AN ISO 9001 & 14001 COMPANY

TENDER DOCUMENT

TENDER No: DLI / CON/ 696/ 411

FOR

‘Supply, Installation, Testing & Commissioning of 11/0.433 KV Indoor/Outdoor Electric Substation and other Associated External Electrical works for Permanent Campus of Central University of Jammu at village Bagla, Distt. Samba (J&K)’

VOLUME – II B

Technical Specification and Drawings
TECHNICAL SPECIFICATIONS

FOR

SUPPLY, INSTALLATION, TESTING & COMMISSIONING OF 11/0.433KV INDOOR/OUTDOOR ELECTRIC SUBSTATION AND OTHER ASSOCIATED EXTERNAL ELECTRICAL WORKS FOR THE PERMANENT CAMPUS OF CENTRAL UNIVERSITY OF JAMMU AT VILLAGE BAGLA, DISTT. SAMBA (J&K)
TECHNICAL SPECIFICATIONS FOR
SUPPLY, INSTALLATION, TESTING & COMMISSIONING OF 11/0.433KV INDOOR/OUTDOOR
ELECTRIC SUBSTATION AND OTHER ASSOCIATED EXTERNAL ELECTRICAL
WORKS FOR CUJ PROJECT, JAMMU

1.0 GENERAL

1.1 The work under the contract shall be carried out in accordance with the schedule of items of work, the
particular specifications drawings forming part of this tender document, and the general conditions
and other provisions of the tender.

1.2 The work in general shall be carried out as per latest CPWD specifications New Delhi for Electrical &
Civil Works unless otherwise specified in the nomenclature of the individual item or in the particular
specifications of concerned items of works.

1.3 For items not covered under latest CPWD specification, for (Electrical & Civil Works) and in
particular specification or nomenclature of the individual item as above, the work shall be done as per
latest relevant BIS codes of practice.

1.4 In case of non-availability of any specification in the above paras or any overlapping provisions, non-
clearly on any issue, applicability of particular provision out of above, shall be decided by Engineer-
in-Charge whose decision shall be final & binding on the contractor.

1.5 The contractor is responsible for executing and completing the work in accordance with the specified
standards and specification and as per requirements of GRIHA V ratings. Execution of Electrical
quality control is intended to provide a comprehensive common and consistent framework of quality
control which is comprised of two main elements.
• Testing
• Inspection

1.6 The contractor shall be responsible for the types of test to be carried out, frequency of testing and
stage of testing as directed by Engineer-in-charge or as stipulated in Indian Standards CPWD
Specifications for electrical and civil works. The cost of all these tests shall deemed to be included in
the item rates quoted by the contractor.

All test samples should be preserved, with proper identification, test log reference, test date and other
applicable information. These samples must be stored on site by the contractor. In addition to tests
performed on site, the contractor is responsible for specialized tests which are performed by
manufacturers or third parties during the manufacturing of various materials and equipment
components, to be incorporated in the works.

1.7 The Substation works & DG Set Works shall be carried out in accordance with Indian Standard Code
work shall also be in conformity with National Electrical Code with upto date amendments. All
Electrical work shall be carried out in accordance with the provision of Indian Electricity Act 1910 &
Indian Electricity Rules 1956 amended upto date. The work shall also conform to Indian Standard
Code of Practice for the type of work involved. It shall also be in conformity with regulations and
requirements of the Local Electricity Supply Authority and Fire Insurance regulations so far as these
become applicable to the installation. Electrical work shall be carried out as per following CPWD
general Specifications for Electrical Works.

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1.8 Wherever this Tender Specifications call for a higher standard of material and or workmanship than those required by any of the above mentioned regulations and specifications then the particular specifications given here under shall take precedence over the said regulations and standards.

1.9 The work shall be executed and measured as per the dimensions given in the Bill of Quantities. Drawings, Designs, Specifications etc. The abbreviations used shall mean as under :

// - Inch (25.4mm)
\ - Foot (12 inches or 30.48 cms)
Sq.Ft. - Square Feet
Sq.Mt (M²) - Square Metre.
Cu. Ft. - Cubic Feet.
Cum (M³) - Cubic Metre.
Kg. - Kilograms (Equivalent to 1000 gms)
T.(M.T.) - Tonne (Equivalent to 1000 Kgs.)
No. - Numbers.
Cm. - Centimetre.
M or R.M. - Metre or Running Metre.

2.0 11KV VACUUM CIRCUIT BREAKER PANEL BOARD

2.1 GENERAL
Vacuum Circuit Breaker shall be incorporated in H.T. Panel wherever specified. VCB’s shall conform to IEC 298 and 694 IS 3427, BS 5227 and VDE 0670, part 6 as well as the regulations mentioned therein. VCB’s shall be suitable for operation on 11KV, 3 phase, 50Hz, AC supply.

2.2 TYPE AND CONSTRUCTION
2.2.1 The metal clad panel shall be fully extensible and compartmentalised to give.
   a. Circuit Breaker Compartment
   b. Busbar Compartment
   c. CT and Cable Compartment

2.2.2 The compartments shall be safe to touch and compartments thus formed shall be dust proof & vermin proof. A light test is to be conducted after assembly by placing lights in different compartments of 11 KV and no light should come out from compartment. A separate metering chamber for fixing the necessary instrumentation metering and protective equipment shall be mounted on the top and bottom of the panel at the front.

2.2.3 The VCB shall consist of three air insulated poles incorporating mechanism of interrupters. The body of interrupters shall be made of nickel chromium steel supported on insulators made out of metalised aluminium oxide. The contacts shall be of chromium copper and butt shaped.

2.2.4 Vacuum circuit breaker shall be mounted on truck or a carriage mechanism. In case of truck mechanism, the breaker shall be on a trolley while in a carriage mechanism, shall be separate door and it shall be possible to perform all operations with front door closed. The drawout carriage shall have two position for the circuit breaker viz isolated/test & service position. Busbars shall be insulated type made of high conductivity copper supported on moulded
monobloc designed to withstand full short circuit currents and shall be provided all along the length of the H.T. board.

2.2.5 It shall be horizontal isolation, horizontal drawout type, or vertical Isolation Horizontal drawout fully interlocked, with dust and vermin proof construction, suitable for indoor installation. The panel shall be supplied with the manufacturer’s test certificates.

2.2.6 Certificates with date of manufacture and shall be complete in all respects as per details in the schedule of quantities. The steel work should have undergone a rigorous rust proofing process comprising alkaline degreasing, decaling in dilute sulphuric acid and recognised phosphating process and shall then be given powder coating (Electrostatic) paint of manufacturer’s standard shade.

2.2.7 The switchgear constructions shall be such that the operating personnel are not endangered by breaker operation and internal explosions, and the front of the panel shall be specially designed to withstand these. Pressure relief flaps shall be provided for safely venting out gases produced inside the high voltage compartment, busbar compartment and termination compartment. These flaps shall be vented upwards and cannot be opened from outside. These relief flaps shall be of such construction as not to permit ingress of dust/water in harmful quantities under normal working conditions. Enclosure shall be constructed with sheet steel of atleast 2.0mm thickness. It shall have a rigid, smooth, leveled, flawless finish.

2.2.8 Total height of the H.T. Panel board shall be max. 2700mm approximately and width 620mm (approx.). On the incoming breaker panel, a 100VA burden and Class 0.5 accuracy potential transformer 11KV/√3 /110V/√3 with LT fuses shall be provided. These shall be three single-phase PTs cast resin insulated type. Adequate space at the rear of the panel shall be provided for termination of power & control cables. The panel shall be provided with suitable terminating arrangement for termination of cables.

2.2.9 The making contact arms (upper & lower) of the circuit breaker shall be encased in polyprolene tubes. Penetration type bushings shall be provided in the busbars & cable compartment for the fixed contacts.

2.2.10 Safety shutters shall be provided to cover up the fixed high voltage contacts on busbar and cable sides when the carriage is moved to Isolated/Disconnected position. The shutters shall move automatically with the movement of the drawout carriage. It shall, however, be possible to open the shutters of busbars side and cable side individually.

2.2.11 Mechanically operated circuit breaker auxiliary switches of minimum 4 NO + 4 NC ways, shall be provided for control and indication purposes. Control wiring shall be done by using 1.5 sq.mm, 1.1KV grade stranded copper PVC insulated cable. All control fuses shall be HRC link type.

2.2.12 Terminal blocks shall be clamp type suitable for connection of only 2 wires per terminal and shall be 650 V grade. The L.T. control circuit shall be routine tested to withstand 2.0KV for one minute.

2.2.13 Busbar compartment shall be provided at the rear. Electrolytic copper busbars shall be of rectangular cross section and insulated. Busbars shall be supported properly by cast epoxy resin insulators so as to withstand thermal and dynamic stresses during system short circuits. Busbars shall be provided with necessary colour coding for phases indication. The busbars shall be designed to withstand a temperature rise of 60 deg. C above and ambient temperature of 45 deg. C.

2.2.14 **SURGE SUPPRESSORS**

11 KV Surge supressors are to be provided as below;

Incomer :- Incoming side cables side
Outgoing : Outgoing side cables side

2.3 BUSBAR AND INSULATORS

All busbars and jumper connections shall be of electrolytic copper conforming to relevant IS standards. They shall be adequately supported on epoxy insulators to withstand electrical and mechanical stresses due to specified short circuit currents. Busbar cross section shall be uniform throughout the length of switchboard.

Contact surface at all joints shall be properly cleaned and No-oxide grease applied to ensure an efficient and trouble free connections. All bolted joints shall have necessary washers for maintaining adequate contact pressure. All connection hardware shall have high corrosion resistance.

Busbar insulators shall be of track-resistance, high strength, non-hygroscopic, non-combustible type & shall be suitable to withstand stresses due to over voltages and short circuit current. Busbar shall be supported on the insulator such that the conductor expansion and contraction are allowed without straining the insulators. The temperatures of the busbars and all other equipments, when carrying the rated of relevant Indian Standards, duly considering the specified ambient temperature.

2.4 EARTHING AND PROTECTIVE EARTHING

Copper earthing bus shall be provided. It shall be bolted/ welded to the framework of each panel. The earth bus shall have sufficient cross time fault currents to earth without exceeding the allowable temperature rise. Suitable arrangement shall be provided at each end of the earth for bolting Owner’s earthing conductors and earth bus shall run inside at the back of the panel for entire length. Facilities shall be provided for integral earthing of busbars & feeder circuit.

2.5 METERING AND PROTECTION

The VCB Panel Board shall be provided with epoxy resin current transformers for metering and protection. The CT’s shall conform in all respects to IS 2705-1964 Part-I, II and III. These shall have accuracy class of 0.5 / 1.0 for metering of 5P10 for protection. Potential transformers shall be epoxy cast resin type & conform to specifications of IS : 3156-1965 Part-I, II & III and shall be class-0.5. Ammeter and voltmeter to be installed on panel shall be of digital type. Electronic type digital energy analyser having parameter of KW, KWH power factor, frequency etc. with 30 days memory shall be provided. All meters shall be tested for 2000V for 1 minute and shall be 96mm square pattern, flush mounting type with necessary selector switches. Necessary indicating lamps of low voltage type with built in resistors shall be provided (maximum wattage 2.5W).

2.6 OPERATING MECHANISM

Vacuum Circuit Breaker shall be equipped with motorised spring charge. These operating mechanisms shall be of the stored energy type. In the closed state of the breaker, the energy stored in the springs shall be suitable for O-C-O duty.

2.7 INTERLOCKING AND SAFETY ARRANGEMENT

Vacuum Circuit Breaker shall be provided with the following safety and interlocking arrangements:

i. The drawout carriage cannot be moved from either test/disconnected to service position or vice versa, when the circuit breaker is ‘On’.

ii. The circuit breaker cannot be switched ‘ON’ when the carriage is in any position between test & service position.

iii. The front door of the panel cannot be opened when the breaker is in service position or in an intermediated position.
iv. The low voltage plug & socket cannot be disconnected in any position except test/isolated position.

v. The door cannot be closed unless the LV plug has been fitted.

vi. It shall be possible to mechanically close and trip the circuit breaker through push buttons with the circuit breaker in service position and the door closed.

vii. Individual explosion vents shall be provided for breaker, busbar, cable chambers on the top of the panel to let out the gases under pressure generated during an unlikely event of a fault inside the panel.

viii. Circuit Breaker & sheet metal enclosure shall be fully earthed.

ix. Self locking shutters shall be provided which close automatically and shall be interlocked with the movement of the drawout carriage mechanism.

2.8 RATING

The rating of the vacuum circuit breaker shall be as per the drawings and schedule of quantities. The rated/breaking capacity of the breaker shall be 350 MVA (18.37 KA RMS) at 11 KV. The rated making capacity shall be as per the relevant standards.

2.9 ACCESSORIES

Circuit Breakers shall be provided with the following accessories.

i. Auxiliary Switch with minimum 4 NO + 4 NC auxiliary contacts.

ii. Tripping Coil

iii. Mechanical Operation Counter

iv. Spring Charging Handle

2.10 ADDITIONAL ACCESSORIES

The loose items to be supplied with the 11KV VCB Panel Board shall comprise of the following:

a. Instruction Book.


c. Reaching in/out handle.

d. Handle for spring charging mechanism.

2.11 MOUNTING

Vacuum Circuit Breakers shall be mounted as per manufacturers standard practice.

2.12 AUXILIARY SUPPLY

a. The tripping shall be at 110 Volt D.C. through a power pack unit. Each breaker (VCB) shall be provided with separate power pack unit.

b. Space heater, closing, indication & other auxiliary supply requirement shall be at 230 V AC. Necessary termination arrangement complete with isolating switch, control fuse & link shall be provided at one place in the panel for receiving the Incoming/Outgoing cables. A control transformer of 1 KVA capacity 11/0.415/230 volts shall be provided alongwith incomer breaker of HT Panel Board for providing auxillary supply 230 Volts.

2.13 TESTS

2.13.1 FACTORY TESTS
The circuit breaker panel shall be subjected to routine tests at manufacturers works in accordance with the details specified in the relevant IS specifications. These shall however necessarily comprise of the following.

a. Power frequency voltage test on the main power circuit.

b. Verification of the correct wiring/Functional Test.

c. Dielectric test at 1.5KV on the control circuit. Apart from above, the vendor shall submit the routine test certificates for the following equipment.
   i. Circuit Breakers
   ii. Current Transformers
   iii. Voltage Transformers

The vendor shall submit the type test certificate for following alongwith the offer.

a. Temperature rise test.

b. Impulse & power frequency voltage test

c. Short time current test on circuit breaker.

2.13.2 SITE TEST

2.13.2.1 GENERAL

1. Verification for completion of equipment, physical damage/ deformities.

2. Alignment of panel, interconnection of busbars & tightness of bolts & connection etc.

3. Interconnection of panel earth busbar with plant earthing grid.

4. Inter panel wiring between transport sections.

5. Cleanliness of insulators and general Cleanliness of panel to remove traces of dust, water etc.

2.13.2.2 CIRCUIT BREAKER & PANEL

1. Check for free movement of circuit breaker, lubrication of moving part & other parts as per manufacturers manual.


3. Meggar before the Hi Pot test.

4. H.T. Test - Hi Pot test (Power frequency withstand test for one minute at 28KV RMS). At site Hi Pot test is carried out at 80% of 28KV RMS value.

5. Meggar after the Hi Pot test.

6. CT/PT ratio/polarity primary injection test.

7. Secondary injection test on relays to practical characteristics.

Note: Clause No. 4 & 6 – These tests can be conducted at the Factory. If these are conducted at factory satisfactorily, these need not be conducted at site.

2.13.3 These tests as per the clauses above will be witnessed by the Architect / Project Managers (PMC) / Engineer-In-Charge at the works for which necessary information has to be given in advance to the Architect / Project Managers (PMC) / Engineer-In-Charge.

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3.0 **11KV OIL TYPE DISTRIBUTION TRANSFORMER (OUTDOOR TYPE WITH ON LOAD TAP CHANGER & RTCC PANEL)**

3.1 **GENERAL**

The transformer shall be double wound core type, oil naturally cooled suitable for Indoor installation. The transformer shall be designed and manufactured as per IS 2026-1977 with upto date amendments and Transformer shall be selected, Installed & Maintained as per IS Code of Practice IS 10028 (Part I) - 1985 with upto date amendments and having no load voltage ratio as 11000/433V. Rating of Transformer shall be as per BOQ item.

3.2 **SPECIFICATION**

a ) **Standard**

Unless otherwise stated below, transformer & transformer oil, shall conform to IS 2026 & 335 respectively.

b ) **Climatic Conditions Affecting Operations**

Minimum Temperature - 5 degree C.

Maximum Temperature + 50 degree C.

c ) **System of Supply**

11kv 3 phase, 50 Hz system.

d ) **No Load Ratio**

11000/433 volts.

e ) **KVA Rating**

Transformer shall be suitable for continuous rating as stated in BOQ and on drawings.

f ) **Type**

Indoor

g ) **Winding**

The transformer shall be copper wound.

h ) **Core**

The magnetic core shall be made up of cold rolled grain oriented low loss steel stampings.

i ) **Cooling**

Natural oil cooling by means of pressed/round tubes around transformer tank (ONAN).

j ) **Frequency**

50Hz plus minus 3%

k ) **Rated Voltage**

Transformer shall operate at its rated KVA at any voltage plus minus 10% of rated voltage of that particular tap.

l ) **Vector Group**

Corresponding to the vector symbols Dyn-11.

m ) **Connections**

H.V. side of transformer shall be provided with cable box suitable for 3 core 240Sq.mm XLPE cable. Indoor heat shrinkable termination kit shall be used for termination of HV Cable. MV side of transformer shall be suitable for Bus Trunking / Bus Duct connection arrangement.
n) **Tapping**  
ON load tap changing arrangement on 11kv side. The range for circuit taps which shall be provided on HV side shall be plus 5% to minus 15% in steps of 1.25%.

o) **Temperature Rise**  
The transformer shall conform to the requirements of temperature rise specified in IS 2026 (Part II) 1977. Continuously rated for full load, temperature rise not to exceed 50 degree C by thermometer in oil (55 degree C by resistance).

p) **Insulation Levels**  
The insulation level shall be in accordance with IS : 2026 (Part III) 1977.

q) **Terminal Markings, Tappings & Connections**  
The terminal marking, tappings & connections shall be in accordance with IS 2026 (Part IV) 1977.

r) **Requirement with regards to ability to withstand short circuit**  
As per IS : 2026 (Part I) 1977.

s) **Impedance Voltage**  
As per table 3 of IS : 2026 (Part I) 1977.

t) **Tap changing switch**  
An externally hand operated on load tap changing switch with handle and a position indicating plate & locking device.

v) **Parallel Operation**  
Transformer shall be suitable for parallel operation with similar unit of same rates.

3.3 **FITTINGS**

The followings accessories and fittings shall be provided with the transformer.

(i). **Lifting Lugs** : The arrangement of lifting the active part of the transformer along with the cover of the tank by means of lifting lugs without disturbing the connections. Also complete transformer lifting lugs shall be provided.

(ii). **Rollers** : The transformer to be provided with 4 Nos. rollers fitted on cross channels to facilitate the movement of transformer.

(iii). **Oil Conservator** : The transformer to be provided with a conservator with welded end plates. It is to be bolted to the cover and can be dismounted for purposes of transport. It has to be provided with oil level gauge with marking for minimum level and an oil filling hole with a cap which can be used for filtering of oil. For draining purposes a plug is to be provided. A connection pipe between the conservator and main tank is to be provided, which projects inside the conservator.

(iv). **Air Release Valve** : An Air release valve shall be provided on top of the tank cover to facilitate the release of the entrapped air while filling of oil.

(v). **Breather** : The transformer shall be provided with an indicating dehydrating silicagel breather of sufficient capacity.

(vi). **Drain Valve With Plug** : The transformer to be provided with drain valve with plug at the bottom of the tank.

(vii). **Diagram And Rating Plate** : One diagram and rating plate indicating the details of transformer connection, diagram vector group, tap changing diagram etc.

(viii). **Thermometer** : Dial type thermometer (100mm dia) with maximum set pointer 75 degree C.
(ix). **Explosion Vent**: Explosion Vent or pressure relief device shall be provided of sufficient size of rapid release of any pressure that may be generated within the tank and which might result in damage to the equipment. The device shall operate at a static pressure less than the hydraulic test pressure for transformer tank.

(x). **Filter Valve**: Filter valve on the top of the tank.

(xi). **Bucholtz**: Oil & gas actuated relay equipment shall conform to IS 3637-1966 (amended upto date) and shall be double float type having contacts which close following oil surge or under incipient fault condition. Bucholtz relay shall have contacts for alarm and trip.

(xii). **Winding Temperature Indicator**: Winding temperature indicator with electrical contract for alarm and trip.

(xiii). **Oil Temperature Indicator**: Oil temperature indicator with alarm & trip contacts.

(xiv). **Marshalling Box**: The transformer shall be provided with suitable size marshalling box to terminate the control cables of thermometer and bucholtz relay. Control cabling between bucholtz relay / Marshalling box to H.T. Panel shall deemed to be including in quoted rate of Transformer.

(xv). **Transformer Oil**: First filling of oil.

(xvi). **Earthing**: Two separate earthing terminals are to be provided at the sides of the tank on both sides for earthing.

### 3.4 Instrumentation Manual

The successful bidder shall submit three copies of manual of complete instructions for the installations, operation, maintenance and repair, circuit diagrams, foundation and trenching details shall be provided with the transformer.

### 3.5 Shop Drawings

Manufacturer shall prepare and furnish shop drawings for the approval by the Architect / Project Managers (PMC) / Engineer-in-Charge before commencing fabrication/manufacture of the equipment. Shop drawings shall be based on requirement laid down in the specification. The manufacture of equipment shall be commence only after the shop drawings have been approved in writing by the Architect / Consultant / Project Managers (PMC). Transformer shall be manufactured as per approved specification of Local Supply Authority.

### 3.6 Installations

(i). The transformer shall be installed as per installation manual of the transformer supplier and conforming to Indian Standard IS 10028 (Part-II) 1981 with upto date amendments.

(ii). The transformer is to be erected on suitable cement concrete foundation / flooring. The transformer supplied shall be lifted by all lifting lugs for the purpose of avoiding imbalance in transit.

(iii). The transformer wheels shall be locked by suitable locking arrangement to avoid accidental movement of the transformer.

(iv). The transformer cable end boxes shall be sealed to prevent absorption of moisture.

(v). Dehydration at all the stages upto the handing over to the Owner shall be done by the contractor free of cost.

(vi). The transformer neutral earthing and body earthing shall be done as shown on the drawing and shall conform to Indian Standard IS : 3043-1987 with upto date amendment.

(vii). Two earths shall be provided for body earthing and two earths for neutral earthing. Copper shall be used for neutral earthing.
3.7 **Factory Tests**

The transformer shall be subjected to test as laid down in IS 2026 (Part-I) 1977 at the factory/manufacturing unit prior to despatch of the transformer to the site. All original test certificate shall be furnished.

3.8 **Test at Site**

Prior to commissioning of the transformer the following tests shall be performed.

(i). Insulation resistance of the winding between phases and earth of H.V. and M.V. Side.

(ii). Winding resistance of all the winding on all tap positions shall be taken.

(iii). Di-electric strength of transformer oil shall be checked in accordance with IS 335-1963. Incase the test is not satisfactory, the oil shall be filtered till proper dielectric strength of oil is obtained. A certificate for the same shall be given to Owner.

Contractor / Manufacturer shall give sufficient advance information about the test schedule to enable the Project Managers to appoint his representative.

3.9 **High Speed Resistor ON Load Tap Changer**

3.9.1 **General**

High speed resistor On-Load-Tap Changer shall be provided with the transformer wherever specified. The high speed, resistor, OLTC shall be for rated voltage upto 11KV, rating current of 100 Amp, 3 phase, 17 step conforming to IS 8468-1977 complete with AVR & RTCC panel.

3.9.2 **Type And Construction**

OLTC shall be a compact unit for use with three phase distribution and substation transformer. It shall be completely self contained and designed to bolt directly to a part flange on the transformer.

The assembly comprises of:

(a). Tank
(b). Selector Switch
(c). Driving Mechanism
(d). Barrier Board
(e). Local Control Gear
(f). Control Cable Terminations
(g). AVR & RTCC Panel

3.9.3 **Tank**

The complete tap changer shall be housed in a single tank of welded sheet steel construction. The tank shall be divided into two separate compartments to house the selector switch, Driving Mechanism and Local Control Gear. Access to the compartments shall be made easy by means of removable covers and a weatherproof door. Anti-condensation heater shall be provided in the compartment which houses driving mechanism and control gear.

3.9.4 **Selector Switch**

The three phase of the tap-changer shall be adequately spaced for full interphase insulation but mounted as a common assembly using vertical synthetic resin bonded insulating boards, each carrying a circle of fixed contacts. Insulating rods and tubes shall be used for the horizontal spacing of the phases and the fixed contacts shall be connected via the barrier board to appropriate tappings in the transformer winding. Each phase shall have a single rotary contact support ring with sliding contact take off connection. This ring carries separately insulated spring loaded snap connected by a non inductive resistance unit accommodated on the contact carrier. One main moving contact shall be connected directly to the centre boss take off point, the second, transition moving contact shall be connected to the resistor. The three contact support rings shall be attached to the central insulating...
drive shaft, which rotates in self aligning ball bearings in the two outer phase boards. This centre shaft shall be of glass reinforced synthetic resin construction. Access to the selector switch shall be via removable cover on the top of the tank.

3.9.5 **Drive Mechanism**

Operation of the selector switch shaft shall be by means of a stored energy spring device having a positive snap-action for rotating the moving contacts quickly through the angle required for each tap change. The driving mechanism compartment shall be external to the oil filled switch tank. The rotary drive from the driving mechanism to the selector switch shall pass through a frictionless positive oil-tight gland. The angular movement of selector switch shaft shall be controlled by an indexing wheel which shall positively locked by the periphery of the operating cam except during the actual time of tap-change operation. The operating cam shall be freely mounted on its shafts, rotation being imparted to it by means of tension springs attached radially between the operating cam hub and the periphery of a concentric spring carrying gear wheel. The spring carrying gear wheel shall be rotated by a driving motor through cam. When the drive pin on the operating cam enters the slot in the indexing wheel the lock shall disengaged but rotation shall be prevented by the locking arm pawl engaging in another slot of indexing wheel. The spring carrying gear wheel continuous to rotate thus charging the springs. When sufficient energy has been stored a trip pin on the gear wheel shall lift the locking arm restraining the indexing wheel and the spring energy shall be released to move the tap selector switch one position, the cam locking coming in operation, accurately controlling the angular movement.

The operation of the selector switch shall be thus positively assured and shall be dependent only upon the quick release of the spring energy. It shall be thus independent of the motor drive. The tap changing sequence shall now complete and the driving motor shall brought to rest by the resetting of auxiliary switches and mechanical friction device. For protective purpose automatic declutching by shear pins shall be incorporated in the drive. The mechanism shall be provided with the auxiliary switches necessary for its operation. A step by step switch for position indication shall also be fitted and additional paralleling & out of step switches provided. A tap change mechanical counter, mechanical tap position indicator, mechanical end stops and electrical limit switch shall be provided. A detachable handle for hand operation shall also be provided. The fitting of this handle shall automatically disconnects the motor drive shaft by the operation of a simply spring loaded dog clutch and at the same time isolates the electrical control supply.

3.9.6 **Barrier Board**

The connections from the transformer winding shall be taken through an insulating terminal barrier board, which shall be supplied loose for clamping to the transformer port flange. Thus the transformer shall be treated and filled with oil before the tap changer is fitted. This arrangement allows the tap selector switch contacts to be inspected or the complete tap changer to be handled separately without disturbing the oil level in the transformer.

3.9.7 **Local Control Gear**

The motor reversing contactors and associated local control gear shall be housed in the same compartment as the driving mechanism with a common hinged weatherproof door. Weatherproof local control switches when required shall be mounted in an accessible position below the door.

3.9.8 **Operating Mechanism**

An impulse is received, either from a remote control panel or from a local manual operation switch, which energies the appropriate raise/lower contactor to initiate a tap changer in the required direction. The contactor when energised seals itself via its own contact and the driving motor commence to run. At a predetermined point a directional sequence switch closes, taking over the holding duties of the contactor whose original self-hold circuit shall be isolated. At the completion of the tap change the directional sequence switch opens and de-energises the driving motor. This arrangement ensures that a short period initiating pulse shall be accepted by the control gear.
3.9.9 Control Cable Termination
A detachable undrilled gland plate and the terminal station for the all external connections shall be provided in the driving mechanism compartment of the tap-changer.

3.9.10 Automatic Voltage Regulator
Solid state Automatic Voltage Regulator shall be provided for regulation of the secondary voltage of power transformer with on load tap changer (OLTC). The band width control shall allow the dead band to be set in terms of upper (LOWER VOLTS) and lower (RAISE VOLTS) voltage limits around a particular nominal value with a specified sensitivity. AVR shall be provided with time delay control to allow the regulator to respond only to voltage fluctuations lasting for period greater than a selected time delay. Where the voltage correction requires more than one tap change, the time delay shall be reinitiated before further tap changes. Regulation shall reset automatically after voltage correction. Solid state lamps (LED) shall be provided to indicate voltage outside the preset limits & control relay operation.

3.9.11 RTCC Panel
RTCC Panel shall be provided to operate OLTC from Control Room located in Substation. RTCC shall be provided with main switch, a sequence selector switch. RTCC shall be provided with lower push button & raise push button, tap change in progress & complete, A.C. supply ON/OFF lamp indicator & AVR relay operated indication. Cubicle panel shall be totally enclosed, floor mounting and fabricated with a framed structure with rolled/folded sheet steel channel section of minimum 2mm thickness. All sheet steel work forming the exterior of RTCC panel shall be smoothly finished and all steel work used in construction of RTCC panel shall undergone a rigorous metal treatment process consisting of effective cleaning by hot alkaline degreasing solution followed by cold water rinsing, pickling in dilute sulphuric acid to remove scales and rust formation, a recognized phosphating process, passivating in deoxalite to retain & augment the effects of phosphating, drying with compressed air and dust free atmosphere, primer coating with two coats of highly corrosion resistant primer applied under strictly controlled conditions and finished coat of stoving synthetic enameled paint of grey colour.

4.0 PACKAGE/COMPACT TYPE SUBSTATION

4.1 CODE & STANDARDS:
4.1.1 All equipment and material shall be designed manufactured and tested in accordance with the latest applicable Indian Standard / IEC standard.
4.1.2 The electrical installation shall met the requirement of Indian Electricity Rules as amended upto date relevant IS code of practice and Indian electricity act.
4.1.3 The Package type Substation offered shall in general comply with the latest issues including amendments of the following standards but not restricted to it.

<table>
<thead>
<tr>
<th>Title</th>
<th>Indian Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Voltage Low Voltage Pre-Fabricated Substation</td>
<td>IEC:62271-202</td>
</tr>
<tr>
<td>11 kV Switchgear cubicles</td>
<td>IS:13118, IS:3427, IEC:60694, IEC:60298</td>
</tr>
<tr>
<td>Code of practice for selection, installation and maintenance of Switchgear</td>
<td>IS:10118</td>
</tr>
<tr>
<td>Ring main unit 11KV Grade</td>
<td>IS:9920, IEC: 60265</td>
</tr>
<tr>
<td>Distribution Transformer</td>
<td>IS: 2026</td>
</tr>
<tr>
<td>Colour for ready mix paints</td>
<td>IS:5</td>
</tr>
<tr>
<td>Enamel synthetic, exterior a) Undercoating, b) finishing</td>
<td>IS:2932</td>
</tr>
</tbody>
</table>
4.2 DESIGN CRITERIA

4.2.1 Package Substation consisting of **11KV SF6 insulated Non-Ext compact switchgear with VCB + Transformer + L.T. 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**. 11KV VCB controls incoming-outgoing feeder cables of the 11KV distribution system. The Vacuum Circuit Breaker shall be used to control and isolate the 11kV/433V Distribution transformer. The transformer L.T. side shall be connected to L.T. switchgear. The connection cables to consumer shall be taken out from the L.T. switchgear.

4.2.2 The prefabricated package type substation shall be designed for a) Compactness, b) fast installation, c) maintenance free operation, d) safety for worker/operator & public.

4.2.3 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.

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

4.2.5 **Service Conditions:**

4.2.5.1 The equipment offered shall be suitable for continuous satisfactory operation in tropical area of Installation.

**Enclosure:** The Enclosure, High Voltage switchgear-control gear, Low Voltage switchgear-control gear & Transformer of the package type 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. The enclosure construction shall be such that it fully protects ingress of rain water & rusting. For this purpose, construction without welded joint is preferred.

4.3 SPECIFIC REQUIREMENT

The main components of a prefabricated package type substation are Transformer, High-voltage switchgear-control gear, Low-voltage switchgear-control gear, corresponding interconnections (cable, flexible, busbars) & 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.

4.3.1 **Ratings:**
<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Voltage / Operating Voltage</td>
<td>kV rms</td>
<td>11</td>
</tr>
<tr>
<td>Rated frequency &amp; Number of phases</td>
<td>Hz &amp; nos.</td>
<td>50 &amp; 3</td>
</tr>
<tr>
<td>Rated maximum power of substation</td>
<td>Kva</td>
<td>630KVA, 500KVA, 400KVA &amp; 315KVA</td>
</tr>
<tr>
<td>HV Insulation Level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated withstand voltage at power frequency of 50 Hz</td>
<td>kV rms</td>
<td>28</td>
</tr>
<tr>
<td>Rated Impulse withstand Voltage</td>
<td>kV peak</td>
<td>75</td>
</tr>
<tr>
<td>HV Network &amp; Busbar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated current</td>
<td>Amp</td>
<td>200Amp</td>
</tr>
<tr>
<td>Rated short time withstand current</td>
<td>kA rms/ 3sec</td>
<td>21</td>
</tr>
<tr>
<td>Making capacity for switch-disconnector &amp; earthing switches</td>
<td>kA peak</td>
<td>52kA</td>
</tr>
<tr>
<td>Breaking capacity of Isolators (rated full load)</td>
<td>A</td>
<td>630Amp</td>
</tr>
<tr>
<td>LV Network</td>
<td></td>
<td>As per the requirement</td>
</tr>
</tbody>
</table>

**Outdoor enclosure:**

4.3.2.1 The enclosure shall be made of Galvanised Sheet Steel tropicalised to Indian weather conditions.

4.3.2.2 The metal base shall ensure rigidity for easy transport & installation.

4.3.2.3 The structure of the substation shall be capable of supporting the gross weight of all the equipment & the roof of the substation compartment shall be designed to support adequate loads.

4.3.2.4 The protection degree of the Enclosure shall be **IP:23D** for Proper / adequate ventilation aperture shall be provided for natural ventilation by way of Louvers etc.

4.3.2.5 The doors shall be provided with proper interlocking arrangement for safety of operator.

4.3.2.6 The H.V. & L.V. outgoing of the transformer are to be connected to Breaker of HT Panel Board & incomer of the L.V.

4.3.3 **Internal Fault**: Failure within the package type substation due either to a defect, an exceptional service condition or mal-operation may initiate an internal arc. Such an event may lead to the risk of injury, if persons are present. It is desirable that the highest practicable degree of protection to persons shall be provided.

4.3.4 **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.

4.3.5 **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 flexible jumpers/straps & 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:

a) The enclosure of Package type / prefabricated substation,
b) The enclosure of High voltage switchgear & control gear from the terminal provided for the purpose,
c) The metal screen & the high voltage cable earth conductor,
d) The transformer tank or metal frame of transformer,
e) The frame &/or enclosure of low voltage switchgear,

4.3.6 Package substation enclosure has internal lighting activated by associated switch for HV, Transformer & LV compartments separately.

4.3.7 **Labels**: Labels for warning, manufacturer’s operating instructions etc. & those according to local standards & regulations shall be durable & clearly legible.

4.3.8 **Cleaning & Painting**:

a) The paints shall be carefully selected to withstand tropical heat rain. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.
b) Special care shall be taken by the manufacturer to ensure against rusting of nuts, bolts and fittings during operation. All bushings and current carrying parts shall be cleaned properly after final painting.
c) The Fabrication process shall ensure that there are no sharp edges on GI sheet used.

4.3.9 **11KV SF-6 insulated VCB Panel Board**: The requirement of 11KV HT Panel is as under.

4.3.9.1 SF6 insulated VCB Breakers complete with operating mechanism suitable for load breaking fault making with cable box accessible from the front.

The above breakers, Busbars should be mounted inside a robotically welded sealed for life, stainless steel tank of 3mm thick sheet metal. The tank should be filled with SF6 gas at adequate pressure. The degree of protection for gas tank should be IP67.

4.3.9.2 The VCB is required to control 11 kV/433 volts distribution Transformer of following rating and relay settings shall be selected accordingly.

- 630KVA / 500KVA / 400KVA / 315KVA Transformer.

4.3.9.3 **General Finish**: Totally enclosed, metal clad, vermin and dust proof suitable for tropical climate use as detailed in the specification.

4.3.9.4 **Breaking & Making Capacity**: Breaker shall be capable of having rupturing capacity of minimum 21KA (350 MVA at 11KV has 18.37KA breaking capacity) symmetrical at 11000 volts three phase.

4.3.9.5 **Busbar**: Switchgear shall be complete with all connection, bus-bars etc. Copper bus bars continuous rating shall be 800 Amps. The bus bars should be fully encapsulated by SF6 gas inside the steel tank.

4.3.10 **Switchgear**:

4.3.10.1 The VCB pressure details shall be submitted with the Tender document. Sealed for life, the enclosure shall meet the “sealed pressure system” criteria in accordance with IEC:298 (a system
for which no handling of gas is required throughout service life of approximate 20 years.) There shall be no requirement to ‘top up’ the SF6 gas. In addition, manufacturer shall confirm that maximum leakage rate is lower than 0.1% per year. It shall provide full insulation, making the switchgear insensitive to the environment. Thus assembled, the active parts of the switchgear unit shall be maintenance free.

4.3.10.2 The switchgear & switchboard shall be designed so that the position of different devices is visible to the operator on the front of the switchboard & operation is visible as well. The switchboard shall be designed so as to prevent access to all live parts during operation without the use of tools.

4.3.10.3 11 KV VCB Panel Board should be tested for internal arc fault test.

4.3.11 VCB:

4.3.11.1 The Unit shall consist 630A Tee-off spring assisted, three pole VCB circuit breaker, with integral fault making/ dead breaking earth switch. The function shall be naturally interlocked to prevent the main & earth switch from being switched ‘ON’ at the same time & the CB not allowed to trip in ‘Earth On’ position. The selection of the main/earth switch lever on the panel, which is allowed to move only if the main or earth switches in the off position. The lever shall be able to pad locked in either the main or earth position.

4.3.11.2 The manual operation of the circuit breaker shall not have an effect of the trip spring. This should only be discharged under a fault (electrical) trip condition; the following manual reset operation should recharge the trip spring & reset the CB mechanism in ‘main off’ position.

4.3.11.3 Protection:

Protection Relays: The CB shall be fitted with microprocessor based self powered relay inside the front cover to avoid any tampering.

4.3.12 Cable Box:

4.3.12.1 Every VCB shall be provided with suitable and identical cable boxes for connecting 3 core, 11kV cable from vertically below. The cable boxes shall be so located at convenient height to facilitate easy cable jointing work. The height available for cable termination should be minimum 500mm The Cable termination shall be done by Heat shrinkable Termination method so adequate clearances shall be maintained between phases for Termination. Access to all the cables should be possible form the front of HT Panel Board.

4.3.12.2 Locking Arrangement: Suitable padlocking arrangements shall be provided as stated below.

a) CB manual operating handle in the “OFF” position.
b) Each feeder Panel operating handles in ‘Closed’ ‘Open” or ‘Earth’ position.
c) Each VCB operating handle in ‘Closed’, ‘Open’, or ‘Earth’ position.

4.3.13 Ratings:

<table>
<thead>
<tr>
<th>1.3.6.1</th>
<th>Switchgear Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Type VCB in SF-6 Tank</td>
</tr>
<tr>
<td>b)</td>
<td>Number of phases 3</td>
</tr>
<tr>
<td>c)</td>
<td>Voltage 11000V</td>
</tr>
<tr>
<td>d)</td>
<td>Rated Frequency 50 Hz</td>
</tr>
<tr>
<td>e)</td>
<td>Rated Current 200 Amp (Breaker)</td>
</tr>
<tr>
<td>f)</td>
<td>Short Circuit rating</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>i) Breaking Minimum 21 KA (350 MVA) at 11 KV</td>
<td></td>
</tr>
<tr>
<td>ii) Short time withstand for 3 Sec. Minimum 21 KA</td>
<td></td>
</tr>
<tr>
<td>iii) Rated S/c making 52 kA peak for Breaker</td>
<td></td>
</tr>
<tr>
<td>g) Short duration power freq. 28 kV</td>
<td></td>
</tr>
<tr>
<td>h) Insulation Level 95 KV peak</td>
<td></td>
</tr>
<tr>
<td>i) System earthing Solidly earthed at substation</td>
<td></td>
</tr>
</tbody>
</table>

4.3.14 **Tests For 11 KV HT Panel Board**: Each type of 11kV Switchgear shall be completely assembled, wired, adjusted and tested at the factory as per the relevant standards i.e. IS:9920, IS:3427, IS:13118, IEC:265, IEC:298 and during manufacturing and on completion

4.3.15 **Routine Tests**: The tests shall include but not necessarily limited to the following:

a) Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme and proper functioning of the equipment.

b) All wiring and current carrying part shall be given appropriate High Voltage test.

4.3.16 **Distribution Transformer (Oil Filled Transformer)**

4.3.16.1 **Requirement**: 11000/433 Volt Oil immersed, **630KVA to 315KVA** ONAN cooled suitable for installation at outdoor in Enclosure for ground mounting. The transformer should be hermetically sealed & should be with corrugated wall design

4.3.16.2 **Voltage Ratio**: No load voltage 11000/433 volts within tolerance as stipulated in IS:2026.

4.3.16.3 **Rating**: The transformer shall have a continuous rating as specified at any of the specified tapping position and with the maximum temperature rise specified.

4.3.16.4 **Temperature Rise**: The maximum temperature rise at the specified maximum continuous output shall not exceed 40°C by thermometer in the hottest portion of the oil or 50° C measured by resistance of winding above ambient temperature, not exceeding 40°C daily average or 50°C maximum.

4.3.16.5 **Type of Load**: The transformer shall be suitable for carrying load within temperature rise indicated in the Indian Standard specification IS:6600 ‘Guide for loading of oil immersed Transformer’.

4.3.16.6 **Overloads**: The transformers shall be suitable for carrying overload within temperature rise indicated in IS:6600 ‘Guide for Loading of oil immersed Transformer’.

4.3.16.7 **Connections**: H.V. Delta and L.V Star connected with neutral brought out on the secondary side for connection to earth; Vector group DYn11 of IS:2026.

4.3.16.8 **Tapping**:

a) Each transformer shall be provided with **Rotary type tap switch** so as to provided for a voltage adjustment on H.V. from +5% to –5% of rated voltage of 11000 volts in 4 equal steps (5 position) to obtain rated voltage of 433 volts on LV side. The tapping shall be provided for following voltage ratios at no load.

b) Each transformer shall be provided with adjustable **tapping Links** such as to provided for a voltage adjustment on H.V. from +5% to –5% of rated voltage of 11000 volts in 4 equal steps (5 position) to obtain rated voltage of 433 volts on LV side. The tapping shall be suitable to change on H.V. side by links provided for this purpose.
4.3.16.9 **Cleaning & Painting:**

a) All steel surfaces shall be thoroughly cleaned by sand blasting or chemical agents, as required to produce a smooth surface free of scales, grease and rust.

b) The internal surfaces in contact with insulating oil shall be painted with heat resistant insulation paint which shall not react & be soluble in the insulating liquid used.

c) The external Surfaces, after cleaning, shall be given two coats of high quality epoxy based rust resisting primer as per IS:2074 followed by filler coats.

d) The transformer shall be furnished with coats of weather resisting battleship gray epoxy based enamel paint as per IS:2932 specially recommended for transformer use.

e) The paints shall be carefully selected to withstand tropical heat rain, effect of proximity to the sea etc. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.

f) Special care shall be taken by the manufacturer to ensure against rusting of nuts, bolts and fittings during operation. All bushings and current carrying parts shall be cleaned properly after final painting.

4.3.16.10 Both H.V. and L.V. bushings shall have creepage corresponding to very heavily polluted atmosphere.

4.3.16.11 **Oil:** New transformer oil used shall be according to IS:335.

4.3.16.12 **Phase Marking & Danger Plate:** Phase markings in fluorescent paint on small non-corrodible metallic tags shall be permanently fixed for H.V. and L.V sides. Phase markings tags shall be properly fixed with proper alignment. Danger plates shall be provided on the H.V & LV sides, mentioning the Corresponding Voltages.

4.3.16.13 **Core:** The core shall be constructed from high grade, cold rolled, non-ageing, low loss, high permeability, grain oriented, cold-rolled grain oriented silicon steel laminations. The transformer shall be so designed as to have minimum humming noise. The percentage harmonic potentials with the maximum flux density under any conditions shall be such that capacitors connected in the system shall not be overloaded.

4.3.16.14 The core and coil assembly shall be securely fixed in position so that no shifting or deformation occurs during movement of transformer. The core and coil assembly shall be capable of withstanding without injury, the thermal and mechanical effects of short circuit at the terminals of any winding as per IS:2026.

4.3.16.15 **Impedance Volts:** The Percentage impedance value at 75 Deg. C at any tap shall be 5% subject to tolerance as specified in IS:2026. The value of the impedance volts at each tapping over the specified range shall be specified in the bid.

4.3.16.16 **Regulation:** The regulation at 75°C at full load at unity and 0.8 power factor subject to the usual tolerance as per IS:2026 shall be specified in the bid.

4.3.16.17 **Power Freq. High Voltage & Insulation Level (Impulse voltage):** The distribution transformer shall be designed so that they are capable of withstanding high voltage & impulse voltages as per IS:2026 and as given below:

a) Impulse Voltage for 11kV winding: 75 kV (1.2/50 Microsecond wave shape).

b) High Voltage : 28kV rms.

4.3.16.18 **RATINGS (Summary):**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Application</th>
<th>630 KVA to 315 KVA Corrugated Tank</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>Service</td>
<td>Outdoor in an Enclosure, Distribution Transformer</td>
</tr>
<tr>
<td>(ii)</td>
<td>Type</td>
<td>Oil immersed corrugated tank</td>
</tr>
<tr>
<td>S. No.</td>
<td>Application</td>
<td>630 KVA to 315 KVA Corrugated Tank</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------------------------------------------------</td>
<td>------------------------------------</td>
</tr>
<tr>
<td>(iii)</td>
<td>Cooling system</td>
<td>ONAN</td>
</tr>
<tr>
<td>(iv)</td>
<td>No. of Phases</td>
<td>3</td>
</tr>
<tr>
<td>(v)</td>
<td>No. of winding per phase</td>
<td>2</td>
</tr>
<tr>
<td>(vi)</td>
<td>Rated output (MVA) With ANAN cooling</td>
<td>630 KVA to 315 KVA</td>
</tr>
<tr>
<td>(vii)</td>
<td>Rated voltage in KV (Line to Line)</td>
<td>HV-11 kV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LV-0.433 kV</td>
</tr>
<tr>
<td>(viii)</td>
<td>Rated frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>(ix)</td>
<td>Temperature rise above 40°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) In winding by resistance</td>
<td>50°C or above</td>
</tr>
<tr>
<td></td>
<td>b) In Oil by thermometer</td>
<td>40°C or above</td>
</tr>
<tr>
<td>(x)</td>
<td>Insulation level</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) H.V. Power Freq. KV rms</td>
<td>28 kV</td>
</tr>
<tr>
<td></td>
<td>b) H.V. (kVpeak ) Impulse</td>
<td>75 kV</td>
</tr>
<tr>
<td></td>
<td>c) L.V. (kV)</td>
<td>-</td>
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<tr>
<td>(xi)</td>
<td>Vector Group</td>
<td>Dyn11</td>
</tr>
<tr>
<td>(xii)</td>
<td>Parallel operation</td>
<td>Yes</td>
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<tr>
<td>(xiii)</td>
<td>Type of taps provided</td>
<td>Off Load full capacity</td>
</tr>
<tr>
<td></td>
<td>a) Taps provided</td>
<td>H.V. winding</td>
</tr>
<tr>
<td></td>
<td>b) Range of taps</td>
<td>+5% to -5% in steps of 2.5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(4 steps, 5 position)</td>
</tr>
<tr>
<td></td>
<td>c) Method of Tap Change control</td>
<td>Rotary Switch</td>
</tr>
<tr>
<td></td>
<td>d) Manual load</td>
<td>Yes ‘Off Circuit’</td>
</tr>
<tr>
<td>(xiv)</td>
<td>Percentage impedance at 75 Deg. C</td>
<td>5% with tolerance</td>
</tr>
<tr>
<td>(xv)</td>
<td>System earthing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) H.V.</td>
<td>Solidly earthed</td>
</tr>
<tr>
<td></td>
<td>b) L.V.</td>
<td>Solidly earthed</td>
</tr>
<tr>
<td>(xvi)</td>
<td>Terminal arrangement</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) H.V.</td>
<td>From H.V. Bushing on Top.</td>
</tr>
<tr>
<td></td>
<td>b) L.V.</td>
<td>From L.V. Bushing on Top.</td>
</tr>
<tr>
<td></td>
<td>c) L.V. Neutral</td>
<td>From L.V. Neutral Bushing on Top.</td>
</tr>
<tr>
<td>(xvii)</td>
<td>Transformer-bushing voltage class</td>
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</tr>
<tr>
<td></td>
<td>a) H.V. (kV)</td>
<td>12 kV class</td>
</tr>
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<td></td>
<td>b) L.V. (kV)</td>
<td>1.1 kV class</td>
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<tr>
<td>(xviii)</td>
<td>System fault level</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) H.V. side</td>
<td>350 MVA (11 kV)</td>
</tr>
<tr>
<td></td>
<td>b) L.V. side</td>
<td>-</td>
</tr>
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<td>(xix)</td>
<td>Short circuit withstand capability duration</td>
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</tr>
<tr>
<td>(xx)</td>
<td>L.T. side C.T. ratings</td>
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</tr>
<tr>
<td></td>
<td>a) Current Ratio</td>
<td>1250/5 Amps &amp; 500/5 Amps</td>
</tr>
<tr>
<td></td>
<td>b) Class of Accuracy</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>c) Burden</td>
<td>5 VA</td>
</tr>
<tr>
<td></td>
<td>d) Type</td>
<td>ring type</td>
</tr>
</tbody>
</table>

**4.3.16.19 Fittings & Accessories For Corrugated Tank Transformer:**
The following accessories conforming to IS:3639 shall be provided for 11kV / 0.433kV, distribution transformer.

a) Two earthing terminals with copper lugs. The lugs shall be provided in such a way that they shall not obstruct the movements of rollers. The earthing continuity for all the connected equipments shall be properly done.

b) Two lifting lugs for complete transformer as well as enclosure.

c) Off circuit tapping switch shall be rotary type, 3 pole gang operated, top mounting draw out type only. Tap switch shall be suitable for rated current considering 20% overloading & operating voltage. Switch shall be provided with externally operating hand wheel handle with indicator and locking device, with direction changing facility and locking arrangement.

d) **Rating plate and diagram plate** of durable non-corroding metal giving information as required under IS:2026. Rating plate shall also include Transformer Actual %Z, No-Load Loss & Full-Load Loss at 75°C along with details like Purchase Order Number, date. The name plate marking shall be done with fluorescent colour. Each equipment shall carry individual name-plate with proper instructions & affixed with screws.

4.3.17 LT Switchgear:

4.3.17.1 **System:**

a) **Declared voltage** :- 3 Phase,400V (±6%) 50 Hz,

b) **Neutral** :- Solidly earthed at substation.

4.3.17.2 **General finish:**- Tropical, totally enclosed, metal-clad, weather-proof, vermin and dust proof.

4.3.17.3 **Enclosure:**- Type of enclosure shall be able to provide the degree of protection IP:54 .

4.3.17.4 **Circuit Ways:**

As per the requirement given in the specifications / schedule of requirement.

4.3.17.5 **Construction :**

a) The terminals shall be of sufficient mechanical strength and shall provide adequate electrical contact for the appropriate size of cable used. They shall be capable of receiving appropriate size of Aluminum conductors. They shall be provided with stainless steel nut bolts, plane washers and spring washers for cable connection.

b) The enclosure shall be of sheet steel of 2mm CRC sheet steel, dust vermin proof, duly powder coated and wired as per standard engineering practice and CPRI tested.

c) No contact pressure shall be transmitted through insulating material & the gripping of the conductor shall take place between metal faces.

4.3.18 **Earthing :**

4.3.18.1 Earthing arrangement shall be provided for earthing each cable, PVC cable gland, neutral busbar, chassis and frame work of the cubicle with separate earthing terminals at two ends. The main earthing terminals shall be suitably marked. The earthing terminals shall be of adequate size, protected against corrosion, and readily accessible. These shall be identified by means of sign marked in a legible manner on or adjacent to terminals.

4.3.18.2 Neutral bus bar strip shall be connected to Earthing terminal with help of copper strip of suitable capacity & nut-bolt arrangement.

4.3.19 **Accessories:** The following accessories shall be supplied duly mounted..

One incandescent lamp (with necessary fuse) to illuminate the fuse board internally.

4.3.20 **LT Switchgear**

Specification/Selection of Air Circuit Breaker and Moulded Case Circuit Breakers:-
1) Upto 100Amp MCCBs shall be used of 25kA Short Ckt. Current and should be Thermal Magnetic.

2) Above 100Amp and below 250Amp MCCBs shall be used of 35kA short Ckt. Current and should be Thermal Magnetic.

3) From 250Amp to 630Amp MCCBs shall be used of minimum 35kA short Ckt. Current and should be microprocessor based.

<table>
<thead>
<tr>
<th>Rating of MCCB</th>
<th>Electrical Endurance</th>
<th>Mechanical Endurance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 160 A</td>
<td>7000 Opns</td>
<td>25000 Opns</td>
</tr>
<tr>
<td>Above 160 A</td>
<td>4000 Opns</td>
<td>15000 Opns</td>
</tr>
</tbody>
</table>

**Frame Size**

The MCCB shall have the following Frame Size:

a) Upto 160 A. Rating 160 A Frame
b) From 160 A. to 250 A. 250 A Frame
c) From 250 A. to 400 A. 400 A Frame
d) From 400 A. to 630 A. 630 A Frame

For thermal magnetic protection the O/L adjustment should be 75%-100% and for microprocessor-based release the adjustment should be 40%-100% and S/c for 2 to 12 times.

4) From 800A onwards ACBs shall be used of 50kA(Icu=Ics) with Thermal Magnetic (TM) based overload, short circuit and earth fault protection.

<table>
<thead>
<tr>
<th>Rating of ACB Electrical Endurance</th>
<th>Mechanical Endurance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 1600 A</td>
<td>10000 Opns</td>
</tr>
<tr>
<td>2000-4000A</td>
<td>20000Opns</td>
</tr>
</tbody>
</table>

The air circuit-breakers (ACB’s) used in low-voltage installations shall be designed, built and tested in compliance with the standards of the IEC 947-2 & EN 60947,

- The ACB’s shall have a rated operating voltage of up to 690 V (50/60Hz)
- The rated insulation voltage shall be equal to or greater than 1000 V.
- The rated impulse withstand voltage shall be equal to 12 kV; the device can be used for every installation category in this way, in compliance with the international standards CEI IEC 664-1

**Setting range of protection release**

a) Overload protection shall have adjustable setting from 40% to 100% of the ACBs rated.

b) Current in steps of 10% and adjustable time setting from 3-18m sec.

c) Short circuit protection shall have adjustable current setting from 100% to 1000% of the overload setting and adjustable time delay setting for fault discrimination from 50-500 m sec.

d) E/F protection if specified will have adjustable current setting from 40% to 100% of ACB rated current and adjustable time setting from 100-800m sec. It shall be possible to charge the release setting on load.

f) There should not be any defeat facility of overload protection.

**4.3.21 TYPE/ROUTINE TEST ON PACKAGE TYPE SUBSTATION:**

**4.3.21.1 TYPE TESTS FOR THE PACKAGE TYPE SUBSTATION:**
The offered package type substation should be fully type tested as per the IEC-1330

4.3.21.2 **Routine Tests:** The routine tests shall be made on each complete prefabricated substation.

a) Voltage tests on auxiliary circuit.

b) Functional test.

c) Verification of complete wiring.

4.3.21.3 **Test Witness:** Routine test shall be performed in presence of Owner’s representative if so desired by the Owner. The Vendor shall give at least fifteen (15) days advance notice of the date when the tests are to be carried out.

4.3.21.4 **Test Certificates:**

4.3.21.4.1 Test report for the test mentioned under Type tests clause shall be submitted along with offer.

4.3.21.4.2 Certified reports of all the tests carried out at the works shall be furnished in three (3) copies for approval of the Owner.

5.0 **MAIN L.T. PANEL**

5.1 **GENERAL**

This specification of Main L.T. Panel shall be applicable for Main L.T. Panel (Normal Supply) and Main L.T. Panel (Essential Supply) of all Substations.

Main L.T. Panel shall be indoor type, metal clad, floor mounted, free standing, totally enclosed, extensible type, air insulated, cubicle type for use on 415 Volts, 3 phase, 50 cycles system with a fault level withstand of 50 KA RMS symmetrical. Main L.T. Panel (Essential Supply) shall be provided with PLC for load management. PLC shall check load on various bus section. PLC shall also give command to Main L.T. Panel (Essential Supply) incomer breakers to open and closed and also for buscoupler switching. PLC shall also provide interlocking of incomer breakers and buscoupler. PLC shall provide signal to AMF Panel for load status and AMF shall give command to DG Sets to auto start / auto stop depending upon load status and requirement. All hardware and software required to ensure above operation of Main L.T. Panel (Essential Supply) shall deemed to be included in the cost, wether these items are listed out or not in the BOQ item.

5.2 **STANDARDS**

The equipment shall be designed to conform to the requirements of :

i. IS : 8623- Factory Built Assemblies of switchgear and controlgear.

ii. IS : 4237- General requirements for switchgear and control gear for voltages not exceeding 1000 volts.

iii. IS : 2147- Degree of protection provided by enclosures for low voltage switchgear and controlgear.

iv. IS : 375- Marking and arrangement of busbars.

Individual equipment housed in the Main L.T. Panels shall conform to the following IS Specification.

i. Air Circuit Breakers/ Moulded Case Circuit Breaker - IS: 13947 (Part-II) & IEC 947 (2).

ii. Fuse switch and switch fuse units - IS: 13947 (Part-3) & IEC 947 (3).

iii. HRC fuse links - IS: 13703

iv. Current Transformers - IS: 2705

v. Voltage Transformers - IS: 3156

vi. Indicating Instruments - IS: 1248

vii. Integrating Instruments - IS: 722
viii. Control Switches & Push Buttons  -  IS: 6875
ix. Auxiliary Contactors  -   IS: 13947 (Part-4/Sec.-I) & IEC 947 (4/1)
x. Relays  -  IS: 3231

5.3 CONSTRUCTION

Main L.T. Panels shall be:-

i. Of metal enclosed, indoor, floor mounted, free standing construction, extensible type.

ii. Made up of the requisite vertical sections, which when coupled together shall form continuous dead front switchboards.

iii. Provide dust and damp protection, the degree of protection being not less than IP 54 to IS : 2147.

iv. Be readily extensible on both sides by the addition of vertical sections after removal of the end covers.

Main L.T. Panel shall be constructed only of materials capable of withstanding the mechanical, electrical and thermal stresses, as the effects of humidity, which are likely to be encountered in normal service.

Each vertical section shall comprise of :

i. A front-framed structure of rolled/folded sheet steel channel section, of minimum 2mm thickness, rigidly bolted together. This structure shall house the components contributing to the major weight of the equipment, such as circuit breaker cassettes, fuse switch units, and main horizontal busbars, vertical risers and other front mounted accessories.

The structure shall be mounted on a rigid base frame of folded sheet steel of minimum 2 mm thickness and 100 mm height or MS channel of 100mm x 50mm x 5mm thick. The design shall ensure that the weight of the components is adequately supported without deformation or loss of alignment during transit or during operation.

ii. A rear cable chamber housing the cable end connections, and power/control cable terminations. The design shall ensure generous availability of space for ease of installation and maintenance of cabling, and adequate safety for working in one vertical section without coming into accidental contact with live parts in an adjacent section.

iii. A cover plate at the top of the vertical section, provided with a ventilating hood where necessary. Any aperture for ventilation shall be covered with a perforated sheet having less than 1 mm diameter perforations to prevent entry of vermin.

iv. Front and rear doors fitted with dust excluding neoprene gaskets with fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors, generous overlap shall be assured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust.

v. All doors shall be lockable mounted lock.

vi. Gland plate shall be 3mm thick.

The height of the panels should not be more than 2400 mm. The total depth of the panel should be adequate to cater to proper cabling space and should not be less than 1350mm. Operating handle not higher than 1800mm and not lower than 350mm.

Doors and covers shall be of minimum 2mm thick sheet steel. Sheet steel shrouds and partitions shall be of minimum 2mm thickness. All sheet panels shall be smoothly finished, levelled and free from flaws. The corners should be rounded.

The apparatus and circuits in the power control centres shall be so arranged as to facilitate their operation and maintenance and at the same time to ensure the necessary degree of safety.
Apparatus forming part of the Main L.T. Panel shall have the following minimum clearances.

i. Between phases - 32mm
ii. Between phases and neutral - 26mm
iii. Between phases and earth - 26mm
iv. Between neutral and earth - 26mm

When, for any reason, the above clearances are not available, suitable insulation shall be provided. Clearances shall be maintained during normal service conditions.

Creepage distances shall comply to those specified in relevant standards.

All insulating material used in the construction of the equipment shall be of non-hygroscopic material, duly treated to withstand the effects of the high humidity, high temperature tropical ambient service conditions.

Functional units such as circuit breakers and fuse switches shall be arranged in multi-tier formation, except that not more than two air circuit breakers shall be housed in a single vertical section. Cable entry for various feeders shall be from the rear. Panel shall be suitable for termination of busduct for incoming breakers.

Metallic perforated barriers shall be provided within vertical sections and between adjacent sections to ensure prevention of accidental contact with:

i. Main busbars and vertical risers during operation, inspection or maintenance of functional units and front mounted accessories.
ii. Cable termination of one functional unit, when working on those of adjacent unit/units.

All doors/covers providing access to live power equipment/ circuits shall be provided with tool operated fasteners to prevent unauthorised access.

Provision shall also be made for permanently earthing the frames and other metal parts of the switchgear by two independent connections.

5.4 METAL TREATMENT & FINISH

All steel work used in the construction of the Electrical cubicle panels should have undergone a rigorous metal treatment process as follows:

i. Effective cleaning by hot alkaline degreasing solution followed by cold water rinsing to remove traces of alkaline solution.
ii. Pickling in dilute sulphuric acid to remove oxide scales & rust formation, if any, followed by cold water rinsing to remove traces of acidic solution.
iii. A recognised phosphating process to facilitate durable coating of the paint on the metal surfaces and also to prevent the spread of rusting in the event of the paint film being mechanically damaged. This again, shall be followed by hot water rinsing to remove traces of phosphate solution.
iv. Passivating in de-oxalite solution to retain and augment the effects of phosphating.
v. Drying with compressed air in a dust free atmosphere.

5.5 BUSBARS

The busbars shall be air insulated and made of high conductivity, high strength aluminium alloy complying with the requirement of grade E-9IE of IS-5082.
The busbars shall be suitable braced with non-hygroscopic SMC supports to provide a through fault withstand capacity of 50KA RMS symmetrical for one second and a peak short circuit withstand capacity of 105KA. The neutral as well as the earth bar should be capable of withstanding the above level. Ridges shall be provided on the SMC supports to prevent tracking between adjacent busbars. Large clearances and creepage distances shall be provided on the busbar system to minimize possibilities of fault.

The Main L.T. Panel shall be designed that the cables are not directly terminated on the terminals of breaker/switch fuse/fuse switch etc. but on cable termination links. Capacity of aluminium busbars shall be considered as 0.8Amp/sq.mm of cross section area of the busbar. The main busbars shall have continuous current rating throughout the length of L.T. Panel. The cross section of neutral busbars shall be same as that of phase busbar for busbars of capacity upto 200Amp; for higher capacity the neutral busbar shall not be less than half (50%) the cross section of that the phase busbars. The busbar system shall consist of main horizontal busbar and auxiliary vertical busbars run in busbar alley/chamber on either side in which the circuit could be arranged/connected with front access.

Connections from the main busbars to functional circuit shall be arranged and supported to withstand without any damage or deformation the thermal and dynamic stresses due to short circuit currents. Busbars to be colour coded with PVC sleeves.

5.6 MEDIUM VOLTAGE AIR CIRCUIT BREAKERS

5.6.1 GENERAL

Air circuit breakers shall be incorporated in Main L.T. Panel wherever specified. ACBs shall conform to IS : 13947 (Part-II) & IEC 60947-2 and their latest amendments and should be type tested and certified for compliance to Indian standards from CPRI / ERDA. Manufacturer shall submit test report for combined sequence tests from CPRI / ERDA. The breaker shall be suitable for isolation and shall be clearly indicated on frontfacia. ACBs shall be suitable for operation on 415 volts, 3 phase, 50Hz, AC supply. Rated insulation voltage (U1 : 1000 volts AC)

5.6.2 TYPE AND CONSTRUCTION

Air Circuit Breakers shall be of enclosed pattern, dead front type with ‘trip free’ operating mechanism. Air Circuit Breakers shall be of fixed type or withdrawable type with horizontal drawout carriage. The ACBs shall be strong and robust in construction with suitable arrangements for anchoring when in fully engaged or fully drawout positions. The carriage or cradle on which the breaker is mounted shall be robust design made of fabricated steel, supported on rollers. Cradle shall also comprise of main and secondary separable contacts and all drawout mechanism in a completely fig welded assembly. There shall be no dependence upon the switchboard frame for any critical alignment. The withdrawal arrangement shall be such as to allow smooth and easy movement.

All the current carrying parts of the circuit breakers shall be silver plated, suitable arcing contacts shall be provided to protect the main contacts. The contacts shall be of spring-loaded design. The sequence of operation of the contacts shall be such that arcing contacts ‘make before’ and break after’ the main contacts. Arcing contacts shall be provided with efficient arc chutes on each pole and these shall be such suitable for being lifted out for inspection of main as well as arcing contacts. The contact tips and arc chutes shall be suitable for ready replacement. Self-aligning isolating contacts shall be provided. The design of the breaker shall be such that all the components are easily accessible to inspection, maintenance and replacement. Interphase barriers shall be provided to prevent flashover between phases.

5.6.3 OPERATING MECHANISM

Air Circuit breaker shall be provided with a quick-make, trip free operating mechanism, the operating mechanism shall be ‘strain-free’ spring operated. The operating handle shall be in front of the panel type. The design shall be such that the circuit breaker compartment door need not be opened while moving the breaker from completely connected, through test, into the disconnected position. Manually operated circuits breakers shall be provided with spring operated closing mechanism, which shall be independent of speed of manual operation. Electrical operated breakers shall have a motor wound spring charged closing mechanism. Breaker operation shall be
independent of the motor, which shall be used solely for charging the closing spring. The operating
mechanism shall be such that the breaker is at all times free to open immediately the trip coil is
energised. Mechanical operation indicator shall be provided to show open and closed position of
breaker. Electrically operated breakers shall be additionally provided with mechanical indication to
show charged and discharged condition of charging spring.
Means shall be provided for slow closing and opening of the breaker for maintenance purposes and
for manual charging and closing of electrically operating breakers during emergencies.

5.6.4 INTERLOCKING AND SAFETY ARRANGEMENT
Air Circuit Breakers shall be provided the following safety and interlocking arrangements:
i. It shall not be possible for breaker to be withdrawn when in “ON” position.
ii. It shall not be possible for the breaker to be switched on until it is either in fully inserted
    position or for testing purposes it is in fully isolated position.
iii. The breaker shall be capable of being racked into ‘testing’ ‘isolated’ and maintenance
    positions and kept locked in any of these positions.
iv. A safety catch to ensure that the movement of the breaker, as it is withdrawn is checked
    before it is completely out of the cubicle.
v. The operating mechanism shall provide for racking the breaker into connected, test and
disconnected positions without operating compartment door. When cubicle door shall be
open position, the breaker can be pulled out to a fourth position, maintenance, where free
access shall be possible to all parts of the breaker.

5.6.5 RATING
The rating of the circuit breaker shall be as per the drawings and schedule of quantities. The
rated/breaking capacity of the breakers shall be 50KA or higher for one (1) second at 415 volts. The
rated making capacity shall be as per the relevant standard. ACBs shall have Ics = Icu = Icw for one
second for short circuit capacity of not less than 50KA rms at 415 volt 50Hz etc.

5.6.6 ACCESSORIES
The incoming breaker shall be equipped with microprocessor release and the outgoing breaker shall
be equipped with thermal magnetic or microprocessor releases to provide over current protection
and short circuit protection. In addition to over current, earth fault release shall also be provided
with the breaker. A multi tap current transformer shall be provided. The buscoupler breaker shall
be provided without protection releases. The incoming & outgoing breaker shall be fitted with
following accessories for control, signal and interlocking.
i. Earth fault release.
ii. Auxillary contacts 6 NO + 6 NC, rated at 16Amp 415 volts 50Hz.
iii. Under voltage release with built in time delay of 3 ± 1 Sec. pickup at 80% & drop off from
    35% to 65% (to be provided in incomer breaker of Transformers & DG).
iv. Shunt release for tripping the breaker remotely and shall be suitable for 240volt/ 415-volt
    50Hz with range of operation from 10% to 130% of rated voltage.
v. Micro switch kit for separate indication of overload and short circuit.
vi. Micro switches shall be mounted on the cradle of drawout breaker to indicate the position of
    the breaker on the cradle.
a. Kit for test/isolated indication.
b. Kit for service position indication.
c. Kit for shutter assembly.
vii. Accessories for following interlocking schemes shall be provided.
a. Accessory kit for locking the breaker in isolated position. This kit is useful for interlocking scheme as well as keeping personal and equipment safe.

b. Door interlock kit: Panel or cubicle door cannot be opened with the ACB in Test or Service position.

c. Lockable trip push button.

5.6.7 MOUNTING
Circuit Breakers shall be mounted as per manufacturer’s standard practice.

5.6.8 TESTING
Testing of circuit breaker for routine & type tests shall be as per relevant IS Code. Test Certificates shall be submitted.

5.7 MOULDED CASE CIRCUIT BREAKERS
5.7.1 GENERAL
Moulded Case Circuit Breakers shall be incorporated in Electrical Panels wherever specified. MCCB’s shall conform to IS 13947-2 and/or IEC 60947-2 and shall have test certificate for breaking capacities from independent test authorities CRPI / ERDA. MCCB’s shall be suitable either for single phase AC 230 volts or three phase 415 volts. MCCB shall be with thermal magnetic release type. All MCCB of 250Amp and above rating shall have microprocessor release. Rated service breaking capacity should be equal to rated ultimate breaking capacity (Ics = Icu)

5.7.2 FRAME SIZES
The MCCB’s shall have the following frame sizes subject to meeting the fault level specified elsewhere.

i) Up to 100A rating ............ 100Amp frame.
ii) Above 100A to 200A ............ 200Amp frame.
iii) Above 200A to 250A ............ 250Amp frame.
iv) Above 250A to 400A ............ 400Amp frame.
v) Above 400A to 630A ............ 630Amp frame.

5.7.3 CONSTRUCTIONS
5.7.3.1 The MCCB cover and case shall be made of high strength heat treatment and flame retardant thermo-setting insulating material. Operating handle shall be of rotary type quick make/quick break, trip-free type. The operating handle for simultaneous operation and tripping of all the three phases.

5.7.3.2.1 Suitable fire extinguishing device shall be provided for each contact. Tripping unit shall be of thermomagnetic type provided in each pole and connected by a common trip bar such that tripping of any one pole operates all three poles to open simultaneously. MCCB shall be current limiting type with trip time of less than 10 millisecond under short circuit condition. MCCB shall be either 3 or 4 Poles as specified in BOQ. MCCB shall be line load reversible type. MCCB’s shall be site adjustable thermal release (80% to 100%) of rated current. Device shall have IDMT characteristics for sustained overload and short circuits. MCCB shall be current limiting type MCCB shall be provided with rotary handle.

5.7.3.3 Contacts trips shall be made of suitable are resistant, silver alloy for long electrical life. Terminals shall be of liberal design with adequate clearance.

5.7.4 RUPTURING CAPACITY
The Moulded Case Circuit Breaker shall have a service breaking capacity (Ics) of not less than 50KA RMS at 415 volts for Main L.T. Panels. MCCB for Sub Distribution Boards shall have service breaking capacity (Ics) of not less than 25 KA RMS at 415 Volts. Short circuit with stand capacity (Service breaking capacity) specified shall be for one second.

5.7.5 TESTING
Test certificate of the MCCB as per relevant Indian Standards (IS) shall be furnished.
5.8 **POWER CONTACTORS:**

5.8.1 The contactors shall comply with the requirements of IEC 60947-4-1 / IS 13947 – Part 4-1. Contactors for motor application should be of 3 Pole AC3 duty as specified in standards.

5.8.2 Main contacts of contactors shall be silver plated copper. Coil insulation should be of class H to withstand the higher temperature rise. Spare contact kits and spare coils replacement should be possible for the entire range for maintenance. The maintenance of contactors and replacement of spare kits should be possible with disturbing busbar / cable termination.

5.8.3 The contactor should be having front and rear parts are in thermoplastics for rugged construction. The contactor should confirm to glow wire tests as per IEC 60695-2-1 with superior quality of engineering grade plastic used for insulation purpose. Complete range should be suitable for AL termination.

5.8.4 Contactors should have the possibility of having finger proof structure safety feature.

5.9 **THERMAL OVERLOAD RELAY:**

5.9.1 Thermal Overload Relay used in the circuit with contactor shall be in conformity with IS : 842 part 2-1966 and it shall withstand insulation test to IS: 12083 part 2. The relay shall be provided with adjustable current settings and with a provision of sealing the same to make it tamper proof.

5.9.2 The relay shall have built in single phasing protection and over load protection as per IEC 947-part 4. The relay shall have in built NO & NC contact. The thermal over load relay shall be suitable for Copper / Aluminium termination, with a maximum permissible temperature rise of 65°C, at the terminals, with maximum ambient temperature of 45°C.

5.10 **MEASURING INSTRUMENTS, METERING & PROTECTION**

5.10.1 **GENERAL**

Direct reading electrical instruments shall be in conformity with IS 1248. The accuracy of direct reading shall be 1.0 for voltmeter and 1.0 for ammeters. Other type of instruments shall have accuracy of 1.5. The errors due to variations in temperature shall be limited to a minimum. The meter shall be suitable for continuous operation between-10 degree Centigrade to + 50 degree Centigrade. All meters shall be of flush mounting type of 96mm square or circular pattern. The meter shall be enclosed in a dust tight housing. The housing shall be of steel or phenolic mould. The design and manufacture of the meters shall ensure the prevention of fogging of instruments glass.

Instruments meters shall be sealed in such a way that access to the measuring element and to the accessories within the case shall not be possible without removal of the seal.

Suitable selector switches shall be provided for all ammeters and voltmeters intended to be used on three phase supply.

The specifications herein after laid down shall also cover all the meters, instrument and protective devices required for the electrical work. The ratings type and quantity of meters, instruments and protective devices shall be as per the schedule of quantities.

5.10.2 **AMMETERS**

Ammeters shall be digital type 7 segment LED display. Ammeter shall be suitable for accuracy class 1.0 and burden 0.5 VA approx. The ammeters shall be capable of carrying sustained overloads during fault conditions without damage or loss of accuracy.

5.10.3 **VOLTMETERS**

Voltmeter shall be digital type 7 segment LED display. Voltmeter shall be suitable for accuracy class 1.0 and burden 0.5 VA approx. The range for 3 phase voltmeters shall be 0 to 500 volts. The voltmeter shall be provided with protection fuse of suitable capacity.

5.10.4 **CURRENT TRANSFORMERS**

Current transformers shall be in conformity with IS: 2705 (Part I,II & III) in all respects. All current transformers used for medium voltage applications shall be rated for 1kv. Current transformers shall have rated primary current, rated burden and class of accuracy as required.
However, the rated secondary current shall be 5A unless otherwise specified. The acceptable minimum class of various applications shall be as given below:

**Measuring** : Class 0.5 to 1.

**Protection** : Class 5P10.

Current transformers shall be capable of withstanding without damage, magnetic and thermal stresses due to short circuit fault of 50KA on medium voltage system. Terminals of the current transformers shall be marked permanently for easy identification of poles. Separate CT shall be provided for measuring instruments and protection relays. Each C.T. shall be provided with rating plate.

Current transformers shall be mounted such that they are easily accessible for inspection, maintenance and replacement. The wiring for CT’s shall be copper conductor, PVC insulated wires with proper termination lugs and wiring shall be bunched with cable straps and fixed to the panel structure in a neat manner.

### 5.11 MISCELLANEOUS

Control switches shall be of the heavy-duty rotary type with escutcheon plates clearly marked to show the operating position. They shall be semi-flush mounting with only the front plate and operating handle projecting. Indicating lamps shall be of the filament type of low watt consumption, provided with series resistor where necessary, and with translucent lamps covers, bulbs & lenses shall be easily replaced from the front.

Push buttons shall be of the momentary contact, push to actuate type fitted with self-reset contacts & provided with integral escutcheon plates marked with its functions.

### 5.12 BATTERY & BATTERY CHARGER

A set of 24V DC power supply shall be provided for indication, relay operation etc. for Main L.T. Panel (Essential Supply). DC Power supply shall be sealed maintenance free batteries of 65 AH capacity. Suitable battery chargers shall also be provided to charge the battery to perform during mains failure. One set of 24V, 360 AH automotive battery with battery charger shall be provided for each DG Set & one set of 24V, 65AH SMF battery with battery charger for PLC.

### 5.13 CABLE TERMINATIONS

Cable entries and terminals shall be provided in the Main L.T. Panel to suit the number; type and size of aluminium conductor power cables and copper conductor control cable specified.

Provision shall be made for top or bottom entry of cables as required. Generous size of cabling chambers shall be provided, with the position of cable gland and terminals such that cables can be easily and safely terminated.

Barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of another live circuit.

Cable risers shall be adequately supported to withstand the effects of rated short circuit currents without damage and without causing secondary faults.

### 5.14 LABELS

Labels shall be anodised aluminium with white engraving on black background shall be provided for each incoming and outgoing feeder of L.T. Panels.

### 5.15 TEST AT MANUFACTURES WORK

All routine tests specified in IS: 8623-1977 shall be carried out and test certificates produced to the Department.

### 5.15.1 TESTING AND COMMISSIONING

Commissioning checks and tests shall be included all wiring checks and checking up of connections. Primary/secondary injection tests for the relays adjustment/ setting shall be done before commissioning in addition to routine meggar test. Checks and tests shall include the following.

a) Operation checks and lubrication of all moving parts.
b) Interlocking function check.

c) **Insulation test:** When measured with 500V meggar, the insulation resistance shall not be less than 100 mega ohms.

d) Trip tests & protection gear test.

5.16 **LOAD MANAGEMENT WITH PLC**

Load Management through Micro PLC to achieve auto opening and closing of incomer breakers, buscoupler switching, interlocking providing signal to AMF Panel for load status and AMF shall give command to DG Set to auto start / auto stop depending upon load status and requirement etc. and necessary hardware and software required to perform the operation shall be provided by the contractor including all control wiring and rates for the same shall deemed to be included in the quoted rate of the panel.

6.0 **CAPACITOR BANK & PANEL**

6.1 **GENERAL**

This specification covers requirements of Medium Voltage Capacitors and Control Panel to be used for power factor improvement of the electrical system and shall be a part of Main L.T. Panels. Automatic Power Factor Correction Panel shall function to improve power factor of the system in which it is connected. It shall improve power factor upto 0.99 from initial power factor of 0.70. Capacitor Panel shall have 10-15% of capacitor bank directly connected to ensure power factor remains within prescribed limit during low load demand period and / or night period.

6.2 **CODES AND STANDARDS**

The design, manufacture and performance of power capacitors and accessories shall comply with all currently applicable statutes, regulations and safety codes for power installation as prescribed in relevant IS codes and to requirement of Local Electricity Supply Authority to which the equipment shall be installed.

Unless otherwise specified the capacitor and control panel shall conform to following.

a. IS : 2834 - Shunt capacitors for power systems.

b. IS : 2147 - Degree of protection provided by enclosures for low voltage switchgear and controlgear.

c. IS : 4237 - General requirements for switchgear and controlgear for voltages not exceeding 1000V.

d. IS : 8623 - Specification for factory built assemblies of switchgear and controlgear (Upto 1000 volts).

e. IS : 2208 - HRC cartridge fuse links upto 650 volts.

f. IS : 4064 - Specification for Fuse Switch & Switch Fuse switchgear and controlgear.

g. IS : 2959 - AC contactors for voltage not exceeding 1000 volts.

6.3 **CONSTRUCTIONAL FEATURE**

a) Capacitor bank shall be suitable for operation on 415 volts 3 phase, 4 wire, 50c/s, solidly earthed AC supply system. The capacitor shall be connected to the 415 V Switchgear bus and shall be manually as well as automatically switched in and out in steps so as to correct the power factor to be required value depending on the actual KVAR requirement of bus.

b) The capacitor bank shall be complete with the required capacitor units with the supporting post insulators, sheet steel cubicles, busbars, connecting strips, foundation channels, fuses, corrosion proof
rating plate etc. Capacitor shall be MPP type. Reactor shall be provided to counter for presence of harmonics in the system.

c) Each basic unit is to be built up with a number of elements. These elements should be wounded with high grade metallised poly propylene film. These metallised film capacitors should be self healing, having very low loss factor. Capacitor element to be completely sealed with epoxy resins to provide maximum humidity protection and highest insulation. The capacitor elements are to be given adequate outside insulation and should be put in all welded surface treated MS containers. These capacitors shall be impregnated with special grade of capacitor oil under high vacuum. The metal case shall be equipped with porcelain bushings to permit connection between power lines and active capacitors.

i. Externally each capacitor unit shall have two separate earthing points, name plate conforming to the requirements of IS-2834 (amended upto date), discharge resistances etc.

d) The capacitor bank may comprise suitable number of single phase self cooled hermetically sealed units in series parallel combination to achieve required KVAR rating. However, failure of one unit shall not create over voltage on other units connected in parallel to avoid failure of parallel units.

e) Each capacitor unit/bank shall be provided with directly connected continuously rated, low loss discharge device built into the unit to reduce the residual voltage to a safe value within the specified time as recommended in the relevant standard after the capacitor has been disconnected from the supply.

f) All capacitor shall be suitably protected against over current by means of suitable over current protection (other than fuses) which is adjusted to interrupt the circuit when the current exceeds the safe permissible limit. Capacitor units shall also be protected against the internal faults and the effected units/banks shall be automatically and immediately isolated in the event of such fault.

g) Each capacitor unit shall continuously operate at the following overload conditions separately.

i. Over voltage upto 10% of the rated RMS voltage.

ii. Over current upto 15% of the rated current.

iii. Maximum reactive output upto 30% over the rated reactive output.

h) Each capacitor unit shall be individually protected by HRC fuses with visual indication for operation.

6.4 CAPACITOR CONTROL PANEL

a) The control panel shall be indoor, cubicle type, floor mounted, dust and vermin proof conforming to degree of protection IP-54 excepting the enclosure enclosing capacitor bank which shall be of protection class IP-41.

b) Cubicle shall comprise rigid structural frame enclosed by 2mm thick cold rolled sheet steel, doors and covers shall also be from 2.0mm thick cold rolled sheet steel. Structural framework with foundation bolts etc. shall be provided at the bottom to mount control panel directly on concrete/floor/steel channel base. Fabrication metal treatment and painting of Capacitor Panel shall be as specified in clause 5.3 and 5.4 of this specification.

c) All doors, removable covers shall be gasketed all around preferably with neoprene gaskets.

d) The capacitors control panel shall, in general, comprise of the following and shall be housed in well ventilated panels. Capacitors and their control elements may be installed in different compartments of the same panel to minimize space requirement.

i. Microprocessor based power factor correction relay.

ii. Time delay and No-volt relays.

iii. Protection fuses.

iv. Capacitor duty contactors for individual capacitor bank.
v. Change over switch for either automatic operation or manual operation with Push button control.

vi. Visual indications for capacitor IN-OUT.

c) Switches shall be triple pole, air break AC-23 duty. The switch shall have a quick make, quick break mechanism operated by a suitable external handle complete with position indicator.

d) The Compartment door shall be interlocked mechanically with the switch so that the door cannot be opened unless the switch is in OFF position. Means shall be provided to releasing this interlock at any time.

e) Fuses shall be HRC, preferably link type, with a minimum interrupting capacity equal to the listed short circuit current. Fuses shall be complete with fuse base and fitting of such design as to permit easy and safe replacement of fuse element. Visible indication shall be provided on blowing of the fuse.

f) The Contactors shall be three pole, air break type designed for capacitor duty with non bouncing silver/silver alloy contacts. Each Contactor shall be provided with 2 NC & 2 NO auxiliary lamps contacts rated at 10 Amp. Indicating lamps shall be LED type. Lamp and lens shall be replaceable from front.

i) The main buses and connection shall be of high conductivity aluminium/aluminium alloy, sized for specified current ratings shall be limited to 105 degree centigrade and 100 degree centigrade for silver plated copper joints and aluminium joints respectively.

j) For all bus connections adequate contact pressure shall be ensured by means of two bolt connection with plain and spring washers and locknuts.

k) Busbars and connections shall be fully insulated for working voltage with adequate phase/ground clearance. Insulating colour coded PVC sleeves for busbars and shrouds for joints shall be provided. Shrouds for busbar and for joints shall be provided. Shrouds for busbar joints and tapping points shall be of two part epoxy resin cast/fibre glass moulded. Minimum clearance of 32mm is required between phases and 26mm between phase and earth irrespective of sleeve/shrouds provided for busbar. Insulating shrouds shall be of moulded type.

i. Bus supports shall be non-hygroscopic type epoxy SMC with high creepage surface.

l) All buses and connections shall be supported and braced to withstand the stresses due to maximum short-circuit current and also to take care of any thermal expansion.

m) Busbars shall be colour coded for easy identification and so located that the sequence R-Y-B shall be from left to right, top to bottom or front to rear, when viewed from the front to panel assembly.

n) The horizontal busbar chamber shall be separate and totally enclosed.

o) Gland shall be minimum 3mm thick.

p) Screws of corrosion resistant material shall be furnished on all ventilating louvers to prevent the entry of insects.

q) All internal wiring inside the cubicle shall be carried out with 650 V grade, PVC insulated copper wires duly ferruled at either end. The power wiring above 100A shall be carried out with PVC insulated aluminium links.

r) Separate labels shall be provided for relay, instruments, switch, indicating lamp etc. Approval for the type of label shall be taken from the Engineer-in-charge.

s) Metal treatment, finish and painting shall be done as per the specification Para Ref. 5.4 of this tender.

t) Automatic control relay with necessary taps shall be provided.

6.5 TESTS
(a) Routine tests shall be carried out on assembled capacitors and control panel as per relevant Indian Standards.

(b) Type tests reports for similar capacitor units shall be submitted.

(c) Three (3) copies of type test and routine test certificates shall be submitted for Engineer-in-Charge approval before despatch of capacitor and control panel.

6.6 **INSPECTION**

(a) Visual inspection including witnessing routine tests shall be carried out by Engineer-in-Charge or his authorised representative.

(b) Contractor shall notify Engineer-in-Charge or his authorised representatives in writing at least fifteen (15) days prior to Contractor’s scheduled inspection test.

6.7 **DRAWINGS AND INSTRUCTIONS MANUALS**

(A). Contractor shall submit four copies of the following certified drawings after award of contract.

   a. General arrangement of capacitor bank and control panel indicating main dimensions, type of mounting, locations of various devices etc. as foundation details.

   b. Schematic diagram for automatic sequential switching with terminals and ferrules numbers.

   c. Wiring diagram of control panel indicating terminal blocks and various apparatus.

   d. Final list of components of control panel.

(B). Contractor shall submit four (4) copies of installation and maintenance manual.

(C). One print of each drawing shall be returned to Contractor after making all necessary corrections, changes and required specification. Contractor shall incorporate these and send within fifteen days five (5) prints of these each drawing shall be marked certified for record and use.

7.0 **MAIN / SUB DISTRIBUTION BOARDS.**

7.1 **GENERAL**

MDB / SDB & Meter Board shall be metal clad totally enclosed, rigid, floor mounting, air insulated, compartmentalized cubicle type Panel Board for use on 415 volts, three phases, 50 cycle system. Equipment shall be designed for operation in high ambient temperature and high humidity tropical atmospheric conditions.

7.2 **STANDARDS**

The equipment shall be designed to conform to the requirements of:

   a) IS 8623 - Factory Built Assemblies of switchgear and controlgear.

   b) IS 4237 - General requirements for switchgear and controlgear for voltage not exceeding 1000 volts.

   c) IS 2147-Degrees of protection provided by enclosures for low voltage switchgear and controlgear.

   d) IS 375 - Marking and arrangement of busbars.

7.2.1 Individual equipment housed in the MDB / SDB & Meter Boards shall conform to the following IS specifications:


   b) Current Transformers - IS : 2705.

   c) Indicating Instruments - IS : 1248.

   d) Integrating Instruments - IS : 722.
CONSTRUCTIONS

7.3.1 MAIN / SUB DISTRIBUTION BOARD

Main / Sub Distribution Boards shall be constructed only of materials capable of withstanding the mechanical, electrical and thermal stresses, as the effects of humidity, which are likely to be encountered in normal service.

Each vertical section shall comprise of:

a) A front framed structure of rolled/folded sheet steel channel section, of minimum 2mm thickness, rigidly bolted together. This structure shall house the components contributing to the major weight of the equipment, such as circuit breaker cassettes, fuse switch units, main horizontal busbars, vertical risers and other front mounted accessories.

b) The structure shall be mounted on a rigid base frame of folded sheet steel of minimum 2mm thickness and 100 mm height or 100 mm x 50mm x 5mm thick MS Channel. The design shall ensure that the weight of the components is adequately supported without deformation or loss of alignment during transit or during operation.

c) A side cable chamber in Main / Sub Distribution Boards for housing the cable end connections, and power/ control cable terminations. The design shall ensure generous availability of space for ease of installation and maintenance of cabling, and adequate safety for working in one vertical section without coming into accidental contact with live parts in an adjacent section.

d) A cover plate at the top of the vertical section, provided with a ventilating hood where necessary. Any aperture for ventilation shall be covered with a perforated sheet having less than 1 mm diameter perforations to prevent entry of vermin.

e) Front and rear doors fitted with dust excluding neoprene gaskets with fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors, generous overlap shall be assured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust.

f) All doors shall be lockable mounted lock.

g) Gland plate shall be 3mm thick.

7.3.2 The height of the Main / Sub Distribution Boards should not be more than 2000mm. The total depth of the panel should be adequate to cater to proper cabling space and should not be less than 400mm. Operating handle not higher than 1800mm and not lower than 300mm from bottom of MDB / SDB / Meter Board.

7.3.3 Doors and covers shall be of minimum 2mm thick sheet steel. Sheet steel shrouds and partitions shall be of minimum 2mm thickness. All sheet panels shall be smoothly finished, levelled and free from flaws. The corners should be rounded.

7.3.4 The apparatus and circuits in the panel board shall be so arranged as to facilitate their operation and maintenance and at the same time to ensure the necessary degree of safety.

7.3.5 Apparatus forming part of the Main / Sub Distribution Boards & Meter Boards shall have the following minimum clearances.

i. Between phases - 32mm.
ii. Between phases and neutral - 26mm.
iii. Between phases and earth - 26mm.
iv. Between neutral and earth - 26mm.

7.3.6 When, for any reason, the above clearances are not available, suitable insulation shall be provided. Clearances shall be maintained during normal service conditions.

7.3.7 Creepage distances shall comply to those specified in relevant standards.
7.3.8 All insulating material used in the construction of the equipment shall be of non-hygroscopic material, duly treated to withstand the effects of the high humidity, high temperature tropical ambient service conditions.

7.3.9 Functional units such as circuit breakers and fuse switches shall be arranged in multi-tier formation, except that not more than two air circuit breakers shall be housed in a single vertical section. Cable entry for various feeders shall be from the rear / front. Panel board shall be suitable for termination of cable for incoming breakers.

7.3.10 Metallic/perforated barriers shall be provided within vertical sections and between adjacent sections to ensure prevention of accidental contact with:
   i. Main busbars and vertical risers during operation, inspection or maintenance of functional units and front mounted accessories.
   ii. Cable termination of one functional unit, when working on those of adjacent unit/units.

All doors/covers providing access to live power equipment/ circuits shall be provided with tool operated fasteners to prevent unauthorized access.

Provision shall also be made for permanently earthing the frames and other metal parts of the switchgear by two independent connections.

7.4 METAL TREATMENT AND FINISH.

All metal work used in the construction of the MDB / SDB & Meter Boards should have undergone a rigorous metal treatment process as follows.

   i. Effective cleaning by hot alkaline degreasing solution followed by cold water rinsing to remove traces of alkaline solution.

   ii. Picking in dilute sulphuric acid to remove oxide scales & rust formation, if any, followed by cold water rinsing to remove traces of acidic solution.

   iii. A recognised phosphating process to facilitate durable coating of the paint on the metal surfaces and also to prevent the spread of rusting in the event of the paint film being mechanically damaged. This again, shall be followed by hot water rinsing to remove traces of phosphate solution.

   iv. Passivating in de-oxalite solution to retain and augment the effects of phosphating.

   v. Drying with compressed air in a dust free atmosphere.

   vi. A finishing coat of powder coating of Siemens grey colour.

7.5 BUSBARS

7.5.1 The busbars shall be air insulated and made of high conductivity, high strength Aluminium complying with the requirement of grade 63401 WP.

7.5.2 The busbars shall be suitably braced with non-hygroscopic SMC supports to provide a through fault withstand capacity of maximum 50KA RMS symmetrical for one second and a peak short circuit withstand capacity of 105 KA.

7.5.3 The neutral as well as the earth bar should be capable of with standing the above level. Ridges shall be provided on the SMC supports to prevent tracking between adjacent busbars. Large clearances and creepage distance shall be provided on the busbar system to minimize the possibility of fault. The main phase busbars shall have continues current rating throughout the length of the Panel. The cross section of neutral busbars shall be same as that of the phase busbar for busbars of capacity upto 200 Amp; for higher capacities, the neutral busbar shall not be less than half (50%) the cross section of that of the phase busbars. Connections from the main busbars to functional circuits shall be so arranged and supported to withstand without any damage or deformation the thermal and dynamic stresses due to short circuit currents. Busbars shall be colour coded with PVC heat shrinkable sleeves. All connectors of bus bars to busbars & outgoing termination arrangement is to be in Stainless steel non magnetic grade nut & bolts.

7.5.4 Capacity of aluminium busbars shall be considered as 0.8 Amp per sq.mm of cross section area of the busbars.
7.6 MOULDED CASE CIRCUIT BREAKERS

7.6.1 GENERAL
Moulded Case Circuit Breakers shall be incorporated in MDB / SDB & Meter Boards wherever specified. MCCB’s shall conform to IS 13947-2 and/or IEC 947-2 in all respects. MCCB’s shall be suitable either for single phase AC 230 volts or three phase 415 volts. MCCB shall be with thermo magnetic release type. All MCCB of 250Amp and above rating shall have microprocessor released.

7.6.2 FRAME SIZES
The MCCB’s shall have the following frame sizes subject to meeting the fault level specified elsewhere.

i) Up to 100Amp rating .......... 100Amp frame.
ii) Above 100Amp to 200Amp .......... 200Amp frame.
iii) Above 200Amp to 250Amp .......... 250Amp frame.
iv) Above 250Amp to 400Amp .......... 400Amp frame.
v) Above 400Amp to 630Amp .......... 630Amp frame.

7.6.3 CONSTRUCTIONS
The MCCB cover and case shall be made of high strength heat treatment and flame retardant thermo-setting insulating material. Operating handle shall be of rotary type quick make/quick break, trip-free type. The operating handle for simultaneous operation and tripping of all the three phases.

Suitable fire arc extinguishing device shall be provided for each contact. Tripping unit shall be of thermomagnetic type provided in each pole and connected by a common trip bar such that tripping of any one pole operates all three poles to open simultaneously. MCCB shall be line load reversible type. MCCB’s shall be site adjustable thermal release (80% to 100%) of rated current. Device shall have IDMT characteristics for sustained overload and short circuits. MCCB shall be current limiting type MCCB shall be provided with rotary handle.

Contacts tips shall be made of suitable arc resistant, silver alloy for long electrical life. Terminals shall be of liberal design with adequate clearance.

7.6.4 RUPTURING CAPACITY.
The Moulded Case Circuit Breaker shall have a minimum fault breaking capacity (Ics) of not less than 25 KA RMS at 415 volts for MDB / SDB & Meter Boards and / or higher capacity as specified in individual panel item.

7.6.5 TESTING.
Test certificate of the MCCB as per relevant Indian Standards (IS) shall be furnished.

7.7 MEASURING INSTRUMENTS, FOR METERING.

GENERAL
Direct reading electrical instruments shall be in conformity with IS 1248. The accuracy of direct reading shall be 1.0 for voltmeter and 1.0 for ammeters. Other type of instruments shall have accuracy of 1.5. The errors due to variations in temperature shall be limited to a minimum. The meter shall be suitable for continuous operation between-10 degree Centigrade to + 50 degree Centigrade. All meters shall be of flush mounting type of 96mm square or circular pattern. The meter shall be enclosed in a dust tight housing. The housing shall be of steel or phenolic mould. The design and manufacture of the meters shall ensure the prevention of fogging of instruments glass. Instruments meters shall be sealed in such a way that access to the measuring element and to the accessories within the case shall not be possible without removal of the seal. The meters shall be provided with white dials and black scale markings.
The pointer shall be black in colour and shall have zero position adjustment device which could be operated from outside. The direction of deflection shall be from left to right.

Suitable selector switches shall be provided for all ammeters and voltmeters intended to be used on three phase supply.

The specifications herein after laid down shall also cover all the meters, instrument and protective devices required for the electrical work. The ratings type and quantity of meters, instruments and protective devices shall be as per the schedule of quantities.

7.8 DIGITAL AMMETERS

Ammeters shall be digital type 7 segment LED display. Ammeter shall be suitable for accuracy class 1.0 and burden 0.5 VA approx. The ammeters shall be capable of carrying sustained overloads during fault conditions without damage or loss of accuracy.

7.9 DIGITAL VOLTMETERS

Voltmeter shall be digital type 7 segment LED display. Voltmeter shall be suitable for accuracy class 1.0 and burden 0.5 VA approx. The range for 3 phase voltmeters shall be 0 to 500 volts. The voltmeter shall be provided with protection fuse of suitable capacity.

7.10 CURRENT TRANSFORMERS

7.10.1 Current transformers shall be in conformity with IS: 2705 (Part I, II & III) in all respects. All current transformers used for medium voltage applications shall be rated for 1kv. Current transformers shall have rated primary current, rated burden and class of accuracy as required. However, the rated secondary current shall be 5A unless otherwise specified. The acceptable minimum class of various applications shall be as given below:

- Measuring : Class 0.5 to 1.
- Protection : Class 5P10.

7.10.2 Current transformers shall be capable of withstanding without damage, magnetic and thermal stresses due to short circuit fault of 50KA on medium voltage system. Terminals of the current transformers shall be marked permanently for easy identification of poles. Separate CT shall be provided for measuring instruments and protection relays. Each C.T. shall be provided with rating plate.

7.10.3 Current transformers shall be mounted such that they are easily accessible for inspection, maintenance and replacement. The wiring for CT’s shall be copper conductor, PVC insulated wires with proper termination lugs and wiring shall be bunched with cable straps and fixed to the panel structure in a neat manner.

7.11 MISCELLANEOUS

Control switches shall be of the heavy-duty rotary type with escutcheon plates clearly marked to show the operating position. They shall be semi-flush mounting with only the front plate and operating handle projecting.

Indicating lamps shall be of the LED type, and with translucent lamps covers. Bulbs & lenses shall be easily replaced from the front.

Push buttons shall be on the momentary contact, push to actuate type fitted with self-reset contacts & provided with integral escutcheon plates marked with its functions.

7.12 CABLE TERMINATIONS

Cable entries and terminals shall be provided in the sub distribution boards to suit the number, type and size of aluminium conductor power cable and copper conductor control cable specified.
Provision shall be made for top or bottom entry of cables as required. Generous size of cabling chambers shall be provided, with the position of cable gland and terminals such that cables can be easily and safely terminated. Cable glands shall be double compression type, barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of another live circuit.

Cable risers shall be adequately supported to withstand the effects of rated short circuit currents without damage and without causing secondary faults.

7.13 CONTROL WIRING

All control wirings shall be carried out with 1100/660V grade single core PVC cable conforming to IS 694/ IS 8130 having stranded copper conductors of minimum 1.5 sq.mm for potential circuits and 2.5 sq.mm for current transformer circuits. Wiring shall be neatly bunched, adequately supported and properly routed to allow for easy access and maintenance. Wiring shall be identified by numbering ferrules at each end. All control fuses shall be mounted in front of the panel and shall be easily accessible.

7.14 TERMINAL BLOCKS

Terminal blocks shall be 500 Volts grade of the stud type. Insulating barriers shall be provided between adjacent terminals. Terminals block shall have a minimum current rating of 10 Amps and shall be shoruded. Provisions shall be made for label inscriptions.

7.15 LABELS

Labels shall be of anodized aluminium, with white engraving on block background. They shall be properly secured with fasteners.

7.16 TEST AT MANUFACTURES WORK

All routine tests specified is IS : 8623-1977 shall be carried out and test certificates submitted to the Engineer-in-Charge.

7.16.1 TESTING AND COMMISSIONING

Commissioning checks and tests shall be included all wiring checks and checking up of connections. Primary/secondary injection tests for the relays adjustment/setting shall be done before commissioning in addition to routine megger test. Checks and tests shall include the following.

a) Operation checks and lubrication of all moving parts.

b) Interlocking function check.

c) Insulation test: When measured with 500V meggar, the insulation resistance shall not be less than 100 mega ohms.

d) Trip tests & protection gear test.

7.17 MINIATURE CIRCUIT BREAKER

The MCB’s shall be of the completely moulded design suitable for operation at 240/415 Volts 50 Hz system.

The MCB’s shall have a rupturing capacity of 10 KA.

The MCB’s shall have inverse time delayed thermal overload and instantaneous magnetic short circuit protection.

Type test certificates from independent authorities shall be furnished.
8.0 BUS DUCT

8.1 GENERAL

Bus duct shall be supplied as per BOQ, specification & drawings. The Bus duct shall be of indoor/Outdoor type. Bus duct system air cooled (self cooled), non segregated type and shall be suitable for continuous current rating and shall have rupturing capacity of 36 MVA at 415 volts. Bus duct shall be suitable for short circuit withstand capacity of 50 KA. Manufacturer shall submit type test certificate of similar Bus duct from recognised test lab like CPRI or equivalent.

8.2 CONSTRUCTION

Bus duct shall consists of three phase and neutral busbars permanently positioned. Part of Bus duct outside the station building shall conform to degree of enclosure protection IP 54 while part of Bus duct inside the Substation building shall conform to degree of enclosure protection IP 42 with upto date amendments. Minimum thickness of sheet steel enclosure shall be of 2mm. The busbars shall be of high conductivity electrolytic quality aluminium conforming to relevant Indian Standards and shall be of sufficient cross section. Overall busbar cross section size shall not be less than the cross section based on 0.8 Amp / Sq.mm. and shall be as per Table VI of CPWD General specification for Electrical Works Part I – Internal-2013 and whichever is of higher cross section. The cross section of neutral busbar shall be same as that of phase busbar. Entire length of busbars shall be provided with colour coded PVC sleeves. Bus duct shall be natural cooled with inspections covers at suitable intervals. Busbars shall be supported with 12mm thick non hygroscopic insulating material at every 600mm but allowing busbar to expand on normal operation but restrict excessive movement under fault conditions. Expansion joints shall be provided in such a way that expansion and contraction does not have undue strain on the bus at the terminals at both ends.

The Bus duct arrangement shall have a common frame earth bar of sizes 2No. 32mm x 5mm of Aluminium for entire length suitably loop earthing various section. Two number of each terminals shall be provided for earthing connections. Frame earthing of Bus duct system shall be connected to two earthing terminals at Main L.T. Panels and Transformer ends.

8.3 Contractor shall submit the busbar sizing calculation for short circuit withstand capability and maximum temperature rise indicating the de-rating factors clearly for the approval of Employer/Engineer-In-Charge.

8.4 TESTS

8.4.1 FACTORY TESTS

Contractor / Supplier shall submit manufacturer copy of test certificates for Type test & original test certificates for Routine test & laid down in relevant IS.

8.4.2 SITE TESTS

Contractor / Supplier shall coordinate with erection Contractor for testing of Bus duct prior to commissioning and following tests shall be carried out at site and test results recorded.

i. Insulation resistance test with 500 volts megger. The insulation resistance shall be not less than 100 mega ohms. The testing shall be done as per IS 8084-1976 with upto date amendments.

ii. Earth continuity test.

9.0 CABLES

9.1 H.T. CABLES
9.1.1 CONSTRUCTION

All H.T. Cables shall be of 11 KV grade XLPE insulated & PVC sheathed flat steel wires (strips) armoured electrical purity aluminium conductor cables shall be manufactured & tested in accordance with IS : 7098 (Part II) 1985. H.T. Cable shall be earthed type. The conductor shall be made electrical purity aluminium wires and shall be of stranded construction and shall comply to IS 8130. High quality XLPE unfilled insulating compound shall be used for insulation. Insulation shall be carried out by extrusion process and shall be chemically cross linked in continuous vulcanisation process. Core screen shall consists of a layer of extruded semi-conducting compound. Additional insulation shield shall be provided with semi conducting and metallic tape shield over the extruded insulation shield. Inner and outer shielding with insulation shall have perfect bonding. Cores shall be stranded together with suitable non hygroscopic fillers in the interstices and provided with common covering of plastic tape wrapping. Armouring shall be applied over the inner sheath and shall comprise of flat steel wires (strips). Outer sheath shall be of tough, heat resistance PVC compound as per IS : 5831 and shall be extruded over the armouring. Cables shall be tested for type tested & routine tested in accordance with IS:7098 (Part II).

9.1.2 TERMINATION JOINTS

Terminal joints shall be carried out inside the cable end boxes fixed on the equipment. Cables shall be penciled with layers of black ampere tapes wrapped over the conductor and the insulations then the entire joint shall be wrapped in layers of ampere tapes upto the terminals, butted and lugged. Lugs shall be fitted by the means of bolts and nuts with the terminal studs. On the glands, armour of the cable shall be fixed by means of clamps which shall be grounded. Heat shrink cable termination kit shall be used for terminations.

9.1.3 INSTALLATION OF CABLES

Cables in the HT Rooms of the Sub-Station shall be laid in trenches. All cables shall be bent in radius not less than 15 times the diameter of cables or as prescribed by the manufacturer which ever is higher. Cable laying shall be carried out as per CPWD specifications.

9.2 L.T. CABLES

9.2.1 GENERAL

L.T. Cables shall be supplied, inspected, laid tested and commissioned in accordance with drawings, specifications, relevant Indian Standards specifications and cable manufacturer’s instructions. The cable shall be delivered at site in original drums with manufacturer’s name clearly written on the drums. The recommendations of the cable manufacturer with regard to jointing and sealing shall be strictly followed.

9.2.2 MATERIALS

L.T. Cables shall be XLPE insulated and PVC sheathed aluminium conductor armoured cables conforming to IS: 7098 (Part I)-1988. Cables shall be of 1100volt and with ISI certification mark. Conductor of power cables shall be made of electrical purity aluminium conforming to IS 8130-1984. All power cables shall be FR type

9.2.3 INSTALLATION OF CABLES

Cables shall be laid directly in ground, pipes, masonry ducts, on cable tray, surface of wall/ceiling etc. as indicated on drawings and/or as per the direction of Engineer-in-Charge. Cable laying shall be carried out as per CPWD specifications.

9.2.4 INSPECTION

All cables shall be inspected at site and checked for any damage during transit.

9.2.5 JOINTS IN CABLES

The Contractor shall take care to see that the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilisation and avoiding of cable joints. This apportioning shall be got approved from Engineer-in-Charge before the cables are cut to lengths.
9.2.6 **LAYING CABLES IN GROUND**

Cable laying shall be as per IS: 1255-1983 with upto date amendments and as specifying. Cables shall be laid by skilled experienced workmen using adequate rollers to minimize stretching of the cables. The cable drums shall be placed on jacks before unwinding the cable. With great care it shall be unrolled on over wooden rollers placed in trenches at intervals not exceeding 2 metres. Cables shall be laid at depth of 0.75 metres below ground level. A cushion of sand total of 250mm shall be provided both above and below the cable, joint boxes and other accessories.

The cable shall not be laid in the same trench or along side a water main.

Cables shall be laid in excavated trench over 80mm layer of sand cushion. The relative position of the cables, laid in the same trench shall be preserved. At all changes in direction in horizontal and vertical planes, the cables shall be bent smooth with a radius of bent not less than 12 times the diameter of cables. Minimum 3 metre long loop shall be provided at both end of cable.

Distinguishing marks may be made on the cable ends for identifications of phases. Insulation, tapes of appropriate voltage and in red, yellow and blue colours shall be wrapped just below the sockets for phase identifications.

9.2.7 **PROTECTION OF CABLES**

The cables shall be protected by bricks laid on the top layer of the sand for the full length of underground cable. Where more than one cables is laid in the same trench, the bricks shall cover all the cables and shall project a minimum of approximately 80mm on either side of the cables. Cable under road crossings and any other places subject to heavy traffic, shall be protected by running them through Hume Pipes of suitable size.

9.2.8 **EXCAVATION & BACK FILL**

All excavation and back fill required for the installation of the cables shall be carried out by the Contractor in accordance with the drawings and requirements laid down elsewhere. Trenches shall be dug true to line and grades. Back fill for trenches shall be filled in layer not exceeding 150mm. Each layer shall be properly rammed and consolidated before laying the next layer.

The Contractor shall restore all surface, road ways, side walks, kerbs wall or the works cut by excavation to their original condition to the satisfaction of the Engineer-in-Charge.

9.2.9 **LAYING OF CABLES ON CABLE TRAY/SURFACE OF WALL/CEILING**

Cable shall be laid on perforated M.S. Cable tray. Cables shall be properly dressed before cable ties/clamps are fixed. Wherever cable tray is not proposed, cables shall be fixed on surface of wall or ceiling slab by suitable MS clamps/ saddles. Care shall be taken to avoid crossing of cable.

9.2.10 **CABLES ON HANGERS OR RACKS**

The Contractor shall provide and install all iron hangers racks or racks with die cast cleats with all fixings, rag bolts or girdler clamps or other specialist fixing as required.

Where hangers or racks are to be fixed to wall sides, ceiling and other concrete structures, the Contractor shall be responsible for cutting away, fixing and grouting in rag bolts and making good.

The hangers or racks shall be designed to leave at least 25mm clearance between the cables and the face to which it is fixed. Multiple hangers shall have two or more fixing holes. All cables shall be saddled at not more than 150mm centres. These shall be designed to keep provision of some spare capacity for future development.

9.2.11 **CABLES TAGS**

Cable tags shall be made out of 2mm thick aluminium sheets, each tag 1-1/2 inch in dia with one hole of 2.5mm dia, 6mm below the periphery. Cable designations are to be punched with letter/number punches and the tags are to be tied inside the panels beyond the glanding as well as below the glands at cable entries. Trays tags are to be tied at all bends. On straight lengths, tags shall be provided at every 5 metres.

9.3 **TESTING OF CABLES**
Prior to installation burying of cables, following tests shall be carried out. Insulation test between phases, phase & neutral, phase & earth for each length of cable.

a. Before laying.
b. After laying.
c. After jointing.

On completion of cable laying work, the following tests shall be conducted in the presence of the Engineer in Charge.

a. Insulation Resistance Test (Sectional and overall).
b. Continuity Resistance Test.
c. Earth Test.

All tests shall be carried out in accordance with relevent Indian Standard code of practice and Indian Electricity Rules. The Contractor shall provide necessary instruments, equipments and labour for conducting the above tests & shall bear all expenses of conducting such tests.

10.0 CABLE TRAY

10.1 PERFORATED TYPE CABLE TRAY

The cable tray shall be fabricated out of slotted/perforated MS sheets as channel sections, single or double bended. The channel sections shall be supplied in convenient lengths and assembled at site to the desired lengths. These may be galvanised or painted as specified.

Typically, the dimensions, fabrication details etc. are shown in CPWD General Specification for Electrical Works Part-II-External.

The jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section. Two coupler plates, each of minimum 200mm length, shall be bolted on each of the two sides of the channel section with 8mm dia round headed bolts, nuts and washers. In order to maintain proper earth continuity bond, the paint on the contact surface between the coupler plates and cable tray shall be scraped and removed before the installation.

The maximum permissible uniformly distributed load for various sizes of cable trays and for different supported span are as per Table-IV. The sizes shall be specified considering the same.

Factory fabricated bends, reducers, tee/cross junctions, etc. shall be provided as per good engineering practice. (Details are typically shown in figure-3) of CPWD General specifications of Electrical Work Part-II – 1994. The radius of bends, junctions etc. shall not be less than the minimum permissible radius of bending of the largest size of cable to be carried by the cable tray.

The entire tray (except in the case of galvanised type) and the suspenders shall be painted with two coats of red oxide primer paint after removing the dirt and rust, and finished with two coats of spray paint of approved make synthetic enamel paint.

10.2 LADDER TYPE CABLE TRAY

Ladder type cable tray shall be fabricated out of double bended channel section longitudinal members with single bended channel section rungs of cross members welded to the base of the longitudinal members at a centre to centre spacing of 250mm. The channel sections shall be supplied in convenient lengths and assembled at side to the desired lengths. These may be galvanised or painted to the desired lengths. Alternatively, where specified, the cable tray may be fabricated by two angle irons of 50mm x 50mm x 6mm as two longitudinal members, with crosses bracings between them by 50mm x 5mm flats welded/bolted to the angles at 1 m spacing.
Typically, the dimensions, fabrication details etc. are shown in CPWD General Specification for Electrical Works - Part II - External, 1994.

The jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section. Two coupler plates, each of minimum 200mm length, shall be bolted on each of the two sides of the channel section with 8mm dia round headed bolts, nuts and washers. In order to maintain proper earth continuity bond, the paint on the contact surfaces between the coupler plates and cable tray shall be scraped and removed before the installation.

The maximum permissible uniformly distributed load for various sizes of cable trays and for different supported span are as per CPWD General Specification of Electrical Work Part II -1994. The sizes shall be specified considering the same.

The width of the cable tray shall be chosen so as to accommodate all the cable in one tier, plus 30 to 50% additional width for future expansion. This additional width shall be minimum 100mm. The overall width of one cable tray shall be limited to 900mm.

Factory fabricated bends, reducers, tee/cross junctions, etc. shall be provided as per good engineering practice. Details are typically shown in figure 3 of CPWD General Specification of Electrical Work Part-II-1994. The radius of bends, junctions etc. shall not be less than the minimum permissible radius of bending of the largest size of cable to be carried by the cable tray.

The entire tray (except in the case of galvanised type) and the suspenders shall be painted with two coats of red oxide primer paint after removing the dirt and rust, and finished with two coats of spray paint of approved make synthetic enamel paint.

The cable tray shall be bonded to the earth Terminal of the switch bonds at both ends.

The cable trays shall be measured on unit length basis, along the center line of the cable tray, including bends, reducers, tees, cross joints, etc, and paid for accordingly.

The cable tray shall be suspended from the ceiling slab with the help of 10mm dia MS rounds or 25mm x 5mm flats at specified spacing as per CPWD General Specification of Electrical Work Part II -1994. Flat type suspenders may be used for channels upto 450mm width bolted to cable trays. Round suspenders shall be threaded and bolted to the cable trays or to independent support angles 50mm x 50mm x 5mm at the bottom end as specified. These shall be grouted to the ceiling slab at the other end through an effective means, as approved by the Engineer, to take the weight of the cable tray with the cables.

11.0 DIESEL GENERATOR SET (SILENT TYPE)

11.1 General

DG Set shall consist of Diesel Engine coupled to alternator housed in an acoustic enclosure & conforming to CPCB norms. BHP of engine & alternator KVA rating shall be as per BOQ item. The Diesel Generator set shall consist of all accessories and control such as starting device, Lubricating arrangements, speed control, automatic control devices, protection gear, instrumentation etc. as required and specified herein after. The Diesel Generator set shall be factory assembled, factory tested, excise duty paid in all respects.

11.2 Diesel Engine

11.2.1 General
Diesel Engine shall be of heavy duty, robust construction, suitable for continuous duty. Emission for Diesel Engine shall be within prescribed emission limits as per CPCB norms dated 01/07/2004 and manufacturer shall be furnished certificate issued by approved agencies of CPCB.

11.2.2 Engine

The engine shall be of standard design of the original manufacturer. It should be 4 stroke cycles, radiator cooled, naturally aspirated / turbo charged (as per manufacturer standard), diesel engine developing suitable BHP. The engine shall be capable for 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 one hour in every 12 hours.

The speed governing mechanism shall be electronic type and should keep correct frequency for class A1–Governing at all possible operating conditions.

Starting shall be push button electric starting type by an axial type starter motor from a 24 volts lead acid battery.

A length of flexible exhaust pipe shall be supplied connected to the exhaust manifold. Silencer and exhaust piping from D.G. Set to silencer form part of the item of D.G. Set and deemed to be included in quoted rates. Silencers shall be hospital type. Piping from silencer onwards shall be measured as linear basis.

Dry type air filters shall be fitted.

11.2.3 Engine Details

Type : Multi-cylinder Diesel.
Method of starting : Electric Start.
Type of Cooling : Radiator type with Fan.
Type of Governor : Electronic Variable speed.
Type of fuel : High speed diesel.
Type of lubricating oil : Multi grade (as per IS : 13656-1993)

The above engine shall be equipped with the following:-

a. Fly wheel of suitable diameter and weight.
b. Fuel tank suitable for 990 ltrs. capacity with necessary piping and fuel gauge.
c. Fuel and lubricating oil filter.
d. Fuel injection equipment.
e. Air cleaner/filter.
f. Lubricating oil pump.
g. Flexible coupling.
h. Radiator with fan.
i. Governor electronic type as per standard design of approved manufacturer.
j. Turbo charged after cooled.
k. Fuel Hoses.
1. Batteries & battery charger.

m. Engine control panel.

Suitable stop device to stop the engine in case any of the controlled variables exceed the upper or lower limit (Temperatures of cooling water, pressure of lub oil & over speeding).

DG Set shall be provided with Power command control Panel (Cumin PCC 2100 or requirement) for microprocessor base governing, regulation, metering monitoring. Power command controller shall have feature of AMF.

Indicating panel of Engine shall be consisting of the following.

a) Water temperature indication.
b) Lub oil pressure gauge.
c) Lub oil temperature gauge.
d) Starting Switch with key.
e) RPM meter with hour meter (Techno-hour meter).
f) Battery charging ammeter.
g) Toggle switch.
h) Push button for starting.
i) Safety control indicator lamps.

Oil service tank with all accessories such as level indicator, manhole, valved inlet and outlet, air vent, drain plug, mounting pedestals etc.

11.2.4 **Base and Mounting**

11.2.4.1 **Base**

The D.G Set i.e. diesel engine and alternator, shall be mounted on a steel skid base. An oil and water drain block shall be provided on the base rail.

11.2.4.2 **Mounting**

The set will be mounted on spring loaded cushy-footing pads. Cushy footing pads shall be spring loaded Anti-vibration Mountings of GERB.

11.2.5 **Performance of D.G Set**

Voltage regulation: Plus or minus 2.5% from no load to full load and at power factor from 0.8 P.F. (lag) to unity with 1% speed regulation of the engine.

11.3 **Alternator**

11.3.1 **General**

Alternator shall be of salient pole, rotating field type and shall be self exciter suitable for 415 volts, 50Hz, AC 0.8 power factor and 1500 RPM. The alternator shall be of drip-proof construction. Alternators shall generally conform to IS: 4722 and BS 2613.

11.3.2 **Frame**

Frame shall be of cast iron construction, the feet and terminal box mounting being cast integral with the frame. A terminal box (adoptor) shall be used if required for proper termination of cables/bus duct.

11.3.3 **Stator core**

Stator core shall be built up to silicon steel laminations compressed hydraulically and rigidly supported by either cast iron or steel end rings. The core shall be designed for minimum reactance, low voltage wave form distortion and maximum efficiency, stator coils shall be of tropicalized mica or leatheriod. End windings shall be taped with fibre glass tape and the complete windings shall be
impregnated with varnish and spray finished with moisture protection varnish. Otherwise 100% epoxy impregnating with an overcoat of resilient insulating materials shall be carried out.

11.3.4 End Frames
The end frames shall be of well ribbed cast iron design. The end frames shall spigotted to the stator frame and secured by easily available set screws. Ventilation openings shall be cast into the vertical and bottom side face which shall be screen protected and drip proof.

11.3.5 Bearings
The bearings shall be of heavy duty prelubricated cartridge design ball or roller bearings. Single bearing alternators shall have self-aligning ball on roller bearing. The end frames of the rotor shall be removable (from stator) without disturbing the bearings.

11.3.6 The Rotor
The rotor shaft shall be turned either from a high tensile MS bar or from a MS forging. Field coils shall be wound with synthetic enamel covered or varnish bounded and glass cover copper strips of high conductivity. Poles shall be of bolt on type made of sheet steel of high premeability. The insulation between the pole and coil shall comprise of varnished fibre glass cloth backed mica around the body and thick insulating washers on the top and bottom of the coil. Coils shall be impregnated with resin and the complete rotor shall be spray finished with a moisture protection varnish suitable for tropical conditions. However 100% epoxy impregnation and an overcoat of resilient insulating material shall be preferable.

11.3.7 Damper Windings
Damper windings shall be provided to assist parallel operation of alternators. The damper bars of copper brazed to heavy copper and connectors shall be located in a semi closed circular slots situated in the pole faces.

11.3.8 Type
Alternator shall be brushless.

11.3.9 Coupling
Engine & alternator shall be directly coupled through a sturdy flexible coupling.

11.3.10 Terminals
Terminals shall be housed in a suitable cast iron box fixed on to the stator frame. The terminals shall have ample clearance between phases and between phases to earth and shall be readily accessible. The terminal shall be suitable for receiving suitable size of aluminium conductor XLPE insulated, PVC sheathed and steel armoured cables.

11.3.11 Temperature Rise
The alternator shall be suitable for temperature rise of 50 degree C above ambient and shall be capable of withstanding 10% overload for one hour continuously in 12 hours as per IS : 4722.

11.3.12 Exciter -Voltage Regulators
The exciter shall be over hung, rotating type without any bearing exciter of static type or semi conductor may be provided. Solid state voltage regulator with all accessories and relays shall be provided for proper voltage regulation.

11.3.13 Balancing
All the rotating part shall be dynamically balanced to ensure smooth vibration free running.

11.4 AUTO - MAINS FAILURE PANEL (AMF PANEL)

11.4.1 General
DG Set shall be provided with Auto – Mains Failure Panel (AMF Panel) for auto start, auto stop of DG Sets. AMF Panel shall be complete with contactor / Electrical operated Air Circuit Breaker.
AMF Panel shall be equipped with suitable arrangement for auto changeover from grid to DG Set source and vice versa and shall be complete with all switchgears, timer contactors, relays etc. to ensure the functionality of the system.

11.4.2 Operations
a. The normal or mains source shall be constantly monitored by a main voltage monitor.
b. When main voltage fails or drops below 80% adjustable and selectable of the rated voltage, the automatic control system shall give a starting signal to the Generator Set.
c. As soon as the diesel generator set reaches its operating speed and attains its operating voltage, the load shall be transferred to the generator set.
d. Upon the return of the normal source voltage of 90% of rated voltage for a minute the switch shall retransfer the load to the normal source.
e. The automatic control system shall reset itself and start the engine generator set upon the failure of the normal source.
f. In the event of failure of the diesel generator set due to faulty starting the normal Contactors/Switch shall get energised without any time delay on the restoration of the normal source.
g. If the diesel set fails to start and reach its operating speed in 25 second in three attempts, the set shall automatically be disconnected and locked in isolated position.

11.4.3 Protection, Instrumentation & Accessories

The automatic transfer facility shall be in addition to following for manual operation

11.4.4 Protection Gear
i. Solid Neutral.
ii. Adjustable time delay relays for transfer and retransfer of loads.
iii. Engine start/stop control relays, three attempt start facility & failure to start lockout.
v. Push buttons, start/stop/reset/test.
vi. Selector switch for engine control on/off.
vii. A bypass arrangement in the control panel for isolating the control panel from main supply for carrying out maintenance, repairs to control panel.

11.4.5 Instrumentation.
i. AC voltmeters.
ii. AC ammeters.
iii. Frequency meter.
iv. KWH / Energy Analyser meter with protection fuses.
v. CT’s of specified ratio and burden.
vi. Signal lamp ‘Load on set’.
vii. Signal lamp (load on mains).
viii. Signal lamp (set fails to start).
ix. Audio visual system to indicate abnormalities in the standby system.

11.4.6 Accessories
i. Battery charging equipment and instruments for starting of the engine and controls energisation.
ii. Cable alley for incoming and outgoing cable with glands.

iii. Removable side panels for easy access and locking arrangement to prevent tempering.

11.5 SPECIFICATION OF MATERIALS

11.5.1 Exhaust Silencer Piping.

The exhaust silencer piping system shall be of heavy-duty MS pipes conforming to relevant IS code. Suitable length of flexible piping shall be used for connecting the exhaust piping to the engine as per the recommendations of the manufacturer. MS screwed flanges and bends shall be used as per site requirements.

DG Set exhaust pipe shall be legged with 80mm thick glass wool insulation. Cladding shall be done with 24 SWG aluminium sheet.

11.5.2 Oil Piping.

Oil piping shall be of MS suitable to withstand the pressure as recommended by manufacturer.

11.6 Foundation.

Suitable size 1:2:4 cement concrete foundations is to be casted by the Civil Contractor by referring approved manufacturer foundation drawing of DG Set for erection of DG Set. Foundation bolts etc. shall be provided by the D.G. Set Contractor.

11.7 24 Volts DC Batteries

24 volts batteries for each shall comprise of standard lead acid stationary batteries consisting of required cells of each 2 volts to have 180 AH / 360 AH capacity at twenty (20) hours rate of discharge. Battery cells shall conform to IS: 1651 with up-to-date amendments. The battery bank shall be provided with the following accessories.

(a) Battery stand.

(b) Set of connectors with ends take off suitable for connections.

(c) Cell insulators and stand insulators.

(d) Spring type hydrometer.

(e) Thermometer with specific gravity correction scale.

(f) Cell testing voltmeter.

(g) Set of tools consisting of spanners, rubber syringe, acid resisting funnel and acid resisting tube of 2 litres capacity - one set.

The batteries shall be supplied duly filled, charged and acid filled.

11.8 Battery Charging Equipment

Battery boost charger of suitable capacity intended to operate on single phase 230 volts, 50 cycles supply system and suitable for charging current. The battery boost charger shall be provided with the following accessories.

a. A.C. and D.C. “ON” and “OFF” switches with HRC fuses.

b. Indicating lamps for indicating mains “ON” and battery charging.

c. Ballast to give charging.

d. Single phase double wound (copper conductor) impregnated natural air cooled mains transformer for rectifier stack.

e. Rotary switch to give step control.

f. Single phase full wave bridge connected silicon rectifier stack.

g. Moving coil ammeter to indicate charging current.

h. Moving coil voltmeter with a selector switches to measure the battery/charger voltage.

i. Silicon blocking diodes connected to a suitable tap to maintain continuity of D.C. supply.
j. A.C. and D.C. contactors of suitable rating as required.

All the components for battery charger shall be adequately rated and housed in a well ventilated sheet steel cubicle with input and output terminals. Proper cables glands shall be provided for incoming and outgoing cables.

11.9 **Wiring**

a. All control cabling / wiring between D.G. Sets & Main L.T. Panel shall carried out with suitable size armoured copper cable.

b. The minimum size of wires outside the panel shall be 2.5 sq.mm copper conductor.

c. The minimum size of control cables inside the panel shall be 1.5sq.mm copper. Control cables and connection shall form part of contract and deemed to be included in the cost.

d. All the wires and cables shall be suitable for 650/1100 volts.

11.10 **Painting**

The contractor shall paint all exposed metal parts of plant and equipment supplied by him. Painting shall be by application of two coats of synthetic enamel paint of approved colour. All piping shall be colour coded.

11.11 **Testing**

The Contractor shall give notice well in advance to the Project Manager / Engineer-in-charge before commencement of any site testing. All material like consumable stores, fuel, oil grease, lubricating oil etc. required for the trials shall be arranged by the Contractor.

11.11.1 **Factory Tests**

The factory tests shall incorporate the following and manufacturer’s test certificates to be submitted.

a. Routine tests.

b. High Voltage test.

c. Short circuit current test.

d. Instantaneous short circuit withstand test.

e. Insulation resistance test.

Contractor shall furnish type tests certificate for Engine and alternator. These tests shall be conducted as per the requirements of BS: 2613 or IS: 4722 and the original tests certificates shall be furnished.

11.11.2 **Site Tests**

After erection is completed following tests shall be conducted.

a. Insulation resistance of the generator.

b. Speed, No load voltage and full load voltage regulations.

c. Frequency on no-load, half load and full load.

The readings shall be observed with calibrated meters. Only one meter shall be used for the test. The readings shall be properly tabulated submitted in triplicate to Engineer-in-charge.

11.12 **TRIALS**

11.12.1 **Preliminary Trials**

After completion of erection of generating sets and before carrying out main trials. Preliminary trials shall be conducted in the presence of the Project Managers (PMC) / Engineer-in-Charge. Such trials shall include the checking and adjustments of all instrument relays, timers, interlocks and meters. Crank shaft alignment shall be checked when the engine is cold. Insulation resistance of stator, rotor and exciter windings reading recorded.

11.12.2 **Main Trials**
Main trial shall be for 6 hours. Continuous run at full load and including one hour at 110% of full load. Fuel & Lub Oil required for trial run shall be provided by the Contractor & shall deemed to be included in the quoted tender rates.

11.13 ACOUSTIC ENCLOSURE

11.13.1 General

The enclosure shall be of compact sleek design conforming to international standard to provide insertion loss of 25 DBA as per the requirement of central pollution control board norms. The enclosure shall be fabricated using high grade cold rolled cold annealed (CRCA) sheet & steel members. High density sound absorption material shall be used to reduce the sound level. Sound level shall not be more than 75 dB(A) at a distance of one metre away from the set and DG Set supplier shall give an integral acoustic enclosure and the acoustic enclosure shall have approval from anyone of the agencies as listed / approved by CPCB. The enclosure shall be surface treated and powder coating painted to make it weather proof and suitable for outdoor application. The enclosure shall be provided with durable industrial locking system with doors duly gasketed.

11.13.2 Acoustic Insulation

High density resin bonded rock wool shall be provided on all six sides includes door, roof and base to absorb noise. The insulation shall be covered with fire proof acoustic material, light resin rock wool and shall be supported by perforated sheet. Sound attenuators/down stream silencers shall be provided at all openings for air inlet/outlet to facility free air flow but to absorb sound resulting in extremely low noise level. Detachable partitions shall be provided inside the enclosure to attain further noise attenuation of the engine.

11.13.3 Noise Suppressor

A suitably designed hospital type noise suppressor shall be provided to minimize the exhaust noise of the engine. Hospital type noise suppressor shall be placed outside the acoustic enclosure.

11.14 Exhaust System

11.14.1 Exhaust piping shall be of M.S. & shall be conforming to relevant IS. The runs forming part of factory assembly on the engine flexible connections up to exhaust silencer shall be exclusive of exhaust piping item. The work includes necessary cladding of exhaust pipe work using 50mm thick glass wool/mineral wool/rockwool, density not less than 46 kg/m sq. and aluminium cladding (0.80mm thick) for the complete portion. The exhaust pipe work includes necessary supports, foundation etc. to avoid any load & stress on turbo charger/exhaust piping. The exhaust pipe support structure shall be got approved from the Architect / Project Manager / Engineer – In – Charge before execution.

a) Exhaust system should create minimum back pressure but not more than 2” of mercury (Hg) column.

b) Number of bends should be kept minimum and smooth bends should be used to minimize back pressure.

c) Pipe sleeve of larger dia should be used while passing the pipe through concrete wall & gap should be filled with felt lining.

d) Exhaust piping shall be lagged with asbestos rope along with aluminium sheet cladding from DG Set to top of the building.

e) Exhaust flexible shall have it’s free length when it is installed. For bigger engines, two flexible bellows can be used.

f) Bellow shall be provided in exhaust piping preferably at 10 metre internal.

g) Class B MS pipes and long bend/elbows should be used.

h) The exhaust outlet should be in the direction of prevailing winds and should not allow exhaust gases to enter air inlet/windows etc.

i) When tail end is horizontal, 45 Degree downward cut should be given at the end of the pipe to avoid rain water entry into exhaust piping.
j) When tail end is vertical, there should be rain trap to avoid rain water entry. If rain cap is used, the distance between exhaust pipe and rain cap should be higher than diameter of pipe. Horizontal run of exhaust piping should slope downwards away from engine to the condensate trap. Silencer should be installed with drain plug at bottom.

11.14.2 Optimum Silencer Location: Location of the silencer in exhaust system has very definite influence on both reduction of noise and back pressure imposed on the system. The preferred silencer locations are given in the Table below, where L is length of the total exhaust system measured from exhaust manifold in metres. Please note that locating the silencer as per optimum silencer location is not mandatory. For high rise buildings, suitable arrangements may have to be provided in consultation with acoustic engineer.

**Optimum Location of Silencer (In metres)**

<table>
<thead>
<tr>
<th></th>
<th>In-line Engine</th>
<th>‘V’ Engine</th>
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</thead>
<tbody>
<tr>
<td>Best</td>
<td>2L/5</td>
<td>(4L − 1.5)/5</td>
</tr>
<tr>
<td>Second best</td>
<td>4L/5</td>
<td>(2L − 4.5)/5</td>
</tr>
<tr>
<td>Worst Location of</td>
<td>L/5 or 3L/5 or</td>
<td>(3L − 10)/5 or at</td>
</tr>
<tr>
<td>Silencer</td>
<td>at tail end of</td>
<td>the tail end of</td>
</tr>
<tr>
<td></td>
<td>Exhaust piping</td>
<td>exhaust piping</td>
</tr>
</tbody>
</table>

11.14.3 Exhaust stack height: In order to dispose exhaust above building height, minimum exhaust stack height should be as follows :-

(a) For DG set:

\[
H = h + 0.2x / KVA
\]

Where = Height of exhaust stack

H = height of building

11.14.4 Care should be taken to ensure that no carbon particle emitted due to exhaust leakage enters and deposits on alternator windings and on open connection.

11.14.5 Support to Exhaust piping: Exhaust piping should be supported in such manner that the load of exhaust piping is not exerted to turbo charger.

11.15 **Air system**

It is preferable to provide vacuum indicator with all engines to indicate choked filter. Maximum air intake restrictions with clean and choked filters should be within prescribed limit as per OEM/manufacturer recommendation for the particular model of the engine. Gensets should be supplied with heavy duty air cleaners. (Heavy duty air cleaner should be used for installations in dusty or polluted surroundings.).

11.16 **Cooling System**

DG Set shall be water cooled radiator type with suitable capacity radiator & fan.

11.16.1 OEM shall provide acoustic enclosure of duly approved design from CPCB and shall ensure temperature rise within the acoustic enclosure does not exceed 5% to 7% (max.) on continuous operation of the DG set. OEM may provide forced air intake fan and / or forced exhaust fan as per OEM standard design. However it is OEM / contractors sole responsibility to ensure that the acoustic enclosure complies with CPCB norms for insertion loss and temperature within the acoustic enclosure conforms to the temperature requirement.

11.17 **Painting**

Enclosure shall be painted with weather proof, acid proof, heat resistant, powder coated paint shade as approved by the Architect / Consultant / Engineer-in-Charge after pretreatment for degreasing, derusting, pickling, phosphating and passivation.

11.18 **TEST ACCEPTANCE CRITERIA**
The Contractor shall be required to carry out any further tests/trials that the Architects / Consultants / Owners may desire to satisfy themselves that the Generator Sets and associated equipments fully comply with the conditions as set out in these Specifications.

All instruments, materials, load configurations and labour required for carrying out of the test shall be provided by the Contractor free of cost. Fuel required for testing and commissioning shall however be provided by Owners free of cost to the Contractor.

The Contractor shall give ample notice of the test to the Architects/Consultants/Owners.

### TECHNICAL DATA OF DG SET

<table>
<thead>
<tr>
<th>S.NO.</th>
<th>PARTICULAR OF DETAILS</th>
<th>GUARANTEED DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td><strong>DIESEL ENGINE</strong></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Specifications to which it conforms.</td>
<td>:</td>
</tr>
<tr>
<td>1.2</td>
<td>Type &amp; Make</td>
<td>:</td>
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<tr>
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<td>BHP Rating</td>
<td>:</td>
</tr>
<tr>
<td>1.4</td>
<td>Frequency</td>
<td>:</td>
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<tr>
<td>1.5</td>
<td>Method of Starting</td>
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</tr>
<tr>
<td>1.6</td>
<td>Type of Cooling</td>
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<td>Type of Governor</td>
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<td>Type of Lubricant Oil</td>
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</tr>
<tr>
<td>1.10</td>
<td>No. of Stroke and Cylinder</td>
<td>:</td>
</tr>
<tr>
<td>1.11</td>
<td>Fuel Consumption / Hr.</td>
<td>:</td>
</tr>
<tr>
<td>1.12</td>
<td>Voltage regulation from on load to no load</td>
<td>:</td>
</tr>
<tr>
<td>1.13</td>
<td>Speed regulation form 0.8P.F. to unity power factor</td>
<td>:</td>
</tr>
<tr>
<td>1.14</td>
<td>Heat Exchanger</td>
<td>:</td>
</tr>
<tr>
<td></td>
<td>a) Type</td>
<td>:</td>
</tr>
<tr>
<td></td>
<td>b) Make &amp; Model</td>
<td>:</td>
</tr>
</tbody>
</table>
2.0 ALTERNATOR

2.1 Specifications to which it conforms : 

2.2 Type & Make : 

2.3 Output in KVA (Continuous) : 

2.4 Power Factor : 

2.5 RPM : 

2.6 Voltage Grade : 

2.7 Temperature rise : 


3.0 GENERAL

3.1 Approximate Weight of DG Set : 

3.2 Dimension of DG Set (L x W x H.) : 


12.0 DISTRIBUTION FEEDER PILLAR

12.1 Outdoor type Distribution Feeder Pillars shall be suitable for 3 phase, 50Hz, 415 volts, A.C. system and shall generally conform to IS 5039. Rating and size of Distribution Feeder Pillar shall be as detailed in drawings and in BOQ.

The Distribution Feeder Pillars shall be fabricated out of heavy gauge 2.00 mm thick MS sheet steel with suitable stiffners. Distribution Feeder Pillar shall be constructed with slanting roof top/over hang for protection against rain & weather and adequately ventilated by providing louvers with wire mesh from inside. The Distribution Feeder Pillar shall be provided with degree of protection IP 54 as per IS : 2147. Distribution Feeder Pillar shall be double door construction with M.S. hinges and handle for opening the door. Each door shall open to minimum 135 degrees. Locking on both the doors with two keys for each lock shall be provided with each pillar. The Distribution Feeder Pillar shall be dust, vermin proof and weatherproof type.

Neoprene gaskets shall be provided for the doors. The enclosure shall be provided with ventilated louver cover with wiremesh, lifting hooks, supporting legs and double earth terminal with double washer.

The metallic parts of the enclosure shall be subjected to seven-tank process to include cleaning, derusting, rinsing, phosphatising etc. and epoxy painted.

Distribution Feeder Pillar shall be provided with suitable size of aluminium alloy busbars.

Moulded case circuit breaker shall be provided for incoming and MCB shall be provided for outgoing feeders & conforming to IS 8828-1978. Gland plate shall be 3mm thick with suitable number of flanged type brass cable glands of required sizes shall be provided. Provision shall be suitable for lighting the interior when the doors are open. Danger notice board shall be provided on front door of the Distribution Feeder Pillar. Distribution Feeder Pillar shall be complete with contactor, timers & switch gears for auto / manual operation of Street / Road lighting.

Distribution Feeder Pillar shall fully comply with CPWD General Specification for Electrical works (Part-II External-1994). Erection or installation shall also be carried out as specified in CPWD Specification 1994.

12.1.1 INSTALLATION

Distribution Feeder Pillar shall be erected/installed on brick masonary foundation 600mm above surrounding ground level. All civil work like excavation PCC base concrete, brick masonary work, plastering, refilling, painting of brick masonary pedestal/foundation of Distribution Feeder Pillar including providing PVC sleeves in foundation for cable entry shall deemed to be included in quoted rates of Distribution Feeder Pillar.

12.2 MOULDED CASE CIRCUIT BREAKERS

12.2.1 GENERAL
Moulded Case Circuit Breaker shall be incorporated in the Distribution Feeder Pillar. MCCBs shall conform to IS : 13947 (Part-II) IEC-947(2) in all respects. MCCBs shall be suitable either for single-phase AC 230 volts or three phase 415 volts.

12.2.2 FRAME SIZES
The MCCBs shall be of the standard frame of the manufacturer sizes subject to meeting the fault level as specified elsewhere.

12.2.3 CONSTRUCTIONS
The MCCB’s cover and case shall be made of high strength heat treatment and flame retardant thermo-setting insulating material. Operating handle shall be quick make/quick break, trip-free type. The operating handle shall have suitable “ON”, “OFF” “and” “tripped” indicators. Three phase MCCBs shall have common operating handle for simultaneous operation and tripping of all the three phases. MCCB shall be provided with rotary handle. MCCB shall be load/line reversible type. MCCB shall be site adjustable type with thermal setting of 80% to 100%.

Suitable extinguishing device shall be provided for each contact. Tripping unit shall be of thermo-magnetic or static release type provided in each pole and connected by a common trip bar such that tripping of any pole operates all three poles to open simultaneously. MCCB shall be current limiting type. Contacts trips shall be made of suitable air resistant, silver alloy for long electrical life. Terminals shall be of liberal design with adequate clearance.

12.2.4 RUPTURING CAPACITY
The Moulded Case Circuit Breaker shall have a minimum service breaking capacity (Ics) of not less than 25KA RMS at 415 volts for Feeder Pillar.

12.2.5 TESTING
a. Type test certificate of the MCCB as per relevant Indian Standards (IS) shall be furnished.

b. Pre-commissioning tests on the Distribution Feeder Pillar incorporating the MCCB shall be done as per standard.

12.3 MINIATURE CIRCUIT BREAKER
The MCB’s shall be of the completely moulded design suitable for operation at 240/415 Volts 50 Hz system.

The MCB’s shall have a rupturing capacity of 10 KA.

The MCB’s shall have inverse time delayed thermal overload and instantaneous magnetic short circuit protection.

Type test certificates from independent authorities shall be furnished.

12.4 CABLE TERMINATIONS
Cable termination compartment and arrangement for power cables shall be suitable for stranded aluminium conductors, armoured, PVC insulated and sheathed. 1100 V grade cables. The temperature rise over ambient of 50 degree C. at bus bars / terminals for external cable connections shall be limited to 20 degree C. For power wiring colour-coded wires shall be preferred. All necessary cable terminating accessories such as Gland plates, supporting clamps and brackets, power cable lugs, hardware etc. shall be provided by the contractor.

The gland plates shall be removable type and shall cover the entire cable alley. Bidder shall ensure that sufficient space is provided for all cable glands. Gland plates for power cables only shall be factory drilled according to the cable gland sizes and number. For all single core cables, gland plates shall be of non-magnetic material. Provision shall be made for top or bottom entry of cables as required. Generous size of cabling chambers shall be provided, with the position of cable gland and terminals such that cables can be easily and safely terminated.

Barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of another live circuit.

Cable risers shall be adequately supported to withstand the effects of rated short circuit currents without damage and without causing secondary faults.

12.5 TEST AT MANUFACTURES WORK
All routine tests specified in IS: 8623-1977 shall be carried out and test certificates produced to the Department.

12.6 TESTING AND COMMISSIONING
Commissioning checks and tests shall be included all wiring checks and checking up of connections. Primary/secondary injection tests for the relays adjustment/ setting shall be done before commissioning in addition to routine meggar test. Checks and tests shall include the following,

a) Operation checks and lubrication of all moving parts.
b) Interlocking function check.
c) Insulation test: When measured with 500V meggar, the insulation resistance shall not be less than 100 mega ohms.
d) Trip tests & protection gear test.

13.0 EARTHING

13.1 GENERAL
Earthing of Substation equipment shall be carried out in conformity with IS 3043-1987, Indian Electricity Rules and CPWD specification.

13.2 EARTHING OF NON CURRENT CARRYING METAL PARTS OF SUBSTATION EQUIPMENT (BODY EARTHING).

Body earthing of Substation equipment like 11KV VCB Panel Board, Transformer, Main L.T. Panel, Capacitor Panel etc. shall be through a common grid formed in the Substation Building. Each equipment shall be connected with two independent earth conductors to earth bar located in respective area. Each earth bar shall be connected to Earth Grid by two independent earth conductors. Earthing Grid shall be directly connected to number of earth electrodes as shown on drawing. Earthing electrode shall be 600 x 600 x 6mm thick G.I plate (existing).

13.3 NEUTRAL EARTHING OF EQUIPMENT
Neutral terminals of Transformers shall be earthed independently. Each neutral terminal shall be earthed with two independent earth electrode. Earth electrode shall be 600 x 600 x 3mm thick copper plate. Earthing conductor shall be 25mm x 5mm copper. Earthing conductor in ground shall be in G.I. pipe whereas inside building shall be on SMC insulator on surface.

13.4 EARTHING CONDUCTOR FOR SUB-STATION EQUIPMENT

Earthing conductor shall be G.I. Earthing conductor from earth electrode to earth bar shall be of 25mm x 5mm G.I. Strip. G.I. Strip laid in ground shall be protected with G.I. pipe whereas inside the building shall be on SMC insulator on surface. Body earthing of each equipment like H.T. Panel, Transformer, Capacitor Panel, Main L.T. Panel (Normal Supply), Main L.T. Panel (Essential Supply), other electrical equipment / Panel shall be done with 2 No. 25mm x 5mm G.I. strip.

13.5 PLATE EARTH ELECTRODE

Earthing shall be provided with copper/G.I plate electrode of following.

i. Copper Plate Electrode. : 600mm x 600mm x 3mm thick
ii. G.I plate Electrode : 600mm x 600mm x 6mm thick

The electrode shall be buried in ground with its faces vertical and not less 4.5metres below ground level. 20mm dia medium class GI pipe shall be provided and attached to the electrode.

A funnel with mesh shall be provided on the top of this pipe for watering and earth electrode. Earth electrode the watering funnel attachment shall be housed in masonry enclosure of not less than 300 x 300 x 300mm deep. A precast RCC frame with cover shall be provided at top of chamber. Earth electrode may not effect the column footing or foundation of the building. In such cases electrode may be further away from the building.
13.6 **ARTIFICIAL TREATMENT OF SOIL**

If the earth resistance is too high and the multiple electrode earthing does not give adequate low resistance to earth, then the soil resistivity immediately surrounding the earth electrodes shall be reduced by addition of sodium chloride, calcium chloride, sodium carbonates copper sulphate, salt and soft coke or charcoal in suitable proportions.

13.7 **RESISTANCE TO EARTH**

The resistance of earthing system shall not exceed 1 ohm.

14.0 **PREAMBLE TO BILL OF QUANTITIES**

14.1 The Bill of Quantities should be read with all the other sections of this tender. All the items of work mentioned in the Bill of Quantities covered by this contract shall be carried out as per the drawings, specifications and directions of the DEPARTMENTS and shall include the cost of all labour, materials, tools and plants, equipments, and testing of materials, if any, with CONTRACTOR’s testing appliance, all octroi, duties, royalties, sales tax on works contract, toll tax, taxes (including service tax) and CONTRACTOR’s profit and overheads etc…….

14.2 The TENDERERS shall be deemed to have studied the drawings, specifications and details of work to be done within the time schedule and to have acquainted himself of the conditions prevailing at site. The quoted rates shall be applicable for all works in any section / size / shape and Design etc.

14.3 The quantities shown against the various items are only approximate. Any increase or decrease in the quantities shall not form the basis for alteration of the rates quoted and accepted. Quantities can be eliminated if required from tender.

14.4 In case where the specifications given in the Description of the item of work given in Bill of Quantities are found wanting, the C.P.W.D. General specifications for Electrical Works – I, II, VI, & VII shall be followed.

14.5 The rates quoted for items of work shall include working in all conditions at all heights / depths including in / under water, liquid mud, foul conditions etc. and shall also include bailing or pumping out water from the foundations basements or any other place of construction collected from rain or any other source whatsoever at any time, till the completion of work including all suspension period and delays whatsoever.

14.6 The DEPARTMENT reserves the right to with draw from the scope of work and/or to order to any other agency for any item or group of work, or to split the work between two or more sub-CONTRACTOR’s if necessary. Such a step shall not constitute a breach of the contract.

14.7 All the items of work shall be carried out as per description given in the Bill of Quantities and as shown in the drawings. All materials to be got approved from the Architect / EPI / Project Managers.

14.8 The rates quoted for cable tray & suspenders shall include two coats of red oxide primer paints after dust and dirt removal and finished with two coats of spray paints of approved make and shade synthetic enamel paint.

15.0 **TECHNICAL SPECIFICATION OF CIVIL WORK**

**General**

The Contractor may make a special note of the strictness of the concrete mix to be adopted in items of maximum water-cement ratio, minimum slump, control of total chloride and sulphate contents, use of admixtures etc.

Minimum cement contents are given purely from durability point of view. Larger contents shall have to be provided if demanded by mix design.
Provision of cement slurry to create bond between plain/reinforced concrete surface and subsequent applied finishes (floor, plaster, dado, skirting etc.) shall not be paid extra.

All full-fledged laboratories shall be established at site to start of construction and shall also stock all relevant codes as per the requirements of the special specifications.

Procedure of mixing the admixtures shall be strictly as per manufactures recommendations if not otherwise directed by the Engineer.

The batching plant for all concrete shall be used. Alternatively, use of ready mix concrete from an approved source shall be permitted. Concrete shall be transported using concrete pumps of adequate capacity including necessary stand by.

All the water tanks and other liquid retaining concrete structures shall undergo hydro-testing as per special specifications.

Special benches shall be provided at site for stacking reinforcement bars of different sizes as per the specifications.

Form work for beams of RCC areas shall be designed in such a way that the form work of the adjacent slabs can be removed without disturbing the props/supports of the beams.

Wherever there are tension/suspended concrete members, which are suspended from upper level structure members, the shuttering/scaffolding of such members at lower level shall have to be kept in place till upper level supporting members gain minimum required strength. Cost of such larger durations of keeping in place the shuttering/scaffolding shall be deemed to be included in the price quoted for respective structural members.

In the mobilization period, the contractor shall carry out expeditiously and without delaying the following works

- Material testing and mix design of concrete as contemplated in the specifications.
- Setting up of full-fledged site laboratory as per the requirement of these specifications.
- Any other pre-requisite items required for final execution.

The specifications for market rate items to be executed under this contract are enclosed.

Items, which are not covered under the specifications, shall be executed; as per latest CPWD specification and relevant IS codes or with specifications under the direction of engineer in charge.

Testing

It is made clear that cost of testing, cost of material for testing, all field apparatus required for sampling and testing as per CPWD/IS codes and manpower incident to such testing will be provided along with necessary transport arrangement to and fro to the approved testing agency or laboratory by the Contractor during the construction phase of the work and defect liability period. The expenditure in this regard shall be borne by the Contractor and nothing extra shall be payable by owner on this account. Field laboratory with all the required apparatus and staffs shall be established by the Contractor at site of work at his cost for carrying out field tests at stipulated frequencies.

Sampling and Testing

The Contractor or his accredited representative shall be present during sampling/testing and signify his concurrence for sampling / testing carried out by signing the test records. The Contractor shall be liable of all actions consequent to the test and their results as if he himself attended to the tests. The Contractor is duly advised to be present himself for sampling and testing or in the alternative, have fully qualified duly
authorized Engineer for this purpose.

15.0 **SPECIFICATIONS FOR ANTITERMITE TREATMENT**

15.1 **Pre-Construction Chemical Treatment**

- Treatment shall be done by the approved specialist Subcontractor / Agency as per the procedures laid down in IS : 6313 (Part-II) in the following areas or elsewhere as required to make chemical barriers against termites:
  - At Column-Pits, Wall-Trenches and Basement Excavations
  - At Plinth Filling
  - At the Junction of Wall & Floor
  - Along External Perimeter of Building
  - At Expansion Joints
  - At Soil Surrounding Pipes / Wastes Pipes & Conduits
  - Hand operated pressure pump shall be used for uniform spraying of the chemicals. To have proper check for uniform spraying of chemicals, graduated containers shall be used. Proper check shall be kept so that the specified quantity of chemicals is used for the required area during the operation.

15.2. The contractor shall arrange entire quantity of chemical (Chlorophyriphos or Lindane 20% EC) required for entire work. The chemical shall be brought in sealed container. Concentration percentage, Date of manufacturer and expiry shall be clearly indicated on the containers. Samples shall be obtained from the lot and got tested on approved laboratory before using in work.

15.3. The material so brought shall be safely and securely stored (away from other materials) and shall be under the control of Engineer-in-Charge. The quantity required on particular day based on area shall be issued on written requisition, records of which shall be safely and securely kept.

15.4. If any portion in original container remains unused, the same duly sealed shall be returned to store and reissued against next use.

15.5. The empty can should immediately be punctured and crushed so that the cans cannot be used for any other purpose. Such destroyed cans shall be returned to store for a counter check of inventory and the actual quantum of chemical used.

15.6. The work shall be carried out by approved agency as per following procedure.

15.7. Chemical solution shall be made by mixing one litre of Chlorophyriphos or Lindane 20% EC with 19 litres of water and this solution shall be used in the following steps.
<table>
<thead>
<tr>
<th>S.No.</th>
<th>STAGE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Bottom &amp; sides of trenches</td>
<td>5 Litre per Sqm of surface area.</td>
</tr>
<tr>
<td>b.</td>
<td>Back Filling</td>
<td>7.5 litre per Sqm of vertical surface in contact with the soil. The treatment shall be done in sequence of layers of filling. For spray &amp; saturating the soil holes @ 150 mm centre to centre shall be made in soil with crow bar.</td>
</tr>
<tr>
<td>c.</td>
<td>Junction of wall &amp; floor</td>
<td>7.5 Litre per Sqm of vertical wall and column surface</td>
</tr>
<tr>
<td>d.</td>
<td>External Perimetre</td>
<td>7.5 litre per Sqm of vertical surface in contract with the soil for spray &amp; saturating the soil holes @ 150mm centre to centre shall be made in soil with crow bar.</td>
</tr>
<tr>
<td>e.</td>
<td>Under Apron/ Plinth protection/ top surface of plinth filling</td>
<td>5 litre per Sqm</td>
</tr>
</tbody>
</table>

Critical areas such as trenches carrying conduits, sanitary lines and expansion joints also be treated as per specifications.

Signing guarantee Performa for anti-termite treatment i.e. satisfactory performance for minimum of ten years from the date of final completion of project on an approved Performa. The guarantee shall be executed and extended by the contractor and not by the anti-termite agency.

16.0 LIST OF INDICATIVE MAKES:

The following is the list of products and indicative makes. Bidder is free to propose any other equivalent Make meeting entire Technical Requirements, Specifications along with required details in support of the same. The same would be analyzed and accepted if found suitable after discussion between EPI and bidder. The Makes shall be finalized during Technical evaluation prior to opening of Price-Bids.

Bidders are required to offer reputed equipment / component which is strictly meeting technical requirements, enclosed specifications along with NIT and other relevant / latest applicable Standards & Rules.

**LIST OF PREFERRED VENDORS**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name of Items</th>
<th>List of approved manufacturers / brand / applicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Civil Works</td>
<td>ACC / Grasim / Ambuja / Ultratech / Lafarge and equivalent</td>
</tr>
<tr>
<td>1.</td>
<td>Cement</td>
<td>SAIL, TISCO, RINL and equivalent</td>
</tr>
<tr>
<td>2.</td>
<td>Reinforcement Steel TMT Bars (Fe 500 grade) &amp; TMT Re-bars conforming to IS 1786-2008 Fe500 corrosion resistant steel grade</td>
<td>SAIL, Tata Steel Limited, Rashtriya Ispat Nigam Ltd. (RINL), Apollo, Jindal Steel and equivalent</td>
</tr>
<tr>
<td>3.</td>
<td>Structural Steel, MS Plates, ISMB Etc.</td>
<td>SAIL, Tata Steel Limited, Rashtriya Ispat Nigam Ltd. (RINL), Apollo, Jindal Steel and equivalent</td>
</tr>
</tbody>
</table>

**B ELECTICAL WORK**

| 1      | 11KV VCB Panel Board With Built in HT AVR         | ABB-Ambit Switchgears. Schneider - Sudhir Siemens (APSPL) and equivalent                 |

Tech. Spécification - 60
<table>
<thead>
<tr>
<th>No.</th>
<th>Component Description</th>
<th>Manufacturers</th>
</tr>
</thead>
</table>
| 2   | Distribution Transformer (Oil Type) (OLTC Type)                       | Crompton Greaves  
Intra Vidyut Ltd  
Kirloskar  
Voltamp  
ESENNAR and equivellant |
| 3   | Package / Compact Type Substation                                      | ABB  
ESENNAR  
Schneider - Sudhir and equivellant |
| 4   | Main L.T. Panel, Capacitor Panel & AMF Panel                           | Adlec Systems Pvt. Ltd.  
Advance Panel & Switchgear (P) Ltd.  
Sudhir Gensets Ltd.  
Jakson Engineers Ltd.  
Conquerent Controls Pvt. Ltd. (Madhu Electrical)  
and equivellant |
| 5   | Air Circuit Breaker                                                   | Schneider Electric (Master pact – MVS)  
Siemens (3 WT)  
L&T (C Power)  
Eaton Power Quality Pvt. Ltd. and equivellant |
| 6   | Moulded Case Circuit Breaker with rotary operating handle.            | L & T (D Sine & DH Range)  
Siemens (3VT)  
Schneider (Compact CVS)  
Eaton Power Quality Pvt. Ltd. and equivellant |
| 7   | Contactors, Timers, HRC Fuses, Fuse Fitting, Indicating Lamps.        | L & T  
Siemens  
Schneider Electric and equivellant |
| 8   | Miniature Circuit Breaker                                             | Schneider Electric (Multi-9)  
Legrand  
Hager and equivellant |
| 9   | Capacitor                                                             | L & T  
EPCOS  
Matrix and equivellant |
| 10  | APFC Relay (Microprocessor based)                                     | Conzerv  
L & T  
EPCOS  
Trinity and equivellant |
| 11  | Protective Relays                                                     | L & T  
Alstom  
Conzerv and equivellant |
| 12  | Energy Analyser Meter                                                 | L & T  
AMTL  
Secure  
EL-Measure  
Conzerv and equivellant |
| 13  | Current Transformer                                                   | AE  
Kappa  
Newtek Electricals (Aurangabad) and equivellant |
| 14  | Voltmeter, Ammeter Selector Switch                                     | AE  
Rishline (L & T)  
MECO  
Kaycee and equivellant |
| 15  | Indicating Lamp                                                       | L & T  
Siemens and equivellant  
Kaycee |
| 16  | PLC                                                                    | Allan Bradley  
Siemens and equivellant |
<p>| 17  | L.T. Cable, 1.1 KV grade XLPE                                        | Havell’s |</p>
<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>XLPE 11 KV Cable</td>
<td>Skytone, Gloster, Havell’s, Nicco and equivellant</td>
</tr>
<tr>
<td>19</td>
<td>Termination Kits (Heat shrinkable Type)</td>
<td>Raychem, Xicon (CCI), Denson</td>
</tr>
<tr>
<td>20</td>
<td>Cable Lug (Tinned Copper)</td>
<td>Dowells, Multi, Capital, Action and equivellant</td>
</tr>
<tr>
<td>21</td>
<td>Cable Gland</td>
<td>Peeco, Commet, Gripwell, Dowells and equivellant</td>
</tr>
<tr>
<td>22</td>
<td>Cable Tray</td>
<td>Fedders Lloyd Corp. Ltd, Sloco, Pillco, Indiana and equivellant</td>
</tr>
<tr>
<td>23</td>
<td>Battery Charger</td>
<td>Uptron, Volstat Electronics, AE, Statcon and equivellant</td>
</tr>
<tr>
<td>24</td>
<td>Batteries</td>
<td>Exide, Standard Furukawa, Prestolite and equivellant</td>
</tr>
<tr>
<td>25</td>
<td>MS &amp; GI Pipes</td>
<td>Jindal - Hissar, Jindal Star (above 150MM), Tata and equivellant</td>
</tr>
<tr>
<td>26</td>
<td>MS Conduit &amp; Accessories (ISI Marked)</td>
<td>BEC, AKG and equivellant</td>
</tr>
<tr>
<td>27</td>
<td><strong>Diesel Generator Set</strong></td>
<td></td>
</tr>
<tr>
<td>27a</td>
<td>Diesel Engine</td>
<td>Cumins - Sudhir Genesets Ltd, Caterpillar, Perkins, Volvo Penta and equivellant</td>
</tr>
<tr>
<td>27b</td>
<td>Alternator</td>
<td>Kirloskar Electric Company, Stamford, Leroy somer and equivellant</td>
</tr>
</tbody>
</table>
17.0 LIST OF TENDER DRAWINGS.

<table>
<thead>
<tr>
<th>S.NO</th>
<th>DRAWING TITLE</th>
<th>DRAWING NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SITE PLAN SUBSTATION, COMPACT TYPE SUBSTATION, HT &amp; LT CABLE ROUTE LAYOUT</td>
<td>ESC/CUJ/EL-SITE-01</td>
</tr>
<tr>
<td>2</td>
<td>SITE PLAN (SUB PHASE-I)</td>
<td>ESC/CUJ/EL-SITE-02  (SB-PH-1)</td>
</tr>
<tr>
<td>3</td>
<td>SINGLE LINE DIAGRAM FOR SUBSTATION 1 TO 6 (COMMERCIAL BUILDINGS)</td>
<td>ESC/CUJ/SS-SLD-01</td>
</tr>
<tr>
<td>4</td>
<td>SINGLE LINE DIAGRAM FOR RESIDENCIAL AREA WITH COMPACT/PACKAGE TYPE SUBSTATION</td>
<td>ESC/CUJ/SS-SLD-02</td>
</tr>
<tr>
<td>5</td>
<td>CIVIL WORK (SUBSTATION PLAN)</td>
<td>A-01</td>
</tr>
</tbody>
</table>