

PORBANDAR MUNICIPAL CORPORATION – PORBANDAR

PORBANDAR

BID DOCUMENTS FOR SUPPLY, INSTALLATION, TESTING AND COMMISSIONING OF 100 KVA SILENT DIESEL GENERATOR SET WITH AUTOMATIC CONTROL PANEL INCLUDING ELECTRICAL CONNECTIONS, AND ALL ASSOCIATED WORKS AT CHHAYA BUILDING FOR PORBANDAR MUNICIPAL CORPORATION.

Item no.:1

Supplying and erecting, commissioning and testing of Diesel Generating set confirming to IS: 4722:1968 & BS:5514 having continuous rating, 3 phase, 415 volts, 50 cycles A.C. supply comprising of a totally enclosed air/water cooled diesel engine with multi-cylinders developing suitable BHP not less than following capacity at 1500 RPM with 10% overload for one hour in 24 hours with standard accessories like fly wheel, lubricating oil cooler, "A" class governor, heavy duty fuel wheel and lubricating oil filter, oil bath air filler, lubricating oil pressure gauge, end exhaust manifold, standard set of tools with adjustable spanners, screw drivers, cylinder head to cover, joint cylinder head to exhaust, element lube oil filter, 12 / 24 volts electric starting equipment complete with standard heavy duty battery, dynamo, cut-outs, ammeter, necessary wiring, pressure gauge, starter etc and heavy duty Residential type exhaust silencer (With DEF System) and vertical hot air duct both logged with asbestos rope, save oil trays, exhaust piping of required length, standard wall/floor mounted fuel with level indicator and piping and drip proof alternator, self excited, self regulated, screen protected, with excitation system, capable of delivering the rated system output at 415 volts, 3 phase, 0.8 PF, 50 Hz, 4 wire, running at 1500 RPM, conforming to IS-4722- 1968 with voltage regulation $\pm 5\%$ of rated voltage from no load to full load. Both the engine and alternator fitted on a common fabricated steel base plate with antivibration mounting engine and alternator both connected to each other by flexible flange coupling and with floor/wall mounted control panel box comprising of voltmeter ammeter, selector switches, ACB / MCCB / MCB of adequate capacity, indicator lamps duly wired with HRC fuses. The alternator & control panel shall be connected with provided suitable capacity armoured cable and complete with Acoustic enclosure (canopy) made out of 16 SWG CRCA Sheet, sound absorbing material Rockwool of 64 density & 100 mm thick conforming to IS:8183 / PU Foam of 40 Density - at least 40 mm. The resin bonded rockwool covered from inside the canopy by perforated sheet with 3/4 mm holes, sound level not more than 75 dB at a distance of 1 mtr, as per PVCT norms. DG set should have in built fuel tank capacity of minimum 8 hrs of continuous running capacity on full load . Erection, commissioning and satisfactory testing as per

requirement with first filling of fuel (minimum up to the 80% of fuel tank capacity), oil, etc. with guarantee / Warrantee of complete system for Two years. & with obtaining all necessary certificate from Electrical Inspector. The Capacity and Ratings of DG sets are as below. (As per new CPCB4+ Emission norms Engine With - Turbo Charger, EGR (Exhaust Gas Recirculation), CRS (Common Rail Fuel System), DOC (Diesel Oxidation Catalyst), SCR (Selective Catalytic Reduction), Integrated wiring harness connected to ECU .) (L) Continuous rating of 100 KVA ,BHP not less than 126 BHP

1. Scope of Work

The work shall include supply, installation, testing, commissioning and obtaining approval from the Electrical Inspector for a complete 100 kVA DG set suitable for continuous duty operation, including engine, alternator, control panel, fuel system, exhaust system, acoustic enclosure, cabling, earthing, accessories, first fill of fuel and lubricants, and all associated works required for satisfactory operation.

2. Applicable Standards

The DG Set shall conform to the latest editions of:

- IS 4722 – Rotating Electrical Machines for Generating Sets
- BS 5514 – Reciprocating Internal Combustion Engines
- IS 13364 – Performance Requirements of Diesel Generating Sets
- IS/IEC 60034 – Alternators
- IS 3043 – Code of Practice for Earthing
- IS 2026 – Power Transformers (where applicable)
- CPCB-IV+ Emission Norms
- Central Electricity Authority (CEA) Regulations
- Applicable State Electrical Inspectorate Requirements

3. DG Set Rating

- Continuous Rating: **100 kVA**
- Prime Power Output: 100 kVA at 0.8 PF
- Voltage: 415 Volts $\pm 5\%$
- Frequency: 50 Hz

- Phase: 3 Phase, 4 Wire
- Speed: 1500 RPM
- Duty: Continuous Duty
- Overload Capacity: 10% overload for one hour in every 24 hours
- Minimum Engine Output: **126 BHP**

4. Diesel Engine

The engine shall be:

- Water cooled, four-stroke cycle diesel engine.
- Multi-cylinder inline configuration.
- Turbocharged and after-cooled.
- Suitable for direct coupling with alternator.
- Capable of developing not less than 126 BHP at 1500 RPM.
- Electric start system with 12V/24V batteries.
- Mechanical/Electronic Class-A Governor.
- Complete with:
 - Flywheel
 - Lubricating oil cooler
 - Heavy-duty fuel filter
 - Lube oil filter
 - Dry/Oil bath air cleaner
 - Fuel injection system
 - Engine protection devices
 - Engine instrumentation

5. CPCB-IV+ Emission Compliance

Engine shall comply with CPCB-IV+ norms and shall incorporate:

- Turbo Charger

- EGR (Exhaust Gas Recirculation)
- CRS (Common Rail Fuel System)
- DOC (Diesel Oxidation Catalyst)
- SCR (Selective Catalytic Reduction)
- DEF (Diesel Exhaust Fluid/AdBlue) System
- Electronic Control Unit (ECU)
- Integrated Wiring Harness
- Necessary Sensors and Monitoring Devices

Manufacturer shall provide emission compliance certificate from CPCB-approved authority.

6. Alternator

The alternator shall be:

- Brushless, self-excited and self-regulated.
- Screen protected and drip-proof.
- Class-H insulation.
- Tropicalized and vacuum impregnated windings.
- Suitable for continuous operation at 50°C ambient temperature.
- Voltage Regulation: $\pm 5\%$ from no load to full load.
- Rated Output: 100 kVA, 415V, 3 Phase, 50 Hz.
- Degree of Protection: IP23 minimum.

7. Base Frame and Mounting

- Common fabricated steel base frame.
- Anti-vibration mounting pads.
- Integral fuel tank arrangement.
- Lifting hooks and transportation provisions.
- Base frame painted with corrosion-resistant epoxy paint.

8. Fuel System

The fuel system shall comprise:

- Built-in fuel tank with minimum 8-hour full-load running capacity.
- Fuel level indicator.
- Fuel piping with valves and accessories.
- Fuel return arrangement.
- Fuel filtration system.
- First filling of diesel up to minimum 80% tank capacity.

9. Exhaust System

The exhaust system shall include:

- Residential grade exhaust silencer.
- Heavy-duty insulated exhaust piping.
- Flexible exhaust bellows.
- Vertical hot air duct.
- Thermal insulation using asbestos-free insulation rope/mineral wool.
- Rain cap and support structure.

10. Acoustic Enclosure

The canopy shall be factory fabricated and weatherproof.

Construction:

- 16 SWG CRCA sheet steel.
- Powder-coated finish.

Acoustic Treatment:

- Rockwool insulation:
 - Density: 64 kg/m³
 - Thickness: 100 mmOR
- PU Foam:

- Density: 40 kg/m³
- Thickness: minimum 40 mm

Features:

- Lockable access doors.
- Viewing windows.
- Emergency stop push button.
- Ventilation louvers.
- Internal perforated metal sheet lining.

Noise Level:

- Maximum 75 dBA at 1 metre distance under full load condition.

11. Control Panel

The DG control panel shall be floor/wall mounted and include:

- Voltmeter with selector switch.
- Ammeter with selector switch.
- Frequency meter.
- Hour run meter.
- Indicator lamps.
- Engine start/stop controls.
- Battery charger.
- HRC fuses.
- MCCB/ACB of suitable rating.
- Protection against:
 - Overload
 - Short circuit
 - Over speed
 - Low lube oil pressure

- High coolant temperature
- Battery charging failure
- Emergency shutdown

12. Batteries and Starting System

- Heavy-duty maintenance-free batteries.
- Battery stand.
- Battery cables and terminals.
- Alternator charging system.
- Automatic battery charger.

13. Cabling

- Armoured XLPE insulated copper/aluminium cable of suitable size.
- Complete with glands, lugs, ferrules and termination accessories.
- Cable tray/supports wherever required.

14. Earthing

The DG set shall be provided with independent earthing for:

- Engine body
- Alternator body
- Neutral
- Control panel
- Acoustic enclosure

Earthing shall conform to IS 3043.

15. Testing and Commissioning

The following tests shall be carried out:

- Insulation Resistance Test.
- Earth Continuity Test.
- Voltage Regulation Test.

- Frequency Stability Test.
- Full Load Trial Run.
- Load Acceptance Test.
- Noise Level Measurement.
- Emission Compliance Verification.
- Functional Testing of Protection Systems.

16. Documentation

The contractor shall provide:

- Manufacturer's Test Certificates.
- CPCB-IV+ Compliance Certificate.
- Electrical Inspector Approval.
- Operation & Maintenance Manuals.
- Wiring Diagrams.
- Spare Parts List.
- Warranty Documents.

17. Warranty

- Comprehensive Warranty: **24 Months** from date of commissioning.
- Warranty shall cover engine, alternator, ECU, DEF system, control panel, acoustic enclosure and all accessories.

18. Approved Makes

- Engine: Kirloskar / Cummins / Greaves or approved equivalent.
- Alternator: Stamford / Leroy Somer / Kirloskar or approved equivalent.
- **Battery:** Exide / Amaron / Amco
- **Control Panel Components:** L&T / Siemens / Schneider / ABB

Measurement Unit: Per Number (Each) complete installed and commissioned DG Set.

Item no.:2

Providing & erecting approved make AMF control panel suitable for following size of 3 phase, 415 V., 50 cycles, A.C. diesel generating set complete of scope as detailed below:

1) Power module: A pair of electromechanically interlocked contactors (for mains & generator) Overload relay for generator contactor Neutral contactor for mains and generator Power socket for connections.

2) Control and metering module: Line voltage monitor. Generator voltage monitor Ammeter 3 items attempt start facility. Air circuit breakers/MCB/MCCB of suitable rating for auto/manual operation. Auto/manual switch. Emergency stop push buttons. Manual start push button. frequency meter. Engine hour meter. Two earthing studs. 3) **Protection module:** The engine shutdown in the unlikely event of Low lube oil pressure High cylinder head temperature. V belt failure.

4) Indicators with alarm Load on generator.

5) Indicators Load on mains Engine fails to start . Emergency stop battery charger.

The AMF Panel of following capacity (C) AMF Control Panel for 100 KVA/125 KVA 3 phase DG Set

1. Applicable Standards

- IS/IEC 61439 (LV switchgear & controlgear assemblies)
- IS/IEC 60947 series (contactors, MCCB/MCB, overload relays)
- IS/IEC 60051 / IEC 61557 (meters and monitoring devices)
- IS 3043 (earthing)
- CEA safety regulations and local Electrical Inspector requirements

2. System Rating

Parameter	Requirement
DG Compatibility	Set 100 kVA / 125 kVA
System Voltage	415 V AC, 3-phase, 4-wire
Frequency	50 Hz
Control Supply	12 V / 24 V DC (matching engine starting system) with battery charger

Parameter	Requirement
Switching Duty	Automatic transfer between mains and generator with no parallel operation

3. Power Module

The AMF panel shall contain:

1. One mains contactor and one generator contactor of AC-3 duty, rated for the DG output current and fault level.
2. Electromechanical interlocking between mains and generator contactors to prevent simultaneous closure.
3. Generator overload relay (adjustable thermal/electronic type) coordinated with the generator contactor.
4. Neutral switching arrangement: neutral contactor/pole for mains and generator as per system design and applicable code requirements.
5. Power terminals / socket arrangement suitable for incoming mains, DG input and outgoing load connections.
6. MCCB/ACB/MCB of suitable rating for protection and isolation of mains and generator circuits.

Minimum current ratings

Current ratings shall be selected on the basis of DG full-load current and prospective fault level. For reference, a 100 kVA, 415 V, 0.8 PF DG has a full-load current of approximately 139 A; a 125 kVA DG approximately 174 A. Contactors, MCCBs and busbars shall have adequate margin above these values.

4. Control & Metering Module

The panel shall provide automatic and manual operation with the following controls and instrumentation:

Feature	Requirement
Line Voltage Monitor	Monitors mains voltage for undervoltage/phase failure and initiates AMF sequence

Feature	Requirement
Generator Monitor	Voltage Verifies DG voltage before load transfer
Ammeter	Three ammeters (or multifunction meter with phase current indication)
Frequency Meter	Generator frequency indication
Engine Hour Meter	Non-resettable running hours indication
Auto/Manual Selector	Maintained switch for AMF or manual operation
Manual Start Button	Push For local manual starting of engine
Emergency Stop Button	Push Mushroom head, maintained latch type
Attempt Start Facility	Minimum three automatic crank attempts with adjustable crank/rest timers
Earthing Studs	Two external earthing studs bonded to panel body

5. Protection Module

The AMF panel shall receive engine protection signals from the DG engine/ECU or dedicated sensors and shall shutdown the engine on any of the following trips:

- Low lube oil pressure
- High cylinder head / coolant temperature
- V-belt failure (where sensor/contact is provided)

Protection contacts shall be fail-safe where available and shall generate both visual alarm and shutdown indication.

6. Indications & Alarms

LED indicators with audible alarm shall be provided for, at minimum:

Status / Alarm	Type
Load on Generator	Green indication
Load on Mains	Green indication
Engine Fails to Start	Red indication + alarm
Emergency Stop Activated	Red indication + alarm
Battery Charger Healthy / Fail Indication (green/red as applicable)	
Common Fault	Amber/red indication + alarm

An Alarm Accept / Silence push button shall be provided; fault indication shall remain latched until reset after fault clearance.

7. Functional Sequence (AMF Logic)

1. On healthy mains, mains contactor remains closed and DG remains stopped.
2. On mains failure (undervoltage/phase loss as set), the controller starts the DG automatically.
3. After DG reaches rated voltage and frequency and an adjustable warm-up delay expires, the panel transfers load to DG by opening mains contactor and closing generator contactor.
4. On restoration of healthy mains and expiry of return delay, the panel retransfers load to mains, opens generator contactor, and runs the DG unloaded for an adjustable cool-down period before stopping.
5. If DG fails to start after the configured attempts, Engine Fails to Start alarm is generated and no transfer to DG occurs.

8. Panel Construction

Item	Requirement
Enclosure	CRCA steel, floor/wall mounted as specified
Ingress Protection	Minimum IP42 indoor / IP54 outdoor (as applicable)

Item	Requirement
Busbars	Tinned copper or aluminium, sized for continuous current and short-time withstand
Wiring	Ferruled copper control wiring, neatly loomed and identified
Finish	7-tank pretreatment and powder-coated finish, shade RAL 7032 or approved equivalent
Door Accessories	Lockable doors, danger labels, wiring diagram pocket

9. Battery Charger

The panel shall include a float-cum-boost automatic battery charger suitable for the engine starting battery voltage (12 V or 24 V DC), with current limiting, reverse polarity protection and charger healthy/fail indication.

10. Earthing & Cabling

- Panel body shall be bonded to the earth bar.
- Two external earthing studs shall be provided.
- Power and control cable glands/lugs shall be included for the specified cable sizes.
- Internal neutral and earth bars shall be clearly segregated and labelled.

11. Tests & Commissioning

Factory routine tests and site commissioning shall include:

- Visual inspection and wiring verification
- Insulation resistance test
- Functional test of contactor interlocking
- Protection/alarm simulation (low oil pressure, high temperature, fail to start, emergency stop)
- AMF sequence test with simulated mains failure and restoration
- Load transfer and retransfer verification
- Battery charger operation test

- Earth continuity test

All settings (voltage thresholds, delays, crank attempts, cool-down time) shall be documented and handed over.

12. Deliverables

- Approved GA drawing and schematic diagram
- Bill of materials and datasheets
- Factory test report
- Site commissioning report
- O&M manual
- Warranty certificate (minimum 12 months unless project specification requires longer)

Project note

If the DG set uses an ECU-based engine with CAN/J1939 communication, the AMF controller shall be compatible with the engine interface and shall support remote start/stop, engine status, alarms and shutdowns through the ECU in addition to hardwired backup contacts where provided by the engine manufacturer.

Item no.:3

Supply, installation, testing and commissioning of 100 KVA, 3-Phase, Oil Cooled Automatic Servo Voltage Stabilizer suitable for indoor installation, complete with microprocessor based control system, input MCCB protection, bypass changeover switch, digital LCD display for input/output voltage and load current indication, over voltage, under voltage, overload, short circuit and single phasing protections, AC synchronous stepper motor driven servo mechanism, individual phase dimmers and buck boost transformers, busbar connection arrangement, shunt trip cut-off facility, earthing bolt, powder coated enclosure conforming to IS:9815, suitable for input voltage range 330–500 Volt AC and output 415 Volt AC $\pm 1\%$, frequency 47–63 Hz, oil cooled with first filling of transformer oil conforming to IS:335, including all accessories, internal wiring, mounting arrangement, labour, testing and commissioning, Online Support will be provided (24 X 7) without any extra cost, complete as directed by the Engineer-in-Charge. Transportation, loading, unloading, installation, and all incidental works complete.

1. Scope of Work

The work shall comprise the supply, installation, testing and commissioning (SITC) of a 100 kVA, 3-Phase, Oil-Cooled Automatic Servo Voltage Stabilizer (AVS) suitable for indoor installation, complete with all accessories, protection devices, control systems, transformer oil, cabling terminations, testing and commissioning, as specified herein and approved by the Engineer-in-Charge.

2. Applicable Standards

The equipment shall conform to the latest editions of:

- IS 9815 – Automatic Voltage Stabilizers
- IS 2026 – Power Transformers
- IS 335 – Transformer Oil Specifications
- IS/IEC 60076 – Power Transformers
- IS/IEC 60947 – Low Voltage Switchgear and Controlgear
- IS 8623 / IEC 61439 – Low Voltage Switchgear Assemblies
- IS 3043 – Earthing Code of Practice
- Applicable CEA Regulations

3. Electrical Ratings

Parameter	Requirement
Capacity	100 kVA
System	3 Phase, 4 Wire
Input Voltage Range	330 V – 500 V AC
Output Voltage	415 V AC
Output Regulation	±1%
Frequency	47 Hz – 63 Hz
Duty	Continuous Duty
Cooling Method	Oil Cooled
Installation	Indoor Type

Parameter	Requirement
Efficiency	Minimum 98% at Full Load
Waveform Distortion	Nil Additional Distortion

4. Stabilizer Construction

The stabilizer shall consist of:

Servo Control System

- Microprocessor-based digital controller.
- High-speed voltage sensing and correction system.
- Independent phase-wise voltage correction.
- Automatic balancing of output voltage.
- Stable operation under fluctuating supply conditions.

Servo Motor

- AC synchronous stepper motor driven mechanism.
- Maintenance-free design.
- Fast correction speed.
- High positioning accuracy.

Variac Assembly

- Copper wound continuously variable auto-transformer.
- Carbon brush assembly with low wear rate.
- Suitable for continuous operation.

Buck-Boost Transformers

- Individual buck-boost transformers for each phase.
- Copper winding construction.
- Vacuum impregnated windings.
- Suitable for full load operation.

5. Oil-Cooled Transformer Assembly

The transformer section shall be:

- Oil immersed type.
- Copper wound.
- Naturally oil cooled.
- Filled with insulating transformer oil conforming to IS:335.
- First filling of transformer oil included in the scope.
- Suitable for tropical climatic conditions.

The oil tank shall be provided with:

- Oil level indicator.
- Drain valve.
- Filling plug.
- Air release plug.
- Earthing terminal.
- Lifting hooks.

6. Control and Monitoring System

The stabilizer shall be equipped with a microprocessor-based controller incorporating:

Digital Display

LCD/LED Digital Display indicating:

- Input Voltage (R-Y-B)
- Output Voltage (R-Y-B)
- Load Current (R-Y-B)
- Frequency
- Load Percentage
- Fault Indications
- Operational Status

Monitoring Functions

- Continuous voltage monitoring.
- Output voltage correction monitoring.
- Fault diagnostics.
- Event indication.

Online Support

- Provision for 24 × 7 online technical support.
- Remote diagnostics support as offered by manufacturer.
- Software and firmware support during warranty period.

7. Protection Features

The stabilizer shall be provided with the following protections:

Electrical Protections

- Input MCCB Protection.
- Over Voltage Protection.
- Under Voltage Protection.
- Over Load Protection.
- Short Circuit Protection.
- Single Phasing Protection.
- Phase Failure Protection.
- Output Over Voltage Cut-Off.
- Output Under Voltage Cut-Off.

Motor Protection

- Servo Motor Overload Protection.
- Motor Stall Protection.

Safety Protection

- Shunt Trip Cut-Off Facility.

- Emergency Isolation Facility.
- Internal Fuse Protection.

8. Switching Arrangement

The unit shall be provided with:

Input Protection

- MCCB of suitable rating.
- Adjustable thermal-magnetic release.
- Short circuit breaking capacity suitable for site fault level.

Bypass Arrangement

- Manual bypass changeover switch.
- Maintenance bypass facility.
- Interlocked operation to prevent wrong switching.

Busbar Arrangement

- Heavy duty copper busbars.
- Properly insulated and shrouded.
- Adequately rated for full load current.

9. Enclosure

The stabilizer enclosure shall be:

- Fabricated from CRCA steel sheets.
- Indoor type construction.
- Powder-coated finish.
- Corrosion resistant.
- Floor mounted.
- Ventilated design.

Enclosure Features

- Lockable access doors.

- Inspection windows.
- Cable entry provision.
- Name plate.
- Danger notice.
- Earthing studs.

Minimum Degree of Protection:

- IP21 for indoor installation (or higher as specified).

10. Earthing

The stabilizer shall be provided with:

- Minimum two earthing terminals.
- Internal earth bus.
- Earthing bolt/stud on enclosure body.
- Earthing as per IS 3043.

11. Internal Wiring

Internal wiring shall be:

- FRLS copper conductors.
- Ferruled and identified.
- Neatly dressed and clamped.
- Suitable for operating temperature conditions.

12. Testing

Routine Factory Tests

- Ratio Test.
- Voltage Regulation Test.
- Functional Operation Test.
- Insulation Resistance Test.
- High Voltage Test.

- Phase Balancing Test.
- Controller Functional Test.
- Protection Operation Test.

Site Tests

- Installation Inspection.
- IR Value Measurement.
- Earthing Verification.
- Input-Output Voltage Verification.
- Load Trial Run.
- Protection Testing.
- Bypass Operation Testing.

13. Commissioning

The contractor shall:

- Transport equipment to site.
- Load, unload and position equipment.
- Fill transformer oil.
- Connect incoming and outgoing cables.
- Carry out testing and commissioning.
- Demonstrate satisfactory operation under load.
- Train operating personnel.

14. Documentation

The supplier shall furnish:

- Manufacturer's Test Certificates.
- Inspection Reports.
- GA Drawing.
- Wiring Diagram.

- Technical Data Sheet.
- Operation & Maintenance Manual.
- Warranty Certificate.

15. Warranty

- Warranty shall cover:
 - Servo motor
 - Variac assembly
 - Buck-boost transformers
 - Control electronics
 - Digital controller
 - MCCB and switching components
 - Oil leakage defects
 - Manufacturing defects

Measurement Unit

Each Unit (No.) – Complete supply, installation, testing and commissioning of 100 kVA, 3-Phase, Oil-Cooled Automatic Servo Voltage Stabilizer with all accessories, protections, first filling of transformer oil, online support facility, testing and commissioning complete.

Item no.:4

Supplying and erecting triple pole & neutral 440V / 500V panel mounting Copper Busbars with four equal Nos. of electrolyte bus having current density not more than 1.6 Amp. / sq.mm (Rated current / cross section area) duly wrapped with colour insulating tape for phase sequence of following current carrying capacity, erected with necessary bus bar supports /insulators, main cable socket to each bar, erected in existing cubical panel with necessary connections. (B) Suitable for 200 Amp. capacity

Technical Specification – 200 Amp TPN Copper Busbar System

1. Scope of Work

Supply, erection, testing and commissioning of Triple Pole and Neutral (TPN) Copper Busbar System, suitable for 440/500 Volt AC, 3 Phase, 4 Wire distribution panel, comprising four equal electrolytic copper busbars (R, Y, B and Neutral), complete with busbar supports,

insulators, cable termination pads, colour identification, hardware and all accessories required for installation inside an existing cubicle panel.

2. Applicable Standards

The busbar system shall conform to the latest editions of:

- IS 5082 – Electrolytic Copper Busbars
- IS/IEC 61439 – Low Voltage Switchgear and Controlgear Assemblies
- IS 8623 – Factory Built Assemblies of Switchgear
- IS 375 – Marking and Identification of Conductors
- IS 3043 – Code of Practice for Earthing
- Relevant CEA Regulations

3. Electrical Ratings

Parameter	Requirement
System Voltage	440/500 V AC
System Type	3 Phase, 4 Wire
Busbar Arrangement	Triple Pole + Neutral
Continuous Current Rating 200 Ampere	
Frequency	50 Hz
Short-Time Rating	Suitable for panel fault level
Current Density	Maximum 1.6 A/mm ²

4. Busbar Material

The busbars shall be manufactured from:

- High conductivity electrolytic grade copper.
- Minimum copper purity: 99.9%.
- Hard drawn copper suitable for switchboard application.
- Uniform cross-section throughout length.

- Free from cracks, laminations, burrs and surface defects.

Conductivity

- Minimum 97% IACS conductivity.

5. Busbar Sizing

The busbar cross-sectional area shall be selected based on the specified current density:

Given:

Current = 200A

Current\ Density = 1.6A/mm²

Required minimum area:

Area = 200 / 1.6 = 125 mm²

Therefore each phase and neutral busbar shall have:

Minimum Copper Cross Section

125 mm² per busbar

Typical acceptable sizes:

- 25 mm × 5 mm
- 32 mm × 4 mm
- Equivalent approved section

The final size shall satisfy current carrying capacity and temperature rise requirements.

6. Busbar Configuration

The system shall consist of:

- 1 No. Red Phase Busbar (R)
- 1 No. Yellow Phase Busbar (Y)
- 1 No. Blue Phase Busbar (B)
- 1 No. Neutral Busbar (N)

All four busbars shall be of equal cross-sectional area.

7. Insulation and Identification

Each busbar shall be:

- Wrapped with approved PVC insulating tape or heat-shrink sleeves.
- Colour coded as per IS standards:

Phase Colour

R Red

Y Yellow

B Blue

Neutral Black

Insulation shall withstand normal operating temperatures without deterioration.

8. Busbar Supports

Busbars shall be mounted on:

- Non-hygroscopic SMC/DMC insulators.
- Epoxy resin supports or approved equivalent.
- High mechanical strength supports.
- Flame-retardant and tracking-resistant material.

Support spacing shall be designed to withstand electrodynamic forces during short circuits.

9. Cable Termination Arrangement

The busbar system shall include:

- Copper termination pads.
- Drilled holes for cable lugs.
- Tinned contact surfaces.
- Suitable cable sockets/lugs.
- Brass or high tensile galvanized hardware.

All joints shall ensure low contact resistance.

10. Hardware

All fixing hardware shall comprise:

- Brass nuts and bolts or
- Zinc passivated high tensile steel hardware.

Spring washers and flat washers shall be provided at all bolted joints.

11. Temperature Rise Requirements

The busbar system shall be designed so that:

- Temperature rise does not exceed limits specified in IS/IEC 61439.
- Hot spots are avoided.
- Continuous operation at rated current is possible without overheating.

12. Earthing

The panel shall include:

- Earth continuity connection to metallic framework.
- Proper bonding of all metallic components.
- Earthing arrangement conforming to IS 3043.

13. Installation

The scope shall include:

- Dismantling of existing busbars if required.
- Fixing of insulators/supports.
- Installation of new busbars.
- Alignment and tightening of all joints.
- Termination of incoming and outgoing cables.
- Dressing and identification of conductors.
- Completion of all electrical connections.

14. Testing

The following tests shall be carried out after installation:

Visual Inspection

- Verification of dimensions.

- Colour coding check.
- Tightness of connections.

Electrical Tests

- Continuity Test.
- Insulation Resistance Test.
- Earth Continuity Test.
- Contact Resistance Check.
- Functional Verification under Load.

15. Documentation

The contractor shall submit:

- Manufacturer's Test Certificate.
- Copper Purity Certificate.
- Busbar Size Calculation.
- Installation Report.
- Test Reports.

16. Measurement

Unit: Running Meter (RM) or Set, as specified in BOQ.

Item no.:5

Providing and erecting Annealed bare Copper wire 8 to 16 SWG.

1. Scope of Work

Supply, laying, fixing, jointing and commissioning of **annealed bare copper wire of size 8 SWG to 16 SWG**, complete with all accessories, supports, clamps, saddles, connectors, jointing materials and labour required for installation as indicated in drawings and directed by the Engineer-in-Charge.

The wire shall generally be used for:

- Earthing conductors
- Bonding connections
- Lightning protection systems
- Equipment grounding

- Electrical continuity conductors

2. Applicable Standards

The material and workmanship shall conform to the latest editions of:

- IS 8130 – Conductors for Insulated Electric Cables
- IS 282 – Annealed Copper Conductors
- IS 3043 – Code of Practice for Earthing
- IS/IEC 62561 (where used in lightning protection systems)
- CEA Safety Regulations

3. Material

The conductor shall be:

- Electrolytic grade copper.
- Annealed for high flexibility.
- Bare (uninsulated) copper conductor.
- High conductivity type.
- Uniform circular cross-section.
- Free from cracks, joints, scales and surface defects.

Copper Purity

- Minimum 99.90% pure copper.

Conductivity

- Minimum 97% IACS conductivity.

4. Wire Size

The wire shall be of the specified Standard Wire Gauge (SWG) size.

Typical dimensions:

SWG Size Approx. Diameter (mm) Approx. Area (mm²)

8 SWG	4.06 mm	12.95 mm ²
10 SWG	3.25 mm	8.30 mm ²
12 SWG	2.64 mm	5.47 mm ²
14 SWG	2.03 mm	3.24 mm ²
16 SWG	1.63 mm	2.08 mm ²

The exact size shall be as specified in the drawing or BOQ.

5. Mechanical Properties

The conductor shall possess:

- Good flexibility.

- High tensile strength.
- Resistance to corrosion.
- Resistance to atmospheric oxidation.
- Adequate mechanical strength for installation and service conditions.

6. Installation Requirements

The copper wire shall be installed:

For Earthing Applications

- Along walls, ceilings, trenches or structures.
- Fixed using brass/copper saddles and clamps.
- Protected against mechanical damage where necessary.
- Routed through the shortest practical path.

For Equipment Bonding

- Securely connected to metallic equipment.
- Connected using approved copper lugs and connectors.
- Ensuring continuous electrical conductivity.

For Lightning Protection (if applicable)

- Installed as down conductors.
- Fixed with non-corrosive fasteners.
- Routed with minimum bends.
- Continuous from air termination to earth electrode.

7. Jointing

Where joints are unavoidable:

- Compression joints shall be preferred.
- Brazed or exothermic welded joints may be used where specified.
- Joints shall have conductivity equal to or greater than that of the conductor.
- All joints shall be mechanically strong and corrosion resistant.

8. Supports and Fixing Accessories

The rate shall include:

- Brass saddles.
- Copper saddles.
- Clamps.
- Spacer supports.
- Screws and fasteners.
- Joint clips.
- Connector blocks.

Support spacing shall generally not exceed:

- 0.5 m to 1.0 m for horizontal runs.
- 1.0 m to 1.5 m for vertical runs.

or as approved by the Engineer-in-Charge.

9. Electrical Requirements

The installed conductor shall provide:

- Low resistance earth continuity path.
- Reliable fault current carrying capability.
- Continuous electrical bonding.
- Compliance with IS 3043 earthing requirements.

10. Testing

After installation, the following tests shall be carried out:

Visual Inspection

- Verification of size and routing.
- Check for damage and loose connections.

Continuity Test

- Verification of electrical continuity throughout the conductor length.

Earth Continuity Test

- Measurement of continuity resistance.

Earth Resistance Test

- Where connected to an earthing system, overall earth resistance shall be measured as specified.

11. Workmanship

Installation shall ensure:

- Neat appearance.
- Straight alignment.
- Proper support spacing.
- Firm fixing without sagging.
- Protection against corrosion and mechanical damage.

12. Measurement

The item shall be measured as per BOQ

Item no.:6

Providing and erecting HOT deep Galvanized iron strip wire 8 to 16 SWG.

1. Scope of Work

Supply, laying, fixing, jointing and commissioning of **Hot-Dip Galvanized Iron (GI) Wire of size 8 SWG to 16 SWG**, complete with all accessories, clamps, saddles, fasteners, binding materials and labour required for installation, testing and commissioning as directed by the Engineer-in-Charge.

The GI wire shall be used for:

- Earthing continuity conductors
- Equipment bonding
- Lightning protection systems
- Fencing and support applications
- General electrical grounding works

2. Applicable Standards

The material and workmanship shall conform to the latest editions of:

- IS 280 – Mild Steel Wire for General Engineering Purposes
- IS 4826 – Hot-Dip Galvanized Coatings on Round Steel Wires
- IS 2629 – Hot-Dip Galvanizing Process
- IS 4759 – Zinc Coatings on Structural Steel and Iron Articles
- IS 3043 – Code of Practice for Earthing
- CEA Safety Regulations

3. Material

The wire shall be manufactured from:

- High-quality mild steel wire.
- Uniform circular section.
- Hot-dip galvanized after drawing.
- Free from cracks, scales, laminations and surface defects.

The wire shall be soft enough for easy bending and installation while possessing adequate tensile strength.

4. Galvanizing

The galvanizing shall be:

- Hot-dip galvanized process.
- Uniform zinc coating throughout the wire length.
- Smooth and adherent coating.
- Free from bare spots, blisters, flakes and rough surfaces.

Zinc Coating Requirements

The zinc coating shall conform to IS 4826 and shall withstand standard wrapping and adhesion tests without peeling or cracking.

5. Wire Sizes

The wire shall be of the specified SWG size.

SWG Size	Approx. Diameter (mm)	Approx. Area (mm ²)
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8 SWG	4.06 mm	12.95 mm ²
10 SWG	3.25 mm	8.30 mm ²
12 SWG	2.64 mm	5.47 mm ²
14 SWG	2.03 mm	3.24 mm ²
16 SWG	1.63 mm	2.08 mm ²

The size shall be as specified in the BOQ or drawings.

6. Mechanical Properties

The wire shall possess:

- Adequate tensile strength.
- Good ductility.
- Resistance to corrosion.
- Uniform diameter throughout the length.
- Capability to withstand normal installation stresses.

7. Installation Requirements

Earthing Applications

The GI wire shall be laid:

- Along walls, ceilings, cable trenches or structures.
- In the shortest practical route.
- Protected from mechanical damage where necessary.
- Properly bonded to earth electrodes and equipment.

Lightning Protection Applications

Where used as down conductors:

- The wire shall be installed vertically with minimum bends.
- Proper spacing from combustible materials shall be maintained.
- Continuous electrical path shall be ensured.

Bonding Applications

The wire shall be securely connected to:

- Metallic structures.
- Electrical panels.
- Cable trays.
- Equipment frames.
- Earthing terminals.

8. Supports and Fixing Accessories

The rate shall include:

- GI saddles.
- GI clamps.
- Spacer supports.
- Anchor fasteners.
- Binding wire.
- Screws, nuts and bolts.

Typical support spacing:

- Horizontal runs: Maximum 1.0 m.
- Vertical runs: Maximum 1.5 m.

or as approved by the Engineer-in-Charge.

9. Jointing

Where joints are necessary:

- Joints shall be mechanically secure.
- Approved compression connectors, clamps or twisted and soldered joints may be used as specified.
- All joints shall maintain electrical continuity.
- Joint locations shall be kept to a minimum.

10. Earthing Requirements

For earthing applications, installation shall comply with IS 3043 and shall provide:

- Low resistance path to earth.
- Continuous metallic continuity.
- Adequate fault current carrying capacity.
- Corrosion-resistant connections.

Connections to earth electrodes and equipment shall be made using GI clamps, bolts and nuts of approved quality.

11. Testing

After installation, the following tests shall be conducted:

Visual Inspection

- Verification of wire size.
- Galvanizing quality.
- Support spacing.
- Tightness of joints.

Continuity Test

- Verification of electrical continuity throughout the conductor route.

Earth Continuity Test

- Measurement of continuity resistance.

Earth Resistance Test

- Where connected to an earthing system, overall earth resistance shall be checked.

12. Workmanship

The completed installation shall be:

- Neatly aligned.
- Firmly fixed.
- Free from sharp bends and kinks.
- Protected against mechanical damage.
- Electrically continuous throughout its length.

13. Measurement

The item shall be measured as per BOQ.

Item no.:7

Providing and erecting XLPE(IS:7098)(I)-88 ISI armoured cable multistrand Aluminium conductor for 1.1 KV. to be laid on wall with necessary clamps or in existing trench / pipe of following size of cables (E) 3 1/2 core 95 Sq. mm (50 Sq. mm 1/2 core)

1. Scope of Work

Supply, laying, dressing, fixing, testing and commissioning of **1.1 kV grade XLPE insulated, armoured, aluminium conductor, 3½ core power cable of size 95 Sq.mm (phase conductors) + 50 Sq.mm (reduced neutral conductor)** conforming to relevant Indian Standards, complete with clamps, saddles, supports, identification tags and all accessories required for installation on wall, cable tray, trench or existing pipe/conduit as specified and directed by the Engineer-in-Charge.

2. Applicable Standards

The cable shall conform to the latest editions of:

- IS 7098 (Part 1) – XLPE Insulated PVC Sheathed Cables for Working Voltage up to 1.1 kV
- IS 8130 – Conductors for Insulated Electric Cables
- IS 5831 – PVC Insulation and Sheathing Compounds
- IS 3975 – Mild Steel Wires, Strips and Tapes for Armouring
- IS 10418 – Drums for Electric Cables
- IS 1255 – Installation and Maintenance of Power Cables
- IS 3043 – Earthing Code of Practice

3. Cable Description

The cable shall be:

- Rated Voltage: 1100 Volts (1.1 kV)
- Type: XLPE Insulated, PVC Sheathed
- Conductor Material: Aluminium
- Conductor Construction: Multistrand, compacted
- Number of Cores: 3½ Core
- Armour: Galvanized Steel Wire/Strip Armour
- Outer Sheath: PVC, FR grade, black colour
- Suitable for indoor and outdoor installation.

4. Conductor

The conductor shall be:

- High conductivity aluminium.
- Stranded and compacted.
- Circular shaped.
- Class-2 conductor as per IS 8130.

Conductor Sizes

Core	Size
R Phase	95 Sq.mm
Y Phase	95 Sq.mm
B Phase	95 Sq.mm
Neutral (Half Core)	50 Sq.mm

Total Configuration:

3½ Core × 95 Sq.mm + 50 Sq.mm Neutral

5. Insulation

The insulation shall be:

- Cross Linked Polyethylene (XLPE).
- Extruded type.
- Suitable for continuous conductor temperature of 90°C.
- High insulation resistance.
- Resistant to moisture, chemicals and ageing.

6. Core Identification

The insulated cores shall be identified by colour coding or numbering as per IS requirements:

- Red – Phase R
- Yellow – Phase Y
- Blue – Phase B
- Black – Neutral

7. Inner Sheath

An extruded PVC inner sheath shall be provided:

- Over laid-up cores.
- Compatible with insulation and armour.
- Smooth and uniform finish.
- Resistant to moisture and mechanical damage.

8. Armouring

The cable shall be armoured with:

- Galvanized Steel Wire Armour (GSWA) or
- Galvanized Steel Strip Armour (GSTA)

as applicable to cable size.

Armour Requirements

- Adequate mechanical protection.
- Corrosion resistant.
- Suitable for underground and exposed installation.

9. Outer Sheath

The outer sheath shall be:

- Extruded PVC.
- FR (Flame Retardant) type.
- Black colour.
- Resistant to sunlight, moisture, fungus and chemicals.

10. Electrical Characteristics

Parameter	Requirement
Voltage Grade	1.1 kV
Frequency	50 Hz
Maximum Conductor Temperature	90°C
Short Circuit Temperature	Up to 250°C
Insulation Resistance	As per IS 7098
Dielectric Strength	As per IS 7098

11. Installation

The cable shall be installed:

On Wall

- Fixed using approved heavy-duty MS/GI clamps.
- Supported at regular intervals.
- Properly aligned and dressed.
- Protected against mechanical damage.

In Existing Trench

- Laid in existing cable trench.
- Properly supported.
- Maintained with required separation from other services.

In Existing Pipe

- Drawn through existing GI/HDPE/RCC conduit.
- Without damaging insulation or sheath.
- Using approved cable pulling methods.

12. Cable Termination

The scope shall include:

- Cable cutting.
- Dressing.
- Identification.
- Glanding and termination where specified.
- Earthing of armour.
- Cable tags and ferrules.

Suitable aluminium compression lugs shall be used for terminations.

13. Earthing

The cable armour shall be effectively earthed at both ends or as specified in the design.

Earthing shall conform to IS 3043.

14. Testing

The following tests shall be conducted before and after installation:

Factory Tests

- Conductor Resistance Test.
- High Voltage Test.
- Insulation Resistance Test.
- Spark Test.
- Physical Tests on Insulation and Sheath.

Site Tests

- Insulation Resistance Test using Megger.
- Continuity Test.
- Phase Identification.
- Earth Continuity Test.
- Functional Load Test.

15. Workmanship

Installation shall ensure:

- No damage to insulation or sheath.
- Proper bending radius maintained.

- Neat cable routing.
- Correct clamping and support spacing.
- Proper identification of cable runs.

16. Measurement

The cable shall be measured in **Running Metres (RM)** along the actual route laid.

Item no.:8

Supplying & erecting in earthpit of minimum bore dia. 225mm size approved make Safe Earthing Electrode consisting Pipe-in-Pipe Technology as per IS 3043-1987 made of corrosion free hot dipped G.I.Pipes having Outer pipe dia of 80 mm having 80-200 Micron galvanising, Inner pipe dia of 40 mm having 200-250 Micron galvanising, connection terminal dia of 14 mm with constant ohmic value surrounded by highly conductive compound with high charge dissipation suitable for following type of applications with chamber and heavy duty cover (A)(approved make OEM has to submit test certificate including value of earth resistance of installation duly stamped and signed by agency and officer Incharge has to ensure the value of earthing resistance mentioned in test Certificate) & having back filling compound of (B) Inner chemical (CCM Compound)- Resistivity:- 0.2 ohm / meter testing as per IEC 62561-2017, Voltage drop:- < 1 volt at no load & dry form, Sulphur content:- <2%(C) Back fill Compound :- Earthing compound should be capable to retain moisture for long time Necessary test report must be submitted by Agency.

[C] For Electrical Installation covering Transformer Neutrals, Lightning arrester Earthing, A.C.Plant & Sensitive Computer System (like Automation, SCADA) i.e. independent Earthing located in other than normal soil i.e. Soft Rock, Marshy Soil etc..

-Length of Pipe : 3 Mtrs.

-Back filling Compound :2 nos Bags of 25 Kg.

1. Scope of Work

Supply, installation, testing and commissioning of approved make **Maintenance-Free Chemical Earthing Electrode** based on **Pipe-in-Pipe Technology**, complete with earth pit excavation/drilling, conductive backfill compound, inspection chamber, heavy-duty cover, earthing lead connection, testing and commissioning, suitable for transformer neutral earthing, lightning arrester earthing, HVAC plants, automation systems, SCADA systems, computer installations and other sensitive electrical equipment in difficult soil conditions such as soft rock, marshy soil and high-resistivity soils.

2. Applicable Standards

The earthing system shall conform to:

- IS 3043:1987 (Code of Practice for Earthing)
- IEC 62561-7:2017 (Lightning Protection Components – Earthing Enhancing Compounds)
- IS 2629 (Hot Dip Galvanizing)
- IS 4759 (Zinc Coating on Iron and Steel Articles)
- CEA Safety Regulations
- Relevant Electricity Board Requirements

3. Earthing Electrode Construction

The maintenance-free earthing electrode shall be manufactured using **Pipe-in-Pipe Technology** consisting of concentric hot-dip galvanized GI pipes.

Outer Pipe

Parameter	Requirement
Material	Hot Dip Galvanized GI Pipe
Diameter	80 mm
Length	3.0 m
Galvanization Thickness	80–200 Microns

Inner Pipe

Parameter	Requirement
Material	Hot Dip Galvanized GI Pipe
Diameter	40 mm
Length	3.0 m
Galvanization Thickness	200–250 Microns

Terminal Arrangement

Parameter	Requirement
Connection Terminal Diameter	14 mm
Material	Corrosion Resistant GI/Steel
Connection Type	Bolted Clamp Arrangement

The electrode shall be capable of maintaining a stable and low earth resistance value throughout its service life.

4. Earth Enhancement Compound (Inner Chemical CCM Compound)

The electrode shall be factory-filled with conductive chemical compound having the following characteristics:

Property	Requirement
Resistivity	0.2 Ohm-Metre or Better
Test Standard	IEC 62561-7:2017
Voltage Drop	Less than 1 Volt at No Load and Dry Condition
Sulphur Content	Less than 2%
Nature	Non-corrosive
Stability	Permanent and Non-leaching
Environmental Effect	Eco-friendly and Non-toxic

The compound shall improve conductivity and maintain constant ohmic performance throughout the life of the electrode.

5. Backfill Compound

The electrode shall be surrounded by conductive backfill compound.

Requirements

- Quantity: **2 Bags × 25 kg each**
- Moisture retaining type.
- Non-corrosive.
- Highly conductive.
- Non-soluble in water.
- Resistant to seasonal changes.
- Capable of maintaining low earth resistance for long periods.
- Suitable for rocky, dry and marshy soils.

The backfill compound shall not require periodic replacement.

6. Earth Pit

The earth pit shall be constructed as follows:

Parameter	Requirement
Bore Diameter	Minimum 225 mm
Electrode Length	3.0 m
Installation	Vertical
Location	As approved by Engineer-in-Charge

The pit shall be drilled or excavated to accommodate the electrode and conductive compound.

7. Inspection Chamber

Each earth electrode shall be provided with:

Chamber

- RCC, Polymer Concrete or HDPE inspection chamber.
- Weatherproof construction.
- Suitable for underground installation.

Cover

- Heavy-duty cover.
- Load-bearing type.
- Lockable/removable design.
- Suitable for pedestrian or vehicular areas as applicable.

8. Earthing Applications

The earthing system shall be suitable for:

Transformer Neutral Earthing

- Power Transformer Neutral.
- Distribution Transformer Neutral.

Lightning Protection System

- Lightning Arrester Earthing.
- Down Conductor Earthing.

Electrical Installations

- DG Sets.
- LT Panels.
- HT Panels.
- Capacitor Banks.

Sensitive Equipment

- Automation Systems.
- SCADA Systems.
- PLC Systems.
- Data Centres.
- Computer Rooms.
- Communication Equipment.

Difficult Soil Conditions

- Soft Rock Areas.
- Marshy Soil.
- High Resistivity Soil.
- Dry Soil Regions.

9. Electrical Performance

The earthing system shall provide:

- Low earth resistance.
- Stable earth resistance throughout the year.
- High fault current dissipation capability.
- Fast charge dissipation.
- Constant ohmic performance.
- Protection against step and touch potential.

The achieved earth resistance shall comply with IS 3043 requirements and project specifications.

10. Earthing Lead Connection

The earthing lead shall be connected using:

- GI strip, copper strip or copper wire as specified.
- Corrosion-resistant hardware.
- Heavy-duty bolted connection.
- Anti-corrosive coating on joints.

11. Testing

The contractor shall conduct:

Pre-Commissioning Tests

- Visual inspection.
- Verification of electrode dimensions.
- Verification of galvanization thickness.
- Verification of conductive compound quantity.

Earth Resistance Test

Earth resistance shall be measured using an approved Earth Tester.

The measured value shall satisfy the design requirements and IS 3043 recommendations.

Documentation

The OEM/Contractor shall submit:

- Manufacturer's Test Certificate.
- Galvanization Test Certificate.
- Conductive Compound Test Report.
- Earth Resistance Test Report.
- Installation Certificate.

The test report shall clearly mention:

- Location of earthing electrode.
- Earth resistance value achieved.
- Date of testing.
- Signature and seal of testing agency.
- Signature of Engineer-in-Charge.

12. Warranty

The maintenance-free earthing system shall be guaranteed against:

- Corrosion failure.
- Premature deterioration.
- Defective materials.
- Manufacturing defects.

The electrode shall provide long service life without requiring periodic watering or maintenance.

13. Measurement

Unit: Each (No.)

Item no.:9

Making trench in soft soil of suitable width of 90 cm deep for laying cable or locating the fault all over the run and back filling the same and making the surface as normal ground.

1. Scope of Work

The work shall consist of excavating cable trench in soft soil to a depth of 900 mm, of suitable width as required for laying underground power/control cables or for locating and repairing cable faults, including removal of excavated earth, protection of existing utilities, backfilling, compaction and restoration of the ground surface to its original condition, complete as directed by the Engineer-in-Charge.

2. Applicable Standards

The work shall conform to:

- IS 1255 – Code of Practice for Installation and Maintenance of Power Cables
- IS 1200 – Methods of Measurement of Building and Civil Engineering Works
- IS 3764 – Excavation Work Safety Requirements
- IS 3043 – Earthing Code (where applicable)
- Relevant Electricity Utility Specifications and Safety Regulations

3. Site Conditions

The item is applicable for excavation in:

- Soft soil
- Ordinary earth
- Sandy soil
- Clayey soil
- Loose murrum

The item excludes excavation in:

- Hard rock
- Concrete pavement
- Masonry
- Hard strata requiring blasting or chiseling

4. Trench Dimensions

Depth

- Trench depth: 900 mm (90 cm) below finished ground level.

Width

The trench width shall be adequate for the number and size of cables to be laid.

Typical widths:

Number of Cables Minimum Width

Single Cable 300 mm

Two Cables 450 mm

Multiple Cables As per drawing/specification

The width may be increased where necessary to facilitate jointing, fault detection or repairs.

5. Excavation

The excavation shall include:

- Setting out the trench alignment.
- Removal of vegetation and loose material.
- Excavation to required depth and width.
- Dressing and leveling of trench bottom.
- Removal of stones, roots and obstructions.
- Protection of nearby structures and utilities.

Excavated material suitable for backfilling shall be stacked alongside the trench.

Unsuitable material shall be disposed of as directed.

6. Precautions During Excavation

The contractor shall:

- Locate existing underground services before excavation.
- Protect water lines, sewer lines, telecom cables and electrical services.
- Provide warning signs, barricades and caution tape.
- Prevent collapse of trench sides where required.
- Maintain safe working conditions at all times.

Any damage to existing services shall be repaired by the contractor at no extra cost.

7. Trench Bottom Preparation

After excavation:

- The trench bottom shall be leveled.
- Sharp stones and debris shall be removed.
- The bottom shall be prepared to receive cable bedding where applicable.
- Any depressions shall be filled and compacted.

8. Use for Cable Fault Location

Where excavation is carried out for locating cable faults:

- Excavation shall be done carefully to avoid damage to the existing cable.
- Cable exposure shall be sufficient for testing and repair operations.
- Necessary hand excavation near the cable shall be carried out.

9. Backfilling

After completion of cable laying or fault rectification:

- The trench shall be backfilled using excavated earth free from stones and debris.
- Backfilling shall be carried out in layers not exceeding 150 mm thickness.
- Each layer shall be watered and compacted.
- Voids shall be eliminated.

Surplus earth shall be removed from site and disposed of at approved locations.

10. Compaction

Compaction shall be carried out:

- By manual ramming or mechanical compaction.
- To restore original ground stability.
- To prevent future settlement.

The finished surface shall match surrounding levels.

11. Restoration of Surface

After backfilling, the ground surface shall be restored to its original condition.

The restoration shall include:

Earthen Surface

- Leveling.
- Dressing.
- Compaction.

Grass Areas

- Reinstatement of topsoil and turf if disturbed.

Other Areas

- Restoration as directed by the Engineer-in-Charge.

12. Safety Requirements

The contractor shall provide:

- Barricading around open trenches.
- Warning lamps during night.
- Safety signs.
- Protective equipment for workers.

Open trenches shall not be left unattended without adequate protection.

13. Measurement

The work shall be measured in Running Metres (RM) of trench excavated, backfilled and restored.

Item no.:10

Providing & laying approved make Double walled corrugated pipes (DWC) of polyethylene(conforming to IS 14930 II)with necessary connecting accessories of same material at required depth in existing trench for laying of cable. below ground / road surface for enclosing cable (D)120 mm outer dia.

1. Scope of Work

Supply, transportation, laying, jointing and testing of **120 mm Outer Diameter Double Wall Corrugated (DWC) High Density Polyethylene (HDPE) Pipe**, conforming to IS 14930 (Part 2), including couplers, bends, end caps, spacers, pull rope and all necessary accessories, laid at required depth in existing trench below ground/road surface for protection and enclosure of power, control or communication cables, complete as directed by the Engineer-in-Charge.

2. Applicable Standards

The DWC pipe and accessories shall conform to:

- IS 14930 (Part 2) – High Density Polyethylene Pipes for Cable Ducting
- IS 16098 (where applicable)
- IS 4984 – HDPE Materials
- Relevant Electricity Utility Specifications
- CEA Safety Regulations

3. Pipe Description

The pipe shall be:

- Double Wall Corrugated (DWC) Type.
- Made from High Density Polyethylene (HDPE).
- Suitable for underground cable protection.
- Resistant to corrosion, chemicals and moisture.
- Suitable for direct burial under roads and open ground.

Construction

Outer Wall

- Corrugated profile.
- High ring stiffness.
- Resistant to soil and traffic loads.

Inner Wall

- Smooth bore.
- Low friction coefficient.
- Facilitates easy cable pulling.

4. Dimensions

Parameter	Requirement
Pipe Type	Double Wall Corrugated HDPE
Outer Diameter	120 mm
Inner Diameter	As per manufacturer's standard
Length	Standard manufacturing length (typically 6 m)
Colour	As approved for electrical cable ducting

The pipe dimensions and tolerances shall conform to IS 14930 (Part 2).

5. Material Requirements

The HDPE material shall have:

- High impact strength.
- Excellent chemical resistance.
- UV stabilized (where exposed to sunlight).
- Non-corrosive properties.
- Long service life.
- Resistance to bacterial and fungal attack.

6. Mechanical Properties

The DWC pipe shall possess:

- High ring stiffness.
- High crush resistance.

- Resistance to external loads.
- Resistance to deformation under soil pressure.
- Suitability for road crossings and underground installations.

7. Accessories

The scope shall include supply of compatible accessories such as:

- HDPE couplers.
- Socket joints.
- Bends.
- End caps.
- Reducers (if required).
- Cable pulling rope/nylon draw wire.
- Sealing plugs.
- Spacers and supports.

All accessories shall be manufactured from HDPE or approved compatible material.

8. Installation

Trench Preparation

The pipe shall be laid in an existing trench prepared to the required depth.

The trench shall:

- Be free from sharp stones and debris.
- Have a reasonably level bottom.
- Be suitable for proper alignment of the duct.

Pipe Laying

The pipe shall be:

- Laid true to line and level.
- Properly aligned.
- Jointed using approved couplers.
- Protected against displacement during backfilling.

Road Crossings

Where installed under roads:

- Adequate depth shall be maintained.
- Additional protection shall be provided if specified.
- Pipe alignment shall permit future cable replacement.

9. Cable Pulling Arrangement

Each duct shall be supplied with:

- Nylon draw rope/pull cord.
- Continuous through the duct length.
- Suitable for pulling power cables after installation.

10. Jointing

Jointing shall be carried out using:

- HDPE couplers.
- Push-fit joints.
- Socket joints.

The joints shall:

- Be mechanically strong.
- Maintain continuity of duct bore.
- Prevent ingress of soil and debris.

11. Backfilling

After laying:

- The pipe shall be surrounded with selected soil or sand where specified.
- Backfilling shall be carried out carefully to prevent pipe damage.
- The trench shall be compacted in layers.
- Surface restoration shall match existing ground conditions.

12. Testing and Inspection

After installation:

Visual Inspection

- Alignment verification.
- Joint inspection.
- Pipe condition check.

Mandrel Test

- Verification of unobstructed bore.

Draw Rope Test

- Confirmation of pull rope continuity.

Any damaged or deformed duct shall be replaced at no extra cost.

13. Performance Requirements

The installed DWC pipe system shall provide:

- Mechanical protection to underground cables.
- Easy cable installation and replacement.
- Protection against soil pressure.
- Protection against accidental excavation damage.
- Long-term corrosion-free service.

14. Measurement

The item shall be measured in **Running Metres (RM)**