall be so designed that the gasket will not be exposed to the weather. Mechanical stops to prevent crushing shall be provided for compressible gaskets.

The transformer tank and its fitting shall be designed to withstand the pressure which will be encountered in normal operation and during abnormal conditions such as short circuit etc.

An inspection hole with matching cover shall be provided on the tank cover to facilitate inspection.

Tank top cover shall be provided with suitable slope to avoid stagnation of rain water.

Equalising pipe shall be provided between tank and oil filled disconnecting chamber with isolating valves.

Core and coil assembly shall be dried out under vacuum and oil in the transformer tank shall also be filled under vacuum condition.

Two nos. earthing studs shall be provided on base channel at diametrically opposite ends to terminate 2 nos. 50 X 6 mm copper strips.

Detachable cable boxes shall be provided on sides & on opposite faces of the tank and not on the front side of transformer movement. Location of conservator, marshalling box shall be such that MOG, plain oil level gauge, tap indicator, WTI, OTI are easily visible from the front gate side.

Degree of protection of transformer shall be IP-55.

3.6.) Base:

The transformer base shall be provided with flat bi-directional flanged wheels.

3.7.) Oil:

Transformer and associated oil filled equipments shall be supplied with first filling of oil plus 10% extra in non- returnable drums, the oil shall be EHV grade oil and shall conform to IS 335. No inhibitors shall be used in the oil. The make of oil shall be subject to purchaser's approval.

3.8.) Cable Boxes and Disconnection Chambers:

When connection is by cable (please refer specific requirements) disconnection chamber shall be provided for disconnecting and moving away the transformer without unsealing the cable, leaving the cable box or chamber behind on purchaser's external supports. The cable box and disconnecting chamber shall be air insulated fabricated out of sheet steel of adequate thickness and shall be of the phase segregated type. The cable box shall have standard facilities and body earth terminals.

When the connection is by bus duct (refer specific requirements) the 3 LV line terminals and 1 No. LV neutral terminal shall be brought out through an air insulated disconnecting chamber suitable for termination of 3ph. & neutral, sandwich type bus duct.

One additional LV neutral terminal shall be brought out through a weather proof porcelain bushing to facilitate connection of 50x6mm copper strip to station grounding system. Clamping arrangements midway above the floor level shall also be provided. An epoxy cast resin neutral CT having accuracy class PS and secondary current 1A shall be provided inside the LV termination box for REF protection. For ratio of NCT refer specific requirements.

Phase to phase and phase to ground clearance within the chamber shall be as per CBIP standards.

Cable box shall have adequate height for Raychem make cable termination, subject to approval by the purchaser. The MS gland plate shall be of 4 mm thick. The degree of protection of cable box shall be IP-55.

The HV & LV terminals shall be brought out from the side of the tank and not from the tank top cover. A cover for preventing water entry shall be provided on top of HV & LV boxes. Necessary bracket with flanges shall be welded for supporting the cable from bottom.

3.9.) Radiators & Accessories:

Unless otherwise approved, tank mounted radiators shall be of the detachable type with bolted flanged connections. The following accessories shall be provided for each radiator. Radiator sheet shall be min 1.2 mm thick.

i. Shut off valves (butterfly type) and blanking plates on transformer tank at each point of connection.
ii. Top and bottom shut off valves and blanking plates on each radiator.
iii. Lifting lugs.

iv. Top oil filling hole with cap.
v. Air release vent at top.
vi. Oil drain plug at bottom

Special care shall be taken to ensure that all flanged joints of the radiator are absolutely leak proof. Valves shall also be leak proof. Make of the radiators shall be subject to purchaser's approval. Radiators shall be cleaned by shot blasting and provided epoxy painting.

3.10.) Tap Changing Gear

The transformer shall be equipped with ON/OFF load Tap Changing Gear as mentioned in BOQ. The tapping range shall be as per BOQ.

3.11.) Painting:

The interior of all transformers tanks and other oil filled chambers and internal structural steel work shall be cleaned of all scale and dust by shot blasting unless otherwise approved. These surfaces shall be painted with not less than two coats of heat resistant oil insoluble and insulating varnish.

Steel surface exposed to the weather shall be thoroughly cleaned by shot blasting and applied a primary coat of zinc chromate. The second coat shall be weather resistant nature, preferably of distinct colour from the primer and finish coats. The final coat shall be of glossy, oil and weather resisting non-fading paint **epoxy based shade 631 as per IS-5.** If felt necessary additional coat of enamel based paint may be given to entire assembly including radiators, conservators etc.

All exposed bolts, nuts and washer shall be of galvanized steel unless otherwise approved.

Metal parts not accessible for painting shall be made of corrosion resistant material, machine finished and bright surface shall be coated with suitable compound & wrapped.

Interior surface of mechanism chambers and kiosks shall receive three coats of paint, proper cleaning. The final coat shall be of light coloured anti-condensation paint

3.12.) Marshalling Box:

The marshalling box shall be rugged and of welded construction fabricated out of sheet steel having thickness of 2.5 mm. or more, provided with water tight hinged doors with padlock arrangement, neoprene gasket all around door to make enclosure water and dust proof (IP-55). The sheet metal treatment shall be similar to external surface of the tank.

The marshalling box shall be mounted on the tank. Necessary angles with holes shall be accordingly welded on the tank for bolting the marshalling box on the

tank. Location of marshalling box shall be such that WTI/OTI is easily visible from the front.

3.13.) Space heaters:

Strip type space heaters of adequate capacity shall be provided inside each marshalling box to prevent moisture condensation. Space heaters shall be rated for 240V, 1 phase 50 Hz supply. Heaters shall be complete with rotary type 'ON-OFF' switch, MCB on phase, link on the neutral and a thermostat to control switching of the heater.

3.14.) Lighting and socket:

A suitable lamp to light the inside of cabinet along with MCB/Fuse should be provided. A 10 A metal clad 240V 2 pin and earth socket outlet with controlling switch .and MCB should be provided inside the cabinet.

3.15.) Cable glands:

Suitably rated cable glands shall be provided at the bottom of the cabinet to receive purchaser's control and power cables. The number and size of cables will be intimated afterwards. Un-drilled detachable gland plate to be provided. The gland plate shall be non-magnetic type (Aluminium 3 mm thick).

3.16.) Wiring:

Marshalling box shall be supplied completely wired, ready for purchaser's external connections at the terminal blocks. All wirings shall be carried out with 1100 V grade PVC insulated stranded conductors. Power circuits if any shall be wired with stranded copper conductors of adequate sizes to suit the rated current. The minimum size shall be 2.5 sq.mm. Control, alarm and indication circuits, shall be wired with stranded copper conductor of sizes not smaller than 1.5 sq. mm. CT circuits shall be wired with stranded copper conductor of size not smaller than 4 sq.mm. For control, alarm and indication circuits, wires shall be of different colours for easy identification.

Engraved core identification ferrules marked to correspond with the wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wires and shall not fall off when the wire is removed. Spare auxiliary contacts of all relays etc. shall be wired to terminal blocks using solder-less crimping type of tinned lugs. Insulated sleeves shall be provided at all the wire terminations. Wiring shall be neatly bunched and cleated without affecting access to equipment mounted within the box.

1100V grade terminal blocks complete with terminal studs, washers, nuts and lock nuts and identification strips shall be used. Terminals for power connections shall be adequately rated for the circuit current and the rating of other terminal blocks for control indication etc. shall not be less than 15A. Terminal blocks for purchaser's control cables shall be of following sizes:

i. Potential and control circuits: Two of 1.5 sq.mm. stranded copper conductor

ii.

iii. Power circuits : Two of 2.5 sq.mm stranded copper conductors.

iv. CT circuits : Two of 4 sq.mm stranded copper conductors.

Terminal blocks shall be numbered for identification and grouped according to function. Terminal blocks for CT secondary leads shall be provided with short circuiting & Earthing facilities. Location of terminal blocks and clearances shall be subject to purchaser's approval.

Control wiring for trip and alarm circuit shall be carried out on separate terminal blocks. Two spare terminals shall be left blank between any two strip connections so as to keep a minimum of 25 mm. gap.

A minimum of 20% spare terminals shall be provided for control wiring.

All alarm and control devices shall be ungrounded.

A ground bus of 30 x 6mm. copper shall be provided on one side along the height of the control cabinet for connection to circuits which require grounding.

3.17.) FITTINGS AND ACCESSORIES:

List of fittings and accessories:

All oil immersed transformers shall be provided but need not be limited to the following fittings and accessories:

i. Inspection cover.
ii. Rating plate.
iii. Terminal marking plate
iv. Two Earthing terminals.
v. Lifting lugs.
vi. Drain valve with plug or cover plate.
vii. Top filter valve and bottom filter valve.
viii. Oil sampling valve.
ix. De-hydrating breather.
x. Oil filling hole and cap.
xi. Conservator.
xii. Conservator drain valve with plug.
xiii. Valve between the gas and oil actuated relay and conservator.
xiv. Air release device.
xv. Jacking lugs.
xvi. Explosion vent.

xvii. Magnetic oil level gauge with low level alarm contact. (150 mm dia, dial type).
xviii. Plain oil level gauge with low level marking.
xix. Marshalling Box.
xx. Radiators with valves.
xxi. Shut off valves on transformer tank at each point of connection.
xxii. Top & bottom shut off valve on each radiator.

3.18.) Dial type thermometer:

All transformer shall be provided with a 150 mm. dia, dial type thermometer for top oil temperature indication. The thermometer shall have adjustable, electrically independent ungrounded alarm and trip contacts maximum reading pointer & resetting device. This shall be housed in marshalling box.

3.19.) Winding Temperature Indication:

Winding temperature indicator of 150 mm. dia. with adjustable ungrounded electrically independent alarm and trip contacts shall be provided. The winding temperature indicator shall be responsive to and shall indicate the hot spot temperature of the winding. Temperature detecting equipment shall consist of a heating coil, a resistance coil and a current transformer all wired and mounted inside the transformer tank.

3.20.) Gas and oil actuated relay (Buchholz relay):

A double float type Buchholz relay with isolating valves on both sides and as per IS: 3637 shall be provided on each transformer. All gas evolved in the transformer shall collect in this relay. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation. A copper tube shall be connected from the gas collector to a valve located about 1.25 M above ground level to facilitate sampling with the transformer in service. The device shall be provided with two electrically independent ungrounded contacts, one for alarm on gas accumulation and the other for tripping on sudden rise of pressure.

A separate Buchholz as described above shall be provided for OLTC chamber with underground electrically independent trip contacts.

3.21.) Valves: (Consolidated list)

The following valves and accessories shall be provided. These have been already covered under different paragraphs.

i. Conservator drain valve with plug.
ii. Two (2) valves for the gas and oil actuated relay.
iii. c) One (1) top filter valve with blanking plate.
iv. One (1) bottom filter valve with blanking plate.
v. One (1) oil sampling valve with plug.
vi. One (1) oil drain valve with plug.

vii. Radiator valves (shut off valves on transformer tank and on each radiator)

viii. Equalising pipe isolating valves.

Note:

Graphite or other (conducting) material that could be injurious to oil shall not be used in valve stem packing.

3.22.) Location of Fittings /Terminals:

The relative positions of fittings and terminals shall be approved by the purchaser.

3.23.) Under Carriage:

The transformer shall be equipped with four sets of bi- directional flanged wheels/plain type rollers. The wheels shall be provided with proper locking arrangement to facilitate the locking of transformer in its final position to prevent accidental movement of the unit.

3.24.) Ladder:

Suitable ladder shall be provided for transformer above 1.0 MVA rating.

3.25.) TESTS:

The transformer shall be demonstrated capable of performing satisfactorily up to supplier's maximum guarantee. The transformer shall be offered for inspection and testing at manufacturer's works. During the inspection the firm shall offer transformer for all routine, acceptance and type tests as indicated below. All the routine and type tests are indicated below, including repeated tests and inspection that may necessary owing to the failure to meet the tests specified, shall be made at supplier's expense. If transformer fails to pass the tests specified, purchaser shall have option to reject the unit. Additional tests shall be made to locate the failure and after reconstruction, testing shall be repeated to prove that the rebuilt transformer meets the specifications in all respects.

i. Routine Tests:

Before transportation, each transformer shall be subjected to routine factory tests (as per IS 1180 & IS 2026) & shall be witnessed by department engineer.

- Ratio on each tapping, polarity, angular displacement and phase displacement.
- No toad current and no load losses, at rated voltage & higher system voltage (+ 10%).
- Load losses

- Impedance voltage (to be measured at all tapings).
- Resistance of windings at principal and all tapings.
- Insulation resistance.
- Induced over-voltage with-stand (induced potential).
- Separate source voltage with-stand (applied potential).
- Vector group test.
- OLTC operation during OC & SC test.

ii. Type tests:

Temperature rise test for each rating of Transformer shall be carried out at OEM works.

Copies of Type Test Certificates for Impulse Voltage Test & Short Circuit Test carried on similar type & rating of Transformers shall be submitted for Purchasers approval.

iii. Special tests:

iv. Magnetic Balance test.

v. Supplementary tests:

High voltage withstand test on auxiliary wiring at 2 KV for one minute.

No load losses and exciting current shall be measured both at rated voltage, rated frequency and at 110% voltage.

vi. Tests on associated equipments:

All associated equipment like winding temperature indicating devices, dial type thermometers, Buchholz relays, tap changing gears, RTCC Panel, Automatic Voltage Regulator (AVR), cable boxes, bushings, neutral CT etc. covered in the offer shall be tested in accordance with relevant Indian Standards or other accepted standards and a copy of test certificate shall be furnished.

All tests except tests as above shall be performed in the presence of purchaser's representative. The supplier shall give 15 days advance notice of readiness for inspection of components, parts and /or before final assembly and tests so that purchaser's representative may witness such final and acceptance tests before shipment.

Tests shall be conducted in accordance with Indian Standards in effect at the time of testing. 4 sets of all test certificates and 6 sets of instruction manuals shall be submitted to the Purchaser.

vii. Site tests:

Following tests shall be carried out on each transformer at site;

- Ratio test on each tapping.
- Resistance of windings at principal and all tapings.
- Insulation resistance of the winding between HV to earth and HV to MV.
- Vector group test.
- Magnetic Balance test.
- Break down voltage of transformer oil.

3.26.) REJECTION:

Purchaser may reject any transformer if during tests or service any of the following conditions arise: -

i. Maximum total losses exceed figures indicated in the IS 1180 latest amendment.
ii. Oil or winding temperature rise exceeds the specified value during temperature rise test as per relevant IS.
iii. Transformer fails on power frequency voltage withstand test.

3.27.) INCLUSION:

The following item shall be deemed to be included in the bidder's scope of supply:

Interconnecting cables and cable accessories for connections between the marshalling box and all electrical measuring, monitoring and protective device mounted on the transformer. For this purpose, stranded copper conductor PVC insulated and armoured cables shall be used.

3.28.) DEVIATION:

No deviation with respect to specification requirements is acceptable. Deviation if any, shall be clearly spelt out by the Bidder referring the Clause No.

DRY TYPE TRANSFORMERS

1.) SCOPE:

The scope of work shall cover design, engineering, manufacturing & the supply of cast resin (encapsulated winding) dry type transformers suitable for indoor installation meeting the requirements specified in the Data Sheets.

2.) STANDARD & COMPLIANCE:

The following standards shall be applicable:

1.	Dry type Transformers	:	IS:2026(part-11)
2.	Testing of Transformers	:	IS: 2026
3.	Installation & Maintenance of Transformer	:	IS:10028

3.) CONSTRUCTION:

Transformer core shall be built up of low loss non-ageing grain oriented silicon steel insulated laminations. The core construction shall be such as to minimize the magnetizing current. All hardware used in the core assembly and construction shall be zinc passivated.

Transformer cooling shall be as specified in the data sheets and the temperature rise monitored through winding temperature indicator with alarm and trip contacts.

Winding shall have class `F' insulation. Inter-turn insulation of tapped windings shall be reinforced to obtain uniform stress distribution. The winding assembly shall be resin cast. Adequate ventilation ducts shall be provided between the hollow winding cylinders. The winding assembly shall be non-flammable and self-extinguishing with adequate mechanical strength against short circuit forces.

The windings shall be enclosed in CRCA sheet – 2mm thick enclosure. Class of enclosure shall be specified in the data sheets.

4.) FITTINGS:

Following additional fittings shall be provided for the transformer:

i. Lifting lugs.
ii. Inspection cover for the tap links.
iii. 4nos. Bidirectional flat rollers.
iv. 2nos. earthing terminals.
v. Space heater with thermostat in transformer enclosure.

vi. Scanner type Winding temperature indicator with 1no. Alarm & 1no.Trip contact and with 1no. RTD per limb.
vii. Marshalling box complete with wiring of accessories mounted on the transformer.

5.) **FACTORY TESTING:**

Transformers shall undergo following **routine tests** as per IS 11171 and shall form part of the test report to be submitted along with the transformer.

i. Measurement of winding resistance.
ii. Ratio & Polarity test.
iii. Measurement of No load loss & No load current.
iv. Measurement of load loss
v. Measurement of impedance test
vi. Induced over voltage test
vii. Vector group test
viii. Separate source voltage test

6.) **Rejection Criteria:**

i. Losses exceeds the maximum value as per latest ECBC/IS
ii. Impedance value beyond specified limit with tolerance
iii. Winding temperature rise exceeds the class F rating
iv. Failure of impulse test if conducted as per QAP
v. Failure of power frequency voltage withstand test as per agreed QAP
vi. Transformer is found not manufactured in accordance with agreed specification / QAP.

7.) **COMMISSIONING TESTS:**

The following tests shall be carried out prior to commissioning:

i. Insulation resistance of the winding between HV to earth and HV to MV.

ii. Winding resistance of all the windings on all tap positions.
iii. Voltage ratio test shall be carried out by applying low voltage on H.T. side and measuring the voltage between phases and phase and neutral on the L.T. side for every tap setting.

8.) **TESTS ON ASSOCIATED EQUIPMENT:**

i. All associated equipment like winding temperature indicating devices, temperature scanner, bushings, neutral CT etc. covered in the offer shall be tested in accordance with relevant Indian Standards or other accepted standards and a copy of test certificate shall be furnished.
ii. All tests except tests as above shall be performed in the presence of department's representative. The supplier shall give 15 days advance notice of readiness for inspection of components, parts and /or before

final assembly and tests so that department's representative may witness such final and acceptance tests before shipment.

iii. Tests shall be conducted in accordance with Indian Standards in effect at the time of testing. 4 sets of all test certificates and 6 sets of instruction manuals shall be submitted to the Department.

9.) **INCLUSION:**

Interconnecting cables and cable accessories for connections between the marshalling box and all electrical measuring, monitoring and protective device mounted on the transformer are in the scope of work. For this purpose, stranded copper conductor PVC /XLPE insulated and armoured cables shall be used.kkkkkkk\

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CHAPTER 2

UPS SYSTEM WITH BATTERY BACK UP

1.) Scope of Work:

Supply, installation, testing & Commissioning of UPS system with battery backup, Cabling, Earthing etc as per detailed BOQ.

2.) Reference Codes & Standards:

The UPS and all associated equipment and components shall be manufactured in accordance with the following applicable standards. The equipment shall comply with the requirements of latest revision of following standards issued by BIS (Bureau of Indian standards) unless otherwise specified.

- IS-1248 - Direct acting indicating analogue electrical measuring (Part 1, 2, 4, and 9) instruments and their accessories.
- IS/IEC 60529 - Degree of protection provided by enclosures for low voltage switchgear and control gear.
- IS-3700 - Essential ratings and characteristics of semi-conductor devices.
- IS-3715 - Letter Symbols of semi- conductor devices. (Part 1 to4)
- IS-12021 - Control transformers for switchgear and control Gear for voltages not exceeding 1000V AC
- IS-13314 - Solid state inverters run from storage batteries
- IS-13703 - Low voltage fuses for voltage not exceeding 1000V AC or 1500V DC
- IS- 13947 - Specification for low voltage switchgear and (Part-4/Sec-1)
- control gear
- IS- 1651 - Lead Acid Tubular Type Batteries
- IS 15549 - Stationary valve regulated lead acid batteries
- IS- 2026 Part 11 - Dry type transformers
- EN 50091
- IEC 62040
- IEC/EN 60146

3.) UPS Configuration:

UPS shall be true online double conversion type and shall comply with **the classification VFI SS 111 as per IEC 62040-3.**

The UPS shall be modular hot swappable rack mounted scalable array architecture/ conventional (as per BOQ). The bypass input to the UPS shall be derived from the Main primary input.

4.) **UPS System Components :**

The UPS shall contain fully rated input rectifier,boost converter, output inverter & battery charging circuits. The brief functional description of components are as follows:

a.) Fully microprocessor controlled IGBT rectifier:

The rectifier/charger is the solid-state equipment with controls, necessary to convert incoming AC power to regulated DC power for input to boost conveter/ inverter and for battery charging. The rectifier shall be with IGBT technology & shall give high power and fast switching, less drive power & small power losses, over current & over temperature protection, control power failure and short circuit protection etc.

Power semiconductors in the rectifier/charger shall be fused with fast-acting fuses, so that loss of any one-power semiconductor shall not cause cascading failures.

The rectifier/charger shall have an output filter to minimize ripple voltage into the battery. Ripple voltage to the battery shall not exceed 1% RMS. The filter shall be adequate to ensure that the DC output of the rectifier/charger will meet the input requirements of the inverter. The inverter shall be able to operate from the rectifier/charger with the battery disconnected.

In addition to supplying power for the inverter load, the rectifier/charger shall be capable of producing battery-charging current to recharge the battery. After the battery is recharged the rectifier/charger shall maintain the battery at full charge until the next emergency operation.

b.) Fully microprocessor controlled IGBT based Inverter :

The inverter is the solid-state equipment with controls, to convert DC power from the rectifier/charger or battery to regulated AC power, for supporting the critical load. The inverter shall be an IGBT based design capable of providing the specified AC output & shall give high power and fast switching, less drive power & small power losses, over current & over temperature protection, control power failure and short circuit protection etc.

The inverter shall be capable of supplying current and voltage for overloads exceeding 100% and up to 150% of full load current. A status indicator and audible alarm shall indicate overload operation. The UPS shall transfer the load to bypass when overload capacity is exceeded.

c.) Full capacity static switch at the output of the inverter & bypass path :

Static transfer switches and bypass circuits shall be provided as an integral part of the UPS. The static switches shall be rated to conduct full load current continuously and shall enable the critical load to be connected to the inverter output or bypass power source. The static transfer switch control

logic shall contain an automatic transfer control circuit that senses the status of the inverter logic signals, and operating and alarm conditions.

The transfer control logic shall automatically turn on the static transfer switch, transferring the critical AC load to the bypass source, after the transfer logic senses any of the following conditions:

i. Inverter overload capacity exceeded.
ii. Critical AC load over voltage or under-voltage
iii. UPS fault condition.

The transfer control logic shall inhibit automatic transfer of the critical load to the bypass source until of the following conditions are met by control logic of UPS:

i. Inverter/bypass voltage difference within pre-set limits
ii. Bypass frequency within limits
iii. Bypass in synchronization range with inverter output.

Retransfer of the critical AC load from the bypass source to the inverter output shall be automatically initiated unless inhibited by manual control. The transfer control logic shall inhibit an automatic retransfer of the critical load to the inverter until the following conditions are met by control logic of UPS:

i. Inverter/bypass voltage difference within pre-set limits
ii. Bypass frequency within limits
iii. Bypass in synchronization range with inverter output.
iv. Overload condition exists in excess of inverter full load rating / UPS fault condition present.

d.) Full capacity Circuit breaker for battery :

A battery circuit breaker shall be provided to isolate the battery from the UPS. This breaker together with battery circuit breaker controller board shall be mounted in separate enclosure of UPS frame or as per manufacturers standards. The battery breaker provides a manual disconnecting means, short circuit protection, and over-current protection for the battery system. When opened, there shall be no battery voltage in the UPS enclosure. The DC protection shall be ensured by a circuit breaker with under voltage trip coil to isolate the Battery Bank from UPS during fault at the either side of the DC bus. It shall provide protection against deep discharge of the batteries by automatically disconnecting battery bank from UPS.

e.) Full capacity Manual Bypass Switch :

A manually operated maintenance bypass isolator shall be incorporated into the UPS cabinet or as per manufacturer standard to directly connect the

critical load to the input AC power source, bypassing the rectifier/charger, inverter, and static transfer switch.

With the critical load powered from the maintenance bypass circuit, it shall be possible to check out the operation of the rectifier/charger, inverter, battery, and static transfer switch.

f.) Battery as per BOQ:

Batteries shall have a minimum life of 5 years. The inter connection between batteries shall be carried with appropriate size of copper cables.

g.) Isolation transformer shall be provided at load end as per BOQ.

5.) **Modes of Operation:**

The UPS system shall operate as a true on-line system in the following modes:

a.) Normal mode:

The critical server load is continuously powered by the UPS inverters. The rectifier/ chargers derives power from the mains AC power supply source converting this to DC power to supply the inverters, while simultaneously float charging the battery system. Power supplied by the UPS inverters is, to within close tolerances, at rated voltage and frequency.

b.) Emergency/ Battery mode:

Upon failure of the mains AC power supply source, the critical AC load is powered by the inverters which, without any switching, obtain power from the battery system. There shall be no interruption in power to the critical load upon failure or restoration of the mains AC power supply source.

c.) Recharge mode:

Upon restoration of the mains AC power supply source, power to the rectifier/ chargers initially is restricted by a gradual power walk-in. Following this relatively short power walk-in period, the rectifier/ chargers power the inverters and simultaneously recharge the battery. This shall be an automatic function.

d.) Bypass mode:

In the event of an inverter overload, which last longer than the specified time, an output short circuit or a fault on the inverter, the UPS shall transfer the load to bypass. There shall be two kinds of bypass modes. In the first

kind, the UPS shall be set to return to normal mode automatically when the load decreases. In the second kind, the UPS is set to return to normal mode only with a manual transfer. When the main UPS circuit fails or a severe fault occurs, the system will remain in the bypass mode. The system shall return to normal mode only with a manual reset after the fault is cleared.

e.) Maintenance bypass mode:

When the UPS has to undergo routine maintenance, the UPS shall be set to maintenance mode by switching ON the maintenance bypass circuit breaker. The load shall be powered from the maintenance bypass supply without interruption.

6.) **Technical Parameters:**

Sr. No.	**Parameters**	**Specifications**
A.	UPS Capacity	AS per BOQ
B.	No. of UPS & Configuration	1) True online double conversion UPS in standalone configuration & having modular hot swappable rack mounted scalable array architecture. 2) UPS capacity shall be configured with hot swappable modules as per manufacturer's standard. Space provision shall be available to scale modules in future.
C.	Classification of UPS as per IEC 62040-3	VFI SS 111
1.0	**Input :**	
1.1	Nominal Voltage	415V, 3 phase 4 wire
1.2	Input Voltage variation	+ 10% , -15%

1.3	Nominal Frequency	50 Hz
1.4	Input Frequency variation	+/- 10 %
1.5	Input Power factor	'> 0.97
1.6	Input Current	Shall be limited to 125% of system capacity.
2.0	**Battery :**	
2.1	Type of Batteries	AS per BOQ
2.2	Battery backup time	As per BOQ
2.3	Battery breaker enclosure with MCB/MCCB	To be provided in separate enclosure of UPS frame.
3.0	**Output :**	
3.1	Nominal Voltage	415V, 3 phase & neutral
3.2	Voltage regulation	+/- 1 %
3.3	Nominal frequency	50 Hz, +/- 0.05Hz
3.4	Frequency Slew rate	< 1 Hz/sec.
3.5	Load Power factor Compatibility	Lagging or leading >=0.9

3.6	Overload Capability	125% for 10 minutes. 150% for 1 minute.
4.0	**Environmental Condition :**	
4.1	Location	Indoor
4.2	Protection Degree	IP 20
4.3	Ambient temperature	$0\text{-}40^0$ C
4.4	Max. relative humidity	< 95%
4.5	Overall efficiency	min. 96%
5.0	**Additional UPS features desired, but not limited to following:**	
5.1	Battery Management function	The UPS shall have battery management functions including battery fault detection, backup time forecast & available battery life.
5.2	Soft Start function	The surge to the UPS unit from utility source shall be reduced by complete delay soft start function.
		The Power walk in (time required for UPS to take rated load at the time of starting) shall be 1 Sec. through 30 seconds.
5.3	Metering &	The UPS shall be provided with microprocessor based unit status display, metering & alarm for

	Alarm	convenient & reliable user operation. The list of such metering, alarm parameters shall be submitted.
5.4	BMS Connectivity	Each UPS shall have RS 485 port for BMS interface & RJ-45 for LAN connectivity over Ethernet on Modbus/SNMP protocol

7.) **UPS Construction:**

The UPS unit shall be housed in a free standing steel enclosure with key-lockable doors. The enclosure shall be fabricated with cold rolled sheet and structural steel for chassis, covers & partition sheets as per manufacturer standard. Hinged doors shall be provided at the front and back wherever required, with dust tight neoprene gaskets. The enclosure will be built to comply with IP20 when the doors are open. All the cable entries in the UPS enclosure shall be from top/bottom only**.**

The UPS cabinet shall be powder coated as per manufacturer's standard. The UPS shall be constructed of replaceable subassemblies.

Cooling of the UPS shall be forced-air. Low velocity fans shall be used to minimize audible noise output. Fan power shall be provided by the UPS output. Temperature will be monitored by thermal sensors.

8.) **Isolation Transformer as per BOQ:**

Isolation transformers are proposed at the load end in order to retain the neutral to earth voltage at desirable levels. The Isolation transformer allows use of harmonic rich non-linear loads while maintaining safe operating temperatures and gives superior transverse and common mode noise attenuation along with transient spike attenuation.**The transformer shall be rated for 'K' factor of 13 as per UL 1561 standard.**

Transformer shall be copper wound, multi-shielded, three phase delta connected input and three phase star connected output with neutral available for connection, 600 volt class, convection air cooled, dry type, continuous duty.

Terminals shall be provided for isolated three phase output conductors, neutral conductor and ground.

Cabinets shall be manufactured from MS CRCA steel with base sub-structure adequate for fork lifting.

The cabinet shall be powder coated as per manufacturers standard.

The nominal AC input voltage rating of the transformer shall be 415VAC, three phase with sufficient margin to sustain a constant input of +10% without saturation.

Frequency 50 Hz +/-3 %

Temperature - Transformers shall be required to operate without overheating in an ambient temperature range of -20 degrees Celsius to +50 degrees Celsius.

Humidity - Transformers shall operate in a relative humidity of 0 to 95% non-condensing.

The transformer shall have an efficiency more than 95%.

Audible noise - Maximum allowable noise level shall not exceed 50dBA when measured at one-meter distance.

Transformer shall have Input breaker for protection and isolation purpose with digital metering to monitor the parameters.

9.) **Testing:**

The routine & acceptance tests as per IEC 62040 shall be carried out on UPS, in manufacturers works, in presence of departmental representative. The following acceptance test shall be offered on UPS:

i. Interconnection Cable Check.
ii. Light load test.
iii. UPS Auxiliary device test.
iv. AC input failure test.
v. AC input return test.
vi. Transfer & re-transfer test.
vii. Line regulation test.
viii. Load regulation test.
ix. Harmonic component test.
x. UPS efficiency test.
xi. Overload capacity test.
xii. Unbalance load test.

The routine & acceptance testing of batteries, shall be separately carried out at battery manufacturers works & witnessed by departmental representative.

The routine & acceptance testing of dry type transformer as per IS 2026, shall be separately carried out at transformer manufacturers works & witnessed by departmental representative.

10.) **Drawings:**

The Bidder shall submit the General arrangement and single line diagram along with the offer and also during drawing approval stage.

The Bidder shall submit the following drawings for approval of the department after placement of the order but before taking up the fabrication work:

i. GA drawings indicating make of the components.
ii. Power & control schematic drawings.
iii. Layout of the battery bank in battery room.

4 copies of test certificates and 6 copies of descriptive literature, catalogues and instruction manual shall be submitted by the Bidder.

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CHAPTER 3

PACKAGE / COMPACT SUBSTATION

1.) CODE & STANDARDS:

1.1.) All equipment and material shall be designed manufactured and tested in accordance with the latest applicable IEC standards. The Package Substation Design must be as per IEC 61330/62271-202.

1.2.) The Package Sub-station (PSS) / Compact Sub-station (CSS) offered shall in general comply with the latest issues including amendments of the following standards.

Title	Standards
High Voltage/ Low Voltage Pre-Fabricated Substation	IEC:61330
Metal Enclosed High Voltage Switchgear	IEC62271
Low Voltage Switchgear and Control gear assemblies	IEC 60439
Power Transformers	IS 2026

2.) DESIGN CRITERIA

Package Sub-station consisting of HV Non-Extensible SF6 Ring Main Unit with breaker as protection + Transformer + Low Voltage Switchgear with all connection accessories, fitting & auxiliary equipment in an Enclosure to supply Low-voltage energy from high-voltage system as detailed in this specification. The complete unit shall be installed on a substation plinth (base) as Outdoor substation located at very congested places. HV isolators controls incoming-outgoing feeder cables of the HV distribution system. The SF6/VCB Circuit Breaker shall be used to control and isolate the distribution transformer. The transformer Low Voltage side shall be connected to Low Voltage switchgear. The connection cables shall be taken out from the Low Voltage switchgear.

The prefabricated-package substation shall be designed for

i. Compactness,
ii. faster installation,
iii. maintenance free operation,
iv. Safety for worker/operator & public.

The Switchgear and component thereof shall be capable of withstanding the mechanical and thermal stresses of short circuit listed in ratings and requirements clause without any damage or deterioration of the materials.

For continues operation at specified ratings temperature rise of the various switchgear components shall be limited to permissible values stipulated in the relevant standard and/ or this specification.

3.) **Service Conditions:**

The Package substation shall be suitable for continuous operation under the basic service conditions indicated below

- Ambient Temperature: 40 °C
- Relative Humidity upto 95%
- Altitude of Installation upto 1000m

The enclosure of High Voltage switchgear-control gear, Low Voltage switchgear-control gear & Transformer of the package substation shall be designed to be used under normal outdoor service condition as mentioned. The enclosure should take minimum space for the installation including the space required for approaching various doors & equipment inside.

4.) **SPECIFIC REQUIREMENT**

The main components of a prefabricated- package substation are Transformer, High voltage switchgear-control gear, Low-voltage switchgear-control gear and corresponding interconnections (cable, flexible, bus bars) & auxiliary equipment. The components shall be enclosed, by either common enclosure or by an assembly of enclosure. All the components shall comply with their relevant IS/IEC standards.

5.) **ENCLOSURE**

5.1.) Outdoor enclosure:

The outdoor enclosure shall be made of galvanized Sheet Steel tropicalized to local weather conditions. The metal base shall ensure rigidity for easy transport & installation. Substation will be used in outdoor application hence to prevent enclosure from rusting/corrosion, welding should be avoided.

The protection degree of the Enclosure shall be IP54 for LT & HT switchgear compartment & IP34 for Transformer compartment. Proper / adequate ventilation aperture shall be provided for natural ventilation by way of Louvers etc.To avoid

the entry of rodents in the transformer compartment, stainless steel mesh should be provided from inner side of louvers.

Considering the outdoor application of the substation the doors shall be provided with proper interlocking arrangement for safety of operator and to avoid corrosion door should have stainless steel hinges. Door should be provided with stoppers.

Interconnection between HT switchgear and transformer shall be using **min. 1CX 3 X 240 sq.mm Al. unarmoured XLPE cable** and between transformer and LT switchgear shall be using copper busbar.

5.2.) Internal Fault:

Failure within the package substation due to either a defect, an exceptional service condition or mal-operation may initiate an internal arc. Such an event may lead to the risk of injury, if persons are present. It is desirable that the highest practicable degree of protection to persons shall be provided. The Design shall be tested as per IEC61330/62271-202. **Type test report for internal arc test shall be submitted.**

5.3.) Covers & Doors:

Covers & doors are part of the enclosure. When they are closed, they shall provide the degree of protection specified for the enclosure. Ventilation openings shall be so arranged or shielded that same degree of protection as specified for enclosure is obtained. Additional wire mesh may be used with **proper Danger board for safety of the operator**.

All covers, doors or roof shall be provided with locking facility or it shall not be possible to open or remove them before doors used for normal operation have been opened. The doors shall open outward at an angle of at least 90° & be equipped with a device able to maintain them in an open position.

5.4.) Earthing:

All metallic components shall be earthed to a common Earthing point. It shall be terminated by an adequate terminal intended for connection to the earth system of the installation, by way of **min. 120 sq.mm flexible copper jumpers/strips & Lug arrangement**. The continuity of the earth system shall be ensured taking into account the thermal & mechanical stresses caused by the current it may have to carry. The components to be connected to the earth system shall include:

i. The enclosure of Package substation
ii. The enclosure of High voltage switchgear & control gear from the terminal provided for the purpose

iii. The metal screen & the high voltage cable earth conductor
iv. The transformer tank or metal frame of transformer
v. The frame &/or enclosure of low voltage switchgear

There shall be an arrangement for internal lighting activated by associated switch for HV, Transformer & LV compartments separately.

5.5.) Labels:

Labels for warning, manufacturer's operating instructions etc. shall be durable & clearly legible.

5.6.) Cleaning & Painting:

The paints shall be carefully selected to withstand tropical heat and rain. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.

5.7.) Thickness:

Enclosure frame shall be minimum 2mm thick GI/CRCA & Base Frame 4 mm.No part of enclosure should be less than 2mm.

i. **LT panel:** Please refer specifications of LT panel

ii. **RMU:** Please refer specifications of RMU

iii. **Transformer:** Please refer specifications of dry/oil type transformer as per BOQ.

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CHAPTER 4
HT Switchgear Panel

1.) SCOPE:

This specification is intended for the design, manufacture, assembly, testing, inspection, performance guarantee and delivery to site, installation and commissioning of 11/33 KV, 3 Phase, metal clad, indoor, Vacuum switchgears, draw out type, complete assembly with protective devices, accessories, mounted and wired up for installation and operation at the site. The bidder shall furnish all the guaranteed technical particulars as listed in the specification.

This specification shall be read in conjunction with Bill of Quantities(BOQ).

The Equipment covered by this Specification shall be complete in all respects. Any material or accessory which may not have been specifically mentioned, but is essential or necessary for satisfactory and trouble free operation and maintenance of the Equipment shall be furnished without any extra charge to the Department.

2.) STANDARDS AND CODES:

Unless otherwise specifically mentioned in the document, the design, manufacture, testing and performance of all equipment shall conform with latest edition of the following standards:

1	IS/IEC 62271	:	High-Voltage Switchgear and Control gear
2	IS 2705 (Parts I,II,III,IV)	:	Current transformers
3	IS 3156	:	Potential Transformer
4	IS/IEC 60137	:	Bushing for alternating voltage above 1000 Volts.
5	IS/IEC 60529	:	Degree of protection provided by enclosure

3.) TECHNICAL PARAMETERS:

3.1.) 36KV SWITCHGEAR PANEL

1	Existing system details	:	33KV, 3Ph, 50Hz, Neutral Solidly earthed
2	Description of equipment required along with all accessories specified	:	36KV, Vacuum C.B., horizontal draw out type indoor switch-gear panels with including all relays, meters, C.T's and other

			accessories as per bill of material.
3	Fault current rating	:	As per BOQ
4	Service Voltage	:	33 KV (±10%), 3 Ph.
5	Highest System Voltage	:	36KV
6	Frequency	:	50Hz (±3%).
7	Rated current rating of circuit breaker	:	As per BOQ
8	Rated continuous current rating of connected Main bus bars inside the cubicle**.**	:	As per BOQ
9	One minute power frequency withstand voltage	:	70 KV (rms)
10	Standard Impulse with stand voltage (1.2 x 50 micro Sec) KV peak	:	170KV (peak)
11	Rated RMS short time current	:	As per BOQ
12	Symmetrical interrupting capacity at 33 KV	:	As per BOQ
13	Making capacity	:	As per BOQ
14	Operating duty	:	0-0.3sec-CO-3 min-CO
15	Interrupting time	:	3 cycles max.
16	Closing time	:	4 cycles max.
17	Control	:	Local
18	Control Supply	:	110 V DC for closing, tripping, UV and indication and 240 volts, 50 Hz, single phase, A.C. for spring charging motor.
19	Auxiliary contacts	:	In addition to the auxiliary contacts required for normal operation and control of the circuit breaker, the breaker shall be provided with spare 6N/O +6N/C auxiliary contacts.
20	Compartmentalization of switch board panel	:	The switch gear panels shall be compartmentalized as under: i) C.B. Compartment ii) Bus-bar Compartment iii) Cable Termination Compartment iv) L.V. compartment

21	Pressure relief device	:	(i) C.B. Compartment (ii) Bus-bar Compartment (iii) Cable Compartment
22	Operation to be performed on C.B. with front door closed.	:	i) Opening (tripping) of CB mechanically & electrically and closing electrically both in the test & service position ii) Disconnection & connection of C.B. module (racking in & racking out operation) from service position to test / isolated position & vice-versa. iii) Manual spring charging.
23	Type of operation	:	Electrically operated through 110V DC with Manual switch facility. The breaker control switch shall be of ODS type having Trip neutral-close position spring return sequence locking mechanism. The breaker control switch shall be mounted on the front side of cubicle and located at a convenient height for easy operations.
24	Power Cable entry	:	Bottom
25	Circuit breaker operating mechanism	:	All the breakers shall be provided with motor operated, spring charged, stored energy operating mechanism. The spring charging motor should be suitable for a 240 volts AC (+10% & -20% variation) supply voltage with provision for easy manual charging of the spring in case of non-availability of the AC supply.
26	Breaker indication	:	
	Mechanical indication	:	Mechanical indication showing the “OPEN” and “CLOSE” position of circuit breaker and “SPRING CHARGED” & “SPRING DISCHARGED” shall be provided on breaker.
	Electrical indication on C.B. cubicle	:	Electrical indication showing “OPEN” “CLOSE” “AUTO TRIP” (Trip on fault), “Trip Circuit Healthy”, “SPRING CHARGED”, “service

			position" and Test position" of the C.B. shall be provided.
27	Auxiliary supply available	:	110 volts D.C. 240 volts, 50 Hz, AC
28	Bus-Bar	:	The bus bar shall be made of high conductivity, electrolytic copper and be designed to carry rated current continuously within the cubicle. Temp. of bus bars and bus bars connection within the cubicle when carrying rated current at rated frequency shall not exceed the temperature specified in relevant I.S. Tap off to outgoing also shall be for rated current.
29	Ground Bus	:	A copper ground bus having a minimum cross section 300 sq.mm. shall be provided for the switch gear bolted to the frame work to withstand mechanical stress corresponding to the momentary duty specified. The ground bus shall be provided with facility at two diametrically opposite points for connection to the substation grounding system.
30	Minimum width of the panel	:	As per manufacturers standard.
	GA and Layout of switchgear panel	:	The switchgear panel is for installation in the new sub-station.
31	Relays		Relays shall be numerical type with communication port RS 485, except auxiliary relays which shall be electromechanical type, and shall be selected to provide an integrated protection, continuous measurement and monitoring function. Relays with built in testing facilities and flush mounted at the front of the panel. Relays shall be rated for operation on 110V PT secondary voltage and 1A/5A CT secondary current. Aux supply voltage shall be 110V DC.
32	Meters and Selector Switch		Indicating meters (96X96 mm) shall be switchboard type, with 250-degree scale antiglare glass and

			accuracy class of ±1% on full scale. And /or Digital multifunction type with communication port RS 485 as per BOQ.
33	Current Transformers		Current Transformers shall be dual core cast resin dry type with accuracy class 0.5 for metering and 5P20 for relaying. Secondary shall be rated for 1A.
34	Voltage Transformers		Voltage Transformer shall be cast resin dry type with accuracy class 0.5. High voltage winding of transformer shall be protected by current limiting fuses.
35	SCADA Compatibility		HT Panel shall have provision for remote monitoring / control through central station unit through SCADA, in future. Therefore, following provisions shall be made for BMS compatibility: Breaker 'ON', 'OFF', 'Trip', Test / Service / isolation position, ready to close, Spring Charged to be provided in form of soft data points i.e. on RS-485 port with Modbus protocol / with potential free contacts. Suitable I/O points shall be provided for remote control of incomer & bus coupler breaker through SCADA screen. All numerical relays and multifunction meters shall be provided with for RS-485 port on Modbus communication protocol. All communication devices should be compatible and set on same baud rate.

3.2.) 12 KV SWITCHGEAR panel:

1	Existing system details	:	11KV, 3Ph, 50Hz, Neutral Solidly earthed
2	Description of equipment required along with all accessories specified	:	12KV,metal-clad horizontal isolation horizontal draw out type indoor switch-gear panels with Vacuum

			C.B. including all relays, meters, C.T's and other accessories as per bill of material.
3	Fault current rating	:	As per BOQ
4	Service Voltage	:	11KV (±10%), 3 Ph.
5	Highest System Voltage	:	12KV
6	Frequency	:	50Hz. (±3%)
7	Rated current rating of circuit breaker	:	As per BOQ
8	Rated continuous current rating of connected Main bus bars inside the cubicle.	:	As per BOQ
9	One minute power frequency withstand voltage	:	28 KV (RMS)
10	Standard Impulse with stand voltage (1.2 x 50 microSec) KV peak	:	75KV (peak)
11	Rated RMS short time current	:	As per BOQ
12	Symmetrical interrupting capacity at 12 KV	:	As per BOQ
13	Making capacity	:	As per BOQ
14	Operating duty	:	0-0.3S-CO-3 min-CO
15	Interrupting time	:	3 cycles max.
16	Closing time	:	4 cycles max.
17	Control	:	Local
18	Control Supply	:	110 V DC for closing, tripping and indication and 415/240 volts 50 Hz, three/single phase, A.C. for spring charging motor.
19	Auxiliary contacts	:	In addition to the auxiliary contacts required for normal operation and control of the circuit breaker, the breaker shall be provided with spare 6N/O +6N/C auxiliary contacts.
20	Compartmentalization of switch board panel	:	The switch gear panels shall be compartmentalized as under: i) C.B. Compartment ii) Bus-bar Compartment

			iii) Cable Termination Compartment iv) L.V.Compartment
21	Pressure relief device	:	(i) C.B. Compartment (ii) Bus-bar Compartment (iii) Cable Compartment
22	Operation to be performed on C.B. with front door closed.	:	i) Opening (tripping) of CB mechanically & electrically and closing electrically both in the test & service position ii) Disconnection & connection of C.B. module (racking in & racking out operation) from service position to test / isolated position & vice-versa. iii) Manual spring charging.
23	Type of operation	:	Electrically operated through 110V DC with Manual switch facility. The breaker control switch shall be of **ODS type having Trip neutral-close position spring return sequence locking mechanism**. The breaker control switch shall be mounted on the front side of cubicle and located at a convenient height for easy operations.
24	Power Cable entry	:	Bottom
25	Circuit breaker operating mechanism	:	All the breakers shall be provided with motor operated, spring charged, stored energy operating mechanism. The spring charging motor should be suitable for a 415/240 volts AC (+10% & -20% variation) supply voltage with provision for easy manual charging of the spring in case of non-availability of the AC supply.
26	Breaker Indication	:	
	Mechanical indication	:	Mechanical indication showing the “OPEN” and “CLOSE” position of circuit breaker and “SPRING CHARGED” & “SPRING DISCHARGED” shall be provided on breaker.
	Electrical indication on C.B. cubicle	:	Electrical indication showing “OPEN” “CLOSE” “AUTO TRIP” (Trip on fault), “Trip Circuit Healthy”, “SPRING CHARGED”, “service

			position" and Test position" of the C.B. shall be provided.
27	Auxiliary supply available	:	110 volts D.C. 415/240 volts, 50 Hz, AC
28	Bus-Bar	:	The bus bar shall be made of high conductivity, electrolytic copper and be designed to carry rated current continuously within the cubicle. Temp. of bus bars and bus bars connection within the cubicle when carrying rated current at rated frequency shall not exceed the temperature specified in relevant I.S. Tap off to outgoing also shall be for rated current.
29	Ground Bus	:	A copper ground bus having a minimum cross section 300 sq.mm. shall be provided for the switch gear bolted to the frame work to withstand mechanical stress corresponding to the momentary duty specified. The ground bus shall be provided with facility at two diametrically opposite points for connection to the substation grounding system.
30	Minimum width of the panel	:	As per manufacturers standard.
30.1	GA and Layout of switchgear panel	:	The switchgear panel is for installation in the new sub-stations
31	Relays		Relays shall be numerical type with communication port RS 485, except auxiliary relays which shall be electromechanical type, and shall be selected to provide an integrated protection, continuous measurement and monitoring function. Relays with built in testing facilities and flush mounted at the front of the panel. Relays shall be rated for operation on 110V PT secondary voltage and 1A/5A CT secondary current. Aux supply voltage shall be 110V DC.
32	Meters and Selector Switch		Indicating instruments (96X96 mm) shall be switchboard type, with 250-degree scale antiglare glass and

			accuracy class of ±1% on full scale. And /or Digital multifunction type with communication port RS 485 as per BOQ.
33	Current Transformers		Current Transformers shall be dual core cast resin dry type with accuracy class 0.5/1.0 for metering and 5P20 for relaying. Secondary shall be rated for 1A/5A as per BOQ.
34	Voltage Transformers		Voltage Transformer shall be cast resin dry type with accuracy class 0.5. High voltage winding of transformer shall be protected by current limiting fuses.
35	SCADA Compatibility		HT Panel shall have provision for remote monitoring / control through central station unit through SCADA, in future. Therefore, following provisions shall be made for BMS compatibility: Breaker 'ON', 'OFF', 'Trip', Test / Service / isolation position, ready to close, Spring Charged to be provided in form of soft data points i.e. on RS-485 port with Modbus protocol. Breaker Communication Module (BCM) to be provided for fetching breaker data. Suitable I/O points shall be provided for remote control of incomer & bus coupler breaker through SCADA screen. All numerical relays should be IEC 61850 compliant and multifunction meters shall be provided with for RS-485 port on Modbus communication protocol. All communication devices should be compatible and set on same baud rate.

CPRI test report for short circuit performance should be furnished for similar switchboard panel along with the bid.

4.) **CONSTRUCTIONAL FEATURES:**

4.1.) Switchgear Cubicle

Switchgears shall be of dust and vermin proof construction. The sheet steel used in the fabrication of the switchgear housing shall be cold rolled and leveled and finished smooth in such a manner that the complete structure shall be rigid, self-supporting free from vibration, twists and bends. Degree of protection class of cubicle enclosure shall be IP-4X.

All panels enclosing a switchgear unit, hinged doors, partitions and removable panels shall be provided with stiffeners to minimize vibration. The removable panels shall be furnished with fasteners and pressure release shall be of such dimensions that can be easily handled by one man. Pressure release vent openings shall be so designed that hot gases or other material cannot be discharged through them in a manner that can injure the operators.

Structures, buses and control wiring troughs shall be so designed and arranged as to make future extensions readily feasibly.

Access to the circuit breaker operating mechanism shall be through compartment doors, provided with hinge and key type locks/removable bolts so arranged that they are not exposed to any high voltage parts or circuit. All compartments door shall be so constructed that they will not seize in the event of fire within the switchgear. All switch gear component viz. circuit breakers, instruments, Transformers, wiring and Terminal blocks shall be tropicalised and fungus proof for use in hot and humid climate.

Panel shall be compartmentalized in various compartments i.e. circuit breaker compartment, LT compartment, bus-bar compartment and cable compartment. Each compartment shall be easily accessible for maintenance and inspection through removable panels provided on each switchgear cubicle. The different materials used in making of switchgear units such as bus insulation, bus support etc. shall not support combustion. The HT panel shall be extensible type on both sides. The cubicles shall be made up of MS CRCA sheet and the thickness of sheet-steel used for fabrication shall be manufacturer standard. The cubicles shall be powder coated with approved shade after due metal treatment as per relevant IS/IEC standard.

Safety shutter for bus bar and cable side of CB shall be identified by painting / stickers. Wire mesh/barrier shall be provided in cable compartment. Provision of cable entry shall be from bottom or as per approved GA/GTP drawing.

4.2.) Inter-Locks:

i. The breaker shall trip if the cover of the cable chamber is opened.

ii. It shall not be possible to engage or disengage the fixed & moving contact unless the breaker is in the open position.
iii. It shall also not be possible to operate the breaker unless it is in the fully latched in service position, test position.
iv. Shutter shall be provided with mechanism for automatic closing to prevent accidental contact with main stationary contacts or other live parts, when the breaker is drawn out. When the breaker is inserted back into its cubicle, it shall automatically raise the shutters, allowing the breaker to continue its travel until it finally engages the main stationary contacts.
v. It shall not possible to open the door of breaker compartment unless the breaker in fully drawn out condition.

4.3.) Circuit Breakers:

The circuit breaker shall have “Test” position in which control supply shall be maintained for testing the breaker for its operation through control switch and protective relays mounted on breaker panel. The metallic parts of the operating mechanism shall be made of corrosion resistant materials. Breaker contact arm shall be of copper and sliding female contact shall be spring loaded finger type. Suitable guides, slides and stops for proper positioning of the truck or trolley with the breaker shall be provided to ensure easy removal, replacement and positioning of the breaker.

4.4.) Operation, Control and Interlocks:

i. The circuit breaker shall be operated by an electrical spring charging mechanism. Spring operated mechanism shall be complete with motor, opening spring, closing spring and all necessary accessories to make the mechanism a complete operating unit. The mechanism shall be so designed as to enable a continuous sequence of circuit breaker opening and closing operation to be obtained by the control switch as long as power is available to the motor and at least one opening, closing and opening operation of the breaker on failure of power supply to the motor. The operation of the circuit breakers shall be independent of the motor. Charging of the spring shall occur automatically whenever it is discharged. The closing action of the circuit breaker shall charge the opening spring to keep it ready for tripping.
ii. Spring charging motor shall be suitable for operation from 240 Volts A.C., single phase supply. Unless otherwise specified and shall operate satisfactorily between 80% and 110% of the rated voltage. A limit switch shall isolate the motor from supply when the spring is fully charged. A ON/OFF switch shall be incorporated to disconnect the power supply to spring charging motor.
iii. Only one closing operation of the circuit breaker mechanism shall result from such closing operation of a manually operated initiating control devices, even though the breaker trips while the initiating control device

is being held in the closed position. There shall be no pumping action of the breaker. The anti-pumping feature shall be achieved electrically.

iv. The circuit breaker mechanism shall make one complete closing operation, once the closing control switch has been operated and the first device in the control scheme has responded, even though the control switch is replaced before the closing operation is completed. The closing coils and other auxiliary devices shall operate satisfactorily at all voltages between 80% and 110% of the rated voltage. The trip coils shall operate satisfactorily at all voltage between 80% and 110% of the rated voltage. When the circuit breaker is in the closed position, a closing operation of an initiating control device shall not result in further operation of the closing mechanism. All circuit breaker shall have trip free feature.

v. The wiring of the auxiliary switches to the terminal block shall be done through a plug and socket arrangement which would permit withdrawal of circuit breaker without necessitating, the removal of wires at the terminal points. Mimic of bus arrangement with painting shall be provided in the rear side of the switchgear panel. Name plates indicating functions shall be provided in LT chamber for MCB's, control switches, instruments etc.

vi. Interlocking shall be provided between incomer & bus coupler breaker such that it shall be possible to close only any two breakers at a time.

vii. Inter-tripping between upstream & downstream breakers of transformer feeder shall be provided.

4.5.) BUS BAR:

The buses within the cubicle shall be of high conductivity electrolytic copper. Bus-bar joint shall be silver plated and bolted in such a manner that initial contact pressure around the square headed high tensile bolts will remain substantially undiminished at all temperature up to rated full load temperature. Bus support and bushings shall be of epoxy resin cast type/ as per type tested design. The bus bars shall be sleeved / encapsulated type. All tap off bus bar connections (other than bolted portions), inside cable chamber and PT jumpers shall be sleeved / encapsulated type. Feeders tap off to outgoing shall be 1250 A rating or as per BOQ.

4.6.) GROUND BUS:

A copper ground bus having a minimum cross section of 300 sq.mm. shall be provided for the switchgear. All non-current carrying metal parts of the switch gear shall be permanently grounded through the ground bus. The grounding terminals shall be provided at two diametrically opposite points for connection to the Substation grounding system. Earthing of door (CB &LT) shall be through copper braid.

4.7.) WIRING AND TERMINAL BLOCKS:

Wiring shall be carried out with 1100 volts grade, PVC insulated wires comprising stranded copper conductors of the following minimum sizes:

i. Power circuit 230 Volts A.C. -1.5sq.mm copper
ii. Control and Potential circuits 110 volts D.C. and 110 V A.C - 1.5 sq.mm. copper
iii. Current Transformer circuits - 2.5 sq.mm. copper

Each panel shall have separate MCB for AC and DC control and branch MCBs on all closing, tripping, indication and PT circuits.PT circuit shall be wired to all outgoing panel with individual MCB.

Each terminal block shall be one piece moulded, barrier type, 1100 volts grade. Each terminal shall have only one wire terminated on it. For tap-offs, adjacent terminals with shorting strips shall be used. At least 10% spare terminals blocks shall be provided. Control wiring for different functions like trip circuits, alarms and indication circuits, closing circuits etc. will be clearly distinguished by colour coding by sleeves or other means. Identification ferrules will not be considered adequate for this purpose.

Wires shall be provided with numbered ferrules at both ends and drawings shall bear the same numbers. All auxiliary contacts whether spare or otherwise shall be wired and brought out to the terminal blocks. Current transformer secondary leads shall be brought on to the terminal blocks, where facility shall be provided for short circuiting and grounding of C.T. secondary. The terminal blocks shall be of disconnecting type links similar to CDTTS type of M/s. Connect well make with shorting and earthing facility. Wiring between major components within the switchgear cubicle shall be done generally through the terminal block. Wiring between terminals of various devices shall be ‘Point’ to ‘point’ (no wire splicing or TEE connections) with wires neatly trunked along the back of the panels, adequately supported to prevent sagging or damage due to vibration in transit and operation. Wire terminations shall be made with compression type connections which firmly grip the conductor. All control terminals shall be provided with transparent protective cover.

Proper labels and ferrule numbers should be affixed alongside various components and control wire. Concurrence of Dept. engineers shall be obtained on location, qty, etc.

4.8.) SPACE HEATER:

Switchgear enclosure shall be equipped with space heaters to maintain the internal temperature above the dew point to prevent moisture condensation within the enclosure. Space heater shall be rated 240 Volts, single phase, 50 Hz, A.C.

supply. The space heater shall be automatically controlled by thermostat with MCB.

4.9.) ILLUMINATION:

The interior of the cubicle shall be adequately illuminated with 9/11/15W, LED lamps provided with MCB at convenient location.

5.) **INSTRUMENT TRANSFORMERS:**

The instrument transformers of adequate VA burden considering instruments/relays connected as per BOQ shall be provided conforming to the requirement of the latest editions of the relevant Indian Standards.

5.1.) CURRENT TRANSFORMER:

The current transformer (C.T) shall be of the cast Epoxy resin dry type and shall have short circuit withstand capacity of the circuit breaker for 1 sec. CTs shall have polarity indelibly marked on each transformer. All C.T.s shall be grounded through a spare terminal on the terminal block. Accuracy class of current transformers shall be as per BOQ. Secondary shall be rated for 1A. For metering purpose ISF shall be < 5.

5.2.) POTENTIAL TRANSFORMER:

The PT shall be Epoxy resin cast single phase potential transformers. Rated Voltage factor shall be 1.2 continuous / 1.9 for 30 sec. Line PT shall be withdrawable type. PT circuit shall be wired to all outgoing panel with individual MCB. HV windings of voltage transformers shall be protected by current limiting fuse. Low voltage fuses sized to prevent overload shall be installed in all ungrounded secondary leads. Fuses shall be suitably located to permit easy replacement while switchgear is energized.

6.) **INSTRUMENTS, METERS AND RELAYS:**

6.1.) Indicating Meters:

Analog Indicating meters (96X96 mm) shall be switchboard type, with 250 degree scale antiglare glass and accuracy class of ±1% on full scale. These shall be flush mounted on the panel.
Meter selector switch shall be maintained contact, stay put type with knob handle. Ammeter & Voltmeter selector switches shall be four position type. Ammeter selector switch shall have make before break contacts, to prevent open circuiting of CT secondary.

6.2.) Relays:

Relays shall be multifunction numerical type with communication port RS 485, except auxiliary relays, which shall be electromechanical type and shall be selected to provide an integrated protection, continuous measurement and monitoring function.
Relays shall be with built in testing facilities and flush mounted at the front of the panel. Relays shall be rated for operation on 110V PT secondary voltage, 1A / 5A , as specified, CT secondary current and 110V DC Aux. Voltage. Features such as self-diagnosis, external testing, disturbance recording, sequence of event recording, time stamping shall be available with the relay.

6.3.) HT Static Energy Meter Only (For 36kv/12kV Switchgear Incomers) :

The Energy meter shall have accuracy class 0.5 with MODBUS communication protocol on RS 485 bus, PT secondary 110V, CT secondary 5A, backlit display, on site programmable CT/PT ratio, automatic MD reset on some specific date and time as well as manual MD reset with MD reset count, at least one period billing data with following data. i. Time and date, ii. Voltage, iii. Current, iv. Rising and maximum demand, v. instantaneous KW, KVA and KVAR, vi. KWH, vii. KVARH, viii. KVAH. The meters shall be manufactured in accordance with IS/IEC similar to swift Elite of M/s. Secure meters. The test terminal block for energy meter shall be completely wired up for CT/PT connection.

6.4.) ALARM AND ANNUNCIATION SYSTEM:

6/18 window Alarm and annunciation system (similar to Minilec make or equivalent) shall be solid state type duly wired up and installed on each switchgear panel. Annunciation shall be provided with test, accept & reset facility.
The annunciation panels (module) shall be supplied with associated wiring and 110 V DC Electronic type hooters and with 2 nos potential free contacts. The hooter shall be independent for each annunciator module installed on switchgear panels as indicated below. The window shall be marked as follows:

Incomer Feeder	Transformer feeders
O/C, E/F, Auto Trip, Trip Circuit Unhealthy, Numerical relay failure	S/C, O/C, E/F, REF, Auto Trip, Trip Circuit Unhealthy, Numerical relay failure, Buchholz Alarm, Buchholz Trip, Oil Temperature Alarm, Oil Temperature Trip, Winding temperature Alarm, Winding Temperature Trip, Low Oil Level Alarm, Oil surge relay Trip.

6.5.) CONTROL SWITCHES:

Control switches shall be of rotary type with position marking.

7.) **DRAWINGS:**

The design of layout and general arrangement of incomer, bus coupler and outgoing panels along with complete dimensions shall be submitted along with the offer.

After placing the order the bidder shall submit to Engineer in Charge for approval, four copies of which shall include but not limited to the following:

i. Complete assembly drawings of the switchgear showing plan, elevation and typical sectional view.
ii. Panel base plan showing locations of channel sills, foundation bolts and anchors, floor plans and openings.
iii. Single Line Diagram
iv. Complete wiring diagram including terminal wiring designations.
v. Schematic control diagram both AC and DC for breaker control, interlocks, relays, instruments and space heaters.
vi. Complete terminal block details, showing ferrule numbers wire destinations.
vii. Six(6) sets of Instruction Manual shall be furnished by the Manufacturer.

The following shall be submitted on delivery of panels :

i. 4 nos. of Instruction and operation manual
ii. 4 sets of all approved drawings.
iii. 4 sets of operating handles, spring charging handle and door keys

8.) **TESTING AT MANUFACTURER WORKS AND TEST REPORTS:**

The manufacturer at his works shall conduct all routine tests mentioned in the relevant Indian Standard on each breaker, switchgear assembly in the presence of department and 4 copies of test certificates shall be furnished to the department. Also 1 set of copies of test certificates of type tests carried out by the manufacturer on the switchgear with similar characteristics shall be furnished to the department. The supplier shall perform necessary tests to ensure that the equipment and workmanship are in accordance with the stipulations of this specification

The type test certificates shall be submitted prior to inspection & testing at manufacturers works.

The following tests whether included in the manufacturer's routine tests or not shall be carried out on each breaker at manufacturer's works:

8.1.) Complete Switchgear Assembly:

i. Inter-changeability of circuit breakers.
ii. Mechanical operation of circuit breakers, auxiliary switches, manual devices etc.

iii. One-minute power frequency withstand insulation test.
iv. Insulation test, 1 KV for one second, for all control and instrument wiring
v. CT circuit polarity tests and continuity test.
vi. Breaker tripping through relay contacts. All micom relay shall be set at manufactures work and primary injection test of panel will be carried out during testing.

8.2.) Circuit Breakers:

The operation of the breaker shall be tested under the following conditions:

i. Closing of breaker when the voltage at the terminals of the closing device is within 85% to 110% of the rated auxiliary supply voltage.
ii. Tripping of breaker (not carrying load current) when the auxiliary supply voltage is between 80% & 110% of the rated value. (The current in amperes and the voltage required for the closing and tripping operations shall be recorded).
iii. Manual closing and tripping of breaker.
iv. Closing with the trip coil energized
v. Tripping with the closing coil energized
vi. Latching and complete closing from a momentary operation of the control switch.
vii. Checking of anti-pumping device
viii. Milli-volt drop test shall be made across the breaker contacts and between terminals.

9.) INSTALLATION OF SWITCHGEAR PANELS:

Installation, testing and commissioning at site of switchgear panel as per specification shall be carried out. The switchgears are to be installed on the grouted base frame on floor / over trench. Department shall approve the drawing of the base frame and including positioning, leveling, proper alignment of panel, inter-panel connection, extension of bus bars with all required accessories for grouting remaking it with PCC as per site. **Necessary chipping and PCC work, for installation of switchgear panels, as directed by E-I-C at site,** including all necessary anchor fasteners etc. complete.

MS channel (ISMC 100) required for installation of panel on cable trench including cutting of chequered plate cover etc. is included in the scope of work.

The following pre commissioning tests shall be carried out on the panels:

i. Electrical and mechanical operations of circuit breaker
ii. Functional test of CB through relay
iii. Insulation Resistance.
iv. Testing of relays
v. Testing of CT and PT for polarity and ratio

vi. Checking of all electrical connections, electrical and mechanical interlocks.

vii. Inter changeability of breakers as desired by Engineer-in-Charge at site.

Tenderer shall hire manufacturer commissioning team or their authorised representatives for installation, testing & commissioning of vacuum circuit breaker switchboard at site.

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CHAPTER 5
RING MAINS UNIT (RMU)

1.) SCOPE:

This specification is intended for the design, manufacture, assembly, testing, inspection, performance guarantee and delivery to site, installation and commissioning of factory-built, RMU type, SF6 gas insulated metal-enclosed switchgear.

This specification shall be read in conjunction with Schedule of Quantities.

2.) STANDARDS AND CODES:

Unless otherwise specifically mentioned in the document, the design, manufacture, testing and performance of all equipment shall conform to latest edition of the following standards:

1. IEC 62271-1 Common clauses for MV switchgear standards.
2. IEC 62271-200 MV metal-enclosed switchgear.
3. IEC 60265-1 MV switches
4. IEC 62271-102 AC disconnectors and earthing switches.
5. IEC 62271-100 MV AC circuit breakers.
6. IEC 62271-105 MV AC switch-fuse combination.
7. IEC 60529 Degree of protection procured by enclosures (IP code).

3.) TECHNICAL PARAMETERS:

Sr. No.	Parameters		36kV RMU	12kV RMU
1.	Existing system details	:	33 KV, 3Ph, 50Hz, Neutral Solidly earthed	11KV, 3Ph, 50Hz, Neutral Solidly earthed
2.	RMU Configuration	:	As per BOQ	As per BOQ
3.	Type of ring main unit	:	Metal enclosed compact type	Metal enclosed compact type
4.	Insulating gas & nominal operating gas pressure	:	SF6 & 0.3 bar or as per manufacturers standard.	SF6 & 0.3 bar or as per manufacturers standard.
5.	Rated voltage & frequency	:	33 kV & 50 Hz	11 kV & 50 Hz

6.	Highest system voltage	:	36 Kv	12 kV
7.	Rated withstand voltage at power frequency of 50Hz. (in kV rms)	:	70 kVrms	28 kVrms
8.	Rated current rating of inside the cubicle	:		
8.1	Busbar	:	630 A	630 A
8.2	Isolator	:	630 A	630 A
8.3	Vacuum Circuit Breaker	:	630 A	200A/630 A (as per BOQ)
9.	Rated Breaking Capacity of VCB (in kA)	:	25 kA at 33 kV	21 kA at 11 kV
10.	Rated Making capacity	:	62.5kA (peak)	62.5 kA (peak)
11.	Rated internal arc capacity	:	20 kA for 1 sec.	20 kA for 1 sec.
12.	Internal Arc classification	:	As per BOQ	As per BOQ
13.	Relays		Self-powered numerical relay providing over current & earth fault protection included in VCB	Self-powered numerical relay providing over current & earth fault protection included in VCB
14.	Control Supply	:	As per BOQ.	As per BOQ.
15.	HT metering	:	Multifunction meter of accuracy class 1.0 to be provided as per BOQ.	Multifunction meter of accuracy class 1.0 to be provided as per BOQ.
16.	Power Cable entry	:	Bottom	Bottom
17.	Isolator/ Breaker indication	:	Mechanical indication showing the “OPEN” and “CLOSE” position of Isolator/circuit breaker.	
18.	Bus-Bar	:	The bus bar shall be made of high conductivity, electrolytic copper and be designed to carry rated current continuously within the cubicle. Temp. of bus bars and bus bars connection within the cubicle when	

			carrying rated current at rated frequency shall not exceed the temperature specified in relevant I.S. Tap off to outgoing also shall be for rated current.
19.	Rated Ingress Protection Class of enclosure	:	IP 67 for stainless steel tank of RMU IP 2X for front cover mechanism of RMU IP 3X for cable covers of RMU
20.	Current Transformers	:	Current Transformers shall be cast resin dry type with accuracy class 1.0 for metering. Secondary shall be rated for 1A, as specified.
21.	Voltage Transformers	:	Voltage Transformer shall be cast resin dry type with accuracy class 1.0. High voltage winding of transformer shall be protected by current limiting fuses.

4.) **CONSTRUCTIONAL FEATURES (General):**

SF6 Insulated RMU, comprising of Vacuum Circuit Breakers as per configuration indicated in the BOQ, with self-powered over current & earth fault relays.

RMU shall be made of robotically welded stainless steel with all live parts i.e. load break cable switch, VCB, Bus bars; inside stainless steel tank of not less than 2.0 mm thick and SF6 gas shall be used as dielectric medium to make it compact. The operating mechanism of the switches and breakers shall be outside the SF6 tank and accessible from front. The tank should be filled with SF6 gas at adequate pressure. The degree of protection for gas tank should be IP 67. There shall be provision of filling SF6 gas at site. Moreover, the stainless Steel Gas Tank shall confirm to the sealed pressure system as per IEC and ensure the gas leakage to 0.1 % per year requiring no gas filling for 30 years of functional life as per IEC.

It should consist of an SF6 cubicle housing a load break switch and an earthing switch. Busbars and all electrical connections are located inside the tank. The operating shafts for the switches should be have rotary seals where they enter the SF6 cubicle. Front covers containing the mimic diagram and having a degree of protection IP2X close the fronts.

Circuit breaker should be consisting of an SF6 cubicle housing a Vacuum circuit breaker unit and a disconnector earthing switch. An integrated relay and related CTs is used for tripping of the circuit breaker on O/C+ E/F. Bus bars and all electrical connections should be located inside the tank. The operating shafts for the switches should be have rotary seals where they enter the SF6 cubicle. Cable bushings should be located on the front of the SF6 cubicle in a separate cable compartment. Front covers containing the mimic diagram having a degree of protection IP2X seal off the fronts. The circuit breaker main circuit should be

connected in series with a three-position disconnector earthing switch. The operation between circuit breaker and disconnector ear thing must be interlocked.

Circuit breaker complete with operating mechanism, self-powered, static type O/C, E/F protection relay with associated current transformers shall be used for control and protection of feeder. An integral cable earthing switch with full making capacity shall be provided.

General finish shall be totally enclosed, metal enclosed, vermin and dust proof suitable for tropical climate use as detailed in the specification.

The load break switches along with earthing switches shall be capable for breaking rated full load current. The bus bars should be fully encapsulated by SF6 gas inside steel tank.

The circuit breaker shall be fitted with static type self-powered relay (with flag indicator for short circuit & earth fault); inside the front cover to avoid any tampering. The same shall be used in conjunction with suitable CT's and Tripping Coil for fault tripping of the Circuit Breakers. CT's shall be mounted on cable inside cable compartment.

The CT & PT burden shall be considered as per manufacturer's recommendation.

5.) **Cable Termination:**

Each Cable compartment shall be provided with three bushings of adequate sizes to terminate the incoming & outgoing XLPE cables of sizes specified in BOQ. There shall be enough height from the base of the mounted switchgear so that the cables can be bent and taken vertically up to the bushings. The Cable termination shall be done by Heat shrinkable Termination method so that adequate clearances shall be maintained between phases for Termination. Access to all the cables should be possible from the front of RMU. Cable Termination boots shall be supplied by the switchgear manufacturer.

6.) **HT metering:**

HT metering provision should be, as per BOQ & main schematic drawing.

There shall be a multi-function meter for monitoring power and energy parameters, of accuracy class 1, along with measuring CT & PT for HT metering, of rating as per BOQ.

7.) **Other Main Features of RMU:**

7.1.) Front covers

The front cover contains the mimic diagram of the main circuit with the position indicators for the switching devices. The voltage indicators are situated on the front panels. Access to the cable bushings is in the lower part of each module.

7.2.) Position indicators

The position indicators are visible through the front cover and are directly linked to the operating shaft of the switching devices.

7.3.) Voltage indicator

The voltage indicators are situated on the front cover, one for each module, and indicate the voltage condition of each incoming cable. Identification of the phases is achieved with labels L1, L2 and L3 on the front of the voltage indicators. The voltage indicator satisfies the requirements of IEC61243.

7.4.) Cable compartment

It should be possible to terminate Al XLPE incoming & outgoing cables of sizes as indicated in BOQ, in each cable compartment. The access to the compartment will be possible by removing the cable cover, only when earth switch is ON. Cable Compartments of Indoor RMU should be Arc Proof and interlocked with respective Earth Switches. Each module has a separate cable compartment that is segregated from each other by means of a partition wall. A partition wall should be fitted to divide the cable compartment from the rear side of the switchgear. In case of an arc inside the tank, followed by the opening of the pressure relief, the partition wall prevents the hot gases flowing out from the pressure relief to enter the cable compartments. All covers are removable. The ground continuity is achieved when the covers are in place by means of hinged connections.

7.5.) Power connection:

The cables are installed in the dedicated compartment below the mimic front cover. At the bottom of the cable compartment, an earthing bar system made of copper/GI with a minimum cross section of 150 mm^2 should be fitted. In each compartment the earthing bar should be fitted with 4 screws M10. The earthing system is connected to the tank by a copper bar, which rises up to the connecting point of the tank behind the rear partition wall on the middle of the switchgear.

7.6.) Interlocking:

The mechanism for the cable switch should be provide a built in interlocking system to prevent operation of the switch when the earthing switch is closed, and to prevent operation of the earthing switch when the switch is in the closed position.

The mechanism for the T-off switch should be provide a built in interlocking system to prevent operation of the switch when the earthing switch is closed, and to prevent operation of the earthing switch when the switch is in the closed position. The mechanism for the VCB and the disconnector-earthing switch should have a built in interlocking system to prevent operation of the disconnector-

earthing switch when the VCB is in the closed position. Further, it should not be possible to Open the Cable doors unless the Earthing Switch is Turned ON. In case the Cable door is accidentally left open a positive interlock shall prevent operation of Load Break Switch and Isolators / Breaker from any operation.

7.7.) Current Transformers

All current transformers should be complying with IEC 60185.Current transformers should be of dry type, with ratings and ratios as required. Cable current transformers used in circuit breaker modules should be maximum 100mm wide. Current transformers used in metering cubicles should be having dimensions according to DIN 42600, Narrow type. Current transformer shall be placed in the cable covers so that it can be easily replaced at site without removing the bushings.

7.8.) Padlocking facilities :

Circuit breakers, switches and earthing switches can be locked in the open or closed position by 1 to 3 locks.

7.9.) Fault Passage Indicators :

Incoming VCB feeder functions shall be equipped with a fault passage indicator (FPI), in order to detect and localize easily the faulty part of the network.

The latter FPI shall segregate the short circuit and earth faults, shall indicate permanently the phase-per-phase load currents, and shall be possible to actuate a remote indication lamp.

The FPI fault detection core function shall be self-powered without help external power supply or built-in batteries.

8.) **Type and routine tests :**

According to the composition of the switchboard, following type test certificates shall be submitted:

i. Impulse withstand test,
ii. Temperature-rise test,
iii. Short-time withstand current test,
iv. Mechanical operation test,
v. Checking of degree of protection,
vi. Switch, circuit breaker, earthing switch making capacity.
vii. Switch, circuit breaker breaking capacity.
viii. Internal arc withstand
ix. Checking of partial discharge on complete unit

In addition, for switches, test reports on rated breaking and making capacity shall be supplied.

For earthing switches, test reports on making capacity, short-time withstand current and peak short-circuit current shall be provided.

The following routine tests shall be carried out at factory in presence of departments representative & shall include the following:

i. Conformity with drawings and diagrams.
ii. Power frequency withstand test.
iii. Insulation resistance test.
iv. Measurement of circuit resistance.
v. Functional tests.

9.) **DRAWINGS:**

The design of layout and general arrangement of RMU components along with complete dimensions shall be submitted along with the offer. After placing the order the bidder shall submit to Engineer in Charge for approval, of which shall include but not limited to the following:

i. Complete assembly drawings of the switchgear showing plan, elevation and typical sectional view.
ii. Panel base plan showing locations of channel sills, foundation bolts and anchors, floor plans and openings.
iii. Single Line Diagram
iv. Complete wiring diagram including terminal wiring designations.
v. Schematic control diagram.
vi. Complete terminal block details, showing ferrule numbers wire destinations.

The following shall be submitted on delivery of panels:

a. 4 nos. of Instruction and operation manual

b. 4 sets of all approved drawings.

c. 4 sets of operating handles, spring charging handle and door keys

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CHAPTER 6
BATTERY & BATTERY CHARGER

1.) SCOPE:

This specification is intended for the design, manufacture, assembly, testing, inspection, performance guarantee tests at manufacturer's works, delivery to site, installation, testing at site and commissioning of battery and battery charging equipment at various substations, as per following specifications. The Bidder shall furnish the guaranteed technical particulars of equipment as listed in the specification.

This specification shall be read in conjunction with **Bill of Quantities(BOQ)**.

2.) STANDARDS AND CODES:

Unless otherwise specifically mentioned in the document, the design, manufacture, testing and performance of all equipment shall conform with latest edition of the following standards:

	IS 1652	:	Stationary cells and batteries, Lead acid batteries with `Planet' positive plates
	IS 1651	:	Stationary cells and batteries, Lead acid batteries with `tubular' positive plates
	IS 15549	:	Stationary Valve Regulated Lead acid batteries
	IS 266	:	Sulphuric acid
	IS 8320	:	General requirements and methods of tests for lead-acid storage batteries
	IS 1069	:	Quality Tolerances for water for storage Batteries

3.) TECHNICAL PARAMETERS:

3.1.) Battery:

1.1	Application	:	Standby power
1.2	Type	:	Lead acid
1.3	No. of Cells per Battery	:	As per BOQ

1.4	Battery Nominal Voltage	:	As per BOQ
1.5	Battery Ampere Hour capacity	:	As per BOQ
1.6	Proposed method of working		
	Float charging (normal)		As recommended by Battery Manufacturer
	Equalizing Charge (occasional)	:	As above
	Boost charging (after complete discharge)	:	As above
1.7	Intermediate tapping	:	Bidder to indicate
1.8	Mounting	:	Wooden racks

3.2.) Battery Charger:

	Charger	:	One(1) Float and One (1) Float cum-boost
	Type	:	Solid-state, natural air cooled full wave, fully controlled, 3 phase bridge rectifiers.
	Enclosure	:	Sheet steel, IP-42
	A.C. Input		
	Supply voltage	:	415V, 3ph, 50 Hz, 4 wire
	Voltage Variation		±10%
	Frequency variation	:	±5%
	Combined voltage and frequency variation	:	10% (absolute sum)
	Short Circuit Level	:	50kA r.m.s symmetrical
	System earthing	:	Solidly earthed
	Performance Requirements	:	The output voltage of the charger shall be regulated within ±1% of the set value for any load variation from 0-100% and A.C. input voltage and frequency variations as indicated above

			The ripple content in charger D.C. output shall be limited to ±1% of the D.C. output voltage, at nominal A.C. voltage.

4.) **DESIGN CRITERIA:**

The batteries and chargers will be installed indoor. For continuous operation at rated capacity, temperature rise of the various components of battery and charger shall be limited to the permissible values as stipulated in relevant standards.

The float charger shall be sized to carry the rated load and the trickle charging current of the battery plus a 25% margin. The output voltage of the float charger shall be adjustable between -10% to +20 % of rated voltage of the charger. The charger shall also be capable of delivering the rated load even under the specified voltage and frequency variations.

The float-cum-boost charger shall be sized to restore the fully discharged battery to full charge condition in ten (10) hours with 25% margin over maximum charging rate or to operate as a float charger with duty requirement as indicated against clause no. 5.3 whichever is greater.

The batteries & chargers shall be so designed that the maximum fault level on DCDB is limited to 25kA (indicative only; the actual value will be decided by the Bidder after substantiating the same by calculation).

5.) **SYSTEM CONCEPT:**

The float charger will be normally ON, supplying the DC load and at the same time trickle charging the battery. The characteristics shall be such that if load is high and exceeds the charger capacity, the battery will supply the excess load. The float-cum-boost charger will be normally in stand-by (auto float charge) mode and will cut into the circuit automatically

i. to provide occasional equalizing charge as required,
ii. to take over the functions of float charger in case of its failure
iii. to boost charge, the battery up to 2.75 volt per cell.

The float-cum-boost charger shall also have provision for float, equalizing, and boost charging the battery through manual selection. On failure of AC supply, both float and float-cum-boost chargers will go out of service and battery will take over to supply the loads.

6.) **Specification of battery charger:**

Sl. No.	Description	Qty.
1	Charger Rating: Float Charger : As per BOQ Float cum Boost Charger : As per BOQ	
2	Common Components :	
2.1	2 position A.C. mains ON/OFF rotary switch 63Amps, 415 Volts 3 Pole, 2 way with off position along with neutral link.	1 No.
2.2	Digital A.C. voltmeter, 0-500Votts with HRC fuses 2Amps for measuring A.C input voltage with selector switch.	1 No.
3	Float Charger: 415Volts A.C, 3phase, 50 Hz 4 wire system ±10% supply variation.	
3.1	2 position A.C. mains OFF / FLOAT rotary switch 40Amps, 415Volts, 3 Pole, 2way with off position along with neutral link.	1 No.
3.2	Suitably sized input (AC) HRC fuses	3 Nos.
3.3	Pilot lamps (LEDs big size) to indicate A.C. supply condition	3 Nos.
3.4	A.C 3phase power contactor suitably sized for making & breaking the incoming supply (contactor coil voltage 240V ± 10% AC) with thermal overload relay and start/stop push buttons. (Sizing to be furnished by the Bidder)	1 No.
3.5	Natural air cooled main transformer of suitable KVA rating with taps in general confirming to IS 2026 (Sizing to be furnished by the Bidder)	1 No.
3.6	Rectifier stack consisting of suitable number of diodes/thyristors mounted on suitable heat sinks & connected a 3 phase bridge circuit. Each device shall be protected with RC network against over voltage/surge and fuses for short circuit. (Sizing of diodes, SCRs along with heat sinks to be furnished by the Bidder).	1 Set
3.7	Solid state controller to maintain the output voltage +/- 1% of the set value for mains voltage variation of +/- 10% and load variation of 0-100%.	1 Set
3.8	Auto / Manual change over switch: Voltage variation facility 100V-130V for float charging the battery bank (Trickle current 0.5 amps) in addition to	1 No.

Sl. No.	Description	Qty.
	supply of permanent load of 10 amps.	
3.9	Suitable filter circuit for the rectifier unit in 3.6 above. The ripple content should not be more than 1% (sizing to be furnished by the Bidder)	1 Set
3.10	D.C. output switch 2 pole ON / OFF position 40A	1 No
3.11	Suitably sized HRC fuses at the output side	2 Nos.
3.12	D.C. voltmeter Digital type 0-150V with 2 Amps HRC fuses.	1 No.
3.13	D.C. ammeter Digital type 0-40 Amps with suitable shunt	1 No.
3.14	Two terminals with proper marking shall be brought out to terminal block for connecting battery bank.	1 Set
4.0	Float Cum Boost Charger: 415 Volts A.C., 3 Phase, 50Hz, 4 wire system +/- 10% supply variation	
4.1	2 position A.C. mains OFF / BOOST rotary switch 40 Amps, 415 Volts 3 pole, 2 way with off position along with neutral link.	1 No.
4.2	Suitably sized input (AC) HRC fuses	3 Nos.
4.3	Pilot lamps (LEDs big size) to indicate A.C. supply condition	3 Nos.
4.4	Suitably sized AC 3 phase power contactor (coil voltage 240V $\pm$ 10% AC) with thermal overload relay and start/stop push buttons (sizing to be furnished by the Bidder)	1 No.
4.5	Natural air cooled main transformer of suitable KVA rating with taps, in general confirming to IS 2026 (Sizing to be furnished by the Bidder)	1 No.
4.6	Manual voltage regulating device (step less) for adjusting the output D.C. voltage of boost charger up to 160 volts	1 No.
4.7	Rectifier stack consisting of suitable number of diodes/ thyrostors mounted on suitable heat sinks & connected in a 3 phase bridge circuit. Each device shall be protected with RC network against over voltage / surge & fuses for short circuit (sizing of diodes, SCRs along with heat sink to be furnished by the Bidder)	1 Set
4.8	Suitable freewheeling diode with heat sinks	1 Set
4.9	Suitable filter circuit for the rectifier unit in 4.7 above (sizing to be furnished by the bidder)	1 Set
4.10	D.C. Ammeter Digital type 0-40 Amps with suitable shunt	1 No.

Sl. No.	Description	Qty.
	for measuring boost charge current.	
4.11	D.C. Voltmeter Digital type 0-150V with fuses of 2 Amps for measuring charger output voltage.	1 No.
4.12	40 Amps 2 pole ON/OFF D.C. switch for D.C. output.	1 No.
4.13	Suitably sized HRC fuses at the output side.	2 Nos.
4.14	Semiconductor diodes for dropping the boost charger voltage to 115 volts for load circuit from 160 volts. Dropper diode should be provided with 8 position selector switch (or 2 Nos. switches for 4 positions in series).	1 Set
4.15	Suitably sized DC CONTACTOR in voltage dropper circuit.	1 No.
4.16	D.C.Ammeter, 40-0-40 Amps Centre zero with suitable shunt for measuring charge / discharge current of battery bank.	1 No.
4.17	DC Digital ammeter 0 to 40 Amps 3 ½ digit with suitable shunt.	1 No.

NOTE:

a.) Equipment/component which is not specifically indicated above but required for smooth & satisfactory operation of the chargers, shall be provided by the Bidder free of cost.

b.) The Bidder shall also submit an alternative offer for thyristorised automatic voltage regulating arrangement for boost charging section.

7.) **Protection / Alarms (To be provided for each charger):**

i. AC contactor for AC supply failure and single phasing
ii. Protection and alarm (Facia type) with accept, test & reset facility
iii. Mains failure alarm and indication
iv. Charger bridges SCR/diode fuse / freewheeling diode fuse blown
v. DC over voltage
vi. DC Earth leakage
vii. DC under voltage

8.) **Cubicle:**

The cubicle housing the battery charger components shall be fabricated out of CRCA sheet steel having gauge not less than 2mm thickness. The clearance between bottom plate & floor shall be 150mm. The cubicle shall have adequate ventilation for natural cooling and suitable for floor mounting indoor operation and having. a door at the rear with a locking arrangements for easy access to all components inside. A push button switch shall be provided on the rear door of the battery charger cubicle to light up a bulb (240V, 100W) automatically, when the door is opened. The cubicle shall be subjected to 7 tank process & thereafter the cubicle shall be powder coated with approved shade of colour. Degree of protection for enclosure shall be IP-42.

The charging equipment shall be complete with all internal wiring of superior quality PVC sheathed copper wire of proper current ratings, labels, plain holes with gland plates for cable entries for A.C input, out going to battery and outgoing DC supply feeders.

All the component and control circuits on the panel shall be properly described by pasting metal labels.

Cable entry shall be from bottom.

Two earthing points on either side of the panel shall be brought out for connection of earthing conductor

9.) **DC DISTRIBUTION BOARD (BUILT IN WITH CHARGER) :**

40A, two pole MCB for incoming feeder	1 No.
16A two pole MCB for outgoing feeder.	10 Nos.
O-150Volts DC voltmeter Digital type with 2amps HRC fuses of 96 Sq. mm. dial for measuring DC load voltage.	1 No.
LED type 'ON' lamp for I/C & O/G feeders	1 Lot

10.) **TESTS:**

The following tests as indicated below shall be carried out as acceptance tests on the battery charger at the manufacturer's works before delivery of the item. The supplier has to intimate at least 15 days in advance to enable the Purchaser to depute their engineers for witnessing the tests.

i. Load regulation and ripple content on float & boost chargers.
ii. Operation of all components.
iii. Insulation resistance.
iv. HV test on AC & DC circuits.

v. Voltage dropper diode test.
vi. Alarm annunciation test.

11.) **DRAWINGS:**

The Bidder shall submit the General arrangement and single line diagram along with the offer and also during drawing approval stage. The Bidder shall submit the following drawings for approval of the Purchaser after placement of the order but before taking up the fabrication work:

i. GA drawings indicating make of the components.
ii. Power & control schematic drawings.
iii. Layout of the battery bank in single row double tire formation.
iv. 4copies of test certificates and 6 copies of descriptive literature, catalogues and instruction manual shall be submitted by the Bidder.
v. Test certificates of tests carried out on similar type of battery cells shall be submitted along with the offer.

12.) **SPARES:**

The Bidder shall supply the following spares for each set of battery & battery chargers:

a.	Control card for float charger	- 1 No.
b.	Si diode for float charger	- 4 Nos.
c.	Si diode for boost charger	- 7 Nos.
d.	SCRs for float charger	- 3 Nos.
e.	Semi-conductor fuses	- 4 Nos.

13.) **INSTALLATION:**

Installation, testing and commissioning of battery bank including inter cell connection, inter row connection, filling of electrolyte and first charging as per manufacturers recommendation, one full charge-discharge-charge cycle to show the capacity of each cell shall be carried out.

All necessary hardware for installation, testing and commissioning shall be on Bidder's account. During the charging process Bidder has to keep one engineer, one supervisor and necessary staff throughout the charging period to monitor and record the charging process and commissioning, complete. Installation, testing and commissioning of battery charger with all required accessories including IR, HV, and functional test of chargers shall be carried out.

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CHAPTER 7

LIFTS

PART – I: WORKS INSTRUCTIONS TO TENDERER

1.) DELIVERY:

The entire work (including dismantling, design, fabrication, supply, installation, testing & commissioning) shall be completed in all respects as per time schedule in the tender.

i. The lift shall be designed, manufactured, tested & inspected & shall be delivered & installed, tested & commissioned including obtaining the lift license.

ii. All the materials required for above shall be delivered at site. Please note that Department's approval at each stage is essential.

2.) INFORMATION TO BE INCLUDED WITH THE PROPOSAL:

The bidder shall submit all information as requested for in Part-IV – Guaranteed Technical particulars, to enable the Dept. to make an accurate comparison & evaluation of Tenders without the need of further information from the bidder.

3.) PRICE:

The prices for executing work to conform to these specifications shall be indicated as required in Bill of Quantitiesof form of tender.

4.) PACKAGING & TRANSPORT: -

Equipment shall be packed & protected so as not to suffer deterioration, damage or breakage during shipment, transhipments & storage in tropical climate. All materials shall be packed in a way to suit site condition where many activities will be taking place simultaneously like civil work, public health, electrical services etc.

All elevating points on heavy packages shall be clearly marked externally.

Each package shall be properly labelled to indicate the type & quantity of each material it contains, the Work order number, dimensions & weights & any other necessary data to identify the equipment & relate it to the contract.

The contractor shall not dispatch the equipment without the prior approval of the Dept.'s Inspector & subsequent written instructions to do so.

Dispatch instructions relating to shipping forwarding document etc. will be furnished along with the work order.

5.) **DEVIATION FROM TENDER SPECIFICATIONS: -**

Deviation/clarification required if any shall be got clarified during pre-bid meeting.

6.) **CONTRACTOR'S DRAWINGS:**

The contractor shall submit a detailed time schedule covering phases involved i.e. shop drawing, procurement, manufacture, assembly, inspection, testing, delivery, and installation etc. within thirty (30) days of receipt of the order by the contractor for dept.'s approval.

GA drawings are to be submitted for Dept.'s approval. The drawings which are not found satisfactory for approval on the first submission will have to be revised and again to be submitted for approval.

Any shop work done prior to the approval of drawings will be at the contractor's risk. The contractor shall make any changes in the design which are considered necessary to make the equipment conform to the provisions & intent of the specification, without any additional cost to the Dept.

The contractor shall record all the deviations, concessions, omissions, changes, etc. occurring throughout the manufacturing, assembly & testing phases & submit a complete set of 'as built' drawings in reproducible form.

7.) **TRANSPORT LIMITATIONS & FACILITIES:**

The contractor shall be responsible for delivering of the equipment/material at site in packages of sizes & weights that are permissible under the existing rail & road limitations, also keeping in consideration the site storage & handling conditions.

8.) **SUB-CONTRACTORS/VENDORS:**

The contractor may procure & incorporate such ancillary items as are not normally manufactured by themselves from other reputed manufacturers, subject to approval of such items by the Department. They should give full details of all such items & seek prior written permission from the Department for the same.

9.) **SOURCE OF EQUIPMENT:**

Tenderer should indicate the country of manufacture of equipment offered.

10.) **SUPERVISION OF ERECTION: -**

The contractor shall depute an authorized suitable qualified & experienced Engineer or supervisor to supervise & direct the erection of the Lifts at site, who will be responsible for the job.

11.) **OFFER TO BE IN ACCORDANCE WITH SPECIFICATIONS:**

Bidders shall quote for equipment in accordance with the specifications.

12.) **QUALITY SURVELIANCE AND PROGRESS REPORTS:**

All work covered by this documents shall be subject to quality surveillance by Dept. or his authorized representative for which purpose the contractor shall:

i. Allow access into manufacturer's works at all reasonable time during manufacturing & assembling
ii. Provide Gauges, instruments etc. required for inspecting the work.
iii. Provide drawings for inspection.

Inspection & tests shall be carried out as per the requirements of the specifications forming part of this tender document. Parts found unsatisfactory in respect of workmanship the same shall be removed & replaced at free of cost.

Waiving of quality surveillance or acceptance of material or equipment by the quality surveyor shall not absolve the contractor of the responsibility of furnishing materials & workmanship in accordance with these tender documents & as per required standards.

The contractor shall submit monthly detailed report on the manufacturing & assembling of all equipment of lifts as per instruction of EIC. It shall contain the following information:

1. Scheduled dates for completion of:

i. Engineering work.
ii. Different important phases of material procurement.
iii. Assembly & testing.
iv. Packing & shipping.

Actual progress in percentage & dates of completion of each of the above items.

13.) **CO-ORDINATION WITH OTHER AGENCIES:**

The contractor shall work in close cooperation with other agencies working at site & will coordinate lift installation work with the agencies engaged in construction of the building or civil agency engaged in renovation of architraves of occupied buildings. They shall exchange technical information so as to make the execution of works smooth.

14.) **COMPLETENESS OF TENDER:**

Electrical works and minor civil works contingent to lift erection as per specifications, fittings, equipment, assemblies & accessories, hardware, items which are useful & necessary for efficient assembly & operation / installation of lifts shall be deemed to have been included in the scope of work.

Standard terms and conditions of bidders if any submitted along with tender by bidder shall not be made applicable to the tender.

Engineer-in-charge shall have the right to make any alteration in the design of the equipment which may be found necessary to make the equipment confirm to the requirements and intends to these specifications without any additional cost to the department.

Approval of E-I-C to the contract drawings shall not be held to relieve the contractor of any part of the contractor's responsibility to meet all the requirements of these specifications or responsibility for the corrections of the drawings.

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PART-II: GENERAL SPECIFICATIONS OF LIFTS

1.) STANDARDS:

The following BIS Standards and Codes of Practice with up to date amendments shall generally apply to the equipment and the work covered by this contract:

1.1	IS:14665(Part-1)-2000	Electric Traction Lifts – Guide line for outline dimension of Passenger, Goods, Service and Hospital Lifts.
1.2	IS:14665(Part-2)-2000	Electric Traction Lifts – Code of practice for Installation.
1.3	IS : 14665 (Part-3)-2000	Electric Traction Lifts – Safety Rules.
1.4	IS : 14665 (Part-4/Sec 1to 9)-2001	Electric Traction Lifts – Components.
1.5	IS : 4666:1980	Specification for electric passenger and good lifts.
1.6	IS : 1860:1980	Code of Practice for installation, operation and maintenance
1.7	IS : 3534	Outline dimension for electrical lifts.
1.8	IS : 2365	Specification for steel wire suspension ropes for lifts and hoists.
1.9	IS : 1173	Hot rolled and slit steels tee bars.
1.10	IS : 4289	Specification for lift cables.
1.11	IS : 732 : 1963	Code of practice for electric wiring installations
1.12	IS : 4722	Specification for rotating electric machines
1.13	IS : 6362	Designation of method of cooling for rotating electrical machines.
1.14	IS : 800	Code of practice for use of structural steel in general welding construction.
1.15	IS : 814	Covered electrodes for metal arc welding for mild steel.
1.16	IS : 816	Code of practice for the use of metal arc

		welding for general construction in mild steel.
1.17	IS : 817	Code of practice for training testing of metal and welding.
1.18	Is :2742	Automotive brake lining
1.19	IS 6911:2017	Stainless Steel Plate, Sheet and Strip —Specification

Notes:

- Wherever appropriate Indian Standards are not available, relevant British and/or IEC Standards shall be applicable. BIS certified equipment shall be used as a part of the Contract.
- All the materials used shall be tested for quality and shall comply with Indian Standard/International specification wherever such standards exist.
- The installation shall be carried out in conformity with the local lift act & rules and of local municipal by laws, and any other statutory regulation enforces from time to time.
- The installation shall be carried out in conformity with the local fire regulations and rule there under wherever they are in force.
- The tenderers/bidders shall also take into account local and State regulations as in vogue for the design and installation of lifts.

- In addition, the relevant clauses of the following, as amended up to date shall apply
- Central Electricity Authority (Measures related to Safety and Electricity Supply) Regulations 2010 with up to date amendments.

i. Maharshtra Lift Act and Bombay lift rules.
ii. National Building Code 2016

2.) **DESIGN REQUIREMENTS:**

2.1.) General:

Unless inconsistent with this specification, the contractor's standard or usual construction is desired. The equipment shall be capable of safe, proper and continuous operation.

2.2.) Electric Supply:

The lifts shall operate on AC supply of 415 volts +/- 6% between phases and 240 volts +/- 6% between phase and neutral - 3 phase 4 wire AC 50 Hz +/- 3%.

2.3.) Factor of Safety:

The factor safety for any part of the lift shall not be less than 05. Higher factor of safety for various parts shall be applicable wherever specified.

2.4.) Lift components:

2.4.1) Lift Machine:

i. The lift machine shall be designed for rated voltage of the machine with a voltage variation of +10% and -10%. The lift shall have following features:

ii.

iii. The lift machine shall be gearless type and having high efficiency and low power consumption and shall be designed to withstand peak currents in lift duties. Resilient anti vibration mountings of suitable design shall be provided to minimize noise and vibration transmission.

iv.

v. The drive motor shall be Permanent Magnet Synchronous Motor (PMSM) suitable to withstand frequent peak current encountered in lift duty and shall have high starting torque and low starting current.

vi.

vii. The motor shall be capable of not less than 180 starts per hour without excessive temperature rise. The motor shall carry a nameplate giving full details of its ratings and characteristics.

viii.

ix. Motor, electromechanical brake and sheave shall be mounted on a common bed plate.

x.

xi. The motor of each lift machine shaft shall be arranged so as to provide hand winding facilities and suitably marked for the direction of up and down travel of lift car or suitable manual rescue device without assistance of external power supply. There shall be a warning display for switching off electrical supply before the manual operations.

2.4.2) Brake:

Brake shall be provided in lift machine to prevent rotation of lift motor and thus preventing any drive to the lift car when there is no power supply to lift motor. The brake shall essentially consist of two brake shoes on which brake lining are

secured. The shoes shall apply pressure on the brake drum with the aid of compression springs and electrically released.

The brake shall operate automatically with the safety devices and failure of power supply. In normal operation of lift, the brake shall come into action after the lift has come to a complete halt to hold the car in position. It shall be possible to release the brake manually - such release requiring the action of manual force to move the lift in short stops.

2.4.3) Sheaves and pulleys:

All driving sheaves fixed to and revolving with shaft shall be fixed by means of sunk keys and sufficient strength and quality as required and shall confirm to the relevant Indian standards.

Sheaves and pulleys shall be of cast Iron, free from cracks, sand holes and defects. They shall have machined rope grooves. The traction sheave shall be grooved to produce proper traction and shall be sufficiently thick to provide future wear in groove.

The deflector sheave shall be grooved so as to provide a smooth bed for the rope. Deflector or secondary sheaves assembly where used shall be mounted in proper alignment with traction sheave.

2.4.4) HOIST ROPES/FLAT BELT:

The hoist ropes shall be traction stead of suitable size and construction for proper operation. Ropes shall be lubricated with an approved type of lubricant. The suspension wire ropes shall conform to IS: 2365 or as per relevant standard. The rope /belt shall be of continuous length without break or lengthened by splicing.

More than two independent wire ropes shall be used for car and counterweight with traction drive and each of the drum drives and wire ropes shall be fixed independently to car and counterweight. Factor of safety for normal working to be taken as 10. Flat belt if considered shall be as per relevant standard.

2.4.5) GUIDE RAIL AND GUIDES:

Guide rails of the car and counter weights shall be preferably machined section and comprise of steel toes and grooved fish plates & bolts at the ends and securely fastened to the hoist way frame by heavy steel brackets. Car and counterweight frames shall be provided with suitable lubricating system. The guide rails of the lift shall be fastened to the shaft way frame work and concrete inserts suitable intervals so as to safely withstand the application of the car or counter weight, when stopping the car and its rated load or the counter weight.

Adequate packing shall be supplied by the contractor. At least four guide shoes of preferably cast iron type with liners shall be provided. The guide shoes shall be rigidly fixed to the car frame, with two at the bottom and two at the upper ends of the car and counter weight.

2.4.6) COUNTERWEIGHT:

All counterweight sections (filler weights) shall be of metal or non-metal carried in a single frame. Means shall be provided to retain counterweight sections in place and prevent displacement. In case of non-metallic filler weights, the counterweight sections shall be totally enclosed in a metallic covering. Alternatively, non-metallic filler weights which are covered from sides by metallic covering shall be properly supported at bottom of lower most filler weight and top of top most filler weight in the counter weight frame over the entire horizontal surface of filler weight by metal plates of adequate thickness. Where tie rods are used, minimum of two shall be provided, passing through all sections. The factor of safety of steel frame members and the tie rods shall not be less than 5.

If pulleys are fixed to the counter weight, they shall be provided with device to avoid:

a) the suspension ropes, if slack, leaving the grooves; and

b) the introduction of objects between ropes and grooves.

The devices shall be so constructed as not to hinder inspection or maintenance of the pulleys. Counterweights shall withstand the effect of buffer impact.

2.4.7) LIFT CAR:

i. **Car frame:** The car frame shall be made of steel. Connections between car frames shall be riveted, bolted or welded.

ii. **Car**: Lift car shall be enclosed on all sides by means of car body and doors and such enclosures shall be at least 2 m clear in height. Car roof solid or perforated, capable of supporting 2 persons, that is, 2 kg × 68 kg shall be provided. Perforations shall be sufficiently close in mesh and shall reject a ball of 25 mm diameter to provide reasonable protection against falling articles on any person travelling in the car.

iii. **Car panels:** The car enclosure for Passenger lifts shall be of stainless steel sheet of grade SS304 and having finishes and design as mentioned in part-IV: Specific requirements, smooth and free of defects. The panel shall be in one piece vertically from floor to roof of car so fit line securely bolted together or to adjoining members with formed, light proof joints and suitably reinforced to provide rigidity.

iv. **Size of car:** Size of car platform shall be of maximum size that could be accommodated in lift well as per code of practice. The platform shall consist of a structural steel frame designed on the basis of rated load covered with a M.S steel plate covered with marine grade ply wood and having mat finish granite of design, pattern and quality approved by Dept., shall be laid on and securely fixed to the steel sub-flooring in the approved manner.

v. **Hand rails:** SS Hand rail of manufacturer's standard design shall be provided with the approval of Dept.

vi. **Ventilation:** A fan shall be provided in car for adequate ventilation. Auto fan off facility shall be provided, when car is in parking position. A separate circuit with control in machine room shall be provided for fan and light. Ventilation openings shall be provided in the enclosure above 1.8 m level and below 0.3 m level. The total area of openings shall be not less than 0.035 Sq.mtr for each square metre of area of the car floor divided suitably between the top and the bottom levels. Any openings provided by a ventilating fan may be regarded as forming part of the ventilation area in that part of the car in which it is fitted.

vii. **Car platform:** Lift car platforms shall be of framed construction and designed on the basis of rated loads evenly distributed. Platforms for goods cars shall be designed to suit the particular condition of loading. The minimum factor of safety shall be 5 for steel.

viii. **Emergency light and emergency alarm:** Every lift car with solid enclosure and doors shall be provided with battery operated emergency light for minimum 30 min back-up and emergency alarm. The lighting shall automatically come on in case of failure of normal lighting supply.

ix. Battery shall be provided with charger. Auto light off facility shall be provided with manual over ride, when the car is in parking mode.

x. **False ceiling:** A false ceiling made up of stainless steel of SS304 grade with provision for suspension for carrying out maintenance and cutout for lighting fixtures and louvers for fans shall be provided. The design of false ceiling shall be got approved by Dept.

xi. Capacity plate: A name plate shall be fitted in the lift car to indicate the rated capacity of the lift & instructions in Hindi, English & Marathi as per format given in specifications.

xii. **Accessories on car top:** Suitable outlets shall be provided on the top of the lift car to install a lamp during maintenance.

xiii. On the top of the car cage Up, down & stop push button, & one number single phase 230 V power point should be provided.

2.4.8) CAR DOORS:

The car doors shall be made up of SS 304 grade stainless steel sheets having finishes as per specific requirements (PART-IV). Car doors shall be manufactured/provided with required stiffeners to withstand thrust as per the standards. Car doors shall be power operated and provided required car door header for automatic opening & closing feature.

2.4.9) HOIST WAY LANDING DOORS:

The landing doors shall be made up of SS 304 grade stainless steel sheets having finishes as per specific requirements (PART-IV). Landing doors shall be manufactured/provided with required stiffeners to withstand thrust as per the standards. Landing doors shall be power operated and provided required landing door header for automatic opening & closing feature.

All the landing doors shall have a fire resistance of not less than 02 hours as per standards.

Provision for emergency opening of the landing door by means of a special key should be provided at all floors.

2.4.10) Safety devices/components:

The following minimum safety devices shall be provided: including all requirements of electrical/mechanical nature as per lift inspector:

A traveling screen (toe guard apron) as per specification shall be provided below the level of the car floor to prevent fall of person in the shaft from open doorway entrance.

a.) Infra-red sensor along the entire door height shall be provided for sensing obstruction while door closing. Also, protective leading edge device, as a backup to infra-red sensor, shall be provided, to open the door immediately on sensing impact on the door.

b.) Self-Leveling : The lift shall be provided with a self-leveling feature within ± 5 mm.

c.) Terminal and Final Limits: Terminal limit switches shall be provided to slow down and stop the car automatically at the terminal landings, and final limit switches shall be furnished to automatically cut off power should the car travel beyond the terminal landings.

d.) Terminal Buffers: Suitable hydraulic buffers shall be installed/ mounted on steel channels as a means of stopping the car & counter weight.

e.) Interlocking: Adequate interlocking is to be provided so that the car shall not move if the landing doors are even partially open and also the lift is overloaded.

f.) Car and counter weight safety gear: Lift car shall be provided with a safety gear located preferably at the lower part of the car and capable of operating only in the downward direction and capable of stopping lift car carrying the rated load, at the tripping speed of the over speed governor, even if the suspension devices break, by gripping the guides, and of holding the car there.

If accessible spaces do exist underneath the car or counterweight, the counterweight shall also be equipped with safety gear, operating only on a downward moving counterweight, capable of stopping it, at the tripping speed of the over speed governor by gripping the guides, and of holding the counterweight there.

The safety gear of the car and counterweight shall each be tripped by its own over speed governor.

The release of the safety gear on the car (or the counterweight) shall only be possible by raising the car (or the counterweight). After its release, the safety gear shall be in a condition to operate normally. After the release of the safety gear it shall require the intervention of a competent person to return the lift to service.

The jaws or safety blocks shall not be used as guide shoes. The safety gear operating devices shall preferably be located at the lower part of the car. It shall be possible to seal adjustable components.

When the car safety gear is engaged, an electrical safety device mounted on the car shall initiate the stopping of the motor before or at the moment of safety gear operation.

g.) Over speed governor:

The response time of the over speed governor before tripping shall be sufficiently short not to permit a dangerous speed to be reached before the moment of safety gear operation. The over speed governor shall be completely accessible in all circumstances.

Car safety shall be provided with a switch on top of the car and operated by the car safety mechanism. A switch shall also be provided on the speed governor and operated by the over speed action of the governor for car speeds above 1.0 m/s and when used with counterweight safeties. These switches shall, when operated, disconnect power supply from the driving machine motor and brake before or at the time of application of the safety.

The switches shall be positively opened. When operated by speed governor or car safety mechanism, they shall remain in the open position until manually reset after car safety mechanism has been returned to the off position.

During checks or tests, it shall be possible to operate the safety gear at a lower speed than that indicated in 4.1 by tripping the over speed governor in some way. The means of adjusting the over speed governor shall be sealed after setting the tripping speed.

The over speed governor shall be driven by a very flexible wire rope. The braking load of the rope shall be related by a safety factor of at least 8 times to the tensile force produced in the rope of the over speed governor when tripped. The nominal rope diameter shall be at least 6 mm. The rope shall be tensioned by a tensioning pulley. During the engagement of the safety gear, the governor rope and its attachments shall remain intact, even in the case of a braking distance greater than normal. The rope shall be easily detachable from the safety gear.

h.) Automatic Rescue Device (ARD) & Manually Rescue operation:

ARD with batteries shall be provided for the lift other than FIRE lift, for rescue of passengers, in event of power failure. Manually Rescue operation for rescue of passengers, in event of power failure with suitable mechanism not necessarily with batteries.

i.) FIREMANSWITCH:

In a group of four lift bank two lift shall have a Fireman switch with glass front for access by the Firemen. The operation of this switch shall cancel all calls to this lift and will stop at the next nearest landing if traveling upwards. The doors will not open at this landing and the lift will return to the ground floor. In case the lift is traveling downwards when the fireman's switch is operated it will go straight to the

ground floor bypassing all calls enroute. The emergency stop button inside the car shall be rendered inoperative.

The fireman's switch shall be located adjacent to the lift opening at the lowest terminal floor and shall be at a height of approximately 2mtr above the floor level.

j.) Lift Retiring Cam:

Retiring cam essentially consists of an electromagnet or an electric motor and a ramp or cam which actuates the electromechanical lock in order to unlock the landing doors. When the roller of landing door electromechanical lock is pressed by the retiring cam plates the door will be unlocked.

To protect against the risk of failing, it shall not be possible in normal operation to open a landing door (or any of the panels in case of multipanel door) unless the car has stopped or is on the point of stopping, in the unlocking zone of the door. In the case, of power operated car and landing doors operating simultaneously, the unlocking zone may to a maximum of 0.35 m above and below the landing level.

In general, every passenger lift having manually operated landing doors and more than two stops shall have a retiring cam to operate landing door electromechanical locks. However, those electromechanical locks

in which the landing doors cannot be unlocked from a landing even if the car is standing behind the landing except with the help of special key, do not require a retiring cam.

k.) DOOR HANGERS AND TRACKS:

The car and the landing door shall be provided with two-point suspension sheave type hangers complete with tracks. Sheaves and rollers shall be steel with molded nylon collar and shall include shielded ball bearings. Tracks shall be of suitable steel section with smooth surface. The landing doors shall be complete with headers, sills, frames etc. as required.

2.4.11) CONTROLLER:

The lifts shall have microprocessor based, quadrupling, full collective controlled AC variable voltage variable frequency (ACVVVF) drives with closed loop control system. The drive system shall control the starting, stopping, direction of motion, running of the lift motor and application of the brake and/or safety devices in the event of power failure or any other emergency. It shall be so designed as to ensure a smooth and constant acceleration and retardation under all operating conditions.

The controller shall be compatible for remote monitoring by EMS system. The controller shall be wall/floor mounted, vertical, totally enclosed cubicle type with

hinged doors on the front to provide easy access to all components in the controller. The cubicle shall be well ventilated such that the temperature inside never exceeds the safe limits of the components at ambient room conditions in the machine room.

The Controller shall be complete with built in protection against the following:

i. Over current
ii. Under voltage
iii. Overvoltage
iv. Single phasing
v. Phase reversal
vi. Earth leakage

The controller shall be designed to cut off the power supply, apply the brake and bring the car to a rest in the event of any of the above failures occurring.

The tenderer/bidder shall state clearly the forms of protection provided for each equipment.

2.5.) CAR & HOIST WAY OPERATIONS:

The equipment shall be complete with electric door operator with AC VVVF drive/DC drive for opening and closing of Car & Hoist way landing door with close loop. The equipment shall consist of a motor on the lift car to operate the door when the car is stopping at a landing. The Car & Hoist way doors shall be mechanically connected such that both move simultaneously for opening and closing.

The Hoist way landing door shall be provided with an interlock such that:

i. It shall not be possible for the car to be started or kept in motion until all the landing doors and the car door are locked in the closed position.
ii. It shall not be possible to open the landing door from the landing unless the lift car is within the particular landing zone.
iii. The car doors & Hoist way landing doors open automatically as the car is stopping at a landing. The closing of the car and landing door must occur before the car is set in motion.

2.6.) OPERATION BUTTONS & INDICATIONS:

The following operation buttons and indications shall be provided:

2.6.1) Car operating panel:

Stainless steel panel (COP) of suitable thickness flush mounted shall be provided on both side of the door having:

i. LED illuminated push buttons or touch sensitive type buttons corresponding to the floors served. Also all the buttons on the COP shall have Braille inscription.
ii. Door open button.
iii. Door Close button.
iv. Emergency alarm button
v. Two position key operated switch for 'with attendant' and 'without attendant's operation.
vi. Ventilation fan ON/OFF switch with auto OFF when car is in parking mode/there are no calls to attend after 120 sec.
vii. Built in intercom of the hands free type.
viii. Dynamic car direction display (scrolling arrow)
ix. Digital car position indicator with feature to display Overload warning indicator, Out of service display, Lift Under maintenance display

2.6.2) At Landings:

The landing fixtures shall be recess mounted on a base junction box in the wall by the side or on top of landing doors as required.

Each landing fixtures shall consist of micro touch type landing call buttons or touch sensitive type with illuminated call acknowledge signal and illuminated dot matrix type car position indicators on separate stainless steel face panels with brush /hairline finish. The call buttons shall have Braille inscription. At every landing arrival digital car position indicator with gong in indication shall be provided.

The following landing fixtures shall be provided for each lift:

I. Lowest floor
   - Up call button
   - Digital car position indicators
   - Travel direction indicators
   - Manual by pass door key switch for lift landings.

II. All floors other than lowest and top most floors
   - Button up and down call buttons
   - Travel direction indicators

- Digital car position indicators
- Manual by pass door key switch for lift landings.

III. The top most floor

- Down call button
- Travel direction indictors
- Digital car position indicators
- Manual by pass key switch for lift landings.

In addition of above the following combined car position indicator landing fixtures fabricated out of CRCA sheet powder coated with S.S. face plate or as per manufacturer's standard shall be mounted on wall with appropriate height for clear visibility to users.

I. Lowest ground floor.

- Digital car position indicators
- Travel direction indicators (Up & Down)
- Other accessories & wiring etc.

II. Upper ground floor.

- Digital car position indicators
- Travel direction indicators (Up & Down)
- Other accessories & wiring etc.

2.7.) Control Cabinet (Panel) Construction Feature:

i. Control cabinets shall be sheet steel enclosed and shall be dust weather and vermin proof type Sheet steel used shall be of adequate thickness and properly braced to prevent wobbling.

ii. Control cabinets shall be free standing floor mounting type with anti-vibratory pads.

iii. Control cabinets shall be provided with a concealed hinged door with padlocking arrangement.

iv. All doors, removable covers and plates shall have gasket all around with neoprene gaskets, louvers when provided shall have screens and filters. The screen shall be of fine wire mesh.

v. All sheets steel work shall be given standard seven tank treatment and powder coated both inside and outside.

2.8.) Cabinet Internal wiring:

i. Control cabinets shall be supplied completely wired ready for Dept. /Users external connection at the terminal blocks. All wiring shall be wired with copper conductor preferably with FRLS properties of adequate sizes to suit the rated circuit current.

ii. The control alarm and indication circuits shall be wired as per manufacturers standards.

iii. Identification ferrules, marked to correspond with the wiring diagram shall be fitted at both ends of each wire Ferrules shall be provided.

iv. All wiring shall be neatly bunched and dressed without affecting access to equipment mounted within the cabinet. Wiring trough shall be provided for vertical cabinet wiring and for interconnecting wire between front and rear section of the cabinet.

v. Terminal blocks shall be numbered for identification and grouped according to function.

vi. **Labels:** All door mounted equipment as well as equipment mounted inside the control cabinet shall be provided with individual labels, with equipment designation engraved. Also the control cabinet shall be provided on the front with a label engraved with designation of the control cabinet as furnished by Engineer-in-charge. Labels shall have white letters or black or dark blue background as per manufacturer standard.

vii. **Earthing terminals:** Control cabinet shall be provided with two separate earthing terminals suitable to receive earthing conductors as per incoming cable size.

2.9.) Earthing:

The equipment supplied shall be earthed with the following arrangement as per provisions of Indian electricity rules/Act.

2.9.1) For equipment grounding the following sizes of copper conductor shall be used. The grounding pads and clamps provided shall be suitable for these conductors.

i. Machine of rating 20 KW to75KW–25 x 3mm tinned copper strip
ii. Machines of rating upto20KW-8 SWG tinned copper conductor.
iii. Control panel – As per incoming cable size.

2.9.2) Two independent grounding pads at appropriate end shall be provided on the frame of motors, winding machine, the frame of the control panels etc.

2.9.3) The exposed metal parts of electrical apparatus installed in a lift car shall be sufficiently bonded and earthed.

2.9.4) One side of the secondary winding of all transformers and their cases shall be earthed.

2.9.5) Flexible and screwed conduits shall be properly earthed.

3.) INSPECTION AND TESTING AT MANUFACTURERS WORKS:

All the materials & equipment used shall be new and of tested quality. Contractor shall ensure that the material equipment furnished confirm to requirements of the specification and in compliance with standards and codes.

The particulars and procedures of the particulars test shall be submitted to Dept.s.

The dept. representative shall be given full access to all tests adequate time prior to dispatch, the manufacturers shall inform the dept. so that if the dept. so desires his representatives can witness the tests.

3.1 Test at manufacturer's works:

Routine/functional simulated test as per IS standard & other standards as applicable on ARD & controller. Manufacturers test certificate for type test to be submitted for approval. For imported Lift, visual inspection at manufacturer's works or warehouse shall be carried out.

3.2 Tests at Site:

After assembly and erection at site, the lift shall be tested at site before it is put into normal service

The contractor shall be fully responsible for carrying out all the tests including following as listed below in addition to the relevant Indian Standards.

i. Leveling tests
ii. Safety gear test
iii. Contract speed
iv. Lift balance.
v. Car and landing doors locks.
vi. Controller operation.
vii. Normal terminal stopping switches.
viii. Final terminal stopping switches.
ix. Earthing
x. Service temperature rise test.
xi. Over load test.

The reports of the aforesaid tests shall be submitted to the Engineer-in-charge. The contractor shall have to obtain necessary clearance from the lift inspector and fire brigade authorities after the complete installation. It will be the responsibility of the lift contractor to get the installation inspected and passed by the Government Inspector for lifts. Any modification as suggested by inspector for lifts shall be attended by the lift contractor at no extra cost to the department.

4.) **Drawings & data:**

After award of work, the bidder shall furnish the following drawings and data for scrutiny. All the comments on drawings shall be incorporated without financial burden to department.

i. Control cabinet general arrangement drawing showing plan, front view, and foundation details, inside view, terminal block location etc.
ii. Schematic wiring diagram of the control cabinet.
iii. Bill of material listing, equipment designation, makes type rating etc. of the various equipment mounted on the control cabinet.

Part - III : Erection Specifications

a.) The contractor shall at his own expense arrange for the safety provisions (as per statutory regulation, CPWD Safety code, I.S recommendations, regulations under factory act, wherever applicable and instruction issued from time to time) in respect of all labour employed by him directly or indirectly for the installation of this lift.

b.) The contractor shall provide necessary barriers warning signs and other safety measures etc. wherever necessary so as to avoid accident during erection. In case of default, appropriate recoveries, as per rules, will be made from contractor. The contractor shall also indemnify Dept. /User against clauses for compensation arising out of his negligence in this regard.

c.) Inspection of site: The contractor or his representative shall be deemed to have inspected and examined the site and surroundings before submitting his tender, and shall obtain the necessary information as to risks, contingencies and other circumstances which may influence or affect his tender.

d.) Superintendence and labour: The contractor shall provide supervision of erection which shall include without limitations:

e.) The employment of a competent erection superintendent who shall be constantly at the site and shall give his whole time to the superintendence of the erection and commissioning of the works and whose duties shall include supervision of unloading, assembly installation, repair and replacement of any damaged components, and field alterations required to correct errors in detailing of fabrication, and operating adjustments.

The employment of sufficient number of competent assistants to the erection superintendent to provide supervision of the number of working shifts per day and days per week necessary to complete the work within the time specified.

The contractor shall employ only such persons who are careful, skilled and experience in their several trades.

1.) **Notices:**

Any notice, order, direction or other communication to be given to the contractor under any of the provisions of the work order shall without limitation be conclusively deemed to have been received by the contractor if delivered or mailed to the contractor at the address mentioned in the work order or to the contractor's last known place of business or residence or to this superintendent or foreman.

2.) **Sub-Contractors:**

The contractor shall not sub-contract the whole of the erection work. The contractor shall not sublet any part of the erection work without the written consent of the department. The contractor shall be responsible to the Dept. for all the work of the sub-contractors.

3.) **Co-ordination of work:**

The contractor shall plan his operation so as to avoid interference with the operations of the Dept., the general contractor, or of other contractor or sub-contractors at the site. The contractor shall organize his work to suit the timings shown on the construction schedule or revision thereto issued by the Dept..

4.) **Service supplied by the Dept. during erection:**

No services will be provided by department. The contractor will have to get power from supply authority operating in the area. Open space for storage can be provided by department as per standards.

5.) **Site handling and storage of materials and equipment's to be incorporated in the work.**

The contractor shall deliver at site all material and equipment to be incorporated in the works, unload and place in the storage at location designated by the Dept. at site. The contractor will be responsible for adequate arrangement for storage of these materials and equipment until such time as required for site assembly and erection.

The contractor shall be responsible for loading and movement from place of temporary storage to the point of installation of the works.

The contractor shall unload all materials and equipment at the point of installation of work.

6.) **Equipment and service provided by the contractor:**

The equipment's and services provided by the contractor and his sub-contractor shall include but not be limited to the supply, if required, blocking scaffolding, indoor storage for perishable material, locked storage for tools, welding rods and, welding equipment, blasting equipment, miscellaneous seals, and adequate materials

All items of civil works connected with the installation, commissioning of lifts under this contract as listed, below shall be carried out by the lift contractor. Any breaking, chasing etc. required to be to be done by the lift contractor shall have to be got approved by the department in advance and all such breaking, chasing etc. shall be made good to original finish by the lift contractor at his own cost.

They are

a.) All structural steel members like steel beams for machine sheave, bearing plate, lifting beam/hook, buffer channel, fascia plates, pit ladder etc.

b.) Foundation for machine, beams, buffer etc.

c.) Making pockets for grouting rag bolts etc.

i. Car, counter weight, steel angles etc.
ii. Hall position, indicator boxes, push button boxes, fire alarm box, aluminum landing sill etc.
iii. Control panel, selector, governor, AC motor.

iv. Any other items of civil works other than above but required for the job.

7.) **Transportation of erection equipment and materials to the site:**

The contractor shall be responsible for all transportation of all erection equipment and materials to and fro from the site. Contractor has to make necessary arrangement for lifting of machine and other associated equipment from site store to machine room.

8.) **Access road, and temporary buildings:**

The contractor shall have the reasonable use of existing roads at the site. The contractor may use the main roads into the site for vehicle storage, provided that it does not interfere with access by other contractors to the plant.

The work will regulate the entry of vehicles into the plant. Alltemporary buildings, tool sheds, offices etc. shall be provided by the contractor.

9.) **Insurance:**

Lift materials covered under this contract shall be insured from first dispatch from factory until the lift materials are installed and handed over to the department.

10.) **Accommodation & Travel :**

The contractor's lump sum erection prices shall include all travelling, transportation and accommodation cost of all his site staff including supervisory cost excluding service tax.

11.) **Erection:**

The contractor shall take over the machine room & hoist way etc. He shall install the electric lift complete with all structures, lift car with all auxiliaries, driving and control system, safety and protective devices, landing doors, indicating lamps and push button stations for all the floors, electric cabling wring and all other accessories and auxiliaries.

CHAPTER 8
LT SWITCHGEAR PANEL

A.) LT PANEL

1.) SCOPE:

This specification covers the technical requirements of design, manufacture, testing at manufacturer's works, supply, installation, testing and commissioning of LT Switchgear Panel assembly.

2.) STANDARDS & CODES:

The equipment covered under this specification shall conform to the latest revisions of relevant Indian and International Standards some of which are listed below:

IS/IEC 61439	Low voltage switchgear and control Gear assemblies
IS /IEC 60947	General requirements of Switchgear and Control Gear for Voltage not exceeding 1000 / 1200V AC
IS 2705 1992	Current transformers
IS 694 1990	PVC insulated cables for voltages including 1100 V with Copper and Aluminum Conductor).
IS 5082	Electrolytic Aluminum Busbar, Trunking system, Rod tubes & sections for Electrical Purposes
IS 13779 1999	AC Electric Meters / Static Meters.
IEC 60529	Degree of Protection

3.) TECHNICAL PARAMETERS:

A.	System Details		
i)	System Voltage	:	415V +/- 10% 3 phase 4 wire solidly grounded network
ii)	Frequency	:	50Hz +/- 3%
iii)	Control Supply	:	415/230 Volts AC +/- 10% (tapped from phase & neutral)
B.	Air Circuit Breakers		
1	Standard Applicable (Isolation function with the test for line/ load inter-changeability)	:	IS : 60947

2	Rate insulation voltage (Ui)	:	1000 Volts
3	One minute dry withstand test voltage	:	2500 Volts
4	Service (Ics) Breaking capacity at 415V, 50Hz	:	As per BOQ
5	Making capacity	:	As per BOQ
6	Momentary short time current rating (rms) for 1 sec. (Icw)	:	As per BOQ
7	Rating of circuit breaker	:	As per bill of material
8	Type of protection relay/release	:	as specified in BOQ
9	Type of tripping mechanism	:	Shunt trip (Electrical)/ Low Power release as specified in BOQ
10	Normal voltage of tripping coils	:	415/ 230 V AC +10% - 15% or as specified in BOQ
11	Voltage for spring charging motor (for stored energy mechanism)	:	230 V AC +10% - 15%
12	ACB Breaker operations	:	Electrically operated with draw out type or as specified in BOQ
13	Electrical Closing and tripping switch	:	By spring return sequence locking type ODS switch
14	Features of circuit breaker	:	Trip free and anti-pumping
15	Method of closing	:	Electrically operated spring charged (normal), mechanical (emergency).
16	Communication capability	:	All ACBs shall have RS 232/ RS 485 port
C	MCCBs		
1	Standard Applicable (Isolation function with the test for line/ load inter-changeability)	:	IS : 60947
2	Rate insulation voltage (Ui)	:	690 Volts
3	One minute dry withstand test voltage	:	2500 Volts
4	Service (Ics) Breaking capacity at 415V, 50Hz (Ics = 100% Icu)	:	As per BOQ
5	Making capacity	:	As per BOQ
6	Rating of circuit breaker	:	As per bill of material

7	Type of protection relay/release	:	as specified in BOQ
8	Type of tripping mechanism	:	Low power release or specified in BOQ
C	SWITCHGEAR CUBICLES:		
1	Design voltage of switchgear bus	:	415 Volts
2	Clearances (Except Component terminals). a) Between phases b) Between live parts and earth	: : :	 As per IS/IEC
3	Degree of protection (min.) & IK rating	:	IP 42 for indoor Panels & IP 55 for outdoor Panels. IK 10
4	Form of separation	:	As per BOQ
5	Power frequency withstand voltage for complete cubicle	:	2.5KV
6	Method of circuit grounding	:	Solid/flexible copper
7	Space heater details Voltage Ratings Numbers d) Type of controls	 : : : :	 230 V Adequate capacity one per Shipping section Thermostat with MCB.
8	Bus bars		
8.1	Material	:	As per BOQ
8.2	Design	:	Rectangular cross section suitable to take full load current and fault level indicated in BOQ.
8.3	Continuous rating of main bus bars	:	As Per SLD
8.4	Continuous rating of feeder bus bars	:	As Per SLD
9	Temperature rise of the bus bar over the specified design ambient temperature	:	As per IS/IEC.
10	One minute power frequency withstand voltage	:	2.5 KV

11	Ground Bus		
11.1	Material	:	As per BOQ
11.2	Cross Section	:	Sizing as per prospective earth fault current.
12	C.T. Mountings	:	At rear side of the panel
13	Control wire size (Min) :		FRLS PVC Cu wires
13.1	CT circuit	:	2.5 sq.mm. copper
13.2	AC Voltage circuit	:	1.5 sq.mm. copper
14	Painting Procedure	:	With 9 tank sheet treatment and powder coating as per shade indicated in BOQ.
15	Cable entry	:	Bottom / Top as per site condition.
16	Cable compartment door	:	To be provided with hinged doors and knobs
17	Feeder compartment	:	To be provided with hinged doors and knobs
18	Design of switchgear	:	Incomer and bus coupler shall be single tier, outgoing in two tier
19	Quantity	:	As Per SLD

4.) **CONSTRUCTION FEATURES:**

The LT switchboards shall be with compartments housing circuit breakers, Control gear, relays, bus bars, controls and other items of equipment as per BOQ. The switchboards shall be designed & manufactured by panel manufacturer or authorized channel partner as per OEM design.

The Switchboards shall be metal clad totally enclosed, floor mounted free standing type of modular extensible design suitable for indoor mounting. The LT panel cubicles shall have structural steel frame work. It is enclosed on all sides and top by CRCA sheet steel of minimum thickness of 1.6 mm.

Intrinsic load bearing member should have min. thickness of 2 mm. The gland plates shall be 3 mm thick CRCA sheet.

The overall height of the switchboard including height base frame of shall be limited to 2475 mm for all the busbar ratings and type of switchboards. The height of the operating handle, push buttons etc. shall be restricted between 300 mm and 2000 mm from finished floor level.

All the doors and covers shall be with full neoprene gasket to prevent any ingress of dust. Door hinges shall be concealed type for compartment doors. However, for

wire ways, busbar chambers covers and dropper chamber covers shall be bolted type for safety purpose.

Cable compartments shall be of adequate size for easy termination of all incoming and outgoing cables entering from bottom or top. The construction shall include necessary and adequate and proper support shall be provided in cable compartments to support and clamping the cable in the cable alley / cable chamber.

The MCCB's and Switch Fuse units can be arranged in multi-tier formation. Air Circuit Breakers shall be arranged in Single tier for incomer feeder & not more than two ACBs in each outgoing feeder vertical section.

All Outgoing MCCB/Motor Feeders shall be fixed type mounted on a single base Plate. All components like, circuit breakers, switches etc. shall be compatible with the short-circuit levels.

LED indicating lamps shall be SMD type preferably. All CTs & PTs shall be resin cast unless specified otherwise or as approved by the customer. All relays, meters & switches shall be flush mounted. All metering equipment shall be digital unless specified otherwise in the BOQ.

All holes in metalwork shall be protected by substantial grommets or bushes to protect wiring passing through them. The arrangement of controlling switches in the LV panels and their marking shall be such that these are prominent, easily identifiable and accessible.

Single line power / control diagrams shall be placed at the back of door or other accessible locations in the panels or near to panel with complete details as required. The Switchboard shall be provided with “Danger notice plate” conforming to relevant Indian Standards.

5.) **BUS BARS:**

The busbars shall be of hard drawn high conductivity Cu/Al of rectangular cross sections suitable for full load current. The busbars shall be colour coded using identifying colour rings at regular interval. Red, Yellow & Blue colour shall be used for phases & Black for neutral for each shipping section of panels. The earth Busbar shall be identified with Green color rings at regular intervals.

The Busbar sizes shall be determined taking into consideration the continuous rating and fault level indicated, as applicable, without exceeding the temperature raise limits as per IEC, over ambient temperature.

Bus bar supporting systems shall withstand the short circuit forces circuits, without deflection or deformation. The busbars shall be supported at regular intervals using non-tracking SMC or DMC insulators as per the tested design.

Direct access to, or accidental contact with busbars and primary connections shall not be possible.

The busbar system may comprise of a system of main horizontal bus bars and auxiliary vertical bus bars run in busbar chamber on either side in which the circuit could be arranged with front access for cable entrances.

Auxiliary buses for control power supply, space heater power supply or any other specified service shall be provided. These buses shall be insulated, adequately supported and sized to suit specific requirement. Clearances between phases-phases, phase –Earth/ neutral should be in line with IS/IEC.

6.) **EARTHING:**

One Earthing terminals shall be provided on each side of switchboard. The Cu/Al earth bus size must be sized for prospective earth fault current. The earth bar shall be electrically continuous and shall run the full extent of each board as well as the same side as the cable entry. Each unit shall be constructed to ensure satisfactory electrical continuity between all metal parts which are not intended to be alive.

Suitable holes with bolts and nuts shall be provided at each end of earth bar of switchgear for connection to a main Earthing grid. The earth bar shall be accessible in each cable entering compartment either directly or through a branch extension to ground the cable armor and shields. Door earthing shall be provided for all feeder doors, rear doors and CBC doors with suitable size copper flexible wires.

7.) **INTERNAL WIRING:**

The internal wiring shall be FRLS PVC Cu wires of 1100/660V grade. Minimum size of conductor for power circuits shall be 2.5 sq. mm copper. All control wiring except CT secondary wiring shall be carried out with minimum 1.5 sq. mm Copper conductor. CT secondary wiring shall be carried out with 2.5 sq. mm copper conductor. All wiring shall be securely fixed and neatly arranged to enable easy tracing of wires.

All terminal blocks and wires shall be tagged for identification in accordance with IS 11353.All wiring for external connections shall be brought out to the individual terminals on a readily accessible terminal block. Clamp or screw type control terminal blocks shall be provided for outgoing control cables. Minimum 10% spare terminals shall be provided for future use. Control terminal block shall be separated from power terminal blocks by means of an insulating barrier.

8.) **SPACE HEATERS:**

Switchgear enclosures shall be equipped with space heaters of adequate capacity to maintain the internal temperature above the dew point to prevent moisture condensation within the enclosure. Space heater shall be rated for 230 Volts, single phase, 50Hz. A.C. supply. Differential Thermostats shall automatically control the space heaters. ON/OFF and protection should be through adequate rating of MCB for each space heater.

9.) **ILLUMINATION:**

Each vertical cable/ control compartment shall be provided with LED luminaire, provided with MCB of suitable rating operating on 230 volts, 1 phase 50 Hz AC supply and 5+15A socket with switch to be wired in each compartment.

10.) **NAME PLATE & LABELS:**

One name-plate giving designation of the switchboard shall be affixed prominently on top. Details of designation shall be specified.

Labels giving following details shall be affixed on each feeder panel: -

Feeder no as per feeder list

Equipment tag Number Description

Type of Unit (KW/KVA/AMP)

All components whether mounted inside the switchboard or on the door shall be permanently and clearly labeled with reference number and/or letter of their function. Labels for feeder panel designation shall be fixed on the front side of respective panels.

11.) **PAINTING:**

All steel work shall undergo a process of degreasing, pickling in acid bath, phosphating, passivating & shall be subjected to nine tank process and then Powder coated with approved shade as per BOQ.

12.) **INSPECTION AND TESTING:**

Inspection and testing of the panel shall be carried out at works of manufacturer in presence of Department representatives:

Inspection: The inspection shall consist of following, but shall not be limited to the same -

i. Appearance and construction.
ii. Dimensions, mounting details etc.

iii. Feeder arrangement and feeder details.
iv. Door alignment, gaskets etc.
v. Alignment of switch drive and handle.

12.1.) TESTS:

The following tests shall be carried out:

12.1.1) Insulation resistance:

The insulation resistance shall be measured between phases, between phase and neutral and between phase and earth. The insulation resistance shall be measured with 1000Volts megger, both before and after high voltage power frequency test. The insulation resistance shall not be less than three Mega-Ohm in any case.

12.1.2) High voltage power frequency test:

This test shall be carried out by applying a voltage of 2.5KV for one minute.

i. between all three phases and earth.
ii. between the phases.
iii. between phases and neutral.

12.1.3) Heat run test shall be carried out on the panel if specified in BOQ. The heat run test shall be carried out as one panel of each different rating. The selection of the panel on which heat run test shall be carried out shall be decided by Engineer-in-charge.

If the result of inspection and tests are not satisfactory, the defects shall be rectified and tests shall be repeated to entire satisfaction of Engineer-in-Charge without any extra charge to employer. The inspection and tests result shall be submitted in quadruplicate for engineer-in-charge approval.

All type test certificates conducted on similar type complete switchgear assembly as per IS/IEC 61439 shall be submitted during the drawing approval process.

13.) INSTALLATION OF SWITCHGEAR PANELS:

Installation, testing and commissioning at site of switchgear panel as per specification shall be carried out. The switchgears are to be installed on the grouted base frame on floor / over trench. Department shall approve the drawing of the base frame and including positioning, leveling, proper alignment of panel, inter-panel connection, extension of bus bars with all required accessories for grouting remaking it with PCC as per site. Necessary chipping and PCC work, for installation of switchgear panels, as directed by E-I-C at site, including all necessary anchor fasteners etc. complete.

MS channel (ISMC 100) required for installation of panel on cable trench including cutting of chequered plate cover etc. is included in the scope of work.

The following pre commissioning tests shall be carried out on the panels:

Electrical and mechanical operations of circuit breaker

i. Functional test of CB
ii. Insulation Resistance.
iii. Testing of relays/release
iv. Checking of all electrical connections, electrical and mechanical interlocks.
v. Inter changeability of breakers as desired by Engineer-in-Charge at site.

14.) **Drawings & operating manuals:**

The following drawings shall be submitted for Engineer-in-charge approval before taking up the fabrication:

Complete assembly drawings of the switchgear showing plan, elevation and typical sectional view.

Panel base plan showing locations of channel sills, foundation bolts and anchors, floor plans and openings.

Complete wiring diagram including terminal wiring designations.

Schematic control diagram both AC and DC for breaker control, interlocks, relays, instruments and space heaters.

Complete terminal block details, showing ferrule numbers wire destinations.

The following shall be submitted on delivery of panels:

i. 4 Nos. of installation and operation manual
ii. 4 Nos. of all as built drawings.
iii. 6 Nos. of operating handles.
iv. Reproducible drawings on Compact Disc.

B.) AUTOMATIC POWER FACTOR CONTROL PANEL (APFC) WITH CAPACITOR BANK

1.) SCOPE:

This specification covers supply, installation and testing of automatic power factor control panel (APFC) along with 415 Volts shunt capacitor bank. Associated minor civil works are included in the scope of this contract.

STANDARDS:

The equipment covered under this specification shall conform to the latest revisions of relevant Indian and International Standards some of which are listed below:

IS/IEC 61439	Low voltage switchgear and control Gear assemblies
IS 13340/IEC 60831	Shunt power capacitors of the self-healing type for ac systems
IS /IEC 60947	General requirements of Switchgear and Control Gear for Voltage not exceeding 1000 / 1200V AC
IS 2705 1992	Current transformers
IS 694 1990	PVC insulated cables for voltages including 1100 V with Copper and Aluminum Conductor).
IS 5082	Electrolytic Aluminum Busbar, Trunking system, Rod tubes & sections for Electrical Purposes
IS 13779 1999	AC Electric Meters / Static Meters.
IEC 60529	Degree of Protection

2.) CONSTRUCTIONAL DATA FOR APFC:

The APFC switchboards shall be with compartments housing Capacitor banks, circuit breakers, Control gear, relays, bus bars, controls and other items of equipment as per BOQ. The switchboards shall be designed & manufactured by panel manufacturer or authorized channel partner as per OEM design.

The Switchboards shall be metal clad totally enclosed, floor mounted free standing type of modular extensible design suitable for indoor mounting. The cubicles shall have structural steel frame work. It is enclosed on all sides and top by CRCA sheet steel of minimum thickness of 1.6 mm.

Intrinsic load bearing member should have min. thickness of 2 mm. The gland plates shall be 3 mm thick CRCA sheet.

The overall height of the switchboard including height base frame of shall be limited to 2475 mm for all the busbar ratings and type of switchboards. The height of the operating handle, push buttons etc. shall be restricted between 300 mm and 2000 mm from finished floor level.

All the doors and covers shall be with full neoprene gasket to prevent any ingress of dust. Door hinges shall be concealed type for compartment doors. However, for wire ways, busbar chambers covers and dropper chamber covers shall be bolted type for safety purpose.

Cable compartments shall be of adequate size for easy termination of incoming cables entering from bottom or top. The construction shall include necessary and adequate and proper support shall be provided in cable compartments to support and clamping the cable in the cable alley / cable chamber.

All steel work shall undergo a process of degreasing, pickling in acid bath, phosphating & shall be subjected to seven tank process and then Powder coated with approved as per BOQ.

By selection of 'mode selector switch (MSS)' in the panel it shall be possible to operate APFC either in 'auto mode' or full 'manual mode'.

For 'auto mode', 10/8 step power factor (PF) control relay unit to be provided in APFC incomer portion. This relay shall have following features:

Power factor indication, digital to indicate actual system power factor.

Power factor setting dial calibrated from about 0.85 lag to 0.85 lead.

Dead band feature (adjustable) to prevent hunting.

Under current blocking, to switch OFF all capacitors one by one and shutting down of relay, when load current is below 20% with appropriate indication available on the relay.

Low PF and high PF indication.

When the power factor falls below the setting, the capacitor bank shall be switched ON, in sequence at intervals of 4 to 8 seconds minimum and when the power factor rises above the setting, capacitor banks are switched OFF in sequence. The sequence of switching ON and OFF shall be as follows:

Switching ON: Bank 1, 2, 3.....8, 9, 10

Switching OFF: Bank 1, 2, 3..... 8, 9, 10

The relay shall provide feature to provide an adjustable delay of about 0-120 seconds from changeover from 'capacitor OFF' signal to 'capacitor ON' signal, to ensure the capacitor are fully discharged before they are switched in, to prevent dangerous transient over voltages.

The relay shall provide 'LED' indications, to indicate to the operator the full status of relay like auto-manual, load signal healthy and above the minimum operating threshold, low and high power factor, lest mode, indication for the bank switched ON and any other 'LED' necessary for operator convenience and safe/proper operation.

The relay shall be flush mounting type on the APFC door and shall have conveniently removable transparent glass or acrylic cover, also avoiding inadvertent/un-authorized tampering of relay controls, once set.

If mode selector switch is kept in 'manual' mode it shall be possible to switch the capacitor banks ON and OFF in any sequence, through push buttons provided for

each bank. Each bank shall also be provided with ON indication lamp. In the 'manual' mode the following features shall be present:

Between switching ON operation of banks there shall be time delay of about 70 seconds.

Similar time delay shall be present from bank switching OFF to bank switching ON to ensure full discharged capacitor condition, to prevent dangerous system disturbances.

The time delays as above shall be adjustable from 0-120 seconds.

A common indication lamp, 'ready for manual switching', dependent on the timer shall indicate to the operator the readiness of the bank for switching-ON.

The manual operation of APFC shall be available as described even in the case of failure of power control relay.

An emergency, stay put type mushroom-head push button 'emergency OFF' shall be available to de-energise all the contactors and also switch-OFF the incoming MCCB both in auto and manual position of mode selector switch.

The control voltage of APFC shall be 240 Volts A.C/110V D.C. MCB /fuses shall be used in the control circuits for protection and isolation.

SAFETY ANNUNCIATION FEATURES OF APFC PANEL:

The APFC shall have the following: -

Two tone hooter

Fault indication lamp

APFC out of circuit indication lamp

All located at the top portion of the panel.

If MCCB is kept OFF or trips during its operation, the hooter should come ON along with lamp and continue to operate till accept push button, present on the APFC, is pressed to cancel the audio/visual alarm. However, the APFC out of circuit lamp will continue to flash till the MCCB is closed and APFC is put in operation, drawing attention of operators to the situation.

The flashing feature is to be derived by adjustable cyclic timer - electronic type, 0.6 seconds to 60 seconds set at 2 seconds.

Audio/visual annunciation facility with an electronic hooter and two lamps shall be provided as part of central control console. Necessary terminals in the APFC shall be foreseen for this purpose.

3.) **CONSTRUCTIONAL DATA FOR CAPACITOR BANK:**

The capacitor banks shall be provided with suitable capacity as per S.O.Q. Each capacitor unit shall be a three phase unit suitable for delta connections. Each capacitor unit shall consist of capacitor elements connected in parallel. Each unit shall be protected by internal fuse.

The capacitor unit shall be housed on a leak proof bank. The capacitor shall be MPP-H type with 7% detuned reactor or as per manufacturers standard material and then dried both under high degree of vacuum. The capacitor unit shall be provided with the discharge resistors to reduce the phase voltage to 50 Volts

within one minute. Each capacitor unit shall be provided with 2 nos. earthing terminals.

The capacitor unit shall be banked together. They shall have common base frame and a cover shall be provided to prevent the accidental contact with the terminals. Adequate space shall be provided for connecting each capacitor unit.Each capacitor unit shall be provided with a rating plate. The capacitor unit shall be suitable for indoor application. Electromechanical relays used shall not be plug in type.

4.) **INSPECTION AND TESTING:**

Inspection shall consist of the following, but shall not be limited to the same -

Appearance and construction.

Dimensions, mounting details.

Leakage container and at the bushing.

4.1.) TESTS:

The following routing tests shall be carried out as per relevant IS/IEC

i. Test for output and capacitance.
ii. Voltage test between terminal and container (for capacitor unit).
iii. Voltage test between terminal and earth (for capacitor bank).
iv. Insulation resistance test.
v. HV test
vi. Test for efficiency of discharge device.

If the results of the inspection and tests are not satisfactory, the defects shall be rectified and tests shall be repeated to the entire satisfaction of department without extra charges whatsoever.

The inspection & test results shall be submitted in quadruplicate for Department's approval.

5.) **INSTALLATION OF SWITCHGEAR PANELS:**

Installation, testing and commissioning at site of APFC panel as per specification shall be carried out. The switchgears are to be installed on the grouted base frame on floor / over trench. Department shall approve the drawing of the base frame and including positioning, leveling, proper alignment of panel, inter-panel connection, extension of bus bars with all required accessories for grouting remaking it with PCC as per site. Necessary chipping and PCC work, for installation of switchgear panels, as directed by E-I-C at site, including all necessary anchor fasteners etc. complete.

MS channel (ISMC 100) required for installation of panel on cable trench including cutting of chequered plate cover etc. is included in the scope of work.

The following pre commissioning tests shall be carried out on the panels:

i. Electrical and mechanical operations of circuit breaker
ii. Functional test of CB
iii. Insulation Resistance.
iv. Testing of relays/release
v. Checking of all electrical connections, electrical and mechanical interlocks.
vi. Inter changeability of breakers as desired by Engineer-in-Charge at site.

6.) **DRAWINGS:**

The following shall be submitted in quadruplicate for E-I-C's approval: -

i. Guaranteed technical particulars for capacitors.
ii. Dimension drawings and foundation details.
iii. Test certificate for type tests.

C.) AMF PANEL

1.) Construction Features:

The construction features shall generally comply with L.T Panel specifications

2.) AMF Panel Components:

The AMF panel shall be provided as per Drawing along with all other details as Required

Battery charging arrangement with trickle & boost mode, DC ammeter & Voltmeter etc. – 1 nos. (1no. for Each DG set starting batteries)

Microprocessor based AMF controller comprising of, but not limited to, following:

i. Mains supply failure monitor (voltage sensor).
ii. Supply failure timer.
iii. Restoration timer.
iv. Control unit incorporating 3 impulse automatic engine start/stop & failure to start lockout.
v. Impulse counter with locking & reset facility.

AMF Panel control supply will be 110 V DC or as specified in the BOQ and is to be tapped from 110 V DC system of adjoining substation and suitable power cable & control cables to be involved in the scope.

i. Protection:
ii. Field failure relay
iii. Reverse power relay
iv. Earth fault relay

3.) Metering:

2 Nos. 0-500V, 144 sq.mm. voltmeter with 3 way & off selector switches.

1 No. static energy meter

1 No. energy analyzer on load side for monitoring voltage, current, KW, KWh,

pf. Frequency etc.

4.) Push button & switches.

Auto / manual / test mode selector switch

Emergency stop push button.

Hooter accept push button.

Cluster LED indication lamps, 110 V DC.

RYB – Mains ON.

RYB- DG Set ON.

Load on Mains.

Load on DG Set.

DG Set on Test mode.

Trip Circuit Healthy.

12 window Annunciation panel – 110 V DC: -

Engine fails to start.

High water temperature.

Low lub oil pressure.

Engine over speed.

Generator under voltage.

Generator over voltage.

Generator under frequency.

Generator over frequency.

Generator over load.

Generator loss of excitation.

Battery Charger fail.

Canopy temperature high.

Hooter with 110 V DC supply.

Necessary auxiliary contactors for contact multiplication.

Necessary MCB's for supply to canopy lighting, battery charger etc.

The components which are not indicated above, but are required for the functioning of AMF Panel shall be included in the scope of work.

5.) **OPERATIONAL LOGIC:**

The automatic Mains Failure panel should be able to run the DG set in following modes:

i. Auto Mode
ii. Test Mode
iii. Manual Mode.

5.1.) Auto Mode:

If the Mains are absent or Mains fails, the controller starts the engine after a programmable delay and transfers the load to the generating set. If the Mains restores, the load is connected back to the Mains, after a programmable delay and the generating set stops after cooling down time.

In the auto mode, when the "Mains supply" fails the 'Mains supply failure monitor' (Voltage sensing) & mains failure timer operates after a preset time of approx. 10 seconds (adjustable), this activates the 3 impulse auto engine start / stop control

unit. This control unit shall give these starting impulses with an interval of 1-5 seconds. If the engine starts with the first impulse, the control unit should be shut off and if not, the control unit should give further two impulses during which time, if the engine does not start, the control unit shuts off the start signal & activate the audio visual alarm for 'set fails to start'.

On starting of the engine, the alternator ACB should close automatically after sensing the proper voltage level, frequency etc. If at any time the voltage & frequency is not as per the required conditions, the alternator ACB should automatically trip, disconnecting the DG set from the load.

When the Main supply is restored, the 'restoration timer' should operate and after the pre-set time, the load should automatically get transferred to the mains (transfer time to be selectable) and the alternator should shut down thereafter with adjustable (0 to 5 min.) time delay.

5.2.) Test Mode:

By operating the selector switch in 'Test' mode, the conditions of Mains Failure shall be simulated as per point a.i above.

Engine shall build up voltage but the set shall not take load by closing alternator ACB.

During the process of testing, if the mains supply fails, the alternator should be able to feed the load through auto closing of the alternator ACB.

Bringing the mode selector to 'Auto' position shall shut down the set as per point a.iii above, provided mains supply is ON. If the mains supply is not available at that time, the alternator shall take the load as in point b.iii above.

5.3.) Manual Mode:

In a manual mode, it shall be feasible to start up DG set by operator on pressing the 'Start' push button.

Three attempt starting facility shall be operative for the start-up function.

Alternator ACB closing and trip operations shall also be through operator by pressing appropriate button on the ACB and the closure shall be feasible only after alternator has built up full voltage. If the load is already on mains, pressure on close button will be ineffective.

Engine shut down, otherwise due to faults, shall be manual by pressing a 'stop' push button.

6.) **INSPECTION AND TESTING:**

Inspection and testing of the panel shall be carried out at works of manufacturer in presence of Department representatives:

Inspection :The inspection shall consist of following, but shall not be limited to the same -

i. i) Appearance and construction.
ii. ii) Dimensions, mounting details etc.

iii. iii) Feeder arrangement and feeder details.
iv. iv) Door alignment, gaskets etc.
v. v) Alignment of switch drive and handle.

6.1.) TESTS :

The following tests shall be carried out:

6.1.1) Insulation resistance:

The insulation resistance shall be measured between phases, between phase and neutral and between phase and earth. The insulation resistance shall be measured with 1000Volts megger, both before and after high voltage power frequency test. The insulation resistance shall not be less than three Mega-Ohm in any case.

6.1.2) High voltage power frequency test:

This test shall be carried out by applying a voltage of 2.5KV for one minute.

i. between all three phases and earth.
ii. between the phases.
iii. between phases and neutral.

6.1.3) If the result of inspection and tests are not satisfactory, the defects shall be rectified and tests shall be repeated to entire satisfaction of Engineer-in-Charge without any extra charge to employer. The inspection and tests result shall be submitted in quadruplicate for engineer-in-charge approval.

6.1.4) All type test certificates conducted on similar type complete switchgear assembly as per IS/IEC 61439 shall be submitted during the drawing approval process.

7.) **INSTALLATION:**

Installation, testing and commissioning at site of switchgear panel as per specification shall be carried out. The switchgears are to be installed on the grouted base frame on floor / over trench. Department shall approve the drawing of the base frame and including positioning, leveling, proper alignment of panel, inter-panel connection, extension of bus bars with all required accessories for grouting remaking it with PCC as per site. Necessary chipping and PCC work, for installation of switchgear panels, as directed by E-I-C at site, including all necessary anchor fasteners etc. complete.

MS channel (ISMC 100) required for installation of panel on cable trench including cutting of chequered plate cover etc. is included in the scope of work.

The following pre commissioning tests shall be carried out on the panels:

i. Electrical and mechanical operations of circuit breaker
ii. Functional test of CB
iii. Insulation Resistance.
iv. Testing of relays/release
v. Checking of all electrical connections, electrical and mechanical interlocks.
vi. Inter changeability of breakers as desired by Engineer-in-Charge at site.

8.) **Drawings:**

The following are to be furnished and got approved from the department by the successful bidder, before taking up manufacturing:

i. G.A. diagram of AMF panel.
ii. Schematic diagram of AMF Panel and control circuit.

Control cable schedule between DG set & AMF Panel.

D.) DG SYNCHRONIZATION PANEL

1.) SCOPE:

This specification covers the technical requirements of design, manufacture, testing at manufacturer's works, supply, installation, testing and commissioning of DG synchronization panel suitable for automatic start of DG sets, automatic synchronization, automatic load sensing, automatic load sharing, shut down of DG sets as per load sensed & programmed logic etc. for DG sets.

The DG synchronization panel shall comply with general Panel construction specification indicated in Section 1 of this document.

2.) DG SYNCHRONIZATION PANEL COMPONENTS:

i. Programmable Logic Controller (PLC).
ii. 2 nos. of 415V,1250A, FP, EDO ACB, DG incomer breakers.
iii. 415V, 2500A, TPN tinned Cu bus bar.
iv. 2 nos. of 415V, 2500A, FP, EDO ACB, outgoing breakers.
v. DG protection relays & annunciation Panel for each DG incomer feeder.
vi. The DG Synchronization Panel shall be complete with all Auxiliary Relays, timers, Contactors, Programmable Logic Controller, control wiring with 1.5 sq. mm PVC insulated 1100 V grade copper conductor wires, interconnections etc. as required as per operation logic indicated in the specifications and OEM recommendations.

3.) PROGRAMMABLE LOGIC CONTROLLER (PLC) :

The entire operation of the DG power generation system will be controlled automatically through a PLC. The PLCs shall be state of art equipment using latest technology and of most rugged and reliable design. Since they shall be operating in the harsh & unfriendly environment of DG room, they will be suitable to operate trouble free in those conditions. The chosen equipment should be able to withstand high temperature, humidity and voltage fluctuations, thus making it suitable for the operating conditions described above.

The Automatic PLC System basically shall consist of:

i. Main processor unit.
ii. Power supply for unit
iii. Mounting chassis.
iv. Digital input module 32 channel.
v. Digital output module 32 channel.
vi. EEPROM for CPU.
vii. Analog input module 8 channel.
viii. Window based graphic software.

ix. Package with PC to PLC Communication.

4.) FUNCTIONS / FEATURES OF PLC SYSTEM:

In general terms the following will be the functions of PLC:

The system will directly accept CT & PT signals for electrical parameters monitoring and control.

Depending upon the load requirement, starting and stopping of DG sets.

Automatic selection of DG for stopping / tripping as per load & pre-programmed logic.

Monitoring of electrical parameter per DG, Voltage, Frequency, reactive load, active load, energy produced, voltage error (%), frequency error and phase angle error etc.

Status and control of outgoing breakers.

Backup protection electrical / mechanical by time delay tripping of DG sets.

Data acquisition system will have incorporated with the system for the purpose of recording and display of all important and critical parameters of the engine, alternator and system as such in totality.

“B” check alarm after each DG complete 300 hours of running for proper maintenance.

Tripping of less priority loads in the plant in case of under frequency of bus both in isolation as well as synchronized mode.

PLC system shall have provision to test the DG in auto mode without closing the breaker to do the routine electrical / mechanical testing of set without interruption of power generation.

Operation of DG sets shall be monitored and controlled by a Programmable Logic Controller (PLC) which shall actuate and control Auto Mains Failure, Auto Changeover / Interlocking and Auto Load Management functions along with fault annunciation, alternator control and protection. The PLC Panel shall be provided with a total manual over-ride. The PLC shall ensure providing suitable software interlocks, in addition to hard wired interlocks, to achieve the sequence of operation indicated in the specifications.

PLC shall be of state-of-art technology, microprocessor based, fully programmable, modular in Construction with DIN Rail mounting facility. It should be able to perform functions like boolean logic, bracked operation, result assignment, setting/resetting (latching/unlatching), counter and timer functions, load transfer, comparison and jump operation, block calls, special function, logical word gating & arithmetic operations.

PLC or Controller shall have Microprocessor (CPU) with EPROM/EEPROM with a minimum memory size of 8K bytes which will be non-volatile memory & shall be modular & plug in type. The CPU will have a receptacle for such memory sub-module (EPROM/EEPROM) for on- or – Off – line loading for program security. In addition, the CPU contains:

As internal power supply (24V / 9V DC)

Also internal power supply for input / output Modules.

An internal programme memory (RAM) with battery back up to save the contents of the RAM in the event of power failure. RAM memory size should be 4K bytes & above.

A programmer port Built in “COPY” function to save and transfer use programme without a programmer. The programme transfer would be from memory sub module to internal RAM of CPU.

Application program modules like Analog Input/output Modules. Digital Input/output modules for programme algorithms specified. The modules should be Modular plug-in type with in-built LEDs for status indication of each Input/Output. The output modules should be adequate ratings for driving various loads like cranking, fuel Solenoid, ACB closing & trip Coils etc. either directly or through interposing relays.

Execution time of the CPU should be in the range of 2ms to 7ms for 1K binary statements.

The PLC shall have high degree of accuracy for Analog Inputs/Outputs. The PLC shall be suitable for operation in ambient weather conditions of 0 to 50oC & 15 to 95% humidity.

The offer for the system shall be complete in all respect, clearly specifying the bill of materials, make of various components selected number of Analog & Digital Inputs/Outputs considered in the offer along with complete technical details of the PLC selected like RAM/EPROM/EEPROM Memory size, execution time, I/O capacity, no of programmable timers/counters, internal flags etc.

The system supplier will supply built drawing along with trouble shooting and operation and maintenance guidelines.

5.) **SEQUENCE OF SYSTEM OPERATION:**

5.1.) Auto Mode System Operation:

While the normal mains supply is healthy, the DG set shall be at rest and the load shall be supplied by the mains.

The PLC system/ Synchronization relay/ DG controller shall monitor supply voltage on each phase through voltage transducers at the output of the incomer breakers in the Main LT Panel. When the mains supply fails completely or falls below set value (variable between 80% to 95% of the nominal value) on any phase, the monitor module shall initiate start-up of diesel engine. To avoid initiation due to momentary dips or system disturbance, a time delay adjustable between 0.5 to 5 seconds (adjustable) shall be incorporated in the startup initiation.

A three attempt starting facility shall be provided with the sequence 6 seconds ON- 5 seconds OFF-6 seconds ON- 5 seconds OFF and 6 seconds ON. At the end of the third attempt if the engine has not been already started and built up voltage, engine shall be locked out for start. A master timer shall be provided for the function. An audio visual alarm shall be given.

Suitable adjustable timers shall be incorporated which shall make it feasible to vary independently ON-OFF setting periods from 1-10 seconds. If the alternator does not build up voltage after the first or any start, as may be, further starting attempt shall not be made and the starting facility shall be reset.

Once engine has built up voltage, the DG set which achieves the rated voltage built up first, becomes the master & its voltage and frequency is reference for other DG sets to be synchronized with this master DG set.

The DG sets are synchronized by their own engine controllers communicating with other engine controllers through proprietary protocol/ or by synchronization relay. Once the DG sets are synchronized, which is monitored through power monitors at the DG incoming breakers by PLC, the outgoing breakers of synchronization panel is closed by PLC.

System provided in the PLC Panel shall check and ensure that all the engine auxiliaries like lub oil pump are running and healthy. In case of any fault in engine auxiliaries, the system shall automatically stop the DG set and an audio visual alarm shall be given. Suitable inputs for overload and single phase preventor for alternator and for each of the engine auxiliaries shall also be considered as inputs for this function.

PLC system shall continuously monitor total load on the DG set through kW transducers on the incomer breakers of the main Emergency Panel. In case the load on any of the DG sets is less than 60% of the rated value, the PLC shall assess the load on the adjacent DG set. In case the summation of the loads is within 90% of the rating of one of the DG sets, one DG set shall shut down and load shall be transferred to the second DG set. In case the total load on the system is not more than 90% of the full load rating of a single DG set, the PLC controller shall shut down two DG sets and transfer the total load to any one of the four DG sets. In case a DG set is shut down due to non-availability of adequate load and should the load increase, the PLC shall automatically start the DG set as per pre-programmed logic.

The Automatic Load Management system shall be designed to provide optimum utilization of the DG sets so that operation of the DG sets is need based with higher load factor on each set. The PLC shall ensure that that the DG sets are stopped according to the predetermined logic and interlocking scheme to provide a failsafe system.

When the voltage in the mains get restored, its quality shall be monitored for about one minute and if proven satisfactory, the PLC shall open the outgoing breakers & give stop command to DG sets.

The Logic Panel shall automatically arrange for running of DG sets to be based on number of operating hours of each DG set so that to ensure that all DG sets are operated as equally as possible.

In case of overload on the DG system, the logic panel shall be given an audio visual alarm to enable the operators to switch off loads as required and if this is not taken care of in predetermined time, the Logic Panel shall put the DG in shut down mode with alarm.

The DG set shall stop after idle running of one minute after restoration of main supply.

The DG sets reverts to standby conditions and is ready to start should the mains supply fail again.

Tenderers may note that the PLC controls and sequence of operation are indicative of requirements and the PLC shall, notwithstanding the above, be complete in all respects to achieve the control, monitoring and operation of DG sets indicated above.

5.2.) Manual Mode System operation:

Under Manual mode, only single DG set shall be allowed to start or take load. No manual parallel operation of DG sets is allowed.

Under manual mode it shall be possible for the operator to start up the generator set by pressing the (START) push button.

Three attempt starting facility shall also be operative for the start up function.

Alternator circuit breakers & outgoing circuit breaker 'CLOSE' and 'TRIP' operations shall be manual by pressing the appropriate push button on the panel. Closure shall be feasible only after alternator has built up full voltage. If the load is already on 'MAINS' pressure on 'CLOSE' button shall be ineffective.

When running under manual mode, if the mains supply has failed, the load shall automatically get transferred to the alternator immediately overriding the stipulation of pressure on 'CLOSE' button.

Engine shut down, other than due to faults shall be manual by pressing a 'STOP' button.

5.3.) Test Mode System operation:

When under 'TEST' mode, pressure of 'TEST' button shall complete the start-up sequence simulation and start the engine. The simulation will be that of mains failure.

Engine shall build up voltage but the set shall not close alternator circuit breaker when the load is on the mains. Monitoring performance for voltage/frequency etc. shall be feasible without supply to load.

If during TEST run the power supply has failed, the load shall automatically get transferred to alternator.

Bringing the mode selector to auto position shall shut down the sets.

6.) **PROTECTION:**

Following protection are to be incorporated in the PLC Panel along with Alarm Annunciator and Status Indication:

i. Over voltage and under voltage relay.
ii. Reverse power relay.

iii. Under frequency relay.
iv. Over speed relay (over frequency).
v. IDMT O/C & E/F.

7.) **TESTS:**

The following tests shall be carried out at manufacturer works:

i. Insulation Resistance
ii. High voltage power frequency test
iii. Complete functional testing of PLC with simulation of all logics in auto & manual mode of operation at manufacturer's works.
iv. The DG synchronization Panel shall be tested at site, after DG set commissioning, for parallel operation & functional testing of PLC for all logics indicated in the specifications.
v. If the result of inspection and tests are not satisfactory, the defects shall be rectified and tests shall be repeated to entire satisfaction of engineer-in-charge without any extra charge to department. The inspection and tests result shall be submitted in quadruplicate for engineer-in-charge approval.
vi. Test certificate for all type test conducted on similar type complete switchgear assembly, relay and energy meter shall be submitted.

8.) **DRAWINGS:**

The following shall be submitted for engineer-in-charge approval before taking up the fabrication:

i. Complete assembly drawings of the switchgear showing plan, elevation and typical sectional view.
ii. Panel base plan showing locations of channel sills, foundation bolts and anchors, floor plans and openings.
iii. Complete wiring diagram including terminal wiring designations.
iv. Schematic control diagram both AC and DC for breaker control, interlocks, relays, instruments and space heaters.
v. Complete terminal block details, showing ferrule numbers wire destinations.
vi. PLC ladder diagram.
vii. PLC connection schematic diagram.

The following shall be submitted on delivery of panels:

i. 4 Nos. of installation and operation manual
ii. 4 Nos. of all approved drawings.
iii. 6 Nos. of operating handle.
iv. Reproducible drawing on Compact Disc.

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CHAPETR 9
BUS DUCT

A.) AIR INSULATED BUS DUCT

1.) GENERAL:

The specifications are general and comprises of design manufacture, assembly testing of medium voltage bus duct, indoor/outdoor type as per site requirement for interconnection between indoor M.V. switchgear & outdoor transformer.

The current rating of bus duct shall be as indicated in the specific requirements/ Bill of Quantities/drawing.

The size of the neutral bus bar shall not be less than half the size of phase bus bar.

Note: Before fabrication and installation of the bus duct is taken up, the layout of the M.V. switchgear and transformer shall be got approved by engineer and the bus duct layout properly co-ordinated.

2.) STANDARDS:

The following standards shall be recognized: -

IS : 61439 – General requirement of switchgear.

IS : 60529 – Degree of protection provided by the enclosure for L.V. switchgear.

IS : 60947 – Specification for low-voltage switchgear and controller assemblies.

3.) RATING DETAILS:

Rated 3 phase voltage	: 415 V
Standard insulation withstands for	
One minute	: 2500V
Rated frequency	: 50 HZ/Sec.
Maximum sustained 3 phase	
Short circuit rating	: As per BOQ.
Asymmetrical short circuit current	:As per BOQ.
Maximum conductor operating	
temperature at full rated current	: As per IS/IEC
Maximum ambient temperature	: As per IS/IEC
Current rating	: As indicated in specific requirements /Bill of Quantities/drawing.

4.) **CONSTRUCTION:**

The bus duct enclosure shall be fabricated out of sheet steel of 14 SWG on a suitable angle iron frame work. The enclosure shall generally be of rectangular cross section. The size of the enclosure should be indicated clearly in the quotation. Suitable detachable canopy with slope shall be provided for outdoor length of bus duct. The construction of the bus duct shall be strong enough to take the load of bus-bars and to withstand rated maximum fault level and rigorous adverse weather condition. Provision shall be made for expansion and construction of enclosure due to temperature. The construction shall be dust and vermin proof and provision must be there to open any portion of the bus duct for inspection without disturbing the bus bars. There should not be any through bolt in any section of the enclosure. Any joint of busbar enclosure should be provided with flange. Suitable neoprene gasket shall be provided at the point of wall entry from outdoor to indoor, suitable flange shall be fixed with the enclosure for fixing it with wall. The general sealing arrangement acceptable to purchaser is shown in the layout drawings. The detailed bus duct and wall frame assembly drawings proposed by the contractor shall be got approved by Engineer-in-charge before fabrication. Filter type drain plug shall be provided at low point along with run of bus duct to drain out automatically any moisture condensing within the enclosure. The tenderer should furnish detailed arrangements for the same.

Painting of bus trunk and supports shall be painted with 2 coats of epoxy base primer on which 2 coats of final epoxy paint of air craft grey shade as per IS: 5 shade No. 693.

Earth bus as per BOQ should be provided for entire length of the bus trunk. The same should be painted with bituminous paints and shall be fixed on the outside of duct. Suitable copper links shall be provided at the joints of bus duct. Earth bus at the point of wall should have suitable arrangement as approved by the purchaser.

The bus bars housed in bus trunk should have rectangular or channel section. The bus bar should be of high conductivity aluminium conductor of sufficient and uniform cross section. So that the current density of 600 amps per sq. inch is not exceed at normal current rating for operating temperature as permissible by IS over max. 45-degree C ambient temperature. Neutral bus bar shall be rated at 100% of the phase bus bar. The size of bus bars should clearly indicated in the quotation. The bus bars shall be insulated by PVC sleeves. The bus bars should be rated for current as indicated in specific requirements/ schedule of quantities/drawings. The maximum temperatures of the bus bars at full rated current should not exceed 85ºC for an ambient of 45ºC. The length of the bus duct shall include at least one expansion joint preferably at the middle and two other flexible joint one each at transformer and switchgear end.

The bus-bars should be supported with SMC/DMC support on every 250mm interval. The SMC/DMC support should be supported on angle iron structure provided for enclosure.

Bus bars shall be thoroughly cleaned before carrying out any straight through joints, expansion joint or flexible joint. Suitable contact grease shall be supplied at the joints to prevent formation of aluminium oxide. The joints shall be bolted such that the initial contact pressure remains substantially in diminished at all temperature upto rated full load temperature. Spring washer shall be provided at every bolted joints. The joints shall have very low resistance. All flexible joints shall be of copper only. The tenderer should indicate clearly the contact pressure joints. The details of joints shall be furnished by tenderer along with tender.

Transposition of bus bars should be done preferably in ACB adaptors chamber. Terminal arrangement of transformers will be furnished to the successful tenderer at a later date.

All bends required for the complete run of the bus bars or bus duct shall be as per BOQ.

Minimum clearance should be maintained through-out the length of the bus duct including joints and flexible expansion joints as per IS/IEC.

5.) **DRAWINGS:**

Detailed layout and fabrication drawings showing the sizes of bus-bars enclosure, fixing details, supports, bends, joints, wall entry assembly etc. shall be submitted by the contractor for approval of Engineer-in-Charge/Purchaser's comments/modification suggested by the Purchaser shall be incorporated by the contractor. Actual fabrication of the bus duct shall be carried out only after the approval of the purchaser.

6.) **ROUTINE TEST AND HEAT RUN TEST:**

The supplier shall carry out all routine tests and heat run test on the bus-duct in the presence of departmental engineers at works before dispatch. The routine test shall comprise of physical inspection of various components, inspection of clearances with respect to approved drawings, insulation resistance test with 1000 volts meggar, high voltage test 2.5 KV for 1 minute, milli volt drop test for each joint and any other test recommended by the manufacturer.

The tenderer should furnish heat run test certificate for similar bus duct manufactured by them along with tender.

The supplier shall also furnish test certificates for the purity of material from an approved testing laboratory.

7.) **Installation:**

Suitable support shall be provided for the bus duct from ground level/wall bracket. The tenderer should indicate clearly the details of support recommended by them. The cost of bus duct support should be indicated separately.

8.) **TESTING AT SITE:**

The following tests shall be carried out at site in the presence of Engineer-in-charge.

i. Physical inspection of all components
ii. All routine tests mentioned in item 8 above
iii. All other tests recommended by manufacturer
iv. Load testing – This test shall be carried out for the maximum load developed at site in consultation with Engineer-in-Charge.

B.) SANDWICH BUS DUCT

1.) **SCOPE:**

The specification covers the technical requirements of design, manufacturer, test at works, supply, installation, testing & commissioning of 1000 V, LT, Non-segregated Phase, Sandwich type Bus bar Trunking and accessories for efficient and trouble free operation.

The Bus duct shall be suitable for Horizontal and vertical runs.

2.) **STANDARDS:**

The equipment covered by this specification shall unless otherwise stated, be designed, constructed and tested in accordance with the latest revision of relevant International Standards and shall confirm to the regulations of local statutory authorities.

IS/IEC-60529 : Degree of protection provided by enclosures.

IS/IEC 61439 : Particular requirements for Bus Bar Trunking.

DIN IEC 68 Part 2-3 : Suitable for Constant/ cyclic Warm, Humid Climates.

EN 60695-2-1 : Incandescent Wire test for All plastic Parts.

UL 94 : Self-extinguishing Property for all plastic parts.

EN 60332-3 : Fire- retardant.

GENERAL:

The Bus Bar Trunking shall be made from Hot-galvanized 1.5mm thick (min) sheet steel suitable for Indoor /outdoor application.

Standard length of straight feeder shall not exceed 3000mm. End feed Unit shall be suitable for Cable termination.

3.) **CONSTRUCTION:**

The Bus duct enclosure consists of C-ribbed section bars, bordered and riveted, with excellent mechanical, electric and heat loss efficiency.

The sheet metal is made of 1.5 mm thick hot-galvanizes steel treated according to UNI EN 10327 and powder coated as per shades indicated in BOQ, with high resistance to chemical agents. It shall be rigid and robust in construction, compact in size and shall be treated to prevent any possibility of corrosion.

All the run elements (straight feeder, Elbows, etc.) are supplied complete with a factory fitted monobloc. In monoblock there will be two Copper with Silver plated plates per phase and use single bolt system to tighten the joints.

The enclosure shall provide a protection not less than IP- 55 for outdoor and IP-54 for indoor installation, as per IEC-529. For outdoor installations Canopy/ protective cover to be provided.

Single bolted Special monobloc must be used for connecting successive feeders/ Elbows/flange etc. The junction contacts made from two silver plated copper plates for each phase, insulated with red class F thermosetting plastic material and factory fitted in one side of the each trunking components. Bolted type splice plate, Zinc plated bolts & nut with Bellevue washer must be used to achieve an efficient joint. Jointing method shall be as per International Practice.

BUSBARS:

The Busbar conductors have a rectangular cross-section with rounded corner and made up of high conductivity Cu.

The Busbars shall be TP & N, the cross-section of neutral bar being equal to the cross-section of the phase bar.

The insulation between the Bars is ensured by double sheath made with polyester film and thermal class B/ or better. All plastic components shall have a V1 self-extinguishing degree (as per UL94). They shall be fire retardant and comply with glow-wire test according to standard and shall be halogen free.

The Busbars shall be fixed in the supports in such a way to allow for free movement of conductor due to thermal expansion without creating mechanical stresses.

EARTHING:

The Bus-duct enclosures shall be earthed by continuous copper earthing as per BOQ, running both sides of the enclosures through the entire length of Busducts.

4.) **INSTALLATION:**

Installation of bus duct shall be carried out as per manufacturer’s instructions.

For bus duct horizontal runs, horizontal expansion unit shall be provided at 50 m & that expansion joints of building structure.

The bus duct shall be supported every 1.5 m distance & as per requirement detailed in layout. Design data in support of adequacy to withstand mechanical stress during normal & short circuit condition shall be furnished by the tenderer.

5.) **ACCESSORIES:**

Bus duct shall be provided with accessories such as flange ends, elbows, bends, expansion joint box, wall crossing unit with 2 hours rating fire barrier etc. as per schedule of quantity. All the components of busbar ducting i.e. elbows bends etc. shall be made of 1.5 mm GI sheet.

6.) **TESTS:**

6.1.) Type Tests:

i. Copies of the following certificates should be submitted:
ii. Verification of temperature Rise limits.
iii. Verification of dielectric properties.
iv. Verification of short circuit strength.
v. Verification of degree of protection.
vi. Verification of Fire resistance class of insulation.

- The temperature rise test shall be carried out at manufacturers factory for each rating of bus duct.
- The bus duct straight length feeder along with one horizontal & vertical elbows shall be assembled for temperature rise testing.
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6.2.) Routine Test:

i. Insulation resistance test.
ii. Physical Inspection of assembly, interlocks etc.

6.3.) Site test:

i. Insulation resistance test.
ii. All the routine, acceptance & temperature rise test of each rating of bus duct shall be carried out in manufacturer's factory in presence of departmental representatives.

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CHAPETR 10
DG set

1.) SCOPE OF WORK:

The scope of work include supply, installation, testing & commissioning of 415 V, 50 Hz, Diesel Generator set with Acoustic enclosure, fuel tank & fuel piping from day fuel tank to Diesel engine, exhaust piping with external support structure, minor building works like making of opening in walls or in floor & restoring them to their original finish etc., testing of DG set at manufacturers work & site, Clearance / Approval of complete installation from CPCB / State Pollution Control Board, Central Electricity Authority, other licensing authorities, wherever required.

2.) STANDARDS APPLICABLE:

The DG set shall conform to ISO 8528 specifications

The switchgear and other accessories should conform to relevant BS/IS. The DG set shall conform to latest norms of Central Pollution Control Board (CPCB) for emissions.

3.) RATING / CAPACITY OF DG SET:

The diesel generator set of capacity as specified in BOQ shall be rated to deliver full load capacity of alternator i.e. **prime power rating**. **The performance class of the DG set shall be class G2.**

4.) DIESEL ENGINE:

The Diesel Engine shall be multi-cylinder, turbo charged after cooled, 4 stroke diesel cycle developing required BHP at 1500 rpm, radiator cooled by water with fan etc. The Engine shall be capable of delivering specified prime power rating at variable loads for p.f of 0.8 lag with 10% overload available in excess of specified output for 1 hour within every 12 hours.

Necessary certificate indicating the compliance of above capacity requirement for the Engine model so selected along with compliance of noise emission norms as per latest CPCB guidelines shall be furnished from manufacturer.

The engine shall include following subject to design of manufacturer: -

i. Electrical starter DC motor.
ii. Battery charging unit and voltage regulator, suitable for starting batteries, battery racks with interconnecting leads & terminals.
iii. Fuel pump.
iv. Fuel control solenoid.

v. Lubricating oil pump.
vi. Lubrication oil cooler.
vii. Lubrication oil heater.
viii. Lubrication oil filters.
ix. Coolant heater.
x. Turbo charger.
xi. Residential silencer.
xii. Dry type replaceable air cleaner with restriction indicator.
xiii. Dynamically balance fly wheel.
xiv. Electronic governor with over speed cut out.
xv. Radiator with Fan.

Engine controller having digital display & safeties for following & fitted with:

i. Ignition switch (lockable type)
ii. Lube oil pressure indication & low lube oil pressure cut off.
iii. Water Temperature indication & high water temperature cut off.
iv. RPM indication & over speed safety.
v. Engine Hour meter.
vi. Battery charging indication.
vii. Alternator 3 phase Voltage, current, kW, etc.
viii. Under voltage, Over voltage, Under frequency, Over frequency & overload protection for alternator.

The suitable size of control cabling between the DG set and the DG synchronizing Panel/ AMF Panel shall be measured separately. However, cable schedule of control cabling between DG set & DG synchronizing Panel/ AMF Panel shall be furnished by the DG set supplier.

5.) **STARTING SYSTEM:**

The set shall be supplied along with DC lead acid high discharge automotive duty batteries conforming to relevant IS including necessary interconnecting copper leads and shall be in fully charged condition along with suitable crate / stand. Calculation for the sizing of battery shall be furnished.

6.) **FUELSYSTEM:**

990 litres separate day fuel tank (one for each DG set) fabricated out of 3mm thick MS CRCA sheet & complete with necessary supports connecting pipes, valves etc. shall be provided to supply fuel to engine.

Also hand driven semi rotary pump with flexible pipe shall be provided to transfer fuel from portable drums to day fuel tank. **The first filling of day tank is included in the scope of work.**

7.) **EXHAUSTSYSTEM:**

The exhaust system includes flexible SS bellows, residential silencer & exhaust piping with class B MS pipe cladded with 75 mm thick & 96 kg/cu.m LRB rock wool & overall 24 SWG aluminium cladding for complete run. The exhaust pipe work includes necessary angle & supports from ceiling to avoid any load & stress on turbo charger / exhaust piping. Additional bellow/provision for expansion shall be made in exhaust piping.

Exhaust piping shall be provided up to above nearby building height, as per CPCB norms. The outdoor exhaust piping shall be supported by free standing MS structure & shall be got approved by E-I-C before execution. The tail end of exhaust pipe shall have 45 degree downward cut to avoid rain water entry into exhaust piping. The exhaust outlet should be in direction of prevailing winds & should not allow exhaust gases to enter air inlet / windows etc.

The exhaust back **pressure** calculation shall be submitted to check correctness of the exhaust pipe size selected.

8.) **COOLING SYSTEM:**

The DG set shall be radiator cooled & engine jacket water used, shall be mixed with additive as per recommendation of manufacture.

Additional coolant heater shall be provided for working in extreme cold conditions.

9.) **ALTERNATOR:**

Brushless, synchronous, single bearing alternator of suitable rating considering de-rating for 50 degree ambient @**. 0.8 p.f (lag), 50 Hz** rating at 1500 rpm, suitable for 3 phase, 4 wire system having following features:

Voltage regulation	:	+ /-1 % (the alternator should be self-regulated through an AVR) or better.
Insulation	:	Class H
Standard enclosure	:	IP 23 (screen protected, drip proof)
Rotor	:	Dynamically balanced
Excitation	:	Separately excited/self-excited as per BOQ
Over loading capacity	:	Overload of 10% for one hour within 12 hours of operation
Terminal box	:	Terminal box suitable for termination of cable/busduct as per BOQ

The alternator shall be designed for continuous rating. The alternator shall have flanged coupling bolted together with the fly wheel of the prime mover.

The alternator shall have space heater for windings for use during idle state of DG set in extreme cold weather condition.

The alternator shall be suitable for parallel operation with same capacity DG sets. The genset controller shall be capable of auto synchronizing, kW & kVAr load sharing control and on/off control of DG incomer breaker in DG Synchronization Panel etc.

10.) **MOUNTING ARRANGEMENT:**

The complete DG set should be coupled as per manufacturers standard design & both units shall be mounted on a common MS fabricated base frame to ensure perfect alignment of engine & alternator with minimum vibrations. The base frame shall have AVM pads. The common base frame shall be epoxy paint coated in black shade.

11.) **ACOUSTIC ENCLOSURE:**

The enclosure should be fabricated out of 16 SWG MS CRCA sheet & door shall be made air tight with neoprene rubber / foam type gasket & heavy duty locks.

The enclosure shall be provided with suitable size & no. of hinged doors along the length of enclosure on each side for easy access inside the enclosure for inspection, operation & maintenance purpose. The door in front of engine controller shall have viewing window for visual inspection of parameters. Sufficient space shall be provided inside the enclosure on all sides of DG set for inspection, easy maintenance & repairs.

The enclosure shall be modular construction & free standing type.

The enclosure shall be given 7 tank chemical treatment & thereafter finished with UV resistant powder coating of shade as per manufacturer standards.

The material, thickness & density of acoustic insulation inside the canopy shall be as per manufacturer standard to limit overall noise levels to 75 dB (A) at a distance of 1m from enclosure as per CPCB norms.

The batteries shall be accommodated inside the enclosure in battery rack.

An additional hot air duct shall be provided on top of enclosure at radiator end for directional dissipation of radiator exhaust outside DG Room.

Adequate lighting shall be provided inside enclosure.

Canopy shall be provided with enclosure high temperature safety device. The temperature rise inside enclosure should not be more than 5 deg. C for max. ambient above 40 deg. C & should be below 10 deg. C. for ambient below 40 deg. C.

The acoustic enclosure shall have suitable cut outs with rubber groumets for power & control cable connections.

12.) **TEST TO BE CARRIED OUT ON DG SET AND AMF PANEL:**

All major items / equipments i.e. engine and alternator in assembled condition shall be offered for inspection & testing at factory / manufacturers work.

13.) **TESTING AT WORKS:**

Following test shall be conducted at assembler's works in presence of Dept.'s representatives. All consumables shall be supplied by the bidders. The bidder shall arrange the load.

i. Load testing of complete set at 100% rated load with acoustic enclosure till the differential temperature remains steady but not less than 3 hrs. The engine and alternator parameters shall not exceed the guaranteed value during the testing.

ii. Overload testing at 10% overload for one hour immediately after the full load test.

iii. Operation of protective devices.

14.) **ERECTION:**

The responsibility of erection, testing and commissioning of the set and the accessories shall rest with the bidder. The tenderer may note that these is no loading

15.) **SITE TESTING:**

Following tests shall be conducted at site in the presence of the E.I.C before energization. The contractor shall provide all testing equipment, labour, load bank and consumables such as fuel oil, lube oil, coolant etc. required for the testing.

i. Checking the alignment by engine manufacturer's representative and obtaining approval.
ii. Insulation resistance test on alternator, control panel and cabling.
iii. Checking the engine safeties for satisfactory operation.
iv. Checking vibration levels.
v. Testing of individual protective devices on engine and alternator and ensuring that the wiring is carried out properly.
vi. Full load running for 8 hours continuously. All the readings shall be logged to evaluate the fuel consumption, lube oil pressure, water & oil temperature vis-à-vis the electrical load.
vii. The noise level at 1m from the enclosure and the temperature rise inside the enclosure shall be measured during the load test.

Any deviation from the guaranteed parameters shall be made good and these performance parameters should be measured once again till the required results are achieved.

The DG set shall be deemed to be commissioned after satisfactory performance of all associated equipment.

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CHAPTER 11
WIRING INSTALLATIONS & ACCESSORIES

1.) SCOPE:

This specification covers supply, erection, testing and commissioning of mains/sub-mains/power wiring, point wiring, wiring accessories, fittings and fixtures etc. as detailed under Bill of Quantities/ specific requirements.

2.) STANDARDS AND CODES:

The design, manufacture, erection, testing and commissioning shall comply with, but not limited to the latest issue of the following standards and rules: -

	IS - 4648	:	Electrical layout in residential buildings.
	IS - 14927	:	Specification for UPVC Trunking for electrical wiring
	IS - 694	:	PVC insulated cables with copper conductors for voltages upto 1100 Volts
	IS - 732	:	Code of practice for electrical wiring installation (system voltage not exceeding 650Volts)
	IS 17048 : 2018	:	Halogen Free Flame Retardant (HFFR) Cables for Working Voltages Up to and Including 1100 V
	IS 3961 (Part 5):	:	Recommended current ratings for cables
	IS - 1646	:	General code of practice for fire safety of bldg.- electrical installation
	IS - 3043	:	Code of practice for Earthing
	IS 1258	:	Bayonet Lamp Holders
	IS-3854	:	Switches for domestic and similar purposes.
	IS-1293	:	Three pin plugs and socket outlets.
	IS-371	:	Ceiling Roses.
	IS-2268	:	Electrical call bells and buzzers for indoor use.
	IS-9537		Conduits for Electrical Installations
	IS 3419		Specifications for fittings for rigid non-metallic
	SP-30	:	NEC 2023

Indian Electricity Rules 1956, Indian Electricity Act 2003, NBC-2016 as amended up to date and local supply authorities' rules & regulations.

3.) **Introduction**

i. The wiring shall be done from a distribution system through main and/or branch distribution boards.

ii. Each main distribution board and branch distribution board shall be controlled by an incoming circuit breaker. Each outgoing circuit shall be controlled by a circuit breaker.

iii. For non-residential and residential buildings as far as possible DBs shall be separate for light and power or as specified in BOQ.

iv. Only MCCB/MCB type main and branch distribution boards shall be used. HRC/ Rewireable type fuses shall not be used.

v. 'Power' wiring shall be kept separate and distinct from light wiring, from the level of circuits, i.e., beyond the branch distribution boards. Conduits for light/power wiring shall be separate if the distribution boards are separate.

vi. Essential/non-essential/UPS distribution each will have a completely independent and separate distribution system starting from the main, switchboard upto final wiring for each system. As for example, conduit carrying non-essential wiring shall not have essential or UPS wiring. Wiring for essential and UPS supply will have their own conduit system. No mixing of wiring is allowed.

vii. Generally, no switchboard will have more than one source of incoming supply. More than one incoming supply will be allowed only at main board with proper safety and interlocking so that only one source can be switched on at a time.

viii. Each MDB/DB/Switch Board will have reasonable spare outgoing ways for future expansion.

ix. Balancing of loads on 3-phase circuits shall be done.

x. Submain Wiring: Submain wiring shall mean the wiring from Meter box/MDB to Distribution board. Submain wiring shall be measured on linear basis along the run of the wiring. The measurement shall include all lengths from end to end of conduit or channel as the case may be, excluding interconnections inside the switchboard etc.

xi. Conduit carrying Submain will not carry circuit / point wiring. Similarly, conduit carrying point wiring / circuit wiring will not carry Submain.

xii. Wires of point wiring of different phases shall not be routed in same conduits/ casing capping.

4.) **Point Wiring:**

Point wiring shall include all the work necessary to complete the wiring of any length from MCB of the distribution board (DB) & upto the following outlets via their controlling switches on switchboards:

i. Ceiling rose or connector

ii. Back plate (in case of stiff pendants and fluorescent fittings with down rods etc.)
iii. Socket outlets
iv. Ceiling Fan / Fan regulator
v. Lamp Holder
vi. Call bell / Buzzer etc.

The following shall be deemed to be included in point wiring:

i. Installation of conduits / PVC casing & capping.
ii. Installation of recessed GI switch boxes / MS surface boxes.
iii. Drawing of copper conductor insulated wires (Phase+Neutral+Earth) of suitable sizes including termination on both sides with suitable sizes of tinned copper lugs.
iv. Providing Ferrule numbers on both sides of wires for labeling etc.
v. Installation of controlling switches / sockets / fan regulators, cover plate with frame, ceiling rose, PVC square box, Junction box, PVC round plates etc.
vi. Installation of all fixing accessories such as GI screws, Clips, Phil plug compound, Rawl plug, Wooden plugs, bend, elbows, couplers etc. saddles & spacers as required.
vii. Connection of wires to ceiling rose, connector, socket outlet, lamp holder, switch, fan regulator etc. with suitable copper lugs / connectors.
viii. Interconnecting wiring between switches within the switch box on the same circuit.
ix. Providing bunching tags for wires inside casing capping at the intervals of 600 mm to avoid hanging of wires.
x. PVC conduit glands/ double check nuts at conduit terminations. Terminal blocks at switch boards and junction boxes.
xi. Drilling holes in the walls if required, providing PVC sleeves for crossing of the wall & refinishing of wall with white cement.

- ***Unless and otherwise specified, there shall be no linear measurement for point wiring. It shall be measured on unit basis by counting.***

- ***Earth wire shall be looped in all the switchboards present in the premises.***

5.) **Types of point wiring:**

5.1.) Lighting circuit –

- In installations, Light point, Ceiling Fan point, Plug Point (6A socket outlet), Exhaust Fan point & Call bells point shall be wired in a common circuit & such circuit shall be called as lighting circuit. Each circuit shall not have

more than 800 W connected load or more than 10 no. of points, whichever is less.

Independent Earthing from DB shall be provided for lighting circuit of each room.

5.2.) Power Circuit –

- Independent circuit including earth wire shall be provided from distribution board for each Power Point (16A socket outlet) / Water heater point / A.C. point. The load of such circuit shall be restricted to 3000 watts.
- Power circuit shall have only one outlet per circuit. However, for computer points in non-residential buildings, 3 nos. of 6A socket outlets controlled by 16Aswitch can be fed through power circuit.

6.) **Ratings of Outlets**

i. LED fittings shall be rated as per actuals.
ii. Conventional Ceiling fans shall be rated at 70W and BLDC fans shall be rated as per the actuals.
iii. Exhaust fans, fluorescent tubes, compact fluorescent tubes, HPMV lamps, HPSV lamps, CFL fittings etc. shall be rated according to their capacity. Control gear losses shall also be considered as applicable.
iv. 6A and 16A socket outlet points shall be rated at 100W and 1000W respectively, unless the actual values of loads are specified.
v. A.C. point shall be rated as 2 kW & Water heater point shall be rated as 3 kW.

Load more than 1 kW shall be controlled by suitably rated MCB / Isolator.

7.) **General Requirements:**

7.1.) The wiring for lighting circuits shall be done in looping system. The phase conductor shall be looped at switch box for sub-circuit. The neutral conductor for sub-circuit can be looped either from switch box or from light/fan/socket points. Twisted joints for looping are not acceptable.

7.2.) No joints in wiring will be permitted anywhere, except in switch box or point outlets, where jointing of wires will be allowed with use of suitable connector.

7.3.) In case of socket outlet, the controlling switch shall be connected on the live wire / phase wire.

7.4.) Colour Coding of Wiring: Following colour coding shall be followed in wiring:

Wire	Colour
Phase	Red, Yellow, Blue. (Three phase wiring)
Live	Red (Single phase wiring)
Neutral	Black
Earth	Green

7.5.) The size of conductor shall be used as follows:

Circuit	Phase & Neutral Wire Size	Earth wire Size
Lighting Circuit	1.5 sq. mm	2.5 sq. mm.
16 A Power Point Circuit	2.5 sq. mm.	2.5 sq. mm.
AC / Water Heater Circuit	4.0 sq. mm.	2.5 sq. mm.
Submain wiring	6.0 sq. mm.	4.0 sq. mm
	10.0 sq. mm.	6.0 sq. mm

7.6.) Primary Point: In case of more than one light / fan being controlled by one switch, the wiring up to the termination point of the first light / fan including the switch shall be considered as a 'Primary' point.

7.7.) Secondary Point: Loop wiring from termination point of first light / fan to second light / fan shall be considered as a "Secondary point".

Unless otherwise specified all the points are primary points.

8.) SURFACE PVC CASING-N-CAPPING:

i. All casing-n-capping shall be made of good quality heavy gauge rigid Fire Resistant (FR) PVC, free from defects like deformation, unevenness, blisters, cavities etc. having colour & size as mentioned in schedule of quantities.

ii. The Casing Capping shall have a square or rectangular body.

iii. Casing should be equipped with rail on its surface on which clip-on partition (Capping) can be clipped.

iv. The casing shall be fixed using GI screws on wall fixed at an interval of 300 mm along horizontal run and along vertical run. In addition, where ever the direction of Casing changes additional fixing shall be provided for firm fixing.

v. The Capping shall be “CLIP-ON” type with double grooving & double locking arrangement & shall be clipped over the casing once the conductor wires are drawn in

vi. When capping is clipped onto the casing body, cover should completely overlap on the base (casing).

vii. The Casing Capping in straight runs should be in single piece as far as possible so as to avoid joints & shall be of 2 m or 3 m standard length for the ease of installation.

viii. At the bends Vertical / Horizontal section of PVC casing & capping shall be scarfed or cut diagonally at an angle of 45 degrees in a manner to complete matching at the bend & shall be smoothed down by filing to make the joints a very close fit as far as possible and without burrs.

ix. Trucking systems shall be so designed that when they are installed and fitted with insulated conductors and apparatus in normal use, parts are not accessible.

x. The bunching tags at the intervals of 600 mm shall be provided inside casing capping to avoid hanging of wires

xi. Shall be fire resistant & shall not ignited easily or if ignited, should extinguishes within 30 sec, after the removal of flame.

xii. Insulation resistance shall not be less than 100 Mega ohm

xiii. The cover should not detach from main part without use of any tool.

xiv. Testing shall be done as per IS-14927 (2001).

9.) **NUMBER OF WIRES IN CASING-N-CAPPING**

The maximum number of wires that may be laid in PVC trunking for circuit wiring or point wiring is given below :-

Maximum number of PVC insulated 650 / 1100 Volt Grade Aluminium / Copper conductor cable conforming to IS: 694-1990

Nominal Cross sectional area	16 x 16 mm	25 x 12 mm	25 x 16 mm	38 x 16 mm	38 x 25 mm	38 x 38 mm
1.5	3	5	6	8	12	18
2.5	2	4	5	6	9	15
4	2	3	4	5	8	12
6		2	3	4	6	9
10		1	2	3	5	8
16			1	2	4	6
25				1	3	5
35					2	4
50					1	3
70					1	2

Note:

i. Dimensions shown above are outer dimensions of mini trunking.
ii. Size of mini trunking to be used as per S.O.Q.

10.) **HMS PVC CONDUITING:**

10.1.) General requirements

i. All non-metallic conduit pipes shall be rigid FRLS UV Stabilized PVC High Mechanical Strength conduits with ISI marking complying with IS 9537 (Part 3) and IS 3419 for rigid conduits and IS 9537 (Part 5) for flexible conduits. The interior of the conduits shall be free from obstructions.

ii. The conduits shall be circular in cross-section. The conduits shall be designated by their nominal outside diameter.
iii. No non-metallic conduit less than 20 mm in diameter shall be used.
iv. Rigid conduit accessories shall be normally of grip type.
v. Flexible conduit accessories shall be of threaded type.
vi. Bends, couplers etc. shall be solid type in recessed type of works, and may be solid or inspection type as required, in surface type of works. In long distance straight runs of conduit, inspection type couplers at reasonable intervals shall be provided.
vii. Conduit pipes including all bends, unions, tees, junction boxes etc. forming part of the conduit system shall be adequately supported.
viii. All accessories of non-metallic conduit like junction box, bend etc. shall be ISI marked & shall comply to BIS 3837: Accessories for Rigid Non-metallic Conduit.

10.2.) Installation

10.2.1) Common Aspects for Both Recessed and Surface Conduit Works

i. The erection of conduits of each circuit shall be completed before the cables are drawn in.

ii. Conduit Joints: All joints shall be sealed/cemented with approved cement. Damaged conduit pipes/fittings shall not be used in the work. Cut ends of conduit pipes shall have neither sharp edges nor any burrs left to avoid damage to the insulation of conductors while pulling them through such pipes.

10.2.2) Bends in Conduit

All bends in the system may be formed either by bending the pipes by an approved method of heating, or by inserting suitable accessories such as bends, elbows or similar fittings, or by fixing non-metallic inspection boxes, whichever is most suitable. Where necessary, solid type fittings shall be used.

Radius of bends in conduit pipes shall not be less than 7.5 cm. No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet.

Care shall be taken while bending the pipes to ensure that the conduit pipe is not injured, and that the internal diameter is not effectively reduced.

10.2.3) Surface Conducting Work

i. Conduit pipes shall be fixed to wall / column / slab /beam with readymade PVC saddles & spacer, secured to suitable approved plugs with GI screws in an approved manner, at an interval of 450mm.

ii. Where the conduit pipes are to be laid along the trusses, steel joists etc. the same shall be secured by means of saddles or girder clips as required by the Engineer- in-charge. Where it is not possible to use these for fixing, suitable clamps with bolts and nuts shall be used.

iii. If the conduit pipes are liable to mechanical damage, they shall be adequately protected.

10.2.4) Fixing of Conduits in RCC Work

i. The conduit pipes shall be laid in position and fixed to the steel reinforcement bars by steel binding wires before the concreting is done.
ii. The conduit pipes shall be fixed firmly to the steel reinforcement bars to avoid their dislocation during pouring of cement concrete and subsequent tamping of the same.
iii. Fixing of standard bends or elbows shall be avoided as far as practicable, and all curves shall be maintained by bending the conduit pipe itself with a long radius, which will permit easy drawing in of conductors.
iv. Location of inspection / junction boxes in RCC work should be identified by suitable means to avoid unnecessary chipping of the RCC slab subsequently to locate these boxes.

10.2.5) Recessed Conducting Work:

i. Before installing conduits, junction boxes and inspection boxes in the wall, a chase in the wall shall be neatly made and shall be of ample dimensions to permit the conduit & boxes to be fixed in the manner desired.
ii. Fixing Conduits in Chase: The conduit pipe shall be fixed by means of staples or by means of non-metallic saddles, not more than 60 cm apart or by any other approved means of fixing.
iii. The chase shall be closed neatly and shall be finished flush with the wall after erection of conduit system.
iv. All this work shall be completed before plastering of the wall & in Co-ordination with civil agency.

10.2.6) Laying above false ceiling:

Where conduit pipes are to be laid above false ceiling, conduit pipes shall not be clamped to false ceiling frame work and shall be suspended with suitable supports from the suffix of slab. For conduit pipes to run along with wall, the conduit pipe shall be clamped to wall above false ceiling in uniform pattern with readymade PVC saddles & spacer at the intervals of 450mm.

10.2.7) Inspection Boxes

i. Suitable inspection boxes to the minimum requirement shall be provided to permit inspection and to facilitate replacement of wires, if necessary.
ii. These shall be mounted flush with the wall or ceiling concrete. Minimum 65 mm depth junction boxes shall be used in roof slabs and the depth of the boxes in other places shall be as per IS 2667:1988.
iii. Suitable ventilating holes shall be provided in the inspection box covers.
iv. Fixing Switch Boxes and Accessories

- Switch boxes shall be mounted flush with the wall. All outlets such as switches, socket outlets etc. shall be flush mounting type, unless otherwise specified in the Additional Specifications m/ BOQ.

10.2.8) Fish Wire

To facilitate subsequent drawing of wires in the conduit, GI fish wire of min. 20 SWG or as required shall be provided along with the laying of the recessed conduit.

10.2.9) Bunching of Cables

Cables carrying Direct Current may, if desired, be bunched whatever their polarity, but cables carrying alternating current, if installed in metal conduit shall always be bunched so that the outgoing and return cables can be drawn into the same conduit.

Where the distribution is for single phase loads only, conductors for these phases shall be drawn in one conduit. In case of three phase loads, separate conduits shall be run from the distribution boards to the load, points, or outlets as the case may be.

10.2.10) Earthing Requirements

A protective (earth) conductor shall be drawn inside the conduit in all distribution circuits to provide for earthing of non-current carrying metallic parts of the installation. These shall be terminated on the earth terminal in the switch boxes, and/or earth terminal blocks at the DBs.

10.3.) Non-metallic conduit shall not be used for the following applications:

i. In concealed/inaccessible places of combustible construction where ambient temperature exceeds 60 degrees C.
ii. In places where ambient temperature is less than 5 degrees C.

iii. For suspension of fluorescent fittings and other fixtures.
iv. In areas exposed to sunlight.

11.) **M.S. ERW CONDUITING:**

11.1.) SURFACE M.S. ERW CONDUITING

i. All conduits shall be rigid steel M.S. ERW conduit finished with stove enameled surface. All conduits accessories shall be threaded type and under no circumstances pin grip type or clamp type accessories be used.

ii. No M.S. ERW conduit less than 25 mm. dia shall be used. The thickness shall be 16 SWG for conduit upto 25 mm. dia and 14 SWG for conduit above 25 mm. dia.

iii. Conduit pipe shall be jointed by means of screwed couplers and screwed accessories only. In long distance straight runs of conduit, inspection type couplers at reasonable intervals shall be provided.

iv. Threads on conduit pipes in all cases shall be between 11 mm. to 27 mm. long sufficient to accommodate pipes to full threaded portion of couplers or accessories. Cut ends of conduit pipes shall have no sharp edges not any burrs left to avoid any damage to the insulation of conductors while pulling them through.

v. Painting before Erection: The outer surface of conduit including all bends, unions, tees, junction boxes etc. forming part of the conduit system, shall be adequately protected against rust when such system is exposed to weather, by being painted with 2 coats of red oxide paint applied before they are fixed.

vi. Conduit pipes shall be fixed by hot dip min. 1.6mm thick GI saddles & spacers of min. 4 mm. thickness. The length of spacers shall suit the total number of conduits to be run. The conduit pipes shall be individually fixed using galvanized screws at every 600 mm. intervals. The hot dip G.I. saddles for fixing of M.S. ERW conduit should not be less than 20 gauge thick and 19 mm wide for conduits upto 25 mm dia and not less than 18 gauge thick and 25 mm. wide for large dia conduits.

vii. Where conduit pipes are to be laid along the trusses, steel joists etc. the same shall be secured by means of saddles or girder clips or clamps as required.

viii. All necessary bends in the system including diversion shall be done by bending pipes or by inserting normal or inspection type normal bends or by fixing M.S. painted inspection boxes whichever is more suitable.

ix. No length of conduit shall have more than the equivalent of two quarter bends from outlet to outlet. Additional bends shall be provided with inspection bends/boxes.

x. The junction boxes for lighting fixture, fans etc. shall be M.S. 16 gauge black enameled for surface mounting. The boxes shall be complete with covers to be fixed with screws.

xi. The conduit of each circuit or section shall be completed before conductors are drawn in.

xii. Conduits shall not be used as an earth medium.

11.2.) CONCEALED M.S. ERW CONDUITING:

i. All conduits shall be rigid steel M.S. ERW conduit finished with stove enameled surface. All conduits accessories shall be threaded type and under no circumstances pin grip type or clamp type accessories be used.

ii. No M.S. ERW conduit less than 25 mm. dia shall be used. The thickness shall be 16 SWG for conduit upto 25 mm. dia and 14 SWG for conduit above 25 mm. dia.

iii. Conduit pipe shall be jointed by means of screwed couplers and screwed accessories only. In long distance straight runs of conduit, inspection type couplers at reasonable intervals shall be provided.

iv. Threads on conduit pipes in all cases shall be between 11 mm. to 27 mm. long sufficient to accommodate pipes to full threaded portion of couplers or accessories. Cut ends of conduit pipes shall have no sharp edges not any burrs left to avoid any damage to the insulation of conductors while pulling them through.

11.3.) Fixing Conduits in RCC Work

i. The conduit pipes shall be laid in position and fixed to the steel reinforcement bars by steel binding wires before the concreting is done.

ii. The conduit pipes shall be fixed firmly to the steel reinforcement bars to avoid their dislocation during pouring of cement concrete and subsequent tamping of the same.
iii. Fixing of standard bends or elbows shall be avoided as far as practicable, and all curves shall be maintained by bending the conduit pipe itself with a long radius, which will permit easy drawing in of conductors.
iv. Location of inspection / junction boxes in RCC work should be identified by suitable means to avoid unnecessary chipping of the RCC slab subsequently to locate these boxes.

11.4.) Recessed Conducting Work:

i. Before installing conduits, junction boxes and inspection boxes in the wall, a chase in the wall shall be neatly made and shall be of ample dimensions to permit the conduit & boxes to be fixed in the manner desired.
ii. Fixing Conduits in Chase: The conduit pipe shall be fixed by means of staples, J-hooks, or by means of saddles, not more than 60 cm apart or by any other approved means of fixing.
iii. The outer surface of the conduit pipes including all bends, unions, tees, junction boxes etc. forming part of the conduit system shall be adequately protected against rust. In no case, bare threaded portion of conduit pipe shall be allowed unless such bare threaded portion is treated with anti-corrosive preservative or covered with approved plastic compound.
iv. The chase shall be closed neatly and shall be finished flush with the wall after erection of conduit system.
v. All this work shall be completed before plastering of the wall & in Co-ordination with civil agency.

11.5.) Fixing Inspection Boxes

i. Suitable inspection boxes to the minimum requirement shall be provided to permit inspection and to facilitate replacement of wires, if necessary.
ii. These shall be mounted flush with the wall or ceiling concrete. Minimum 65 mm depth junction boxes shall be used in roof slabs and the depth of the boxes in other places shall be as per IS 2667:1988.
iii. Suitable ventilating holes shall be provided in the inspection box covers.

11.6.) Fixing Switch Boxes and Accessories

Switch boxes shall be mounted flush with the wall. All outlets such as switches, socket outlets etc. shall be flush mounting type, unless otherwise specified in the Additional Specifications.

11.7.) Fish Wire

To facilitate subsequent drawing of wires in the conduit, GI fish wire of 1.6 mm/1.2 mm (16/18 SWG) shall be provided along with the laying of the recessed conduit.

11.8.) Bunching of Cables

i. Cables carrying Direct Current may, if desired, be bunched whatever their polarity, but cables carrying alternating current, if installed in metal conduit shall always be bunched so that the outgoing and return cables can be drawn into the same conduit.
ii. Where the distribution is for single phase loads only, conductors for these phases shall be drawn in one conduit.
iii. In case of three phase loads, separate conduits shall be run from the distribution boards to the load, points, or outlets as the case may be.

11.9.) Earthing Requirements

i. The entire system of metallic conduit work, including the outlet boxes and other metallic accessories, shall be mechanically and electrically continuous by proper screwed joints, or by double check nuts at terminations.
ii. The conduit shall be continuous when passing through walls or floors.
iii. A protective earthing conductor(s) shall be laid inside the conduit between the metallic switch boxes and distribution switch boards and terminated with proper earth lugs/ terminals. Only PVC insulated copper conductor cable of specified size green in colour shall be allowed.
iv. The protective conductors shall be terminated properly using earth studs, earth terminal block etc. as the case may be.
v. Gas or water pipe shall not be used as protective conductor (earth medium).

11.10.) The junction boxes, inspection boxes and switch boxes shall be temporarily blocked by jute before concreting is done and shall be co-ordinated with engineer-in-charge/consultant. After concreting is over, all boxes shall be cleaned if they are choked up by concrete.

11.11.) All necessary bends in the system including diversion shall be done by bending pipes or by inserting normal or inspection type normal bends or by fixing M.S. painted inspection boxes whichever is more suitable.

11.12.) No length of conduit shall have more than the equivalent of two quarter bends from outlet to outlet. Additional bends shall be inspection bends/boxes.

11.13.) The junction boxes for lighting fixture, fans etc. shall be M.S. 16 gauge black enameled for surface mounting. The boxes shall be complete with covers to be fixed with screws.

11.14.) The conduit of each circuit or section shall be completed before conductors are drawn in.

11.15.) Conduit shall not be used as a earth medium.

11.16.) Mandatory test for conduits:

The following below mentioned tests are the mandatory tests for rigid metal conduit: -

i. Bending Test
ii. Compression Test
iii. Resistance to Heat test
iv. Resistance to Burning Test
v. Electrical Characteristics Test

The Testing including sampling shall be done as per BIS 9537: part 2:1981 (Reaffirmed 2017).

12.) **NUMBER OF WIRES IN A MS ERW / PVC CONDUIT:**

The maximum number of wires that may be laid in any conduit for circuit wiring or point wiring is given below: -

Maximum number of PVC insulated 650 / 1100 Volt Grade Aluminium / Copper conductor cable conforming to IS: 694-1990

Nominal Cross sectional area of conductor in sq. mm.	20 mm		25 mm		32 mm		38/40 mm		50/51 mm		63/64 mm	
	S	B	S	B	S	B	S	B	S	B	S	B
1.50	5	4	10	8	18	12	-	-	-	-	-	-
2.50	5	3	8	6	12	10	-	-	-	-	-	-
4	3	2	6	5	10	8	-	-	-	-	-	-
6	2	-	5	4	8	7	-	-	-	-	-	-
10	2	-	4	3	6	5	8	6	-	-	-	-

16	-	-	2	2	3	3	6	5	10	7	12	8
25	-	-	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	-	-	3	2	6	5	8	6
50	-	-	-	-	-	-	-	-	5	3	6	5
70	-	-	-	-	-	-	-	-	4	3	5	4

Note:

i. The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.
ii. The columns headed ‘S’ apply to runs of conduits which have distance not exceeding 4.25 m between draw in boxes and which do not deflect from the straight by an angle of more than 15 degrees. The columns headed ‘B’ apply to runs of conduit, which deflect from the straight by an angle of more than 15 degrees.
iii. Conduit sizes are the nominal external diameters.

13.) **WIRING ACCESSORIES:**

- Wiring accessories consists of switch boxes, controlling switches, sockets, fan regulators, cover plate with frame, ceiling rose, Lamp holders etc.
- Controlling switches, sockets, fan regulators, cover plate & frame shall be modular type, made up of polycarbonate material & of white colour unless otherwise specified. The dimensions of switches, sockets, and fan regulators shall preferably be ISI marked.
- Angle holder/ceiling roses shall also be of polycarbonate body.

13.1.) Switch boxes:

13.1.1) Surface switch box:

i. The Surface switch boxes shall be fabricated out of 16 SWG MS CRCA powder coated sheet duly welded at the edges suitable for accommodating the required number of switches & accessories as given in the BOQ.
ii. The surface switch boxes shall be got manufactured by OEM of wiring accessories and the sample of the same shall be got approved by Department. Suitable knockout shall be provided at the top for entry of casing-capping.
iii. All the MS switch boxes shall be provided with one no. of 3 mm dia. brass screw in tapped hole on side for Earthing. The head of the screw shall be outside the box with a nut provided inside box.

iv. All metallic boxes / switch boxes shall be earthed with 1.1 kV grade FRLS PVC insulated 2.5 sq.mm copper flexible wire.

13.1.2) Concealed switch box:

i. The Concealed switch boxes shall be Factory made metal sheet enclosure fabricated out of hot dip GI sheet suitable for accommodating the required number of switches & accessories as given in the BOQ.
ii. The switch boxes shall be got manufactured by OEM of wiring accessories and the sample of the same shall be got approved by Department
iii. Shall have Top, bottom, side and back wall knockout for conduit entry from any direction. Knockouts are such that it is Possible to break open them without any special tool.
iv. Shall have Screw less finish and rounded corners

The mounting and location shall be as specified in the drawing. Unless and otherwise specified, the mounting height shall not be more than 1.4 meter above floor level.

13.2.) Switches

The modular switch shall be having following features as mentioned below: -

S.No.	Descriptions	Dept.'s requirement
1.	Standard	IS 3854
2.	Voltage	240V AC
3.	Current	As per BOQ
4.	Material (Base & Rocker)	Polycarbonate
5.	Construction	Modular
6.	Installation	Snap fit with Modular Plates
7.	Terminals	Brass (Screw Type)
8.	Screws	Steel with zinc plating
9.	Rocker spring	Stainless steel
10.	Shall be	Flame Retardant
11.	IP degree of protection	IP20
12.	Tests	Marking, Mechanical Strength, Making & Breaking Capacity, Temperature rise, Insulation resistance, Electric Strength Test

13.3.) Sockets

The modular Sockets shall be having following features as mentioned below: -

S.No.	Descriptions	Dept.'s requirement
1.	Standard	IS 1293 / IEC 60950
2.	Voltage	240V AC
3.	Current	As per BOQ
4.	Material (Top cover & Base)	Polycarbonate
5.	Construction	Modular with Shutters
6.	Installation	Snap fit with Modular Plates
7.	Terminals	Brass (Screw Type)
8.	Screws	Steel with zinc plating
9.	P-N-E Contact	Brass
10.	Shall be	Flame Retardant
11.	IP degree of protection	IP20
12.	Tests	Marking , Resistance to ageing, Insulation resistance, electric strength, Temperature-rise , Making and breaking capacity , Mechanical strength

13.4.) Fan Regulator

The modular Regulator shall be having following features as mentioned below:

S.No.	Descriptions	Dept.'s requirement
1.	Standard	IS 11037
2.	Voltage	240V AC
3.	Operation	Knob Operated 5 Steps
4.	Material (Top cover, Base & Knob)	Polycarbonate
5.	Construction	Modular
6.	Installation	Snap fit with Modular Plates
7.	Terminals	Brass (Screw Type)
8.	Screws	Steel with zinc plating
9.	Shall be	Flame Retardant
10.	IP degree of protection	IP20
11.	Tests	Leakage current , High voltage ,

		Insulation resistance , Earthing connection , Protection against electric shock , Moisture resistance , Performance , Mechanical endurance, Power losses

13.5.) Cover Plate & Frame

The modular Plate & Frame shall be having following features as mentioned below: -

S.No.	Descriptions	Dept.'s requirement
1.	Cover Plate Material	Polycarbonate
2.	Inner Frame	Metallic (CRCA steel)
3.	Construction	Modular
4.	Installation	Snap fit for Cover Plate & Screwing with screws for Frame
5.	Screws	Steel with zinc plating
6.	Shall be	Flame Retardant
7.	IP degree of protection	IP20
8.	Tests	Fittment Test , Glow Wire Test , Impact Test

13.6.) Lamp Holders

Lamp holders shall be batten, angle, pendant or bracket holder type as per BOQ having following features:

i. Unbreakable polycarbonate body
ii. Brass Ring for holding of bulb to avoid breakage / damage of bulb locking
iii. Brass contacts for high current capacity & Low contact point resistance
iv. Shall be ISI marked

13.7.) Ceiling Rose

i. Ceiling Rose shall be 3 Plate ceiling rose.
ii. Shall be made of polycarbonate body
iii. Shall have brass terminals
iv. Shall be ISI marked

13.8.) Door Bell

i. Doorbell shall be Electronic type Bul-Bul Bell with step down transformer
ii. Shall be of polycarbonate body and
iii. Alarm Range of atleast 10 meter
iv. Shall preferably be ISI marked.

14.) **Wires:**

- Single core 1100 Volts FRLS grade PVC insulated multi-stranded flexible copper conductor wires shall be used for wiring, unless and otherwise specified.
- The size of the conductor shall be as specified in Bill of Quantitiesbut in no case, it shall be less than 1.5 sq. mm for lighting circuit and 2.5 sq. mm. for power circuit.

14.1.) Specifications of wires shall be as mentioned in the below table:

S.No.	**Descriptions**	**Dept.'s requirement**
1	Type	Multistranded Copper Conductor., FR-LSH PVC Insulated, Unsheathed , Single Core Flexible Cable
2	Applicable Standard	As per IS 8130/2013, IS 694/2010 etc. with latest up to date amendments
3	Voltage Grade.	Up to & including 1100 Volts
4	**Conductor :**	
4.1	Material	Plain Annealed High Conductivity Multistranded Copper Conductor
4.2	Nominal cross sectional area	As per BOQ
4.3	Flexibility clause	Class - 5 as per IS:8130
4.4	Dia. of each strands	Wire Size shall be suitably selected to meet the requirements of conductor Resistance as per relevant clause of IS : 8130
4.5	Shape of conductor	Flexible Circular
5	Insulation Material.	PVC Type-D with FR-LSH properties as per IS 5831/1984
6	Insulation Colour	Red, Yellow, Blue, Black, Green
7	**Physical Properties for Insulation**	as per IS 5831 : 1984
7.1	Min. Tensile Strength (N/mm^2)	10.0 N/mm^2
7.2	Min. Elongation at Break (%)	150%

8	**FR-LSH Properties for Insulation**	
8.1	Flammability Test	Burning period after removal of Flame shall not exceed 60 sec & unaffected portion from the lower edge of the top clamp shall be at least 50 mm.
8.2	Critical Oxygen Index @ 27°C	Minimum 29%
8.3	Temperature Index °C	The minimum measured value of temperature Index shall be 250°C at which Oxygen Index is 21%
8.4	Halogen Acid Gas Evolution	The level of Halogen Acid Gas evolved shall not exceed 20% by weight.
8.5	Smoke Density Rating	Maximum 60%

14.2.) Mandatory test for wires:

The Acceptance Test as mentioned in IS 694-2010 (Reaffirmed 2020) shall constitute the mandatory test for wires:

i. Annealing test (for copper)
ii. Conductor resistance test
iii. Test for thickness of insulation
iv. Tensile strength and elongation at break of insulation
v. Insulation resistance test
vi. High voltage test or spark test
vii. Flammability test
viii. Oxygen index test
ix. Test for temperature index
x. Test for halogen acid gas evaluation
xi. Test for smoke density rating

15.) **BLDC ceiling fans:**

Specifications of Ceiling fans shall be as mentioned in the below table:

Sl.No.	Description	Dept.'s requirement	
1.		1200mm sweep	900mm sweep
2.	Colour	White	White
3.	Type of motor	BLDC motor run on 1-Ø, 230 V, 50 Hz, AC	BLDC motor run on 1-Ø, 230 V, 50 Hz, AC
4.	Certification	5-Star Rated BEE	5-Star Rated BEE

Sl.No.	Description	Dept.'s requirement	
5.	Winding material	Super enameled copper wire	Super enameled copper wire
6.	Class of insulation (min.)	'E'	'E'
7.	Temperature rise over ambient temperature (max.)	75° C	75° C
8.	Power factor (minimum)	0.90 at 5th speed.	0.90 at 5th speed.
9.	Minimum air delivery at 230V (M3/min.)	230 CMM at 5th step of fan regulator	170 CMM at 5th step of fan regulator
10.	Rated speed	350 rpm +/-10% at 5th step of fan regulator.	460 rpm +/-10% at 5th step of fan regulator.
11.	THD (maximum)	10%	10%
12.	Service ratio (minimum)	8	5
13.	Max. leakage current (µA)	210	210
14.	Fan blades	Minimum 1.1mm thick powder coated aluminum blades	Minimum 1.1mm thick powder coated aluminum blades
15.	Type of down rod, size and material & length.	ID-15 mm, OD 19 mm, MS split shackles clips, 300 mm for concealed fan hook and 260mm for surface fan hook.	ID-15 mm, OD 19 mm, MS split shackles clips, 300 mm for concealed fan hook and 260mm for surface fan hook.
16.	Additional safety	Fan shall be supplied with additional safety chain (i.e. 18swg GI wire) with locking arrangement, 2 nos. of suitable holes shall be provided on fan shaft for fixing safety chain & termination of earth wire.	Fan shall be supplied with additional safety chain (i.e. 18swg GI wire) with locking arrangement, 2 nos. of suitable holes shall be provided on fan shaft for fixing safety chain & termination of earth wire.
17.	Testing	Procedure as per IS 374	Procedure as per IS 374

Sl.No.	Description	Dept.'s requirement	
18.	Guarantee	Fans shall be guaranteed for 03 years from the date of installation.	Fans shall be guaranteed for 03 years from the date of installation.

- All ceiling fans shall be wired to ceiling roses or to special connector boxes, and suspended from hooks or shackles, with insulators between hooks and suspension rods. There shall be no joint in the suspension rod.

- Interconnections between fan and fan point shall be made with 1.1 kV grade 3 C x 1.0 sq.mm FRLS sheathed PVC insulated multi stranded copper conductor flexible cable including termination with suitable tinned copper lugs etc.

- Routine test certificates as per IS shall be submitted and got cleared from EIC.
- Painting of serial numbers as instructed by Engineer in charge on ceiling fans with black colour paint / permanent marker.
- Canopies shall be provided at top & bottom of the suspension rod.

16.) **Concealed Fan Hook:**

i. For concrete roofs, a 12 mm dia. Powder coated MS rod in the shape of 'U' with their vertical legs bent horizontally at the top at least 19 cm on either side, and bound to the top reinforcement of the roof shall be used
ii. In buildings with concrete roofs having a low ceiling height, where the fan clamp mentioned above cannot be used, or wherever specified, recessed type fan clamp inside metallic box shall be used.

17.) **Surface Fan Hook:**

Fan hook shall be made of MS 'T' section of approx. size 65 x 60 x 5 mm & approx. 100 mm long, painted with two coats of synthetic enamel paint over one coat of red oxide paint including drilling holes in corners and in center of webs & shall be fixed by four nos. of anchor fastener of size min 8 mm x 50 mm. 'S' hook made up of 8 mm dia. (approx.) SS rod shall also be provided for suspension of ceiling fan via T-Hook.

18.) **Water Heater: -**

18.1.) Instant Water Heater:

Water Heater shall be ISI marked 1-litre instantaneous pressure type water heater complying to IS 8978, vertical round type with following specifications:

i. Heating Element - 3 kW heating element with necessary accessories
ii. Inner container - Stainless steel inner container having SS base and SS pipes on which heating element & its accessories will be mounted.
iii. Outer Body - ABS plastic
iv. Protections –
- Thermostat
- Thermal cutout (Reset button for thermal cutout shall be accessible from outside of Water Heater via removing rubber knob).
- Fusible plug
- Pressure release valve

v. Interconnecting Cable - 3C x 1.5 sq.mm flexible FR Multistranded copper conductor chord.

Note: -

The water heater shall be provided with suitable bracket for wall mounting and the bracket shall be got approved by the department.

18.2.) Storage Water Heater :

Water Heater shall be ISI marked Pressure type 25 litre Capacity storage type water heater with following specifications:

i. Heating Element - 2000 W tubular type heating element complete with all accessories
ii. Inner container - Stainless steel inner container / Mild Steel with Glass lined coating
iii. Insulation - Injected PUF insulation between inner & outer container
iv. Outer Body - ABS plastic
v. Protections –
- Thermostat
- Thermal cutout (Reset button for thermal cutout shall be accessible from outside of Water Heater via removing rubber knob).
- Fusible plug
- Pressure release valve

vi. Interconnecting Cable - 3C x 1 sq.mm flexible FR Multistranded copper conductor chord.

Note: -

The water heater shall be provided with suitable bracket fabricated out of 25 mm x 5 mm thick M/S flat with 2 coat of red oxide and 2 coats of enamel paint fixed on wall with 4 nos. of nettle fold screws in wall with nylon/phil plug for wall mounting and the bracket shall be got approved by the department.

18.3.) Acceptance Tests for Water Heaters:

i. Protection against access to live parts
ii. Temperature-rise
iii. Insulation resistance and electric strength at operating temperature
iv. Moisture resistance
v. Earthing connection
vi. Insulation resistance and electric strength after humidity treatment

18.4.) Water Heater Connection Pipe:

Water Heater Connection Pipe shall be 24-inch Connection Hose Pipe with Anti Explosion design & following specifications:

i. 1.) Stainless Steel 304 Grade Braided outer layer
ii. 2.) High temperature resistant EPDM inner Tube
iii. 3.) Double ring silicon sealing at both ends
iv. 4.) Brass / Copper inner joint
v. 5.) 1/2-inch SS female compression thread

Interconnection of inlet & outlet of water heater with existing water heater tapping points shall also be considered.

19.) **Exhaust Fans**

i. The exhaust fan shall be heavy duty, totally enclosed with an Energy Efficient motor.
ii. Motor shall have pre-lubricated double ball bearing for maintenance free running and provided with class "A" / "E " Insulation
iii. Aerodynamically balanced metal blades with pressure die cast Aluminium hub for higher air delivery
iv. Metal frame and arms mounted on rubber bushing for silent operation.
v. Long lasting epoxy powder coating.

Sl.No.	Description	Dept.'s requirement	
1.		380mm sweep (15")	300mm sweep (12")
2.	No. of blades	4	4
3.	Rated voltage	230 V	230 V
4.	Rated frequency	50 Hz	50 Hz
5.	Speed	1400 RPM	1400 RPM
6.	Power consumption	< 170 W	< 110 W

Sl.No.	Description	Dept.'s requirement	
7.	Minimum air delivery at 230V	3250 m^3/h	1710 m^3/h
8.	Noise level	Below 65 dB	Below 55 dB
9.	IS Standard	IS 2312	IS 2312
10.	Tests	High Voltage Insulation resistance Electrical Input Earthing Continuity Fan Speed Air delivery	High Voltage Insulation resistance Electrical Input Earthing Continuity Fan Speed Air delivery

19.1.) Installation of Exhaust Fan:

i. For installation of exhaust fan , an Aluminium framework (made out of 2 mm thick , 50 x 50 mm square tubes of 6063 grade Aluminium) of suitable size on wall/window shall be provided ,which shall be fixed by means of rag bolts embedded in the wall , including making suitable provision in wall/existing window by breaking & chiselling the wall/window, cutting the existing conduits if required, filling the leftover gaps after placing the Aluminium framework with cement mortar, bricks etc. finishing by applying white cement & touch up painting of that area by roller/brush etc.

ii. The exhaust fan shall be connected to the exhaust fan point by means of a flexible cord as per manufacturer standard & 16A, 3 Pin Plug top.

iii. Basket Grill / Fan Guard, made out of 16 SWG S.S. 304 spiral wires shall also be fixed from motor side for covering the fan blades with all SS Hardware as required & as shown in the below figure:

19.2.) Air duct / Weather Hood for exhaust Fan:

Exhaust fan air duct shall be fabricated out of 20 SWG GI sheet (having zinc coating of 25 micron) complete with splitters, turning vanes, transition pieces, bends, elbows, reducers, flanged joints with neoprene rubber gaskets, angle stiffeners (wherever required), exhaust duct, cowl etc. All hardware like nuts, bolts and washers shall be of GI. All flanged joints shall be made reasonably airtight

and all interior surfaces shall be smooth. Bends shall be made with throat radius not less than one half the dimension of the duct in the direction of turn.

A Bird Screen fabricated out of 16 SWG S.S.-304 wire mesh shall also be fixed in front entry of exhaust fan GI duct with all SS hardware as required & as shown in the below figure:

Note :

1) Scope of work includes breaking of wall & filling the leftover gaps in wall after placing the duct with cement mortar, bricks etc. finishing by applying white cement & touch up painting of that area by roller/brush etc.

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CHAPTER 12

Solar PV System

A.) General Requirements

These specifications related to the solar PV installation in the buildings. The specifications cover general requirements to the fulfilled. These general specifications are supplemented by the specific requirement for particular buildings separately attached.

These specifications are governed by the General, additional and special conditions of the contract attached hereto.

1.) Departure from Specifications:

No deviations are allowed in the tender submitted. No addition/alternation should be made in the tender book. However, any deviation should be brought out separately during pre-bid meeting for clarification/confirmations from the dept. otherwise it will be presumed there are no deviation and offer is deemed to include the same.

2.) Completion of Contract:

Any work, fittings, accessories or apparatus which may not have been specifically mentioned in the specification but which are necessary in the equipment for the efficient and satisfactory working of the plant system, should be deemed to be included in the contract and should be executed and proved by the contractor. All plant/system and apparatus should be complete in all respect with all required materials whether details in regards to these materials are mentioned in the specifications or not.

3.) Drawings:

The tender drawings indicate only the general scheme of requirements. The exact positions of panels, inverters & DB's etc. should be approved by the Engineer-in-charge before the commencement of work. Wherever required, detailed drawings shall be prepared by the contractor and should be got approved by the Engineer-in-charge.

Where considered necessary assembly, sub-assembly and other detailed drawings of all the equipment installation should be submitted for approval. The manufacture of any equipment should commence only after the approval of the Engineer-in-charge in writing to the corresponding contract drawings.

i. Four sets of the finally approved drawings incorporating all the modifications proposed by the Engineer-in-charge should be submitted along with the completion certificate before final payment is released and installation accepted by the department.

ii. The modifications should not be made in a drawing already approved without prior consent of Engineer-in-charge. Approval of the contract's drawings will not relieve the contractor if any of his obligation to meet all the requirements of the contract.

iii. Four sets of fully informative drawings for general layout, foundation of the equipment.

4.) **Instrument Instruction Books:**

The contractor should supply on completion of the contract, four copies of Full instructions for the working of all plant with illustrated literature and maintenance manual. Complete price lists of spare parts and tools with their catalogue code numbers.

5.) **Materials:**

All materials to be used in installation shall be new and of best quality conforming to the relevant IS/IEC/BS specifications.

They must be the products of reliable manufacturers of many years standing. All like parts of materials shall be interchangeable. In case of equipment such as circuit breakers, switch fuses etc. as descriptive and illustrated detailed technical data and literature shall accompany the tender.

The name of manufacturers of various materials shall be furnished taking into consideration of approved makes of materials indicated in the tender.

Samples of materials, wherever required should be submitted and got approved by the Engineer-in-charge, before use in the installation. One set of such approved samples shall be deposited with the Engineer-in-charge.

All materials shall be rust-proof or rendered rust-proof by application of suitable covers and paints. The supply of all equipment's, switchgears etc. shall be complete with accessories, fittings and mountings as may be required for their proper performance.

6.) **Workmanship**

Good workmanship and neat finish appearance are the prerequisite for complying with the clause of these specifications. With a view to ensure fine workmanship the tenderer shall employ licensed wiremen. With an experience of not less than 5 years in the type of work they are engaged. The work should be done under the supervision of competent qualified, experienced and proved electrical Engineer or licensed electrical supervisor shall be responsible for carrying out all works in accordance with the approved drawings, specifications and instructions of E.I.C. Bad workmanship will not be accepted and shall be rectified at contractor's own risk and cost to the satisfaction of the Engineer-in-charge.

Tenderer shall furnish the name of supervisors and their wireman who will be engaged in this work with details of their experience.

7.) **Insurance**

The tenderer shall insure at his own cost all the materials during transit from his factory to site as well as during storage at site till the system is handed over to the users after duly complete as per W.O. and instruction E.I.C.

8.) **Finish**

The finish of all the equipment's should be such that they can withstand the humid salty tropical weather condition at site.

9.) **Spares**

The tenderer shall quote separately for spares recommended by manufacturers for 5 years of satisfactory operation. The detailed list of spare parts recommended for the equipment's supplied shall be submitted and tenderer should quote accordingly.

10.) **Tools:**

All special tools required for dismantling and assembly of the equipment covered by the contract shall be supplied and included in the contract. A list of items that will be supplied by the contractor should be submitted along with the tender.

11.) **Testing**

The electrical contractor shall be solely responsible for the testing and commissioning of these installations covered by this specification in compliance with the standard procedure in vogue and also to obtain permission of the competent bodies for installation executed by the contractor. Any modification which is demanded by the competent body shall have to be carried out within the scope of the contract and without additional expense to department.

All necessary instruments for testing installation as per regulations shall be provided by the contractor carrying out the installation work. All tests shall be carried out in the presence of the Engineer-in-charge or his authorized representative and his approval shall be obtained in writing for the test results. The contractor shall submit four copies of approved and signed test certificates before handing over the installation work.

Contractor should carry out the tests on different equipments as specified in the subsequent section with the conditions thereof, in order to enable the Engineer-in-charge to determine whether the plants and work comply with the specifications and test. The contractor should arrange his own testing equipment required for tests to be carried out at site on any of the equipment.

Engineer-in-charge reserves the right to himself of having at the contractors expense any inspection or test of a reasonable nature carried out in addition to those specified in the specifications for different equipment at the contractors or subcontractor's premises or at site to satisfy himself that the plant and materials

comply with the requirements of contract. All equipment must be tested as per IS/BS/IEC specification and IEE regulation in presence of the Engineer-in-charge or his duly authorized representative.

During installation and commissioning necessary testing at different stages should be done as specified under “Testing and commissioning” indicated in the tender document in the presence of Engineer-in-charge.

12.) **Defect Liability period**

i. After the completion of the installation and testing the contractor should issue a certificate at the time of handing over, the **installation shall be guaranteed for a period of 12 months from the date of taking over installations by the Department**. During the period of guarantee all defects in materials and equipments supplied by him or in workmanship, shall be rectified or replaced free of cost to the Department.

ii. If it becomes necessary for the contractor to replace or renew any defective part of the installation or plant/equipments for purpose of rectification under this clause, the provisions of this clause shall apply to the plant/installation so replaced or renewed until the execration of six months from the date of such replacement/renewal or until the end of above mentioned period twelve months whichever may be the later.

iii. The contractor should get a certificate in writing from Engineer-in-charge for taking over the installation and forward the same along with the final bill.

iv. Security Deposit shall be returned to contractor after completion of guarantee period**.**

B.) Grid Tied Solar Photo Voltaic System:

1.) **Introduction**

The Grid Interactive Roof Top Solar Photo Voltaic plant shall consist of three major components viz. the solar photovoltaic (SPV) modules, galvanized array mounting MS structure and the inverter or power conditioning unit(s). The array mounting shall hold the PV modules in required position and the DC electrical energy shall be converted to AC power by the inverter, which is connected to the utility power grid. The AC power output of the inverter shall be fed to the grid panel through metering panel and solar panel. The 415 V AC 3-ph output of the system shall be synchronized with the grid and the power shall be exported to the grid depending upon solar power generation and local consumption.

2.) **Applicable standards**

i. IEC 61215 / IS 14286 - Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval

ii. IS 12762 (Part 1,2,3,9,10) : To measure I-V characteristics of crystalline silicon photovoltaic devices
iii. IEC 61730 Part 1 and 2 - PV module safety qualification
iv. IEC 61701- Salt mist corrosion testing of PV module
v. IEC 62109-1/2 - Safety of power converters for use in photovoltaic power System
vi. IS: 875 - For wind speed design of solar PV structure
vii. IEC 60068-2 (1,2,14,30): Environmental Testing of inverter
viii. IEC 61683: Efficiency Measurement of inverter
ix. IEC 62109-1, 2: Product Safety Standard of inverter
x. IEC 61727: Grid Connectivity Standard/ Utility Interface of inverter
xi. IEC 62116: Test Procedure for Islanding Prevention Measures for Utility Interconnected PV Inverters
xii. IEC 61000: Electromagnet Compatibility of inverter

3.) **Specification of Solar PV Modules**

The Photovoltaic modules must be tested & approved by one of the IEC authorized test centers as per relevant and latest IEC standards.

Solar PV modules shall be High-performance high efficiency MONO PERC Modules. Detailed specifications of the solar PV modules are given below:

Type	Mono PERC with half-cut cell configuration
Efficiency	>20%
Module minimum rated power	540 Wp or more
Number of cells	144
Bypass diodes	3 numbers or more per module (Schottky type)
Glass	3.2 mm Low Iron and Tempered glass with ARC coating
Encapsulate	PID Free & UV Resistant
Degradation warranty	Panel output (Wp) capacity to be >=90% of design nominal power after 10 years and >=80% of design Nominal power after 25 years.
Module frame	Anodized Aluminum Alloy
Junction box	IP68 Split junction box with 3 bypass diodes
PID resistant	The crystalline silicon-based modules supplied should be of Potential Induced Degradation (PID) free modules and the

	test certificate from third party lab complying with the same shall be provided.
RF Identification tag for each solar module	Shall be laminated inside the module and must be able to withstand environmental conditions and last the Lifetime of the solar module.
Wind Speed	2400 Pa
Snow load	5400 Pa
Cable & Connector (Protection degree / Type)	IP68 rated / MC4 compatible

A suitable number of Solar PV modules shall be connected in a series string. A suitable number of series strings shall be connected in parallel to formulate a series-parallel array (if required). The PV strings and array shall be designed to match the inverter input specifications.

The module frame shall be Torsion and corrosion resistant anodized aluminium frame. All the offered solar PV modules shall be of single make.

Testing and inspection:

Following acceptance tests as per IEC 61215 / IS 14286 shall be carried out in the presence of Dept. representatives at the Manufacturer's works or any third-party lab approved by MNRE. Cost of testing shall be included in the cost of the item.

i. Visual inspection
ii. Flash (IV) Test
iii. Electro-Luminescence (EL) Test
iv. Insulation Resistance (IR) Dry
v. Wet Leakage Test
vi. HiPot Test

4.) Solar PV Modules Mounting GI Structure

The PV modules shall be mounted on fully modular dead weight type of metallic structures having adequate strength and appropriate design, which can withstand the load of the modules and high wind velocities. The support structure shall be hot dip galvanized steel.

Detailed specifications for the mounting structure are given below:

Wind velocity withstanding Capacity	50 Meter / Second
Structure material	Hot dip galvanized steel with a galvanization thickness of 100 microns.

Bolts, nuts, spring washers etc.	Stainless steel of grade SS 304 (M6, M10 etc. with 2 set of washers)
Mounting arrangement for PV module	Using prefabricated fully modular hot dip galvanized MS frame work for holding the PV panels comprising of L brackets, Rafters, Perlin's, Vertical posts, Column Bracings, Rear Bracings, Block Tray Members, Base Plates etc.
Mounting arrangement for Dead weight	Prefabricated hot dip galvanized MS \Block Tray made up of L & C sections with suitable support plate welded at the base on each leg. Suitable 2 mm thick EPDM Sheet shall be provided below plate at each leg.
Installation	The structures shall be designed for simple mechanical on-site installation without any welding work. No grouting or tampering of waterproofing is allowed on the roof.
Minimum distance between roof edge and mounting structure	400 mm
Access for panel cleaning and Maintenance	All solar panels must be accessible from the top for cleaning and from the bottom for access to the module junction box.
Panel orientation	Preferably South facing.
Dead Weights for PV panels	M20 grade PCC blocks. PCC blocks shall be properly secured and placed on the frames.

i. The contractor shall prepare installation details of the solar PV modules and the support structures with lay-out drawings and array connection diagrams. The work shall be carried out as per the designs approved by the EIC.
ii. Each structure should have angle of inclination of 9 – 11 degrees (or as per the site condition) to maximize the insolation and also considering to withstand wind velocities.
iii. All structural designs including dead weight (PCC blocks) sizes shall be furnished by the successful bidder for evaluation and validation by EIC before fabrication during execution.

Inspection and testing:

All the GI fabrications shall be inspected at Galvanizer's works for

i. Visual inspection and bill of material at GI structure manufacturer works.
ii. Acceptance Tests for galvanizing material as per IS at manufacturer works as per I5 4759, IS 2629, IS 2633, IS 6745.

iii. Adhesion/Hammer test
iv. Knife test
v. Zinc coating thickness test
vi. Preece test-copper sulphate test
vii. Mass of zinc-stripping test.
viii. Supplier shall submit the chemical test report of the all Mild steel HR sheet materials.

5.) **Array junction box / DCDB**

Array junction boxes shall be provided at Inverter locations to accommodate the following:

i. DC disconnector to disconnect the PV strings from the Inverter for maintenance purpose. (One for each string)
ii. 1000V, Imax 40kA Type 2 Surge Protection Devices for protection against surge currents and voltages. (One for each MPPT).
iii. 1000V DC String fuses (One for each string).

The junction boxes should be wall mountable dust, vermin & waterproof & made of Thermoplastic (polycarbonate) / ABS enclosures with transparent covers having IP 65 & IK 08 protection for long-term use in PV systems.

The junction boxes shall have suitable cable entry points fitted with cable glands of appropriate sizes for both incoming & outgoing cables. Suitable markings shall be provided on the bus bar for easy identification & cable ferrules shall be fitted at the cable termination points for identification. (on AJB side as well as PV module side).

All fuses shall have DIN rail mountable fuse holders & shall have a voltage rating and current rating as required.

5% spare terminals (along with cable glands) rounded off to next higher integer shall be provided to connect the PV strings in future. All terminal blocks shall be rated for min 1000V and rated continuously to carry maximum expected current.

All internal wiring shall be carried out with 1100 V grade FRLS multi-stranded flexible copper wires. All internal wiring shall be securely supported, neatly arranged readily accessible and connected to component terminals and terminal blocks. Wire terminations shall be made with solder less crimping type tinned copper lugs which firmly grip the conductor and insulation.

6.) **Grid Tied String Inverter/Power Conditioning Unit (PCU):**

The string inverter/power conditioning unit shall be provided to convert DC power produced by SPV modules into 3 phase, 4 wire AC power. The power conditioning unit/inverter shall be grid connected. Inverter output should be compatible with the grid voltage & frequency.

Typical technical features of the inverter shall be as follows:

i. The kVA rating of string inverter for each PV system shall be according to the technical design and suitable for solar PV system's wattage.

ii. Inverter shall have inbuilt MPPT (Maximum Power Point Tracking) control to extract maximum energy from solar array and produce AC power.

iii. The AC output voltage and frequency of the inverter must synchronize automatically to the exact AC voltage and frequency of the grid. Grid voltage shall be continuously monitored and in the event of voltage going below or above a preset value, the solar PV system shall be disconnected from the grid within the set time. Both over voltage and under voltage relays shall have adjustable voltage setting and time settings (0 to 5 seconds).

iv. Inverter shall be IGBT (Insulated Gate Bipolar Transistor) based with associated control and protection devices.

v. The continuous power rating of the individual inverter shall be equivalent to minimum 100% of peak power rating of each array or sub array connected to the inverter.

vi. Each individual inverter will have all necessary protections against disturbances in frequency, voltage and current of the grid due to internal or external faults, abnormal temperatures and islanding. Its prime function will be to protect itself and solar array from any factors as well as avoid unintentional islanding.

vii. The PCU shall have anti-islanding protection as per IEC 62116 or equivalent standard. In the event of captive bus failure, the inverter automatically switches to off- within 20-50 milliseconds. The Solar system shall be able to synchronize with the captive bus immediately after the restoration of captive bus.

viii. Control and read out should be provided on the indicating panel which is the integral part to the inverter. Display should be simple and show all the relevant parameter relating to PCU operational data and fault condition on LCD or equivalent display. It shall include all important parameter i.e. DC input voltage, AC output voltage, AC output current, AC output power, frequency etc.

ix. Inverter shall have ground fault protection on DC side.

There shall be following modes of functioning in inverters:

i. Standby Mode

- The control system shall continuously monitor the output of the solar power plant until pre-set value of voltage, frequency is exceeded.

- Basic System Operation (Full Auto Mode)
- The system shall automatically “wake up” in the morning and begin to export power provided there is sufficient solar energy and the grid voltage and frequency is in range.

- Maximum Power Point Tracker (MPPT)
- MPPT control algorithm shall adjust the voltage of the SPV array to optimize solar energy fed into the grid.

ii. Sleep Mode

- Automatic – “sleep” mode shall be provided so that unnecessary losses are minimized at night. The power conditioner must also automatically re-enter standby mode when threshold of standby mode reached.

6.1.) Specifications of Inverter are as follows:

- Maximum Input DC power: Similar to KWp of PV module system
- Maximum DC input voltage: 1000V
- Nominal Output Frequency: 50Hz
- Nominal Output voltage: 415 V (shall follow AC voltage and frequency of the grid)
- Nominal AC voltage tracking range: +20%, - 20%
- Nominal AC frequency tracking range: +5 Hz, -5 Hz
- Minimum number of MPPT per inverter: 2nos
- Power factor: 0.8 lagging to 0.8 leading
- Waveform: Pure Sine Wave
- Harmonics AC side total harmonic current distortion < 3%
- Efficiency >97% at full load and >90% at 20% load
- Losses: Maximum losses in sleep mode: 2W
- Maximum losses in stand-by mode: 10W
- Operation: Completely automatic including wake-up, synchronization (phase locking) and shut down.
- MPPT range must be suitable to individual array voltages.
- Enclosure IP rating: Minimum IP65 (except cooling section if applicable)

6.2.) Protections:

- Surge Protection
- Ground Fault protection
- Over voltage
- Over current

- Over/Under grid frequency
- Over temperature
- Short circuit
- Lightening
- Anti-Islanding
- Manual intervention must be possible through an access code
- Emergency switch-off button

6.3.) Indications through LED/LCD display

- Inverter ON
- Grid ON
- Inverter Under / Over Voltage
- Inverter Overload
- Inverter Over Temperature

6.4.) Accurate displays on the front panel:

- DC input voltage
- DC current & AC voltage (all 3 phases and line)
- AC current (all 3 phases and line)
- Power factor
- Ambient temperature
- Instantaneous & cumulative array power
- Instantaneous & cumulative output power
- Communication interface: LAN port/RS485

The power conditioning units / inverters should comply with applicable IEC/ equivalent BIS standard for efficiency measurements and environmental tests as per standard codes IS/IEC 61683 and IEC 60068 2(6,21,27,30,75,78).

The MPPT units should qualify IEC standards. The enclosures should be IP 65 and as per IEC 62208 specifications.

The PCU/ inverters shall be tested from the MNRE approved test centres / NABL /BIS accredited testing- calibration laboratories. In case of imported power conditioning units, these should be approved by international test houses.

The inverter shall include adequate internal cooling arrangements for operation in a non-AC environment.

6.5.) Inspection and testing:

Following acceptance tests as per IEC 62116, 61627,61683, IS 16169 shall be carried out in the presence of Dept. representatives at the Manufacturer's works or any third-party lab approved by MNRE. Cost of testing shall be included in the cost of the item.

i. Grid Interconnection Tests (Harmonic & DC injection, Protection against abnormal voltage and frequency)

ii. Active Power Control
iii. Fixed Power Factor
iv. Fixed Reactive Power
v. Efficiency Test
vi. Anti-Islanding Test
vii. Earth Fault and Insulation Resistance (IR) Testing

7.) **DC CABLES / WIRES**

500V (DC) grade UV resistant, Halogen Free & Flame Retardant cable conforming to TUV 2 Pfg 1169/08.2007 / EN 50618:2015 with latest amendments as per specifications given below:

Size: 1C x 4 sq. mm for array cabling between solar modules and upto Array junction box (combiner box).

The suitable size DC copper cables shall be selected from Array junction box to Inverter depending on the no. of input DC connectors available in Inverter. Termination of all the DC cables is in the scope of item.

All connections should be properly terminated using MC4 connectors, sealed from outdoor and indoor elements. Relevant codes and operating manuals must be followed.

7.1.) TECHNICAL SPECIFICATIONS:

	Rated DC Voltage	500 V
	No. of core	One
	Core size	4 Sq. mm
	Conductor material	Electrolytic Class-5 ATC multistranded copper
	Insulation	Halogen Free & Flame Retardant XLPO (cross linked polyolefin)
	Thickness of insulation	Min. 0.7 mm
	Outer sheath	Halogen Free & Flame Retardant XLPO (cross linked polyolefin)
	Thickness of outer sheath	Min. 0.8 mm
	Max. Conductor temperature for continuous rated current	120^{o}C
	Max. Conductor temperature during	200^{o}C

	short circuit	
	Max voltage withstands	6500 Volts AC or 15 KV DC for 5 min

7.2.) TESTS:

The following tests shall be conducted on subject material for acceptance in presence of departmental engineer at manufacturer's works.

No.	Kind of test	Test conditions
1	Electrical tests	
1.1	Conductor Resistance	Measuring of conductor resistance acc. to EN 50395
1.2	High voltage test at complete cable	Dielectric test at complete cable with 6.5 kV AC or 15 kV DC for 5 mins.
1.3	Absence of faults	Dielectric test at complete cable with 10 kV AC (100% during production)
1.4	Surface resistance of sheath	Surface resistance > $10^9\Omega$
1.5	Insulation resistance at complete cable	Insulation resistance > $10^{14}\Omega$ (at 20°C) Insulation resistance > $10^{11}\Omega$ (at 90°C)

Remaining all the testing shall be as per the 2 pfg 1169/08.2007 standards.

C.) Standalone / Hybrid Solar Photo Voltaic System

1.) **Introduction:**

Similar to a traditional solar PV system that is connected to the grid, a hybrid solar PV plant still uses photovoltaic (PV) materials to collect and convert sunlight into energy. In a traditional system, that electricity is routed to the grid, which allows the user to go without a battery while still being able to access electricity during overcast days or the night.

With a hybrid solar system, however, the electricity is routed to a hybrid inverter and battery. Once the battery is full, the excess is channeled through a smart meter to the grid's power lines. This allows the user to retain a portion of the electricity, which can help power the installations not only during overcast days or the night but also if there is an energy blackout / Grid Failure.

Most of the components of Hybrid solar PV system are similar to that of Grid tied system except inverter & a battery bank. A Hybrid system uses an Hybrid type of

Solar Inverter which is a combination of Charge controller & Inverter in a same unit. Hybrid system also have a battery bank which is used for storage of energy.

2.) **Applicable standards**

i. IEC 61215 / IS 14286 - Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval
ii. IS 12762 (Part 1,2,3,9,10) : To measure I-V characteristics of crystalline silicon photovoltaic devices
iii. IEC 61730 Part 1 and 2 - PV module safety qualification
iv. IEC 61701- Salt mist corrosion testing of PV module
v. IEC 62109-1/2 - Safety of power converters for use in photovoltaic power System
vi. IS: 875 - For wind speed design of solar PV structure
vii. IEC 60068-2 (1,2,14,30): Environmental Testing of inverter
viii. IEC 61683: Efficiency Measurement of inverter
ix. IEC 62109-1, 2: Product Safety Standard of inverter
x. IEC 61727: Grid Connectivity Standard/ Utility Interface of inverter
xi. IEC 62116: Test Procedure for Islanding Prevention Measures for Utility Interconnected PV Inverters
xii. IEC 61000: Electromagnet Compatibility of inverter

3.) **Secification of Solar PV Modules**

The Photovoltaic modules must be tested & approved by one of the IEC authorized test centers as per relevant and latest IEC standards.

Solar PV modules shall be High-performance high efficiency MONO PERC Modules. Detailed specifications of the solar PV modules are given below:

Type	Mono PERC with half-cut cell configuration
Efficiency	>20%
Module minimum rated power	540 Wp or more
Number of cells	144
Bypass diodes	3 numbers or more per module (Schottky type)
Glass	3.2 mm Low Iron and Tempered glass with ARC coating
Encapsulate	PID Free & UV Resistant
Degradation warranty	Panel output (Wp) capacity to be

	>=90% of design nominal power after 10 years and >=80% of design Nominal power after 25 years.
Module frame	Anodized Aluminum Alloy
Junction box	IP68 Split junction box with 3 bypass diodes
PID resistant	The crystalline silicon-based modules supplied should be of Potential Induced Degradation (PID) free modules and the test certificate from third party lab complying with the same shall be provided.
RF Identification tag for each solar module	Shall be laminated inside the module and must be able to withstand environmental conditions and last the Lifetime of the solar module.
Wind Speed	2400 Pa
Snow load	5400 Pa
Cable & Connector (Protection degree / Type)	IP68 rated / MC4 compatible

A suitable number of Solar PV modules shall be connected in a series string. A suitable number of series strings shall be connected in parallel to formulate a series-parallel array (if required). The PV strings and array shall be designed to match the inverter input specifications.

The module frame shall be Torsion and corrosion resistant anodized aluminium frame. All the offered solar PV modules shall be of single make.

Testing and inspection:

Following acceptance tests as per IEC 61215 / IS 14286 shall be carried out in the presence of Dept. representatives at the Manufacturer's works or any third-party lab approved by MNRE. Cost of testing shall be included in the cost of the item.

i. Visual inspection
ii. Flash (IV) Test
iii. Electro-Luminescense (EL) Test
iv. Insulation Resistance (IR) Dry
v. Wet Leakage Test
vi. HiPot Test

4.) **Solar PV Modules Mounting GI Structure**

The PV modules shall be mounted on fully modular dead weight type of metallic structures having adequate strength and appropriate design, which can withstand the load of the modules and high wind velocities. The support structure shall be hot dip galvanized steel.

Detailed specifications for the mounting structure are given below:

Wind velocity withstanding Capacity	50 Meter / Second
Structure material	Hot dip galvanized steel with a galvanization thickness of 100 microns.
Bolts, nuts, spring washers etc.	Stainless steel of grade SS 304 (M6, M10 etc. with 2 set of washers)
Mounting arrangement for PV module	Using prefabricated fully modular hot dip galvanized MS frame work for holding the PV panels comprising of L brackets, Rafters, Perlin's, Vertical posts, Column Bracings, Rear Bracings, Block Tray Members, Base Plates etc.
Mounting arrangement for Dead weight	Prefabricated hot dip galvanized MS \Block Tray made up of L & C sections with suitable support plate welded at the base on each leg. Suitable 2 mm thick EPDM Sheet shall be provided below plate at each leg.
Installation	The structures shall be designed for simple mechanical on-site installation without any welding work. No grouting or tampering of waterproofing is allowed on the roof.
Minimum distance between roof edge and mounting structure	400 mm
Access for panel cleaning and Maintenance	All solar panels must be accessible from the top for cleaning and from the bottom for access to the module junction box.
Panel orientation	Preferably South facing.
Dead Weights for PV panels	M20 grade PCC blocks. PCC blocks shall be properly secured and placed on the frames.

i. The contractor shall prepare installation details of the solar PV modules and the support structures with lay-out drawings and array connection diagrams. The work shall be carried out as per the designs approved by the EIC.

ii. Each structure should have angle of inclination of 9 – 11 degrees (or as per the site condition) to maximize the insolation and also considering to withstand wind velocities.
iii. All structural designs including dead weight (PCC blocks) sizes shall be furnished by the successful bidder for evaluation and validation by EIC before fabrication during execution.

Inspection and testing:

All the GI fabrications shall be inspected at Galvanizer's works for

i. Visual inspection and bill of material at GI structure manufacturer works.
ii. Acceptance Tests for galvanizing material as per IS at manufacturer works as per I5 4759, IS 2629, IS 2633, IS 6745.
iii. Adhesion/Hammer test
iv. Knife test
v. Zinc coating thickness test
vi. Preece test-copper sulphate test
vii. Mass of zinc-stripping test.
viii. Supplier shall submit the chemical test report of the all Mild steel HR sheet materials.

5.) **Array junction box / DCDB**

Array junction boxes shall be provided at Inverter locations to accommodate the following:

i. DC disconnectors to disconnect the PV strings from the Inverter for maintenance purpose. (One for each string)
ii. 1000V, Imax 40kA Type 2 Surge Protection Devices for protection against surge currents and voltages. (One for each MPPT).
iii. 1000V DC String fuses (One for each string).

The junction boxes should be wall mountable dust, vermin & waterproof & made of Thermoplastic (polycarbonate) / ABS enclosures with transparent covers having IP 65 & IK 08 protection for long-term use in PV systems.

The junction boxes shall have suitable cable entry points fitted with cable glands of appropriate sizes for both incoming & outgoing cables. Suitable markings shall be provided on the bus bar for easy identification & cable ferrules shall be fitted at the cable termination points for identification. (on AJB side as well as PV module side).

All fuses shall have DIN rail mountable fuse holders & shall have a voltage rating and current rating as required.

5% spare terminals (along with cable glands) rounded off to next higher integer shall be provided to connect the PV strings in future. All terminal blocks shall be rated for min 1000V and rated continuously to carry maximum expected current.

All internal wiring shall be carried out with 1100 V grade FRLS multi-stranded flexible copper wires. All internal wiring shall be securely supported, neatly arranged readily accessible and connected to component terminals and terminal blocks. Wire terminations shall be made with solder less crimping type tinned copper lugs which firmly grip the conductor and insulation.

6.) **Hybrid solar inverter cum charge controllers**

Hybrid solar inverter shall be a multi-functional inverter that combines the functions and capabilities of both grid-tie and off-grid solar inverters. One side, it shall stores the electricity into the solar battery for crucial times and on the other side, it shall exports the excess or unconsumed electricity to the utility grid.

As day turns to night, the solar panel will cease to produce energy at which points solar inverter shall automatically fulfill the consumption of the installations from battery stored energy. In case, the consumption exceeds what the batteries are able to supply then it shall automatically switch over to the utility grid and continue to operate.

6.1.) The PCU shall have two operating modes:

i. **Stand-alone:** Solar Inverter operates from solar battery and produces AC output. It shall function as a stand-alone power plant feeding the connected loads when grid is not available.

ii. **Grid Interactive:** In the day time the first priority of the inverter shall be to charge the battery. Whenever battery reaches float charge, inverter shall be supplying the connected load in conjunction with the grid. Any excess solar power shall be exported into the grid. Whenever sufficient solar power is not available to run the load, the required power is shared from the grid.

6.2.) Hybrid Inverter shall have the following features:

- In case inverter is not functioning, there shall be provision to bypass the load on to grid or DG. At any point there shall not be any back feeding to the DG.

- Battery based solar inverter cum charge controller shall be a single panel with Inbuilt high-efficiency MPPT charge controller. Charge controller shall be integral part of inverter (separate units of charge controller and inverter placed in a single enclosure is not acceptable). Charge controller is the front end of the solar inverter which will have the MPPT charger in order to charge the battery and shall be internally coupled with inverter section of the solar inverter.

- The charge controller shall be having the following functionalities:

i. Charge controller shall be capable of 3 step (float, boost and trickle) charging, depending on the state of charge of the battery. Inverter/charge controller shall utilize solar/grid power to charge the battery bank till battery reaches float with solar as priority for charging the battery.

ii. Once the battery cells reach float, solar power generated shall be used to meet the connected site load. The provision for grid export is optional and shall be set point controllable if not required.

iii. In general, the priority of supply to the load should be solar, grid and battery.

iv. Once the battery cell drops below the pre-determined voltage (say 1.1 Vpc), load should be disconnected from battery automatically. Solar/grid charging shall commence and continue till battery reaches float. After battery cells reaches float voltage, charging shall be adjusted in such a way to maintain the float voltage.

- Shall have LCD panel which can display various detailed information.

6.3.) SPECIFICATION

INPUT	
Input Voltage Range	360 VAC to 450 VAC
Nominal Frequency	50 Hz (± 6%)
Input Fault Level	10 kA
Self Consumption	upto 4%
Grid / DG compatibility	Yes
SOLAR	
Charger Type	MPPT
Max PV Voltage (VOC)	Upto 1200V
MPPT Voltage Range	800-1100V
No. of MPPT Channel	3 / 2
Max I/P Amps per Channel (Amps)	Upto 125
Panel Reverse protection	Yes
Solar Charger Effieciency	upto 95%
BATTERY	

Nominal Battery Volatege (Vdc)	Upto 600V
Grid Charging Current	Selectable as 5A steps
Input Power Factor (Grid Charging)	Near to Unity
Battery Charging Volatege	Selectable from LCD Display
Type & No. of Cells	Lead Acid / VRLA / Ni-Cd / Lithium
OUTPUT	
Load Power Factor	0.8 lag
Output Voltage (Inverter Mode)	415V AC
Voltage Regulation	± 2%
Output Frequency (Free Running)	50 Hz ± 0.5%
Output Waveform	Pure Sine Wave
Peak Inveretr Efficiency	upto 90%
THD	<3%
Overload Capacity	125% for 60 Sec, 150% for 5 Sec
Changeover Time (Full Load)	20 msec
AC/DC Isolation	Inbuilt isolation transformer
Anti islanding function	Available
CONFIGURATION	
Modes Available	Hybrid / Grid Export / Standalone
Battery Buffer setting	Selectable 25%, 50%, 75%
GRID Feed Mode	Enable / Disable option
PHYSICAL	
Enclosure	IP20
Cooling	Forced Air
Protections:	Surge Protection Ground Fault protection Over voltage Over current Over/Under grid frequency Over temperature Short circuit Lightening Anti-Islanding Manual intervention must be possible through an access code

	Emergency switch-off button

Inspection and testing:

Following acceptance tests as per IEC 62116, 61627,61683, IS 16169 shall be carried out in the presence of Dept. representatives at the Manufacturer's works or any third-party lab approved by MNRE. Cost of testing shall be included in the cost of the item.

i. Grid Interconnection Tests (Harmonic & DC injection, Protection against abnormal voltage and frequency)
ii. Active Power Control
iii. Fixed Power Factor
iv. Fixed Reactive Power
v. Efficiency Test
vi. Anti-Islanding Test
vii. Earth Fault and Insulation Resistance (IR) Testing

7.) DC CABLES / WIRES

- 500V (DC) grade UV resistant, Halogen Free & Flame Retardant cable conforming to TUV 2 Pfg 1169/08.2007 / EN 50618:2015 with latest amendments as per specifications given below:

- Size: 1C x 4 sq. mm for array cabling between solar modules and upto Array junction box (combiner box).

- The suitable size DC copper cables shall be selected from Array junction box to Inverter depending on the no. of input DC connectors available in Inverter. Termination of all the DC cables is in the scope of item.

- All connections should be properly terminated using MC4 connectors, sealed from outdoor and indoor elements. Relevant codes and operating manuals must be followed.

7.1.) TECHNICAL SPECIFICATIONS:

•	Rated DC Voltage	500 V
•	No. of core	One

•	Core size	4 Sq. mm
•	Conductor material	Electrolytic Class-5 ATC multistranded copper
•	Insulation	Halogen Free & Flame Retardant XLPO (cross linked polyolefin)
•	Thickness of insulation	Min. 0.7 mm
•	Outer sheath	Halogen Free & Flame Retardant XLPO (cross linked polyolefin)
•	Thickness of outer sheath	Min. 0.8 mm
•	Max. Conductor temperature for continuous rated current	120^{o}C
•	Max. Conductor temperature during short circuit	200^{o}C
•	Max voltage withstands	6500 Volts AC or 15 KV DC for 5 min

7.2.) TESTS:

The following tests shall be conducted on subject material for acceptance in presence of departmental engineer at manufacturer's works.

No.	Kind of test	Test conditions
1	Electrical tests	
1.1	Conductor Resistance	Measuring of conductor resistance acc. to EN 50395
1.2	High voltage test at complete cable	Dielectric test at complete cable with 6.5 kV AC or 15 kV DC for 5 mins.
1.3	Absence of faults	Dielectric test at complete cable with 10 kV AC (100% during production)
1.4	Surface resistance of sheath	Surface resistance > $10^{9}\Omega$
1.5	Insulation resistance at complete cable	Insulation resistance > $10^{14}\Omega$ (at 20°C) Insulation resistance > $10^{11}\Omega$ (at 90°C)

Remaining all the testing shall be as per the 2 pfg 1169/08.2007 standards

8.) **Battery Bank:**

i. The batteries shall be solar photovoltaic batteries of flooded electrolyte low maintenance, lead Acid/ VRL batteries as specified in BOQ and as per the relevant BIS standards & MNRE specifications can be used.
ii. Storage batteries should conform IEC 61427 / IS 1652 / IS 13369 as per specifications.
iii. The batteries shall use 2V and battery capacity is to be designed at C/10 rate with end cell cut off voltage of 1.85 V per cell.
iv. Battery terminal shall be provided with covers.
v. Batteries shall be provided with micro porous vent plugs with floats. Charging instructions shall be provided along with the batteries.
vi. Suitable carrying handle shall be provided.
vii. A suitable battery rack with interconnections & end connector shall be provided to suitably house the batteries in the bank. The features and dimensions of the battery rack shall be provided along with the bid document.
viii. The batteries shall be suitable for recharging by means of solar modules via incremental / open circuit regulators.
ix. The design cycle life of batteries at 80%, 10% and 20% depth of discharge at 27 deg. C shall be mentioned.
x. The batteries shall be designed for operating in ambient temperature of site.
xi. The self-discharge of batteries shall be less than 3 % per month at 20 deg. C and less than 6% per month at 30 deg. C
xii. The charge efficiency shall be more than 90% up to 70% state of charge. The topping up frequency shall be 12 – 18 months.
xiii. The batteries shall consist of individual cells, which can be carried separately with ease while transporting.
xiv. Offered batteries shall comply to the following:

- 10 % of DOD: 7200 cycles
- 50 % of DOD: 3000 cycles
- 80 % of DOD: 1200 cycles

xv. The Battery Bank shall be designed to provide 1-day autonomy. Bidder to provide battery sizing details along with their offer. The distance between two batteries may be kept 6 inches & vice versa.
xvi. The batteries should be of tubular plate lead acid & low maintenance type and shall have long service life. The cells should confirm IEC 61427 / IS 1652 / IS 13369 and as per specification given below shall be provided.
xvii.
xviii.

xix. Each battery bank will contain suitable wooden/MS power coated rack, hydrometer, thermometer, cell tester and connecting leads etc. as specified in BOQ.

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CHAPTER 13-
EARTHING

1.) SCOPE:

The scope of work under this section covers the earthing of various panels, distribution boards and utilization equipment.

2.) STANDARDS:

The following standards and rules shall be applicable -

IS – 3043 (latest) : Codes of practice for earthing.

Indian Electricity Act 2003 and rules issued there under.

3.) PLATE ELECTRODE EARTH PIT:

3.1.) Plate earth station shall be provided with heavy dipped tinned copper earth plate electrode 600 x 600 x 3mm in size at the depth of 2.5 m below ground level (bottom of Plate) confirming to IS 3043 complete with all required materials like coke / charcoal, salt, Brass nut bolts, washers, 19 mm dia GI pipe (B class), concrete chamber duly plastered, heavy duty (minimum 6 mm thick) M.S chequred plate cover associated materials like 40 x 40 x 5 mm angle iron frame work, hinged locking arrangements, complete with funnels, Copper test links (50 x 6 mm), two runs of 50 x 6mm copper strips for connecting copper plate including brazing as required & test link etc. including excavation of ground in all types of soils, refilling & removal of excess earth within a radius of 3000 m etc. all as required as per the drawing specifications & instructed by Engineer-in-charge.

3.2.) The chamber cover & frame shall be got approved by Department & painted with two coats of red oxide & one coat of enamel paint.

4.) EQUIPMENT EARTHING:

4.1.) Three phase motors and other three phase apparatus shall have two distinct earth connection of size equal to 50% of the connecting cables.

4.2.) For 1HP motor and 1HP apparatus, the single earth connection shall be provided.

4.3.) For all light fittings and fans, a single earth connection with 1.5 sq. mm. copper shall be provided.

5.) EARTH CONTINUITY CONDUCTOR FOR METALLIC CONDUITS:

5.1.) Metalic conduit shall not be accepted as an earth continuity conductor. A separate copper earth continuity conductor of size of 50% of phase conductor or 14 SWG copper wire whichever is more shall be provided.

5.2.) The earth continuity conductor shall be clamped to the conduit at one meter intervals using approved copper earth clamps. Binding wire is not accepted as a substitute for earth clamps.

6.) Size of copper strips/wires for earthing of distribution panel/sub panels/DBs:

Sr. No.	Size of incomer cable	Size of copper or GI strip/wire
1.	a) 10 sq. mm / 4 core	2 Nos. of 8 SWG tinned copper (or) 2 Nos. of 4 SWG GI
	b) 16 sq. mm / 4 core	
	c) 25 sq. mm / 4 core	
	d) 35 sq. mm / 3 ½ core	
2.	a) 50 sq. mm / 3 ½ core	2 Nos. of 4 SWG tinned copper or equivalent G.I. wire
	b) 70 sq. mm / 3 ½ core	
	c) 95 sq. mm / 3 ½ core	
3.	a) 120 sq. mm / 3 ½ core	2 Nos. of 25 mm x 3 mm tinned copper (or) 2 Nos. of 25 mm x 6 mm GI or 50 mm x 3 mm GI
	b) 150 sq. mm / 3 ½ core	
	c) 185 sq. mm / 3 ½ core	
4.	a) 240 sq. mm / 3 ½ core	2 Nos. of 25 mm x 6 mm tinned copper or 50 mm x 6 mm GI
	b) 300 sq. mm / 3 ½ core	
	c) 400 sq. mm / 3 ½ core	
	d) 500 sq. mm / 3 ½ core	

7.) Grounding EQUIPMENTS:

7.1.) Ground wires shall either terminate on ground lugs provided on the equipment or shall be fastened to the foundation bolt and the frame of equipment.

7.2.) All conduits shall be grounded with approved proper size of earthing wire/strips as requested.

7.3.) Ground wires terminating at every equipment shall have certain flexibility in its connection to the equipment.

7.4.) Suitable size of sleeves required in the wall, column etc. taking earth strips across them shall be provided by the contractor during the civil construction. After laying the earth strip, the sleeve shall be properly sealed.

8.) **ERECTION:**

8.1.) Hot dipped GI strip shall be fixed to wall / slab / column / beam with 2mm thick GI saddle and min, 4mm thick GI spacer

8.2.) In ground at a depth of 750 mm below ground level including excavation in all type of soil with protective baked bricks, refilling and removal of excess earth within a radius of 3000 m, temporary reinstatement and back filling of trench, interconnection of earth strip / wire GI nut bolts & washers, painting with two coats of black bituminous compound for earth strip in ground and green colour enamel painting strip on surface etc. all as required & instructed by the Engineer-in-charge.

8.3.) TERMINATION:

Where the diameter of the bolt at the joints exceeds one quarter of the width of the earth continuity, the connection shall be made with a wider piece sandwiched between two conductors.

9.) **Supply and Installation Of Earthing System:**

All medium voltage equipment shall be earthed by two separate and distinct earth connection using tinned copper/GI earth wire/strip of specified gauge.

All metallic conduits run for lighting & receptacle system shall be provided with continuous earth wire of 14 SWG tinned copper run along the conduit and connected to all lighting/power receptacles of 6A and 16A. Three phase, 60 Amps receptacles and associated conduit run will be earthed by 2 nos of 8 SWG tinned copper conductors or equivalent G.I. Wires/strips.

Earthing conductors, tinned copper/G.I. Earthing clamp and all other accessories required for earthing the lighting and receptacle system, conduit accessories and equipment as per drawings and specifications shall be supplied and installed by the contractor. Earth wires shall be protected against mechanical damage and possibility of corrosion particularly at the point of connection to the earthing terminals of panels and fitting.

All joints shall be made on tinned surfaces in case of copper earth system jointing earth wire shall be done only at junction boxes and equipment earthing terminals. The jointing on earth wires shall be done with approved type of connection & no twisted joint will be allowed.

The whole metallic conduit system shall be electrically continuous throughout and shall be permanently and efficiently connected to earth. When earth wire runs along the conduit the earth wire shall be clamped to the conduits securely on either side of the joint to ensure electrical continuity in the conduit system.

All non-current carrying metal parts of panels, lighting fixtures, junction boxes etc. shall be efficiently connected to earth.

10.) **Gland Earthing:**

Cable gland earthing shall be done with brass earthing tags of suitable thickness, connecting to nearest earthing point with suitable size of earth wire/strip using brass nuts & bolts & washers (in case of copper earthing system) & GI nuts and bolts and washers (in case of GI earthing system) all as directed by Engineer-in-charge.

11.) **Site Test:**

The following earth resistance values shall be measured with an approved earth megger and recorded.

i. i) Each earthing station
ii. ii) Earthing system as a whole
iii. iii) Earth continuity conductors

12.) **MODE OF MEASUREMENT:**

12.1.) Providing an earthing station complete with excavation electrode watering pipe, soil treatment, chamber etc. shall be treated as one unit of measurement.

12.2.) The following items of work shall be measured and paid at unit rate covering the cost of the earth wires/strips, clamps, labour etc :-

- Main equipment earthing grid and connection to earthing station.
- Connection to power panels, distribution boards etc.

12.3.) The cost of earthing the following items shall become part of the cost of the item itself and no separate payment for earthing shall be made :-

- Light fittings -form part of installation of light fitting.
- Conduit / PVC casing & capping - should form part of the wiring of cabling.
- Cable glands earthing.

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CHAPTER 14
MAINTENANCE FREE EARTHING

1.) **Scope:**

This document covers specifications of maintenance free earthing components to be used for following purposes: -

i. Safety Earthing for building.
ii. Earthing for Lightining protection of buildings.

2.) **Applicable Standards:**

IS 3043	Code of practice for earthing.
ANSI/UL 467	Safety for Grounding & bonding equipment.
IEC 62561-2	Requirement for conductors and earth electrodes.
IEC 62561-7	Requirement for earthing enhancing compound .
IEC 60068-2-52	Salt Mist Test and Humid Sulphur Atmosphere Test.
ASTM G 59-97	Potentiodynamic polarization resistance methods.
CET/TS 14997	Leaching behaviours principles and methods.
RDSO/SPN/197	Specification for Code of Practice for Earthing & Bonding System for Signalling Equipments.
IEEE 80 : 2000	Substation Earthing.
BS 7430 : 1998	Code of practice for earthing.
GP-311	CBIP Manual on Earthing of AC system.

3.) **Components of Maintenance free Earthing System**:

The components of Maintenance free earthing system are as follows:

i. Earth Electrode.
ii. Earth enhancement material.
iii. GI/ tinned Cu strip for connecting the earth electrode to earth strip.
iv. GI/ tinned Cu strips for interconnection of earth electrodes below ground.
v. Earth pit for housing GI / tinned Cu main equipotential bar for body earthing.
vi. Earth pit for housing GI main equipotential bar for earthing of lightning protection system.

All the material like copper bonded rod, ground enhancement material, connectors etc. should be sourced from reputed suppliers & of excellent quality conforming to technical specifications.

4.) **Earth Electrode:**

i. The earth electrode shall be made of high tensile low carbon steel circular rods, molecularly bonded with copper on outer surface to meet the requirements of IEC 62561-2.
ii. **The earth electrode shall be connected to GI/ tinned Cu strip by exothermic welding only.**
iii. Marking: Manufacturer's name or trade name, length, diameter, UL catalogue number must be punched on every earth electrode.

5.) **Earth Enhancement material:**

Earth enhancement material is a superior conductive material that improves earthing effectiveness, especially in areas of poor conductivity (rocky ground, areas of moisture variation, sandy soils etc.) it improves conductivity of the earth electrode and ground contact area. It shall be tested and confirm to the requirements of IEC 62561-7 having following characteristics:

i. Shall have high conductivity, improves earth's absorbing power and humidity retention capability.
ii. Shall be non-corrosive in nature.
iii. Shall be suitable for installation in dry form or in a slurry form.
iv. Shall not depend on the continuous presence of water to maintain conductivity.
v. Shall be permanent & maintenance free and in its "set form", maintains constant earth resistance with time.
vi. Shall be thermally stable between-10deg. C to + 60deg. C ambient temperatures.
vii. Shall not dissolve, decompose or leach out with time.
viii. Shall not require periodic charging treatment nor replacement and maintenance.
ix. Shall be suitable for soils of different resistivity.
x. Shall be ROHS compliant & not pollute the soil or local water table and meets environmental friendly requirements for landfill.
xi. Shall not be explosive.
xii. Shall not cause burns, irritation to eye, skin etc.
xiii. Marking : The Earth enhancement material shall be supplied in sealed, moisture proof bags. These bags shall be marked with Manufacturer's name or trade name, quantity etc.

6.) **Backfill material:**

The excavated soil/ good agricultural soil is suitable as a backfill but should be sieved to remove any large stones and placed around the electrode taking care to ensure that is well compacted. Material like sand, salt, coke breeze, cinders and ash shall not be used because of it acidic and corrosive nature. The backfill material shall be non-corrosive & ROHS compliant.

7.) **Earth grid:**

i. The earth electrodes, as per drawing, shall be installed and connected to each other below ground, at each location, forming an earth grid.
ii. These earth pits shall then be inter linked using GI / tinned Cu strip, as per drg, to form a loop using exothermic welding technique.
iii. The interconnecting-conductor shall be buried at depth not less than 500mm below the ground level. This interconnecting conductor shall also be covered with earth enhancing compound as per recommendations of manufacturer & design.
iv. All the GI strip shall have galvanizing thickness of min. 85µ.
v. The earth grid shall be connected to a GI / tinned Cu main equipotential bar. The GI main equipotential bar shall be housed in concrete pit below ground as per instructions of EIC & site condition and all the earth strips from electrical equipment etc. shall be terminated on such GI/ tinned Cu main equipotential bar.
vi. All the interconnections will be done by exothermic welding except the terminations of earth strips from electrical equipment on GI main equipotential bar, which shall be with SS nut bolt/ clamp connection.
vii. The earthing grid for lightning protection shall be provided in similar manner & shall be separate from the safety earthing grid.
viii. The earth grid for lightning protection system shall be connected to a separate GI main equipotential bar. The GI main equipotential bar shall be housed in concrete pit below ground as per site condition and all the lightning down conductors shall be terminated on such GI main equipotential bar.
ix. The grids for safety earthing & lightning of respective buildings shall be interconnected by connecting spark gap arrestor between main equipotential earth bars of both safety earthing & lightning protection system.

8.) **Earth pit (Inspection chamber):**

i. Each earth grid shall have one no. earth pit housing GI / tinned Cu main equipotential bar, as indicated above, for purpose of measuring earth grid resistance.
ii. The earth pit shall be concrete (1:2:4) chamber of size 600 X 600 X 600mm (inside dimension) with MS chequered plate hinged cover of min 10 mm thickness mounted on 40 x 40 x 5mm thick angle iron frame.
iii. The marking plate /pit marking space should be present on the cover.
iv. The date of testing and earth resistance value shall be written on the cover with black base with yellow paint.

9.) **Measurement of earth resistance :**

i. The earth resistance shall be measured at the GI/ tinned Cu main equipotential bar with all the earth pits interconnected, using Fall of Potential method as per IEEE 80, BS 7430 & IS 3043.

ii. The digital earth tester for measurement of grid resistance shall be arranged by contractor & shall be of reputed make. The digital earth tester shall be calibrated & have facility of variable voltage & variable frequency for earth resistance measurement.

iii. The earth resistance value of each isolated safety earthing grids for buildings shall be less than 5Ω.

iv. The earth resistance value of each isolated lightning protection system shall be less than 10Ω.

v. The earth resistance value of earth pit for substation equipment earthing shall be less than 1Ω.

10.) **Testing of Maintenance free Earthing Components:**

i. The manufacturers type test certificates, UL certification in respect to earth rods, Ground enhancement materials & exothermic welding connections shall be provided with delivery of materials.

ii. The following routine & acceptance tests as per IEC 62561, UL 467 etc. shall be conducted at manufacturers premises or in Govt. approved NABL test labs in presence of departments representatives. The following shall comprise acceptance & routine tests

iii. **Acceptance tests :**

Sr.No.	Test
a)	Visual inspection
b)	Adherence of coating test
c)	Bending test
d)	Tensile strength test
e)	Resistivity test (on earth enhancement compound)

iv. Routine tests :

Sr. No.	Test
a)	Visual inspection
b)	Dimensional Check on earth electrode

v. Sample plan

The following sampling plan for earth electrode shall be adopted for acceptance tests:

Lot size	Visual inspection / Dimension	Adherence to coating (457mm each)	Bend test (200mm each)	Tensile strength (200mm each)
2-8	2	2	2	2
9-15	3	2	2	2
16-25	5	4	4	2
26-50	8	4	4	2
51-100	13	4	4	2
101-150	20	4	4	2
151-200	32	4	4	2

vi. For resistivity test min. two samples shall be selected.

vii. If any of the sample fails during acceptance test the complete lot will be rejected.

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CHAPTER 15
DISTRIBUTION BOARDS

1.) **SCOPE:**

The specification covers design, manufacture, testing and commissioning of fabricated lighting / power distribution boards. (Readymade DB to be supplied & installed as per the preferred makes of material & Schedule of Quantity.)

2.) **STANDARDS:**

The design, manufacture and testing of lighting/power distribution board shall comply with the latest issue of following standards :

IS - 61439	:	Low-voltage switchgear and control gear assemblies - part 3 distribution boards intended to be operated by ordinary persons (dbo)
IS - 60529	:	Degree of protection provided by enclosure for low voltage switchgear.
IS 60947	:	LV switchgear
IS 12640	:	Residual current operated circuit- breakers without integral overcurrent protection (RCCB) / with integral overcurrent protection (RCBO) for household and similar uses
IS 14614	:	Residual current-operated protective devices RCDs for household and similar use electromagnetic compatibility
IS 60898	:	Electrical accessories-circuit-breakers for overcurrent protection(MCB) for household and similar installations

3.) **CONSTRUCTION:**

Lighting/power distribution board shall be cubical type suitable for wall mounting or recessed mounting. It shall be totally enclosed, completely dust proof & vermin proof & shall have min. IP-42 degree of protection.

Sheet steel work shall be of high quality and shall be free from burrs. Sheet steel used for the body and door shall be as per manufacturers standard.

Lighting/power distribution board shall have one concealed hinged door which will cover the entire front portion. The door shall be provided with gasket to make the equipment dust tight and also with insulated quick turn screws.

Design shall be dead front type. No live components shall be mounted on door. Adequate space shall be provided for termination of aluminium cables and wires.

The DBs shall be with double door design, with all components to be mounted on removable base plate. The recess mounting DBs shall be provided with two hold fast arrangement. i.e. DBs shall be provided for wire way box at incomer /outgoing, as applicable.

4.) **BUSBARS (wherever applicable):**

Tinned copper busbars shall be provided with suitable insulation covers and supports of epoxy material (non-hygroscopic anti tracking material) as per manufacturer standard.

5.) WIRING AND TERMINAL:

The lighting/power distribution board shall be factory wired. Flexible copper wires shall be used for internal wiring. For neutral terminals, brass neutral terminal block shall be provided. It should have spare capacity of at least 10% or as per manufacturers standard.

6.) **CABLE ENTRY**

Cable entry for incomer shall be from bottom/top but entry for outgoing circuit shall be from top. Removable sheet steel plates shall be provided for conduit entry/cable entry. Compression type plate brass cable gland shall be provided for incoming/outgoing cables. Wire way boxes shall be provided at incoming /outgoing side.

7.) **EARTHING:**

Two numbers earthing terminals shall be provided on either side of the lighting/power distribution board.

8.) **INSPECTION AND TESTING:**

8.1.) Inspection :

The inspection shall consist of following, but shall not be limited to the same –

i. i) Appearance and construction.
ii. ii) Dimensions, mounting details etc.

iii. iii) Feeder arrangement and feeder details.

iv. iv) Door alignment, gaskets etc.

8.2 Tests:

The following tests shall be carried out –

i) Insulation resistance:

1000Volts megger, both before and after high voltage power frequency test. The insulation resistance shall not be less than two megaohm in any case.

ii) High voltage power frequency test:

a) between all three phases and earth.
b) between phases.
c) between phases and neutral.

If the result of inspection and tests are not satisfactory, the defects shall be rectified and tests shall be repeated to entire satisfaction of engineer-in-charge/consultant without any extra charge to employer. The inspection and tests result shall be submitted in quadruplicate for engineer-in-charge/consultant's approval.

CHAPTER 16-

LIGHTNING PROTECTION SYSTEM

1. GENERAL

i. The supply and installation of lightning protection shall be carried out by the contractor to the latest edition of IS : 62305

ii. Installation of lightning protection scheme shall include supply and installation of (a) G.I. spacer and clamp for fixing 25 mm x 3 mm G.I. conductor on roof / columns / walls by lead rawal plugs / PVC sleeves (b) hardware such as P.G. clamps (c) Cadmium plated bolts, nuts, washers, screws, etc. lighting masts along with all hardwares and (d) test link and installation of 25 mm x 3 mm G.I. down conductor. Materials required for completion of the work, shall be arranged to be supplied and installed by the contractor.

iii. The work pertains to provide the lighting protection system for project mentioned elsewhere in the tender. The height of the block form the ground level would be about 30 metres. The scope of work in the present work is the installation of horizontal roof conductors on the building parapet wall on the terrace, providing the down conductors, providing the earth termination and the lightning air termination. The fixing of the lighting conductor must as well as connections of the roof conductors to the same shall be carried out by the contractor in the specified manner.

iv. The work covered in this Tender shall strictly conform to IS : 2309 with latest amendments – Indian Standard Code of Practice for the protections of building and allied structures against lightning, drawing and as per instructions of Engineer-in-charge.

2. ROOF CONDUCTORS:

i. 2.1 The roof conductors shall consist of G.I. plate as of 25 mm x 3 mm size. The roof conductors shall be installed along the top periphery of the parapet wall supported on GI spacers of approved design. These spacers shall be placed at regular intervals of about 600 mm. The GI strip for the roof conductors shall be adopted in as large length as possible so as to minimize the number of joints in the system. Plates in full length of approximately size meters each shall be preferably used and would be preferred to bend the flats to suit the building profile instead of cutting and jointing.

ii. 2.2 Joints in the horizontal run of the roof conductors, if necessary shall be provided by soldering / welding. The contractor may adopt any other suitable method of joining subject to the approval by the Department.

iii. 2.3 The roof conductors shall be connected to the air termination in a manner to be approved by the Department.

iv. 2.4 The roof conductors shall be installed so as to form a closed ring.

v. 2.5 The roof conductors shall be painted with two coats of green paint before installation.

9.)

10.)

11.) **3. DOWN CONDUCTORS:**

The down conductors shall run on each side of the building starting from a point in the roof conductor described above and coming down vertically along the external wall of the building as per drawing and remaining at a point about 1 meter above outside ground level. The size and method of installations, etc. of the down conductors shall be the same as for the roof conductors mentioned above.

The location of the down conductor has been dept such that it may not be necessary to erect a scaffolding for the same and it should be possible for the contractor to install the down conductors from the landings of various floors. If any temporary plank / wooden platform etc. are required at various floor landings for fixing the down conductors, the same would also be provided by the contractor himself. Contractor has to make necessary arrangement as per site conditions for the installation of down / roof conductors. The roof conductors shall be painted with two coats of green paint before installation.

12.)

13.) **4. EARTH TERMINATIONS:**

i. The earth termination system consists of a continuation of the down conductor from a point about one metre above the ground level upto the earth electrode for the final connection of the lightning protection system to the earth. A suitable openable link will be provided between the down conductor and the earth conductor for facility of installation and testing. The earth conductor from this link downwards shall be G.I. flat of 37 mm x 6 mm section only painted with anticorrosive bituminous paint.

ii. The earth pit, earth electrode and the earth conductor below the ground level shall be provided and connected as per specifications.

5.0 **QUALITY OF WORK AND SAFETY:**

The works shall be carried out with best workmanship and special care will be taken to see that the roof conductors as well as down conductors are in approved line and level. All drilling of holes in the walls, etc. shall be carried out only by using electric drills with suitable drill and under no circumstances punching. Hammering of holes will be allowed. The contractor shall ensure complete safety of his personnel during the execution of the work and would exercise all possible care for avoiding any accidents, etc. The department will not be responsible for any accident that may occur to the contractor's workers at site during the execution of the job.

CHAPTER 17
INDOOR LED LUMINAIRES

1.) GENERAL REQUIREMENTS

1.1.) Luminaires:

The luminaire shall be designed and tested for general lighting application as per relevant standards.

1.2.) Housing of the luminaire:

The housing construction of luminaire shall meet safety requirements as per IS 10322. The luminaire housing shall have minimum IP 20, IK 02 and shall be preferably made up of Al pressure die cast and powder coated. Control gear compartment shall be integral part/ independent of luminaire.

In case of non-metallic luminaire housing with above referred IP & IK, the material used shall be halogen free and fire retardant conforming to UL 94 V.0.

LEDs should be provided with secondary lens optics to get optimum optical performance.

1.3.) Lumen maintenance and failure fraction:

The luminaire shall be designed for rating of 50000 hrs(min) and failure fraction of 10%(max) or as per values indicated in the guaranteed technical particulars.

1.4.) Thermal management of LED luminaire:

Luminaire shall be designed for proper thermal management of LEDs. LED die temperature is affected by PCB thermal resistance and LED spacing on the board. Designed luminaire shall be such that the LED die temperature does not exceed the maximum Junction Temperature (Tj).Drive current should be determined for the surrounding ambient temperature (Ta) to dissipate the heat from the product.

1.5.) Optics:

The luminaire optics shall be designed such that the lumen output shall be uniform and glare free.

1.6.) LED driver:

The LED driver shall be designed for operating voltage range specified below and shall have built in voltage surge protection, Short Circuit, & Over Voltage protections.

1.7.) TECHNICAL REQUIREMENTS OF LUMINAIRES:

Sr. No.	Parameter	Range
1.	Minimum system lumen output	As per BOQ
2.	Luminaire Efficacy	>100 lumen/watts or as specified in BOQ
3.	Correlated Current Temperature (CCT)	As per BOQ
4.	Colour Rendering Index (CRI)	>80
5.	Lumen maintenance	L70 @ 50,000 hrs
6.	Diffuser	Shall be UV resistant
7.	Range of Operating Voltage	150-270 V AC
8.	Rated Frequency	50 Hz +/- 3%
9.	Total Harmonic Distortion	< =10%
10.	Power Factor	>0.90
11.	Input Surge Protection	>2.5 KV
12.	Type of Driver	Constant Current
13.	Housing material	Die-cast Al/ CRCA
14.	IP & IK	20 & 02 / as specified in BOQ

2.) **PHOTOBIOLOGICAL SAFETY REQUIREMENTS:**

For photo biological safety requirements, the luminaries shall comply with IS 16108.

3.) **TESTING:**

The following tests shall be conducted on LED luminaries as per IS 16107 & sampling shall be as per IS 10322 (Part-5) from any NABL accredited Lab-

i. Marking
ii. Total input power
iii. Luminaire efficacy (lm/W)

iv. Colour rendering index (CRI) – only initial values to be measured
v. Correlated colour temperature (K) – only initial values to be measured
vi. Chromaticity tolerance – only initial values to be measured
vii. Power factor
viii. Luminous flux
ix. Luminous intensity distribution

4.) **MARKING:**

The Luminaire shall be marked with product information as per IS 16107 / IS 10322.

5.) **WARRANTY:**

Luminaire shall have **three years,** onsite replacement warranty from the supply date including Driver / Control Gear, LED, all accessories etc.

6.) **TECHNICAL DATA SHEET (TDS) :**

The technical data sheets of the offered luminaires, complying with tender technical specifications, shall be submitted along with technical bid for evaluation.

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CHAPTER 18
OUTDOOR LED LUMINAIRES

1.) GENERAL REQUIREMENTS:

1.1.) Luminaires:

The luminaire shall be designed and tested for general lighting application as per relevant standards.

1.2.) Housing of the luminaire:

The housing construction of luminaire shall meet safety requirements as per IS 10322.The luminaire housing shall have following minimum features:

i. Extruded aluminum heat sink, designed to act as efficient heat dissipater important for LED luminaires.
ii. Pressure die cast aluminum cover on both sides for holding of extruded aluminum heat sink.
iii. Luminaire provided with heat resistant UV stabilized polycarbonate/ toughened glass diffuser.
iv. Control gear compartment is an integral part of luminaire. There shall be separate compartment for control gear and LED modules.
v. LEDs are provided with secondary lens optics to get optimum optical performance.
vi. The driver used is specially designed to have sure voltage, open/short circuit protections.
vii. Luminaire is provided with a mounting bracket fixed on pressure die-cast aluminum covers for aiming adjustment.
viii. The luminaire housing shall have minimum IP 66, IK 07 and shall be preferably made up of die cast aluminum.

3.1.1 Lumen maintenance and failure fraction**:**

The luminaire shall be designed for L70 of 50000hrs (min) or as specified and failure fraction of 10% (max).

1.3.) Thermal management of LED luminaire:

Luminaire shall be designed for proper thermal management of LEDs. LED die temperature is affected by PCB thermal resistance and LED spacing on the board. Designed luminaire shall be such that the LED die temperature does not exceed the maximum Junction Temperature (Tj). Drive current should be determined for the surrounding ambient temperature (Ta) to dissipate the heat from the product.

1.4.) Optics:

The luminaire optics shall be designed such that the lumen output shall be uniform and glare free.

1.5.) LED driver:

The LED driver shall be of silicon potted & designed for operating voltage range specified below and shall have built in voltage surge protection, short Circuit, & Over Voltage protections.

2.) **TECHNICAL REQUIREMENTS OF LUMINAIRES:**

2.1.) ELECTRICAL REQUIREMENTS:

SL. NO	PARAMETER	RANGE
1.	Range of Operating Voltage	140 – 270 V AC
2.	Rated Frequency	50 Hz +/- 3%
3.	Total Harmonic Distortion	< 10% or as specified
4.	High Voltage Protection	HV cut off @ 325VAC+/- 15VAC
5.	Short Circuit Protection	Yes
6.	Open Load Protection	Yes
7.	Reverse Polarity Protection	Yes
8.	Driver Isolation	Yes
9.	Power Factor	≥0.90
10.	Input Surge Protection	≥4 KV or as specified
11.	Type of Driver	Constant Current

2.2.) OPTICAL REQUIREMENTS:

SL. NO	PARAMETER	VALUES
1.	Luminaire Efficacy	As per Schedule of quantities
2.	Correlated Current Temperature (CCT)	As per Schedule of quantities
3.	Colour Rendering Index (CRI)	≥70
4.	LED Chip	Shall be LM 80 Certified
5.	Diffuser	Shall be UV resistant PC/ toughened glass

2.3.) MECHANICAL REQUIREMENTS:

SL. NO	PARAMETER	VALUES
1.	Frame/Housing	Pressure die-cast Aluminium housing
2.	Heat Sink	Highly efficient extruded aluminium heat sink
3.	IP Grade	As per Schedule of quantities
4.	Impact resistance	As per Schedule of quantities

2.4.) PHOTOBIOLOGICAL SAFETY REQUIREMENTS:

For photo biological safety requirements, the luminaries shall comply with IS 16108.

3.) **TESTING:**

The following tests shall be conducted on LED luminaries as per IS 16107 & sampling shall be as per IS 10322 (Part-5) from any NABL accredited Lab-

i. Marking
ii. Total input power
iii. Luminaire efficacy (lm/W)
iv. Colour rendering index (CRI) – only initial values to be measured
v. Correlated color temperature (K) – only initial values to be measured
vi. Chromaticity tolerance – only initial values to be measured
vii. Power factor
viii. Luminous flux
ix. Luminous intensity distribution

4.) **MARKING:**

The Luminaire shall be marked with product information as per IS 16107 / IS 10322.

5.) **WARRANTY:**

Luminaire shall have 05 years, onsite replacement warranty from the supply date including Driver / Control Gear, LED, all accessories etc.

6.) **TECHNICAL DATA SHEET (TDS) :**

The technical data sheets of the offered luminaires, complying with tender technical specifications, shall be submitted along with technical bid for evaluation.

CHAPTER 19
HT cables (33kV(E) &11 kV(E))

1.) SCOPE:

This specification is intended for the design, manufacture, testing, inspection, performance guarantee tests and delivery to site, installation and commissioning of HT power cables. The bidder shall furnish all the guaranteed technical particulars as listed in the specification.

This specification shall be read in conjunction with **Bill of Quantities(BOQ)**.

2.) STANDARDS AND CODES:

Unless otherwise specifically mentioned in the document, the design, manufacture, testing and performance of all cables shall conform with latest edition of the following standards & codes:

IS : 7098 (Part-II)	:	Cross linked polyethylene insulated PVC sheathed cable for working voltage from 3.3 KV upto and including 33 KV cables.
IS : 3961 (Part-II)	:	Recommended current ratings for cables.
IS : 3975	:	Mild steel wires, strips and tapes for armouring of cables
IS : 4905	:	Methods for random sampling
IS : 5831	:	PVC insulation and sheath of electrical cables.
IS : 8130	:	Conductors for insulated electrical cables and flexible cords.
IS : 10418	:	Specification for drums for electric cables.
IS : 10810	:	Method of tests for cables.
ASTM-D-2843	:	Standard test method for density of smoke from the burning or decomposition of plastics.
ASTM-D-2863	:	Standard method for measuring the minimum oxygen concentration to support E3 candle like construction plastics.
IEC-754 (Part-I)	:	Test on gases evolved during combustion of electric cables.
SS:424-1475	:	Flammability testing of cables.

3.) **TECHNICAL SPECIFICATION:**

This specification establishes the requirement of design, manufacture, testing at works and delivery to site and installation, testing at site, commissioning of HT cables

Technical Parameters for cables:

i.	Power system details	:	11/33 kV(E), 3Phase, 3wire, effectively earthed
ii.	Frequency	:	50 Hz
iii.	No.of core	:	Three
iv.	Core size	:	As per BOQ
v.	Core identification	:	By insulation colour
vi	Conductor	:	Stranded circular core Aluminium conductor
vii.	Conductor Screening	:	Extruded Semiconductor compound
viii.	Insulation	:	Extruded Cross Linked Polyethylene (XLPE) material.
ix	Insulation Screening Non metallic insulation shield b) Core Shielding material	: : :	 Free strippable semi-conducting compound Copper Tape.
x.	Inner sheath	:	Extruded FRLS PVC type ST-2.
xi	Filler material	:	If used, shall be compatible with other materials of cable Construction.
xii	Armouring	:	Single layer galvanised strip armoured.
xiii	Overall serving	:	Anti rodent and anti termite extruded black FRLS PVC type ST-2
xiv	Manufacturing process for cross linking insulation	:	Dry curing (Gas curing).
xv	Max. conductor temperature for continuous rated current	:	90^0 C
xvi	Max. conductor temperature during short circuit when cable already attained temp.	:	250^0 C

	specified at xv. above.		
xvii	Embossments on cable	:	Cable shall be embossed on the outer sheath at every 1 m. length sequential marking for type of the cable, the metered length of cable, make and year of manufacturing.

4.) INSTALLATION OF HT CABLES IN GROUND:

In ground HT cables shall be laid upto 1200 mm depth in all type of soil/concrete, road cutting/ footpath cutting including excavation, sand bedding, laying of backed bricks on side & top of individual cable, temporary reinstatement, sand cushioning all around, backfilling, leveling, dewatering, consolidation, disposal of excess earth within the radius of 500 m as per specified in BOQ and making good to the original finish etc. providing brass cable number tag including supply of bricks, sand, cable tags etc. complete as per instructions of EIC.

5.) TESTS:

5.1.) Shop Tests:

The cables shall be subjected to shop tests & witnessed by department engineer in accordance with relevant standards to prove the design and general qualities of the cables as below:

Routine tests on each drum of cables.

Acceptance tests on drums chosen at random for acceptance of the lot.

Type tests Certificates shall be submitted for particular size & design of cable.

5.2.) Site Tests:

The cables after installation at site shall be subjected to HV test & Megger test as per instruction of EIC.

Hi-pot testing & commissioning of joints shall be carried out at site.

CHAPTER 20
LT POWER, CONTROL CABLES

1.) SCOPE:

This specification establishes the requirements of design, manufacture, testing at manufacturer's works and delivery to site and installation, testing at site & commissioning of 1.1 KV grade LT PVC/XLPE insulated, galvanized round wire/flat strip armoured Aluminium/copper conductor cables.

2.) STANDARDS AND CODES:

Unless otherwise specifically mentioned in the document, the design, manufacture, testing and performance of all cables shall conform with latest edition of the following standards & codes:

IS : 7098 (Part-I)	:	Cross linked polyethylene insulated PVC sheathed cable for working voltage and including 1100 Volts.
IS : 1554 (Part-I)	:	PVC insulated (heavy duty) electric cables for working voltage upto and including 1100V.
IS : 3961 (Part-II)	:	Recommended current ratings for cables.
IS : 3975	:	Mild steel wires, strips and tapes for armouring of cables
IS : 4905	:	Methods for random sampling
IS : 5831	:	PVC insulation and sheath of electrical cables.
IS : 8130	:	Conductors for insulated electrical cables and flexible cords.
IS : 10418	:	Specification for drums for electric cables.
IS : 10810	:	Method of tests for cables.
ASTM-D-2843	:	Standard test method for density of smoke from the burning or decomposition of plastics.
ASTM-D-2863	:	Standard method for measuring the minimum oxygen concentration to support E3 candle like construction plastics.
IEC-754 (Part-I)	:	Test on gases evolved during combustion of electric cables.
SS:424-1475	:	Flammability testing of cables.

3.) TECHNICAL PARAMETERS:

i)	Power system details	:	415 V +/-10%, 3 phase, 4 wire solidly earthed.
ii)	Frequency	:	50 Hz.
iii)	Size of cable, conductor & quantity	:	As per S.O.Q.
iv)	Core identification	:	Colour scheme as per IS 1554 (part I) /88 or latest
v)	Conductor	:	Stranded circular/sector shape core Aluminium/Copper conductor
vi)	Rated voltage	:	1100 Volts
vii)	Insulation	:	XLPE
viii)	Maximum conductor temperature at rated current.	:	90 degree C
ix)	Maximum conductor temperature during short circuit under hot condition	:	250 degree C
x)	Inner sheath	:	Extruded PVC inner sheath
xi)	Filler material	:	If used, shall be compatible with other materials of cable construction
xii)	Armouring	:	Single layer galvanized steel round wire/ flat strip armoured.
xiii)	Overall serving (outer sheath)	:	Anti rodent and anti termite extruded black FRLS grade PVC sheath (Type ST-2)
xiv)	Embossing on the cable	:	Cable shall be embossed / printed on the outer sheath at every 1 m. length as under :1.1 kV, PVCA/XLPE, conductor material, No. of core and size of cable, sequential marking for the metered length of cable, make and year of manufacturing

4.) INSTALLATION OF LT CABLES IN GROUND:

Installation of 1.1 KV grade, copper/Aluminium conductor PVCA/XLPE cables shall be laid at a depth of 900mm below ground level including excavation in all type of soil/concrete, road cutting/footpath cutting, temporary reinstatement, back filling, levelling, dewatering, consolidation, removal of excess earth within the radius of 500 m, sand bedding, cables covered on top & sides by baked bricks conforming to IS: 1077, sand cushioning all around, making good to the original finish, providing brass cable number tag including supply of bricks, sand, cable tags etc. complete as per instructions of EIC.

5.) INSTALLATION OF LT CABLES ON MS SUPPORT/TRENCHES WALL/SLAB/BEAM ETC.:

Installation of 1.1 KV grade, copper/Aluminium conductor XLPE cables on MS. Support/trenches/sleeves/wall/Slab/ beam/pre-fabricated Trays in cable trench shall be as per IS 1255. All necessary accessories for installation of cables such as G.I. saddle / clamps/supports, screw, nuts and bolts etc.is included in the scope of work.

6.) TESTS:

6.1.) Shop Tests:

The cables shall be subjected to shop tests & witnessed by department engineer in accordance with relevant standards to prove the design and general qualities of the cables as below:

i. Routine tests on each drum of cables.
ii. Acceptance tests on drums chosen at random for acceptance of the lot.
iii. Type tests Certificates shall be submitted for particular size & design of cable.

6.2.) Site Tests:

The cables after installation at site shall be subjected to IR test as per instruction of EIC.

CHAPTER 21

PREFERRED MAKES OF MATERIAL

Sr.No.	Description	Preferred makes
1.	HT VCB Panel	ABB / Siemens / Schneider Electric/ L&T / Crompton Greaves /C&S / Kirloskar Electric
2.	HT RMU	ABB / Siemens /Schneider Electric/ L&T/Crompton Greaves /C&S
3.	Oil filled Transformer	Crompton Greaves / Schneider Electric /Voltamp / Kirloskar Electric / Raychem /Kanohar Electric/ Urja Transformers
4.	Dry type Transformer	Schneider Electric / Voltamp / Kirloskar Electric / Raychem /Crompton Greaves /Urja Transformers/ AmesImpex/DTPL
5.	Package (Unitized) Substation	Schneider Electric / ABB /Siemens / C&S / Crompton Greaves/ Voltamp/Kirloskar/ Raychem
6.	HT Cable	Universal / Torrent / Polycab / KEI / Havells / NICCO / Apar/KEC / RR Kabel /Ravin/Gloster/ Finolex
7.	HT / LT Cable jointing kit	Raychem / Mahindra / 3M/ Yamuna Densons
8.	Compact Sandwich type Bus duct / Air insulated Bus Duct / Rising mains	Zucchini (Legrand) / L&T (Henikwon) / C&S / Schneider Electric / Godrej/Siemens
9.	LT Cable	Universal / Torrent / Polycab / Finolex / KEI / Havells / NICCO / Apar / LAPP/ KEC / RR Kabel /Ravin/Gloster
10.	Cable glands / Cable Socket (Lugs)	Braco / Comet / Dowells / Gripper / Prabhat / Jainson / Lotus / HMI / 3D / Hex
11.	Terminal Strip / Connector	Connectwell / Elmex / Phoenix/Wago
12.	G.I Ladder/ Perforated Cable trays	OBO/ Indiana / Asian / Profab / Sadhana (Steelite group) / Metalman / Patni / PILCO/BEC/ELCON, OM Industries / Globe

Sr.No.	Description	Preferred makes
		Electrical
13.	Wire mesh cable tray	Legrand / OBO/ PILCO
14.	Cable Management System -Wall raceway / Floor raceway / Floor Access box & Pop up box	Legrand / MK Electric /OBO / Schneider Electric
15.	LT Panel Fabricator	OEM and authorised systems houses of L&T, Siemens, Schneider Electric, Legrand, ABB and BCH. C&S /Jakson/Arrow Engineers /Adlec/Samcon/ Marine Electricals/Tricolite/Ambit/Tenco/Ohm Energy Management System Pvt. Ltd., Sriperumpudur / Excel Power Switchgear, Chennai/Power Control Equipments, Bengaluru
16.	Air Circuit breakers	Schneider Electric / Siemens / ABB / L&T / Legrand/ C&S/HAVELLS/BCH
17.	MCCB	Schneider Electric / Siemens / ABB / Legrand / L&T / C&S/HAVELLS/BCH
18.	Switch Disconnector Fuse / Switch Disconnector / HRC fuses/ Change Over Switch	Schneider Electric / Siemens / ABB / L&T/ C&S/ HAVELLS/HPL Socomec/BCH
19.	MCB / MCB type isolator / ELCB / Timers / DB's	Legrand / Hager / Schneider Electric / Siemens / L&T /C&S/HAVELLS/ INDO Asian/BCH
20.	Power / Control Air break Contactors	Schneider / Electric Siemens / ABB / L&T/ Legrand/C&S/Havells/BCH
21.	Numerical / Static / Electromagnetic Relays	Areva / ABB / L&T / Siemens/ Schneider Electric / Ashida / Easun – Reyrolle / Crompton Greaves/C&S
22.	APFC Relay	Epcos / Beluke / Meher / Schneider/L&T

Sr.No.	Description	Preferred makes
23.	CT / PT(for LT)	Kappa / AE / Pragati / ECS / Precise / Indcoil
24.	Analogue Ammeter / Voltmeter / P.F meter	Automatic Electric (AE) / Rishab / L&T / Meco / Imp
25.	Digital Panel meters	Schneider Electric / AE / Rishab / L&T / Siemens
26.	Energy meter / Trivector meter	Secure / ABB / L&T / Schneider Electric / Universal/Landis-Gyr
27.	Indication Lamps/ Push Buttons	Siemens/L&T(ESBEE) / Teknik / Schneider Electric ABB/BCH/Crompton Greaves/C&S/ Essen Deinki / Jainson
28.	Selector Switches	Kaycee / Siemens / L&T (Slazer)/ Switron
29.	Battery Flooded / SMF	Exide / Amara raja / HBL/Microtex/ AMCO/Tata Group/ Panasonic/Union Batteries Pune
30.	Battery Charger	Chabbi / Calydyne (Chloride) / Amara raja/ Universal /Vertiv /Dubas
31.	Capacitors	Universal / Epcos / Schneider Electric / L&T/ Siemens
32.	PVC (HMS) Conduits & accessories	Precision Plastics / Presto Plast/ RNI/ AKG/ BECPlast /Polycab
33.	MS / GI Conduits & accessories	VIMCO / BEC / BI / AKG
34.	PVC casing caping& accessories	Presto Plast / Legrand/ Precision/RNI
35.	FRLS PVC insulated Cu conductor Wires	Finolex/Havells/Apar/KEI/RR Kabel / Polycab/ BCH/Anchor/KEC/L&T
36.	Modular Switches / Sockets/Bell / Buzzer	Legrand (Myrius) / Crabtree (Murano) / L&T (ORIS) / Wipro (North West – Stylus+)/MK (wraparound)/ Anchor-Panasonic (Roma)

Sr.No.	Description	Preferred makes
37.	Luminaires (indoor & outdoor)	Philips / Wipro / Crompton Greaves / Bajaj / Schreder / Binay/Lighting technologies /Havells / C&S/Surya/Halonix/ Jaquar/Keselec
38.	Ceiling Fans	Crompton Greaves / Havells / Usha / Orient / Bajaj
39.	BLDC Fans	Havells / ORIENT/Atomberg
40.	Exhaust Fans / Wall mounted Fans / Pedestal Fans	Crompton Greaves / Havells /Almonard / Usha / Bajaj/Orient
41.	Industrial Switch sockets & Plugs	Legrand / Crompton Greaves / L&T / Siemens / Schneider Electric / Havells /BCH/C&S
42.	Water Heaters	Racold/Crompton Greaves/ Bajaj / AO Smith/ Jaquar/V-Guard/Venus/RR Kabel/Usha/Havells
43.	Cat-6 UTP cable/Patch cords/connectors/Patch Panels / RJ-45 I/O	Systimax / Panduit /Legrand/ Molex/ D-Link / AMP / Nordex
44.	Optical fibre cable	Sterlite / Uniflex(APAR)/Vindhya Telelinks / Aksh / Finolex / Beldon / AMP / Systimax / Polycab
45.	19'' rack for LAN system	APW President / Rittal / Legrand / Valrack/Schneider Electric
46.	Telephone cable	Finolex / Delton/ RPG / Polycab / Vindhya Telelinks
47.	Telephone Tag Block (TTB) with enclosure.	Krone / Pouyet
48.	RG-6 & RG-11 Co-axial cables	Finolex / Delton/ RPG / Polycab
49.	Fire Alarm system detectors	As per VdS std. - Esser – Honeywell / Schrack / Bosch / Siemens /Simplex (Tyco) As per NFPA std. - Notifier / Edwards / Johnson Controls
50.	Fire Alarm Panel	
51.	Break Glass station /	

Sr.No.	Description	Preferred makes
	Sounder strobe	
52.	PA System	Bosch / ATIES/ Honeywell
53.	CCTV Cameras	Bosch / PELCO/AXIS/SONY
54.	Video Recording System (VRS) and server	DellEMC/HPE/Fujitsu/Lenovo /IBM/Pivot3/NetApp
55.	Layer 2/3 switches	HP/CISCO/Alcatel-Lucent/Avaya (Nortel Series)/ Alcatel-Lucent// Allied Telesis
56.	D.G. set assembler	Powerica / Jakson / Sudhir / Kirloskar / Caterpillar / Sterling Generators
57.	Alternator for DG	Stamford (CGT) / KEC / Leroy Somer
58.	Engine for DG	Cummins / Wartsila / Kirloskar / Caterpillar / Perkins / MTU
59.	AMF / Synchronizing Panel	D.G. set assembler and their authorised system house.
60.	Octagonal Poles & High Mast	Bajaj / Surya Roshni/Valmont/Aster/ Trans Rail Lighting
61.	Elevator	Otis/Schindler/Kone/Johnson/Mitsubishi/Omega /Hitachi/Thyssenkrupp
62.	UPS	Schneider/Legrand/ConsulNeowatt/Delta/Reillo/ Piller/Socomec/ Vertiv
63.	Fire Extinguishers	Minimax / Ceasefire / Safex
64.	Lightning Protection System Components	DEHN/OBO/ERICO
65.	Maintenance Free Earthing System Components	DEHN/OBO/ERICO/South Asian/JEF/ TEREC(SGI)/ LORESS/JMV/LPS
66.	MS/GI pipes	Tata/ Jindal/ ITC/ Zenith/ Ambika/ Surya/ Khandelwal/ Hissar
67.	Solar PV System components	MNRE approved

NOTE:

i. **In case, for any material, different makes as listed above, from that mentioned in the Schedule of Quantities, then the make mentioned in the Schedule of Quantities will only prevail and the Contractor will have to supply only that make mentioned in Schedule of Quantities.**

ii. **If any make stated above, does not comply with the Technical Specifications given in the tender then such a make cannot be supplied at this project.**

iii. **For items not covered in the above list, the sample shall be got approved by competent authority of department, prior to use.**

LT panel Fabricator name and place: LT panel Fabricator name and place:

S No.	Name	Place
1	M/S. C&S Electric Ltd	Regd.office -New Delhi, Plant – Noida, Haridwar.
2	M/S. Arrow Engineers	Mumbai, Palghar.
3	M/S. Jakson	Noida
4	M/S. Adlec Power Pvt ltd	Rohad, Harayana.
5	M/S. Samcon Industrials controls Pvt ltd	Mumbai, Thane
6	M/S. Marine Electricals	Regd. Office-Mumbai Plant- Goa.
7	M/S. Tricolite.	Manesar and Sahibabad
8	M/S. Ambit Switchers Pvt Ltd	Noida
9	M/S. Tenco Systems & Switchgears Pvt Ltd	Indore.
10	M/S. Ohm Energy Management System Pvt. Ltd.	Sriperumpudur
11	M/S. Excel Power Switchgear	Chennai
12	M/S. Power Control Equipments	Bengaluru

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भारत सरकार
GOVERNMENT OF INDIA

परमाणु ऊर्जा विभाग
DEPARTMENT OF ATOMIC ENERGY

निर्माण, सेवा एवं संपदा प्रबंधन निदेशालय
DIRECTORATE OF CONSTRUCTION, SERVICES AND ESTATE MANAGEMENT