CHAPTER – E8

TECHNICAL SPECIFICATION

FOR

CONTROL & PROTECTION PANEL WITH MULTIFUNCTION & ENERGY METER

(AT SOURCE SUB STATION)

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OF
CONTROL, RELAY & PROTECTION PANELS

CONTROL, RELAY & PROTECTION PANELS

The control and relay panel offered, where out door switch are installed, shall be procured from short listed vendor at **E-23** and shall have been successfully Type Tested during last five years on the date of bid opening. The Type Test reports shall be submitted along with the bid.

1.0 TYPE OF PANELS

1.1 Simplex Panel

Simplex panel shall consist of a vertical front panel with equipment mounted thereon and having wiring access from rear for control panels & front for relay/**protection** panels. In case of panel having width more than 800mm, double leaf-doors shall be provided. Doors shall have handles with either built-in locking facility or will be provided with pad-lock. The Multifunction Meter and Energy Meter are mounted on the CR panel.

2.0 CONSTRUCTIONAL FEATURES

2.1. Control and Relay Board shall be of panels of simplex type design as indicated in bill of quantity. It is the responsibility of the Contractor to ensure that the equipment specified and such unspecified complementary equipmentrequired for completeness of the protective / control schemes be properly accommodated in the panels without congestion, and if necessary, either more number of panels or provide panels with larger dimensions. No price increase at a later date on this account shall be allowed. However, the width of panels that are being offered to be placed in existing switchyard control rooms, should be in conformity with the space availability in the control room.

2.2. Panels shall be completely metal enclosed and shall be dust, moisture and vermin proof. The enclosure shall provide a degree of protection not less than IP-31 in accordance with IS: 2147.

2.3. Panels shall be free standing, floor mounting type and shall comprise structural frames completely enclosed with specially selected smooth finished, cold rolled sheet steel of thickness not less than **3mm** for weight bearing members of the panels such as base frame, front sheet and door frames, and **2.0mm** for sides, door, top and bottom portions. There shall be sufficient reinforcement to provide level transportation and installation.

2.4. All doors, removable covers **of** panels shall be gasketed all around with synthetic gaskets Neoprene/EPDM generally conforming with provision of IS 11149. However, XLPE gaskets can also be used for fixing protective glass doors. Ventilating louvers, if provided shall have screens and filters. The screens shall be made of either brass or GI wire mesh.

2.5. Design, materials selection and workmanship shall be such as to result in neat appearance, inside and outside with no welds, rivets or bolt head apparent from outside, with all exterior surfaces tune and smooth.

2.6. Panels shall have base frame with smooth bearing surface, which shall be fixed on the embedded foundation channels/insert plates. Anti vibration strips made of shock absorbing materials that shall be supplied by the contractor, **which** shall be placed between panel & base frame.

2.7. Cable entries to the panels shall be from the bottom. Cable gland plate fitted on the bottom of the panel shall be connected to earthing of the panel/station through a flexible braided copper conductor rigidly.

2.8. Relay/protection panels of modern modular construction would also be acceptable.

3.0 MOUNTING

3.1. All equipment on and in panels shall be mounted and completely wired to the terminal blocks ready for external connections. The equipment on front of panel shall be mounted flush.

3.2. Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent devices and are readily accessible without use of special tools. Terminal marking on the equipment shall be clearly visible.

3.3. The Contractor shall carry out cut out, mounting and wiring of the free issue items supplied by others which are to be mounted in his panel in accordance with the corresponding equipment manufacturer's drawings. Cut outs if any, provided for future mounting of equipment shall be properly blanked off with **blanking plate**.

3.4. The centre lines of switches, push buttons and indicating lamps shall be not less than 750mm from the bottom of the panel.The centre lines of relays, meters and recorders shall be not less than 450mm from the bottom of the panel.

3.5. The centre lines of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Like wise the top lines of all meters, relays and recorders etc. shall be matched.

3.6. No equipment shall be mounted on the doors.

3.7. At existing station, **panels shall be matched with other panels in the control room in respect of dimensions, colour, appearance and arrangement** of equipment (centre lines of switches, push buttons and other equipment) on the front of the panel.

4.0 PANEL INTERNAL WIRING

4.1. Panels shall be supplied complete with interconnecting wiring provided between all electrical devices mounted and wired in the panels and between the devices and terminal blocks for the devices to be connected to equipment outside the panels. When panels are arranged to be located adjacent to each other all inter panel wiring and

connections between the panels shall be carried out internally.

4.2. All wiring shall be carried out with 1100V grade, single core, stranded copper conductor wires with PVC insulation. The minimum size of the multi-stranded copper conductor used for internal wiring shall be as follows:

- All circuits except current transformer circuits and voltage transfer circuits meant for energy metering - one 2.5 mm sq. per lead.
- All current transformer circuits - one 2.5 sq.mm per lead.
- Voltage transformer circuit (for energy meters): Two 2.5 mm sq. per lead.

4.3. All internal wiring shall be securely supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters & troughs shall be used for this purpose.

4.4. Auxiliary bus wiring for AC and DC supplies, voltage transformer circuits, annunciation circuits and other common services shall be provided near the top of the panels running throughout the entire length of the panels.

4.5. Wire termination shall be made with solderless crimping type and tinned copper lugs, which firmly grip the conductor. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from terminal blocks. All wires directly connected to trip circuit breaker or device shall be distinguished by the addition of red coloured unlettered ferrule.

4.6. Longitudinal troughs extending throughout the full length of the panel shall be preferred for inter panel wiring.Inter-connections to adjacent panel shall be brought out to a separate set of terminal blocks located near the slots of holes meant for taking the inter-connecting wires.

4.7. Contractor shall be solely responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipments.

The sizes of wiring in different circuits shall not be less than those specified below :

Table – I

Circuit	Minimum permissible Size of wire.
Metering and relaying circuits connected to Current Transformers.	4.0 mm sq.
Potential circuits for metering and	4.0 mm sq.

Relaying,

Other control, visual and audible alarm signaling circuits etc.	2.5 mm sq

The following colour scheme shall be used for the wiring:

Table – II

Circuit where use.	Colour of wire and ferrule.
Red phase of instrument transformer circuit	Red
Yellow phase of instrument transformer	Yellow
Blue phase of instrument transformer circuits	Blue
Neutral connections earthed or not earthed in the instrument transformer circuit	Green
All other wires shall be	Grey

5.0 TERMINAL BLOCKS:

All the terminal blocks to be used in the operating mechanism should be of stud type of Poly-amide material (for non-disconnecting type and for disconnecting type) of make Elmex / Connectwell.

5.1. All internal wiring to be connected to external equipment shall terminate on terminal blocks. Terminal blocks shall be 650 V grade and have 10 Amps. continuous rating, moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Markings on the terminal blocks shall correspond to wire number and terminal numbers on the wiring diagrams. All terminal blocks shall have shrouding with transparent unbreakable material.

5.2. Disconnecting type terminal blocks for current transformer and voltage transformer secondary leads shall be provided. Also current transformer secondary leads shall be provided with short circuiting and earthing facilities.

5.3. At least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.

5.4. Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors of external cable on each side

- All CT & PT circuits: minimum of two of 2.5 mm^2 Copper
- AC/DC Power Supply Circuits: One of 4 mm^2 Copper
- All other circuits: minimum of one of 2.5 mm^2 Copper

5.5. There shall be a minimum clearance of 250mm between the first row of terminal blocks and the associated cable gland plate or panel side

wall. Also the clearance between two rows of terminal blocks edges shall be minimum of 150mm.

5.6. Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal blocks is run in parallel and close proximity along each side of the wiring-duct to provide for convenient attachment of internal panel wiring. The side of the terminal block opposite the wiring duct shall be reserved for the external cable connections. All adjacent terminal blocks shall also share this field wiring corridor. All wiring shall be provided with adequate support inside the panels to hold them firmly and to enable free and flexible termination without causing strain on terminals.

5.7. The number and sizes of the Owner's multi core incoming external cables will be furnished to the Contractor after placement of the order. All necessary cable terminating accessories such as gland plates, supporting clamps & brackets, wiring troughs and gutters etc. (except glands & lugs) for external cables shall be included in the scope of supply.

6.0 PAINTING

Powder coating type

All sheet steel work shall be phosphated in accordance with the IS:6005 Code of practice for phosphating iron and steel.

(1) All unfinished surface of the steel panels and frame work shall be sand blasted to remove rust, scale, foreign, adhering matter of grease.

(2) A suitable rust resisting primer shall be applied on the interior and exterior surfaces of the steel, which shall be followed by application of an under coat suitable to serve as base and binder for the finishing coat. The finishing coat on the exterior of the panels shall be deep gray powder coated. Polished cellulose appearance while on the interior faces the finishing coat shall be of light gray shaded paint sprayed to give a contrasting effect with the cubicle wiring. A small quantity of finishing paint shall be supplied with each consignment of the panels to enable the Employer’s store at site any finish which may get damaged curing the transshipment. The panel boards may alternatively be given a plastic durable covering coat for protection of the finish during the transshipment, which shall be capable of being peeled off after installation.

7.0 MIMIC DIAGRAM

7.1. Coloured mimic diagram and symbols showing the exact representation of the system shall be provided in the front of control panels.

7.2. Mimic diagram shall be made preferably of anodised aluminium or plastic of approved fast colour material, which shall be screwed on to the panel and can be easily cleaned. The mimic bus shall be 2mm thick. The width of the mimic bus shall be 10mm for bus bars and 7mm for other connections. Painted overlaid mimic is also acceptable.

7.3. Mimic bus colour will be decided **during detailed Engineering** by the OPTCL.

TABLE

COLOUR SCHEME FOR MIMIC DIAGRAMS

Equipment	Colour	I.S. Code No.(IS.5)
33 KV	Signal Red	537
11 KV	Brilliant Green	414
415/250V	Black	221
Earth	White	309

7.4. When Semaphore indicators are used for equipment position, they shall be so mounted in the mimic that the equipment in close position shall complete the continuity of mimic.

7.5. Indicating lamp, one for each phase, for each bus shall be provided on the mimic to indicate bus charged condition

8.0 NAME PLATES AND MARKINGS

8.1. All equipment mounted on front and rear side as well as equipment mounted inside the panels shall be provided with individual name plates with equipment designation engraved. Also on the top of each panel on front as well as rear side, large and bold nameplates shall be provided for circuit/feeder designation.

8.2. All front mounted equipment shall also be provided at the rear with individual name plates engraved with tag numbers corresponding to the one shown in the panel internal wiring to facilitate easy tracing of the wiring.

8.3. Each instrument and meter shall be prominently marked with the quantity measured e.g. KV, A, MW, etc. All relays and other devices shall be clearly marked with manufacturer's name, manufacturer's type, serial number and electrical rating data.

8.4. Name Plates shall be made of non-rusting metal or 3 ply lamicoid. Name plates shall be black with white engraving lettering.

8.5. Each switch shall bear clear inscription identifying its function e.g. ‘BREAKER' '52A', "SYNCHRONISING" etc. Similar inscription shall also be provided on each device whose function is not other-wise identified. If any switch device does not bear this inscription separate name plate giving its function shall be provided for it. Switch shall also have clear inscription for each position indication e.g. "Trip- Neutral-

Close", "ON-OFF", "R-Y-B- OFF" etc

8.6. All the panels shall be provided with name plate mounted inside the panel bearing Name of the Substation & feeder and reference drawing number.

9.0 MISCELLANEOUS ACCESSORIES

9.1. **Plug Point**: 240V, Single phase 50Hz, AC Socket with switch suitable to accept 5 Amps and 15 Amps pin round standard Indian plug, shall be provided in the interior of each cubicle with ON-OFF switch.

9.2. **Interior Lighting**: Each panel shall be provided with a fluorescent lighting fixture rated for 240 Volts, single phase, 50 Hz supply for the interior illumination of the panel controlled by the respective panel door switch. Adequate lighting shall also be provided for the corridor in Duplex panels.

9.3. **Switches and Fuses**: Each panel shall be provided with necessary arrangements for receiving, distributing and isolating of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with Fuses. Selection of the main and sub-circuit Fuses rating shall be such as to ensure selective clearance of sub-circuit faults. Voltage transformer circuits for relaying and metering shall be protected by fuses. All fuses shall be HRC cartridge type conforming to IS: 13703 mounted on plug-in type fuse bases. The short time fuse rating of Fuses shall be not less than 9 KA. Fuse carrier base shall have imprints of the fuse 'rating' and 'voltage'.

9.4. **Space Heater**: Each panel shall be provided with a thermostatically connected space heater rated for 240V, single phase, 50 Hz AC supply for the internal heating of the panel to prevent condensation of moisture. The fittings shall be complete with switch unit.

10.0 EARTHING

10.1. All panels shall be equipped with an earth bus securely fixed. Location of earth bus shall ensure no radiation interference from earth systems under various switching conditions of isolators and breakers. The material and the sizes of the bus bar shall be at least **25 X 6** sq.mm copper with threaded holes at a gap of 50 mm with provision of bolts and nuts for connection with cable armours and mounted equipment etc for effective earthing. When several panels are mounted adjoining each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply of Contractor. Provision shall be made for extending the earth bus bars to future adjoining panels on either side.

10.2. Provision shall be made on each bus bar of the end panels for connecting Substation earthing grid. Necessary terminal clamps and connectors for this purpose shall be included in the scope of supply of Contractor.

10.3. All metallic cases of relays, instruments and other panel mounted equipment including gland plate, shall be connected to the earth bus by copper wires of size not less than **2.5 sq. mm**. The colour code of earthing wires shall be green.

10.4. Looping of earth connections which would result in loss of earth connection to other devices when the loop is broken, shall not be permitted. However, looping of earth connections between equipment to provide alternative paths to earth bus shall be provided.

10.5. VT and CT secondary neutral or common lead shall be earthed at one place only at the terminal blocks where they enter the panel.Such earthing shall be made through links so that earthing may be removed from one group without disturbing continuity of earthing system for other groups.

10.6. An electrostatic discharge **arrangement** shall be provided in each panel **so as to discharge human body before he handles the equipments inside the panels**.

11.0 INDICATING INSTRUMENTS & TRANSDUCERS FOR CONTROL PANEL(Multi function meter to be inserted)

All instruments, meters and transducers shall be enclosed in dust proof, moisture resistant, black finished cases and shall be suitable for tropical use. All MEGAWATT , MEGAVAR, BUS VOLTAGE AND FREQUENCY indicating instruments shall be provided with individual transducers and these shall be calibrated along with transducers to read directly the primary quantities. They shall be accurately adjusted and calibrated at works and shall have means of calibration check and adjustment at site. The supplier shall submit calibration certificates at the time of delivery.

However no separate transducers are envisaged for digital bus voltmeters and digital frequency meters and the indicating meters provided in the synchronising equipment.

11.1. Indicating Instruments

11.1.1. Unless otherwise specified, all electrical indicating instruments shall be of digital type suitable for flush mounting.

11.1.2. Instruments shall have 4-digit display; display height being not less than 25mm.

11.1.3. Instrument shall confirm to relevant IS and shall have an accuracy class of 1.0 or better. Watt and Var meters shall have an indication of (+) and (-) to indicate EXPORT and IMPORT respectively.

11.1.4. Digital voltage and frequency meters shall be of class: 0.5 and shall have digital display of 5 and 4 digits respectively, with display size, not less than 25mm (height).

11.2. Transducers

11.2.1. Transducers (for use with Indicating Instruments and Telemetry / Data Communication application) shall in general conform to IEC:688-1

11.2.2. The transducers shall be suitable for measurement of active

power, reactive power, voltage, current and frequency in three phase four wire unbalanced system.

11.2.3. The input to the transducers will be from sub-station current & potential transformers. The output shall be in milli ampere D.C. proportional to the input & it shall be possible to feed the output current directly to the telemetry terminal or indicating instruments.

11.2.4. The transducer characteristic shall be linear throughout the measuring range.

11.2.5. The transducer output shall be load independent.

11.2.6. The input & output of the transducer shall be galvanically isolated.

11.2.7. Each transducer shall be housed in a separate compact case and have suitable terminals for inputs & outputs.

11.2.8. The transducers shall be suitably protected against transient high peaks of voltage & current.

11.2.9. The transducer shall withstand indefinitely without damage and work satisfactorily at 120% of the rated voltage and 120% of the rated input current as applicable.

11.2.10. All the transducers shall have an output of 4-20 mA.

11.2.11. The response time of the transducers shall be less than 1 second.

11.2.12. The **accuracy class** of transducers shall be 0.2.

11.2.13. The transducers shall have a low AC ripple on output less than 1%.

11.2.14. The transducer shall have dual output.

12.0 ANNUNCIATION SYSTEM for Control Panel

12.1. Alarm annunciation system shall be provided in the control board by means of visual and audible alarm in order to draw the attention of the operator to the abnormal operating conditions or the operation of some protective devices. The annunciation equipment shall be suitable for operation on the voltages specified in this specification. Individual switchgear panel will have Annunciator & will have annunciation facility.

12.2. The visual annunciation shall be provided by annunciation facia, mounted flush on the top of the control panels.

12.3. The annunciation facia shall be provided with translucent plastic window for alarm point with approximate size of 35mm x 50mm. The facia plates shall be engraved in black lettering with respective inscriptions. Alarm inscriptions shall be engraved on each window in not more than three lines and size of the lettering shall not be less than 5 mm.

12.4. Each annunciation window shall be provided with two white lamps in parallel to provide safety against lamp failure. Long life lamps shall be used. The transparency of cover plates and wattage of the lamps provided in the facia windows shall be adequate to ensure clear visibility of the inscriptions in the control room having high

illumination intensity **(350 Lux)**, from the location of the operator's desk.

12.5. All Trip facia shall have **Red** colour and all Non-trip facia shall have **White** colour.

12.6. The audible alarm shall be provided by Buzzer/ Hooter /Bell having different sounds and shall be used as follows.

Hooter	Alarm Annunciation
Bell	Annunciation DC failure
Buzzer	AC supply failure

12.7 Sequence of operation of the annunciator shall be as follows :

Sl. NO.	**Alarm**	**Condition Contact**	**Visual Annunciation**	**Audible Annunciation**
	Normal	Open	Off	Off
	Abnormal	Close	Flashing	On
	Accept Push Button Pressed	Close Open	Steady On Steady On	Off Off
	Reset Push Button Pressed	Close Open	On Off	Off Off
	Lamp Test Push Button Pressed	Open	Steady On	Off

12.8. Audible annunciation for the failure of DC supply to the annunciation system shall be provided and this annunciation shall operate on 240 Volts AC supply. On failure of the DC to the annunciation system for more than 2 or 3 seconds (adjustable setting), a bell shall sound. A separate push button shall be provided for the cancellation of this audible alarm alone but the facia window shall remain steadily lighted till the supply to annunciation system is restored.

12.9. A separate voltage check relay shall be provided to monitor the failure of supply (240V AC) to the scheme mentioned in Clause above. If the failure of supply exists for more than 2 to 3 seconds, this relay shall initiate visual and audible annunciation. Visual and audible annunciation for the failure of AC supply to the annunciation system shall be provided and this annunciation shall operate on Annunciation DC and buzzer shall sound.

12.10. The annunciation system described above shall meet the following additional requirements :

a) The annunciation system shall be capable of catering to at least 20 simultaneous signals at a time.

b) One set of the following push buttons shall be provided on each control panel:

- Reset push button for annunciation system
- Accept push button for annunciation system
- Lamp test push button for testing the facia windows

c) One set of the following items shall be provided common for all the control panel (not applicable for extension of substation) :

- Flasher relay for annunciation system
- Push button for Flasher test
- Three Push buttons for test of all audible alarm systems

d) These testing circuits shall be so connected that while testing is being done, it shall not prevent the registering of any new annunciation that may land during the test.

e) The annunciation shall be repetitive type and shall be capable of registering the fleeting signal. Minimum duration of the fleeting signal registered by the system shall be 15 milli seconds.

f) In case of static annunciator scheme, special precaution shall be taken to ensure that spurious alarm condition does not appear due to influence of external electromagnetic/ electrostatic interference on the annunciator wiring and switching disturbances from the neighbouring circuits within the panels and the static annunciator shall meet the high voltage susceptibility test , impulse voltage with stand test , high frequency disturbance test– class III and fast transient disturbance test –level III as per IEC 60255.

12.11. The annunciation system to be supplied for existing sub-stations shall be engineered as **an extension to the existing scheme**.

13.0 SWITCHES

13.1. Control and instrument switches shall be rotary operated type with escutcheon plates clearly marked to show operating position and circuit designation plates and suitable for flush mounting with only switch front plate and operating handle projecting out.

13.2 The selection of operating handles for the different types of switches shall be as follows :

Breaker,Isolator control switches	Pistol grip, black
Synchronising switches	Oval,Black, Keyed handle(one common removable handle for a group of switches or locking facility having common key).
synchronising Selector switches	Oval or knob, black Instrument

switches	Round, knurled, black
Protection Transfer switch	Pistol grip, lockable and black.

13.3. The control switch of breaker and isolator shall be of spring return to neutral type. The switch shall have spring return from close and trip positions to "after close" and "after trip" positions respectively.

13.4. Lockable type of switches which can be locked in particular positions shall be provided when specified. The key locks shall be fitted on the operating handles.

13.5. The contacts of all switches shall preferably open and close with snap action to minimise arcing. Contacts of switches shall be spring assisted and contact faces shall be with rivets of pure silver or silver alloy. Springs shall not be used as current carrying parts

13.6. The contact combination and their operation shall be such as to give completeness to the interlock and function of the scheme.

The contact rating of the switches shall be as follows :

Description	**Contact Rating in Amps**	
	24V/220 V DC	**240V AC**
Make and carry Continuously	**10**	**10**
Make and carry	**30**	**30 for 0.5 sec.**
Break for Resistive load	**20**	**7**
Break for Inductive load with L/R = 40m sec.	-	-

14.0 INDICATING LAMPS

14.1. Indicating lamps shall be of cluster LED type suitable for panel mounting with rear terminal connections. Lamps shall be provided with series connected resistors preferably built in the lamp assembly. Lamps shall have translucent lamp covers to diffuse lights coloured red, green, amber, clear white or blue as specified. The lamp cover shall be preferably of screwed type, unbreakable and moulded from heat resisting material.

14.2. The lamps shall be provided with suitable resistors.

14.3. Lamps and lenses shall be interchangeable and easily replaceable from the front of the panel. Tools, if required for replacing the bulbs and lenses shall also be included in the scope of the supply.

14.4. The indicating lamps with resistors shall withstand 120% of rated voltage on a continuous basis.

Lamps shall have translucent lamp covers to difuse lights coloured red, green, amber, clear white or blue as specified as per the following:

	Function	Quantity	Colour of lens
1.	Circuit Breaker spring charged/normal pressure indication.	1 No.	Blue
2.	Circuit Breaker trip circuit healthy indication.	2 Nos.	White
3.	Circuit Breaker Low Air Pressure indication	1 No.(where necessary	White
4.	Incoming D.C. fail indication.	2 Nos.	White
(i)	A. C. fail indication.	1 No.	White
6.	P. T. supply indication.	3 Nos.(where necessary)	Red/Yellow/ Blue.
7.	Indication lamps for CB closing ,opening Isolator closing and opening		Red and Green
i)	Auto trip	1 No.	Amber
ii)	Protection on Transfer Mode	1 No.	White
iii)	CB on Local/Remote	2 Nos	White

15.0 POSITION INDICATORS (if Applicable)

15.1. Position indicators of "SEMAPHORE" type shall be provided when specified as part of the mimic diagrams on panels for indicating the position of circuit breakers, isolating/earthing switches etc. The indicator shall be suitable for semi-flush mounting with only the front disc projecting out and with terminal connection from the rear.Their strips shall be of the same colour as the associated mimic.

15.2. Position indicator shall be suitable for DC Voltage as specified. When the supervised object is in the closed position, the pointer of the indicator shall take up a position in line with the mimic bus bars, and at right angles to them when the object is in the open position. When the supply failure to the indicator occurs, the pointer shall take up an intermediate position to indicate the supply failure.

15.3. The rating of the indicator shall not exceed 2.5 W.

15.4. The position indicators shall withstand 120% of rated voltage on a continuous basis.

16.0 RELAYS

16.1. All relays shall conform to the requirements of IS: 3231/IEC-

60255/IEC 61000 or other applicable standards. Relays shall be suitable for flush or semi-flush mounting on the front with connections from the rear.

16.2. All protective relays shall be of numerical type and communication protocol shall be as per IEC 61850. Further, the test levels of EMI as indicated in IEC 61850 shall be applicable to these relays.

16.3. All protective relays shall be in draw out or plug-in type/modular cases with proper testing facilities. Necessary test plugs/test handles shall be supplied loose and shall be included in contractor's scope of supply.

16.4. All AC operated relays shall be suitable for operation at 50 Hz. AC Voltage operated relays shall be suitable for 110 Volts VT secondary and current operated relays for **1 amp CT secondary**. All DC operated relays and timers shall be designed for the DC voltage specified, and shall operate satisfactorily between 80% and 110% of rated voltage. Voltage operated relays shall have adequate thermal capacity for continuous operation.

16.5. The protective relays shall be suitable for efficient and reliable operation of the protection scheme described in the specification. Necessary auxiliary relays and timers required for interlocking schemes for multiplying of contacts suiting contact duties of protective relays and monitoring of control supplies and circuits, lockout relay monitoring circuits etc. also required for the complete protection schemes described in the specification shall be provided. All protective relays shall be provided with at least two pairs of potential free isolated output contacts. Auxiliary relays and timers shall have pairs of contacts as required to complete the scheme; contacts shall be silver faced with spring action. Relay case shall have adequate number of terminals for making potential free external connections to the relay coils and contacts, including spare contacts.

16.6. Timers shall be of solid state type. Time delay in terms of milliseconds obtained by the external capacitor resistor combination is not preferred and shall be avoided.

16.7. No control relay, which shall trip the power circuit breaker when the relay is de-energised, shall be employed in the circuits.

16.8. Provision shall be made for easy isolation of trip circuits of each relay for the purpose of testing and maintenance.

16.9. Auxiliary seal-in-units provided on the protective relays shall preferably be of shunt reinforcement type. If series relays are used the following shall be strictly ensured:

(a) The operating time of the series seal-in-unit shall be sufficiently shorter than that of the trip coil or trip relay in series with which it operates to ensure definite operation of the flag indicator of the relay.

(b) Seal-in-unit shall obtain adequate current for operation when one

or more relays operate simultaneously.

(c) Impedance of the seal-in-unit shall be small enough to permit satisfactory operation of the trip coil on trip relays when the D.C. Supply Voltage is minimum.

(d) Trip-circuit seal-in is required for all trip outputs, irrespective of the magnitude of the interrupted current. The trip-circuit seal-in logic shall not only seal-in the trip output(s),but also the relevant initiation signals to other scheme functions, (e.g. initiate signals to the circuit-breaker failure function, reclosing function etc.), and the alarm output signals.

(e) Two methods of seal-in are required, one based on the measurement of AC current, catering for those circumstances for which the interrupted current is above a set threshold, and one based on a fixed time duration, catering for those circumstances for which the interrupted current is small (below the set threshold).

(f) For the current seal-in method, the seal-in shall be maintained until the circuit-breaker opens, at which time the seal-in shall reset and the seal- in method shall not now revert to the fixed time duration method. For this seal-in method, the seal-in shall be maintained for the set time duration. For the line protection schemes, this time duration shall be independently settable for single- and three-pole tripping.

(g) Seal-in by way of current or by way of the fixed duration timer shall occur irrespective of whether the trip command originates from within the main protection device itself (from any of the internal protection functions), or from an external device with its trip output routed through the main protection device for tripping. Trip-circuit seal-in shall not take place under sub-harmonic conditions (e.g. reactor ring down).

16.10. The setting ranges of the relays offered, if different from the ones specified shall also be acceptable if they meet the functional requirements.

16.11. Any alternative/additional protections or relays considered necessary for providing complete effective and reliable protection shall also be offered separately. The acceptance of this alternative/ additional equipment shall lie with the OPTCL.

16.12. All relays and their drawings shall have phase indications as R-Red, Y- yellow, B-blue.

16.13. For **numerical relays**, the scope shall include the following:

a) Necessary software and hardware to up/down load the data to/from the relay from/to the personal computer installed in the substation. However, the supply of PC is not covered under this clause.

b) The relay shall have suitable communication facility for SCADA connectivity. The relay shall be capable of supporting IEC 61850 protocol.

c) The features like fault recorder and event logging function in the relays shall be supplied.

17.0. For 33 KV (Line)

	Back up: Numerical Directional & Non-directional(site selectable) Over Current and Earth fault Protection. The detailed description of line protections is given here under.
(a)	shall have continuous self monitoring and diagnostic feature. include a directional back up Inverse Definite Minimum Time (IDMT) earth fault relay with normal inverse characteristics as per IEC 60255-3 as a built in feature

18.0. Numerical Back-up Directional Over Current and Earth fault protection scheme.

(a) shall have three over current and one earth fault element(s) which shall be either independent or composite unit(s)

(b) shall include necessary VT fuse failure relays for alarm purposes

(c) **over current elements** shall

- have IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting
- have a variable setting range of 50-200% of rated current
- have a characteristic angle of 30/45 degree lead
- include hand reset flag indicators or LEDs

(d) **earth fault element** shall

- have IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting
- have a variable setting range of 20-80% of rated current
- have a characteristic angle of 45/60 degree lag
- include hand reset flag indicators or LEDs
- include necessary separate interposing voltage transformers or have internal feature in the relay for open delta voltage to the relay

(e) Shall have over & under voltage protection facility.

(f) Shall have facility for under frequency protection facility (minimum 03 stages)

(g) Shall have facility of LBB protection.

19.0 TRIPPING RELAY

High Speed Tripping Relay shall be

(a) instantaneous (operating time not to exceed 10 milli-seconds).

(b) reset within 20 milli seconds

(c) D.C. Operated

(d) adequate contacts to meet the requirement of scheme, other functions like auto-reclose relay, LBB relay as well as cater to associated equipment like event logger, Disturbance recorder, fault Locator, etc.

(e) provided with operation indicators for each element/coil.

20.0 DC/AC SUPPLY SUPERIVISION RELAY

(a) The relay shall be capable of monitoring the failure of **D.C./A.C** supply to which, it is connected.

(b) It shall have adequate potential free contacts to meet the scheme requirement.

(c) The relay shall have a 'time delay on drop-off' of not less than 100 milli seconds and be provided with operation indicator/flag.

21.0 TIME SYNCHRONISATION EQUPMENT

21.1. The Time synchronisation equipment shall receive the co-ordinated Universal Time (UTC) **transmitted** through Geo Positioning Satellite System (GPS) and synchronise equipments to the Indian Standard Time in a substation.

21.2. Time synchronisation equipment shall include antenna, all special cables and processing equipment etc.

21.3. It shall be compatible for synchronisation of Event Loggers, Disturbance recorders and SCADA at a substation through individual port or through Ethernet realised through optic fibre bus.

21.4. Equipment shall operate up to the ambient temperature of 50 degree centigrade and 80% humidity.

21.5. The synchronisation equipment shall have 2 micro-second accuracy. Equipment shall give real time corresponding to IST (taking into consideration all factors like voltage & temperature variations, propagation & processing delays etc).

21.6. Equipment shall meet the requirement of IEC 60255 for storage & operatin.

21.7. The system shall be able to track the satellites to ensure no interruption of synchronisation signal.

21.8. The output signal from each port shall be programmable at site for either one hour, half hour, minute or second pulse, as per requirement.

21.9. The equipment offered shall have six (6) output ports. Various combinations of output ports shall be selected by the customer, during detailed engineering, from the following :

- Potential free contact (Minimum pulse duration of 50 milli Seconds.)
- IRIG-B
- RS232C
- SNTP Port

21.10. The equipment shall have a periodic time correction facility of one second periodicity.

21.11. Time synchronisation equipment shall be suitable to operate from 48 V DC as available at Substation.

21.12. Equipment shall have real time digital display in hour, minute, second (24 hour mode) & have a separate time display unit to be mounted on the top of control panels having display size of approx. 100 mm height.

21.13. The reports for following type tests shall be submitted during detailed engineering for the Protective relays.

a) Insulation tests as per IEC 60255-5

b) DC Voltage dips and interruptions/Variation as per IEC 6100-4-29.

c) High frequency disturbance test as per IEC 61000-4 16, Class IV (Not applicable for electromechanical relays)

d) Electrostatic discharges as per IEC 61000-4-2, level; 4 (not applicable for Electromechanical relays)

e) Fast transient test as per IEC 61000, Level IV (Not applicable for electromechanical relays)

f) Relay characteristics, performance and accuracy test as per IEC60255

- Steady state Characteristics and operating time
- Dynamic Characteristics and operating time for distance protection relays and current differential protection relays
- Conformance test as per IEC 61850-10.

For Fault recorder, Disturbance recorder; only performance tests are intended under this item.

g) Tests for thermal and mechanical requirements as per IEC 60255-6

h) Tests for rated burden as per IEC 60255-6

i) Contact performance test as per IEC 60255-0-20 (not applicable for Distance to fault locator and Disturbance recorder)

In case there is a change either in version or in model (Except firmware) of the relay, the contractor has to submit the type test reports for the offered revision/model.

22.0 CONFIGURATION OF RELAY AND PROTECTION PANELS

The following is the general criteria for the selection of the equipments to be provided in each type of panel. However, contractor can optimise the requirement of panels by suitably clubbing the feeder protection and CB relay panels.

CONTROL PANEL: Various types of control panels shall consist of the following

Sl No.	Description	Qty	Description
a.	Multifunction Metr	1	To monitor & display V,I,KW,KVA,KVAR,F,Cosϕ etc
b.	CB Control switch	1 No	for each Circuit breaker
c.	Isolator Control switch	1 No	for each isolator
d.	Semaphore Red indicating lamp	1 no. 1 no.	for each earth switch for each Circuit breaker
e.	Red indicating lamp	1 no.	for each isolator
f.	Green indicating lamp	1 no.	for each Circuit breaker
g.	Green indicating lamp	1 no.	for each isolator
h.	White indicating lamp (DC healthy lamp)	2 nos	for each feeder
i.	Annunciation windows with associated annunciation relays	18 nos	for each feeder
j.	Push button for alarm Accept/reset/lamp test	3 nos	for each control panel
k.	Synchronising Socket	1 no.	for each Circuit Breaker if required
l.	Synchronising selector Switch	1 no.	for each Circuit Breaker switch if required
m.	Protection Transfer Switch with indication lamp(for transfer position)	1 no.	for each breaker in case of DMT /DM*/SMT schemes (Except TBC and BC breaker) - * with by pass isolator
n.	Mimic to represent SLD	Lot	in all control panels
o.	Trip Circuit Healthy with push button	2 Nos	In all the control panel

3. The above list of equipments mentioned for control panel is generally applicable unless it is defined elsewhere and in case of bay extension in existing substations, necessary equipments for

matching the existing control panel shall be supplied.

(I) LINE PROTECTION PANEL

The Line Protection panel for transmission lines shall consist of following protection features/schemes:

Sl No.	Description	33 KV
1	Numerical Directional & Non-directional (Site selectable) Back up Over current and E/F protection scheme with LBB protection	1 Set
	Under frequency protection	
	Over Voltage & under voltage Protection Scheme	
	Fault Recorder	
	Disturbance Recorder*	
	LBB protection	
2	3 Phase Trip Relays	1 Nos
3	Flag relays, carrier receive relays, aux. Relays, timers etc as per scheme requirements	As required
4	Any other Auxiliary relays for AC /DC supervision and etc as per scheme.	As required

23.0 ERECTION AND MAINTENANCE TOOL EQUIPMENTS

All special testing equipment required for the installation and maintenance of the apparatus, instruments devices shall be furnished in relevant schedule.

24.0 TROPICALISATION

Control room will be normally air-conditioned. All equipments shall however be suitable for installation in a tropical monsoon area having hot, humid climate and dry and dusty seasons with ambient conditions specified in the specification. All control wiring, equipment and accessories shall be protected against fungus growth, condensation, vermin and other harmful effects due to tropical environment.

**** ALL THE RELAYS SHALL BE OF NUMERICAL VERSION HAVING IEC 61850 PROTOCOL COMPLIANCE.ALL CARE SHALL BE TAKEN IN DESIGNING THE PROTECTION SYSTEM FOR SCADA PROVISION. THERE SHALL BE ADEQUATE NO OF INPUT AND OUT PUT CONTACTS FOR USE. SHALL HAVE SELF SUPERVISING AND INTERNAL FAULT DETECTING/DIAGNOSING FACILTY. SUFFICIENT FAULT /DISTURBANCE RECORDING FACILITIES.**

PART – B

TECHNICAL SPECIFCATION
FOR
MULTIFUNCTION
&
3 PHASE 4 WIRE CT/PT OPERATED FULLY STATIC AMR COMPATIBLE TRI-VECTOR ENERGY METERS (Common Protocol Energy Meters conforming to companion standard for IEC 62056 / IS 15959) (CATEGORY 'A')

TECHNICAL SPECIFICATION OF MULTIFUNCTION METER & HTTV (CATEGOTY-A) METER

The Multifunction Meter and Energy Meter are mounted on the CR panel.

(A) MULTIFUNCTION METER

GENERAL:

*. Each bay should be provided with a Multifunction meter having following features:-
* Features: By level monitoring of all electrical parameters of V,I,ϕ,cosϕ,Hz,KVA,KVAR, KW & KWH.True RMS measurement
* Accuracy: 0.2s
*. User selectable display ranges. (CT/PT).
*. Auto scrolling/Manual display
*. RS 485 communication port with MODBUS RTU protocol.Compatible for data logging & SCADA application.
*. Inbuilt Real time clock with calendar.
*. 3phase,4 wire,3 element or as per requirement.(to be decided during detail Engineering).
*. Quadrant of operation: 04 Quadrant.
*. Display: Bright red 7-segment LED display.
*. HMI: Through Front panel tactile keys.
*. Indication: Phase voltage, Phase current ,Line voltage,Frequency, Power factor, KVA,KVAR,KW,KVAH,KVARH,KWH.
*. Voltage input: 63.5/110V
*. Current Input: 1 A
*. Auxiliary supply: 85-250 V AC or 48 V DC
*. VA burden: 15VA
*. Frequency Range: 45 to 55 Hz
*. Power factor range: 0.1 lag -1 -0.1 lead
*. Over voltage: 130% continuously & 200% for 30 sec
*. Over current: 2 times continuous, 20 times for 1 sec.
*. Response time: 200 ms
*. Class of accuracy: 0.2s as per IEC 60687, IS 14697
*. Complies to EMI: IEC 61000-4-5,3,4
*. Display resolution: upto 1 decimal
*.Output: Two communication port with optical isolation. RS 485 communication port with MODBUS RTU protocol.
*.CT shorting provision should be there.
*.Mounting: Flush panel mounting.
*. Dimensions:144X144 mm
*.Ambient condition: working: 0-55 deg cent,5-95% RH.

1.1

(a) A flag operated master trip relay should be provided (48 V DC with N/C contact in series with the relay coil): Electromechanical relay having sufficient output contact (N/O & N/C) should be available for interlock, indication & other SCADA purpose.

(b) Other electromechanical auxiliary relays as required as per the scheme to be provided.

(for contact multiplication, Transformer trouble shooting like Oil temp Al& trip, Winding temp Al & Trip, Bucholtz Alarm & Trip, MOG alarm, PRV Trip etc)

(c) A12 Window static annunciator with Test, Accept & Reset arrangement and with Buzzer & Bell.

1.2 Test terminal Blocks- Test terminal Block need be provided for testing meters in test position.

1.3 Indication Lamp(24DC LED type)

Red- Breaker 'ON'
Green Breaker 'OFF'
Amber- Breaker 'AUTO TRIP'
Blue- Spring charge indication.
White-Healthy Trip illuminated push bottom switch

(B) HT Tri-vector meter (HTTV)METERS:

1.0 SCOPE

This specification covers design, manufacturing, testing, supply of high precision three phase four wire static tri-vector energy meters with DLMS protocol of accuracy class 0.2s or better, capable of performing functions of energy audit, feeder metering. The HT Tri-vector meter should be 3-phase 4-wire type suitable for connection to a 3 phase 4 wires as well as 3-phase 3- wire system. The meter should be capable to record and display KWh, KVArh, KVAh and maximum demand in KVA for 3 phase 4 wire as well as 3 phase 3 wire AC balanced/unbalanced loads for a power factor range of zero (lagging) through unity up to zero (leading) as per requirement given in this specification. Energy meter will be provided for more accuracy and to be used as main meter for energy auditing.

1.1 APPLICATION:

In Substation on Outgoing HT feeders,

2.0 STANDARDS TO WHICH METERS SHALL COMPLY:

Guidelines on “Data Exchange for Electricity Meter Reading, Tariff and Load Control – Companion Specification” enclosed with this document as annexure.
IS: 14697 /1999 (reaffirmed 2004) Specification for AC Static Transformer operated Watt Hour & VAR-Hour meters (class 0.2S);
IS-15707 Specification for Testing, evaluation, installation & maintenance of AC Electricity Meters-Code of Practice.
CBIP technical report No. 304 for Specification for AC Static Electrical Energy Meters with latest amendments.

IEC 62053-33, IEC 62053-22-2003 & IEC 62052-11-2003 for AC Static Watt-hour Meters for Active Energy, class 0.2S & 0.5S.
CBIP Technical Report No.111 Revised July 1996 for Specification for Common Meter Reading Instrument.
IS: 9000 for Basic Environmental Testing Procedures for Electronic & Electrical items
IS: 15959 (DLMS/ COSEM) for Open protocol standard for

communication of meter datas

IS: 15707 for Testing, Evaluation, Installation and maintenance

of AC Electricity meters- Code of Practice.

The equipment meeting with the requirements of other authoritative standards, which ensure equal or better quality than the standard mentioned above, also shall be considered; in case of conflict related with communication protocol, the Guidelines on "Data Exchange for Electricity Meter Reading, Tariff and Load Control – Companion Specification" enclosed with this document as annexure shall prevail upon. For conflict related with other parts of the specification, the order of priority shall be – i) This technical specification ii) IS: 14697 /1999 (reaffirmed 2004).
For open protocol IS 15959 is published now.

3.0 GENERAL TECHNICAL REQUIREMENTS

1	TYPE	*AMR Compatible Static, 3 Ph, 4 Wire Tri-Vector Energy Meter*
2	FREQUENCY	*50 Hz ± 5%*
3	ACCURACY CLASS	*0.2s for HT*
4	SECONDARY VOLTAGE	*For CT/PT operated HT Meters-Suitable for operation from 110V Ph-Ph or 63.5V Ph-N*
5	BASIC CURRENT (Ib)	*-/1 Amps*
6	MAXIMUM CONTINUOUS CURRENT	*Starting and Short time current shall be as per IS-14697*
7	POWER CONSUMPTION	*The active and apparent power consumption, in each voltage circuit, at reference voltage, reference temperature and reference frequency shall not exceed 1. 5 W* *The apparent power taken by each current circuit, at basic current, reference frequency and reference temperature shall not exceed 1.0 VA*
8	POWER FACTOR	*0.0 Lag -Unity- 0.0 Lead*

9	DESIGN	*Meter shall be designed with application specific integrated circuit (ASIC) or micro controller; shall have no moving part; electronic components shall be assembled on printed circuit board using surface mounting technology; factory calibration using high accuracy (0.05 class) software based test bench.*

4.0 CONSTRUCTIONAL REQUIREMENT/ METER COVER & SEALING ARRANGEMENT:

The Meters should be designed and constructed in such a way as to avoid introducing any danger in use and under normal conditions so as to ensure specially

- Personnel safety against electric shock.
- Personnel safety against effects of excessive temperature as per relevant standards.
- Protection against penetration of solid objects, dusts and water as per relevant standards. - Protection against spread of fire as per relevant standards.
- Detection against fraud or pilferage.

All the materials used in the manufacture of the meters should be of highest quality. The entire design and construction should be capable of with standing stresses likely to occur in actual service and rough handling during transportation as per standards.

All insulating materials used in the construction of meters should be non hygroscopic, non- aging and of tested quality and should conform to tests as specified in relevant standards. The meter should be designed on application specific integrated circuit and should be manufactured using SMT (Surface Mount Technology) components except a few PTH components.
The terminal block, the terminal cover and the meter case should have reasonable safety against the spread of fire. They should not be ignited by thermo overload of live parts in contact with them.

The meter must conform to the degree of protection IP51 against ingress of dust moisture and vermin"s.

All the parts which are subjected to corrosion under normal working conditions should be protected effectively. A protective coating should not be liable to damage by ordinary handling or damage due to exposure of air under normal working conditions.

The meters should be so designed that their working should remain unaffected by electromagnetic interference, electrostatic

discharges and high voltage transients as specified in CBIP report No. 88 (latest amendments thereof)

For connecting the meters to modem for automatic reading the power supply port shall be provided with breakable plastic cover on the meter cover which shall be broken & used for connecting the modem (this feature is only optional).

Sealable RJ11 connector will be given either under ETBC or side of meter with sealing arrangement.

5.0 METER CASE OPEN:

The Meter shall have meter case opening detection mechanism. The event shall be indicated on meter display continuously in auto scroll mode & shall be logged in memory. The detection & logging mechanism shall work even when meter is not energized. In case of indication in display, it shall get reset in 150 days, logic shall be defined.

On opening of the meter case relevant display like cover open count, last cover open date and time shall be updated and event shall be logged permanently as per DLMS.

6.0 TERMINALS AND TERMINAL BLOCK:

The meter should have tin plated brass terminals suitable for termination of service cable. The terminal block of the meters should be of high-grade engineering plastic, which should form an extension of the meter case and should have terminal holes of sufficient size to accommodate the insulation of conductors. It should have terminal holes of adequate length and of minimum internal diameter 5.5 mm to accommodate the insulation of conductor. The manner of fixing the conductors to the terminals should ensure adequate and durable contact such that there is no risk of loosening or undue heating. Screw connections transmitting contact force and screw fixings that may be loosened and tightened several times during the life of the meter. All parts of each terminal should be such that the risk of corrosion resulting from contact with any other metal part is minimized. Two screws should be provided in each current terminal for effectively clamping the external leads or thimbles. Each clamping screw should engage at-least 3 threads in the terminal. The ends of screws should be such as not to pierce the conductor.

The clearances and creepage distances should conform to relevant standard.

All parts of each terminal should be such that the risk of corrosion resulting from contact with any other metal part is minimized.

The electrical connections should be so designed that contact pressure is not transmitted through insulating material.

6.1 TERMINAL COVER:

The terminal cover should be transparent extended type, which can be sealed independently of the meter cover. The terminal cover should enclose the actual terminals. The conductor fixing screws, the external conductors and their insulation i.e. no part of the meter or cables accessories should be accessible from the front of the meter.

When the meter is mounted, no access to the terminals should be possible without breaking the seals of the meter terminal cover. The meter terminal cover should be fitted with the help of seal able screws.

The terminal cover should have two sealing screws independent of each Other. The fixing screws used on the terminal cover for fixing and sealing should be kept captive in the terminal cover.

6.2 TERMINAL ARRANGEMENTS:

The terminals should be marked properly on terminal block for giving external connections. A sticker showing connections should be provided inside the extended cover of terminal block. The terminal cover should be of extended type such that when it is placed in position it is not possible to approach the connections or connecting wires.

6.3 CONNECTION DIAGRAM:

Every meter should be indelibly marked with connection diagram showing the phase sequence for which it is intended and should be attached to the inner side of the extended terminal block cover. In case of any special precautions need to be taken at the time of testing the meter, the same should be indicated along with the circuit diagram.

7.0 SEALING OF METER:

Proper sealing arrangement should be provided on the meter to make it tamper proof/evident and avoid mishandling by unauthorized persons. The meter cover should have provision for minimum 2 Nos. seals. The terminal block cover should also be provided with two sealing arrangements. Separate sealing arrangement for the communication ports to CMRI/Modem should also be provided.

8.0 WORKING ENVIRONMENT

As per IS 14697-1999 (reaffirmed 2004). Meter to perform satisfactorily under Non-Air Conditioned environment (within stipulations of IS)

Meter body will conform to IP51 degree of protection. For outdoor use meter shall be installed in sealed enclosure conforming to IP 55.

The meter shall be suitable designed for satisfactory operation under the hot and hazardous tropical climate conditions and shall be dust and vermin proof. All the parts and surface, which are subject to corrosion, shall either be made of such material or shall be provided

with such protective finish, which provided suitable protection to them from any injurious effect of excessive humidity.

9.0 MANUFACTURING PROCESS, ASSEMBLY AND TESTING:

Meters shall be manufactured using latest and "state of the art" technology and methods prevalent in electronics industry. The meter shall be made from high accuracy and reliable surface mount technology (SMT) components. All inward flow of major components and sub assembly parts (CT, PT, RTCs/Crystal, LCDs, LEDs, power circuit electronic components etc.) shall have batch and source identification. Multilayer "PCB" assembly with "PTH" (Plated through Hole) using surface mounted component shall have adequate track clearance for power circuits. SMT component shall be assembled using automatic "pick-and-place" machines, Reflow Soldering oven, for stabilized setting of the components on "PCB". For soldered PCBs, cleaning and washing of cards, after wave soldering process is to be carried out as a standard practice. Assembly line of the manufacturing system shall have provision for testing of sub-assembled cards. Manual placing of components and soldering, to be minimized to items, which cannot be handled by automatic machine. Handling of "PCB" with ICs/C-MOS components, to be restricted to bare minimum and precautions to prevent "ESD" failure to be provided. Complete assembled and soldered PCB should undergo functional testing using computerized Automatic Test Equipment.

Fully assembled and finished meter shall undergo "burn-in" test process for 12 hrs at 55 degree Celsius (Max. temperature not to exceed 60 degree Celsius) under base current (Ib) load condition.

Test points should be provided to check the performance of each block/stage of the meter circuitry. RTC shall be synchronized with NPL time at the time of manufacture. Meters testing at intermediate and final stage shall be carried out with testing instruments, duly calibrated with reference standard, with traceability of source and date.

9.1 DISPLAYS:

The meter shall have 7 digits (with ±indication), parameter identifier, backlit Liquid Crystal Display (LCD) of minimum 10 mm height, and wide viewing angle. LCD shall be suitable for temperature withstand of 70 deg C; Sequence of display of various instantaneous electrical parameters shall be as desired by Owner at the time of order.

The data stored in the meters shall not be lost in the event of power failure. The meter shall have Non Volatile Memory (NVM), which does not need any battery backup. The NVM shall have a minimum

retention period of 10 years. In case of failure of power supply the meter could be powered up through an internal battery backup with a push button arrangement.

9.2 PERFORMANCE UNDER INFLUENCE QUANTITIES:

The meters performance under influence quantities shall be governed by IS 14697-1999 (reaffirmed 2004). The accuracy of meter shall not exceed the permissible limits of accuracy as per standard IS: 14697 (latest version).

9.3 OUTPUT DEVICE:

Energy Meter shall have test output, accessible from the front, and be capable of being monitored with suitable testing equipment while in operation at site. The operation indicator must be visible from the front and test output device shall be provided in the form of LED. Resolution of the test output device shall be sufficient to enable the starting current test in less than 10 minutes.

9.4 REAL TIME INTERNAL CLOCK (RTC):

RTC shall be pre-programmed for 30 Years Day/date without any necessity for correction. The maximum drift shall not exceed +/- 300 Seconds per year.

The clock day/date setting and synchronization shall only be possible through password/Key code command from one of the following:

Hand Held Unit (HHU) or Meter testing work bench and this shall need password enabling for meter;

From remote server through suitable communication network or Sub-station data logger "PC"

Time set can be done through transaction only. Time synchronization feature is not supported.

9.5 QUANTITIES TO BE MEASURED & DISPLAYED:

The meter shall be capable of measuring and displaying the following electrical quantities within specified accuracy limits for polyphase balanced or unbalanced loads:

INSTANTANEOUS PARAMETERS

1. Apparent Power - KVA
2. Signed Active Power - kW (+ Forward; -Reverse)
3. Signed Reactive Power - kvar (+ Lag; - Lead)
4. Cumulative Energy - kWh
5. Cumulative Energy - kvarh - Lag
6. Cumulative Energy - kvarh - Lead
7. Cumulative Energy - kVAh

8. Maximum Demand - kW
9. Maximum Demand - kVA

BILLING PROFILE PARAMETERS

The list of parameters shown above in Instantaneous Parameters & Block Load Survey parameters shall be used for computing the daily accounting data at the HOST.

9.6 DEMAND INTEGRATION PERIOD:

The maximum demand integration period should be Programmable with 15 min default.

9.7 MD RESET:

Auto reset at 24:00 hrs at the end of each billing cycle

9.8 MARKING OF METERS:

The marking of meters shall be in accordance with IS: 14697/1999 (reaffirmed 2004). The meters shall bear marking "ODSSP, OPTCL"

The meter shall also store name plate details as given in the table A5.1 of annexure containing the category of meters viz. DLMS – A, DLMS – B & DLMS – C etc. in capital letters. These shall be readable as a profile as and when required.

9.9 COMMUNICATION CAPABILITY:

The meter shall be provided with two ports for communication of the measured/collected data as per guideline document enclosed in the annexure, i.e. a hardware port compatible with RS 232 or RS 485 specifications which shall be used for remote access through suitable Modem (GPRS/GSM/EDGE/CDMA/PSTN/LPR) and an Optical port complying with hardware specifications detailed in IEC-62056-21 / IS 15959 . This shall be used for local data downloading through a DLMS compliant HHU.

The RS 485 port shall be used at Substations suitable for multi-drop connections of the meter for exporting data to sub-station data logger/DCU/Computer and the remote end server. The RS 232 port shall be used at boundary points meters and Distribution Transformer meters & consumer meters capable to transfer and export data to the remote end server through suitable communication

mediums (GPRS/GSM/EDGE/CDMA/ PSTN/LPR). Both ports shall support the default and minimum baud rate of 9600 bps.

9.10 HAND HELD UNIT (HHU):

To enable local reading of meters data a DLMS compliant HHU shall be used. The HHU shall be as per specification given in the enclosed guidelines document. It shall be compatible to the DLMS compliant energy meters that are to be procured / supplied on the basis of this specification. The HHU shall be supplied by the meter manufacturer along with the meter. 1 (One) number of HHU compatible to all categories of COSEM meters shall be provided by the supplier to DISCOM free of cost for each 50 (Fifty Meters).

10.0 TAMPER & FRAUD MONITORING FEATURES:

The meter shall work satisfactorily under presence of various influencing conditions like External Magnetic Field, Electromagnetic Field, Radio Frequency Interference, harmonic Distortion, Voltage/Frequency Fluctuations, and electromagnetic High Frequency Fields etc. The meter shall be immune to abnormal voltage/frequency generating devices and shall record the occurrence and restoration of such tamper events along with parameters such as current, voltages, kWh, power factor, event code, date & time etc. (listed in Table A6.1 to A6.7 in Annexure of the enclosed document).

The bidder may offer any other recordable abnormality event, which will be useful in consumer metering, along with the detailed descriptions, literatures, usefulness and every other implications.

Tamper details shall be stored in internal memory for retrieval by authorized personnel through either of the following:

1 - HHU. 2 - Remote access through suitable communication network.

Minimum 200 numbers of events (occurrences & restoration with date & time) should be available in the meter memory.

LOAD SURVEY

60 DAYS, 15 MIN IP with

following parameters:

PARAMETERS

1. Real Time Clock – Date and Time
2. Current - IR
3. Current - IY

4.Current – IB 5.Voltage -

VRN 6.Voltage – VYN

7.Voltage – VBN

8.Block Energy – kWh

9.Block Energy – kvarh – lag

10.Block Energy – kvarh – lead

11.Block Energy – kVAh

Forwarded energy channels can be given for load profile monitoring on total basis only.

TOD TIMING (Both MD & ENERGY)

00: 00 Hrs to 06:00 Hrs

06:00 Hrs to 24:00 Hrs

MD RESET REQUIRED

AUTO MODE ONLY, MANUAL RESET NOT REQUIRED

HISTORY

TOD MD - 12 months

All Energy - 12 months

History & TOD is not supported in Category A & B

11.0 TYPE TESTS:

The meter offered should have successfully passed all type tests described in the IS 14697 and the meter Data Transfer and Communication capability as per enclosed guidelines document. The front page of the Type test certificate,duly signed by the bidder, shall be uploaded along with the offer and the same shall not be more than 24 months old at the time of bid submission. Make & type of major components used in the type- tested meter shall be indicated in the QAP.

12.0 INSPECTION:

As specified in the GCC of Volume-I and Chapter- E2 of Volume-II of the technical specification.

12.1 ACCEPTANCE & ROUTINE TESTS:

Criteria for selection for such tests and performance requirements shall be as per IS 14697-1999 (reaffirmed 2004)

Additional acceptance shall include Surge withstand (SWC) for 6 kVp as per IEC 62052-11, Lightning impulse test and HF disturbance test as per IS 14697,Magnetic Influence Test as per CBIP report-88,Ageing Test, Burn test for 12 hrs in F.L.. One sample meter per order from one of the offered lot shall be subjected to these specific tests. Meters subjected to these tests shall not be used after tests.

Accuracy tests shall be performed at the beginning and at the end of the acceptance tests specified.

12.2 AGEING TEST:

Prior to final testing and calibration, all meters shall be subjected to accelerated ageing test to eliminate infant mortality, i.e., meters are to be kept in ovens for 72 hours at 55 deg. Centigrade temperature & atmospheric humid condition. After 72 hours meters should work correctly. Facilities / arrangement for conducting ageing test should be available with the manufacturer.

12.3 FULL LOAD TEST FOR 12 HOURS:

The meter should also be subjected to a full load operation continuously for a minimum period of 12 hours to test its durability at high loads.

12.4 GUARANTEE:

Energy Meters supplied shall be guaranteed for a period of 72 months from the date of commissioning . Bidders shall guarantee to repair or replace the meters and meter boxes (if supplied), which are found to be defective/ inoperative at the time of installation, or become in-operative/ defective during guarantee period. Replacements shall be effected within 1 month from the date of intimation.

12.5 TIME OF DAY (TOD) TARIFF:

The meter should be capable to record and store energy consumption as per following time zones of register. This is as per current tariff order. These should be configurable up to 8 time zones.

TOD TIMING (Both MD & ENERGY)

00: 00 Hrs to 06:00 Hrs

06:00 Hrs to 24:00 Hrs

12.6 SOFTWARE LOCKING:

The meter shall have password protected software locking for change of TOD timing, IP etc.

12.7. SOFTWARES:

The firm has to provide required base computer & MRI software for data down loading & analysis with free of cost.

12.8 METER READING PROTOCOL:

The Supplier has to provide Meter Reading Protocols, for billing parameters, tamper data etc. at free of cost. Interoperable DLMS protocol is implemented for meter reading, and tamper data. Suitable software will be provided to read the mentioned parameters.

CHAPTER- E9 -1

TECHNICAL SPECIFICATION

FOR

CONTROL CABLES, HT CABLES

AND

LT POWER CABLES

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PART – A

TECHNICAL SPECIFICATION

FOR

CONTROL CABLES

TECHNICAL SPECIFICATION FOR CONTROL CABLES

1.0 SCOPE

This specification covers the manufacturing, testing and performance requirements of PVC, unarmoured , copper, control cables for installation in substations.

The material offered shall be procured from short listed vendor at **E-23** and shall have been successfully type tested during last five years on the date of bid opening. The front page of type test report showing the evidence of successful type test of the items asked for in this Specification shall be uploaded with the signature of bidder. The full text of the type test report is to be submitted at the time of signing the agreement or within one month of LOA.

The control cables shall conform in all respects to highest standards of engineering, design, workmanship in accordance to this specification and the latest revisions of relevant standards, mentioned below.

2.0 STANDARDS

IEC / ISO	Indian Standard	Title
IEC 811	IS-18-10810:1982	Testing cables
IEC 502	IS - 1554:1988 (part 1)	PVC Cables 1100V
IEC 227	IS - 5819:1970	Short circuit ratings for PVC cables
IEC 228	IS-8130:1984	Conductors for insulated cables
IEC 540	IS - 5831: 1984	Test Methods for insulation and sheaths of electric cables and cords
IEC 287		Calculation of the continuous current rating of cables.

In the case of conflict, the order of precedence shall be

1) Indian Standards
2) IEC

3.0 TECHNICAL DETAILS

3.1 1.1KV POLYVINYL CHLORIDE (PVC) INSULATED CABLES

All control cables to be used shall be un- armored PVC type. The outer sheath of control cable shall be Polyvinyl chloride (PVC) type ST-2 of IS 5831.

3.2 RATED VOLTAGE AND TEMPERATURE

Control and Panel Wiring Cables (PVC insulated)
The conductor shall be of round stranded plain copper wires complying with IS - 8130:1984/ IEC 228.

N.B. - Conductor screening not required in this case.

3.3 **Insulation**

The insulation shall be of Polyvinyl Chloride (PVC) compound. 'Heat Resisting' Type C for the Control and Panel Wiring cables. Both shall conform to the requirements of IS - 5831: 1984.

Type of Insulation	Normal Continuous Operation	Short Circuit Operation
Heat Resisting	85°C	160°C

The PVC insulation shall be applied by extrusion and the average thickness of insulation as specified in IS – 1554 (part 1): 1988.

The insulation shall be applied so that it fits closely on to the conductor and it shall be possible to remove it without damage to the conductor.

Insulation Screening not required

Core Identification and Laying up of Cores

In multi-core cables, the cores shall be laid up together with a suitable lay as recommended in IS - 1554 (Part 1): 1988. The layers shall have successive right and left hand lays with the outermost layer having a right hand lay.

3.4 **Inner Sheath**

The laid up cables shall be covered with an inner sheath made of thermoplastic material (PVC) applied by extrusion.

The thickness of the sheath shall conform to IEC 502/IS - 1554: 1988. Single core cables shall have no inner sheath.

The outer serving shall incorporate an effective anti-termite barrier and shall be capable of withstanding a l0kV DC test voltage for five minutes after installation and annually thereafter.

Current ratings shall be calculated in accordance with IEC 287 "Calculation of the continuous current rating of cables with 100% load factor".

3.5 **Conductor Sizes**

The following shall be used for Control and Panel Wiring:

The No. of Cores & Sizes of the Control Cable shall be 4 Core, 7 Core, 10 Core and 19 Core etc. The size of each shall be 2.5 sg mm flexible Copper Wires. There shall be one single core copper cable of 16 sq mm size. All panel wiring shall be done by 2.5^2 mm fo CT, PT, CVT, and 4^2mm AC & DC Supply and connection from CT secondary to metes.

3.6 **Cable Drum Length**

The cable shall be supplied in 500 metre lengths or more but with prior approval for the owner.

4.0 CABLE IDENTIFICATION

The manufacturer's and Owner's name or trade mark, the voltage grade, cable designation and year of manufacture shall be indented or embossed along the whole length of the cable. The indentation or embossing shall only do on the outer sheath. The alphanumerical character size shall be not less than 20% of the circumference of the cable and be legible.

5.0 SAMPLING OF CABLES

5.1 Lot

In any consignment the cables of the same size manufactured under essentially similar conditions of production shall be grouped together to constitute a lot.

5.2 Scale of Sampling

Samples shall be taken and tested from each lot to ascertain the conformity of the lot to specification.

5.3 Sampling Rates

The number of samples to be selected shall be as follows:

Number of drums in the Lot	Number of Drums to be taken as samples	Permissible number of defective drums
Up to 25	3	0
26 to 50	5	0
51 to 100	8	0
101 to 300	13	1
301 and above	20	1

The samples shall be taken at random. In order to achieve random selection the procedure for selection detailed in IS - 4905: 1968 shall be followed.

6.0 NUMBER OF TESTS AND CRITERION FOR CONFORMITY

Suitable lengths of test samples shall be taken from each of the selected drums. These samples shall be subjected to each of the acceptance tests. A test sample shall be classed as defective if it fails any of the acceptance tests. If the number of defective samples is less than or equal to the corresponding number given in the lot shall be declared as conforming to the requirements of acceptance test.

7.0 TESTS ON 1.1 KV PVC INSULATED Control Cable.

7.1 Type Tests

Certification of type tests already completed by independent test laboratories shall be presented with the bid for each cable type. These tests shall be

carried out in accordance with the requirements of IS -8130: 1984/IEC 502, IS - 5831:1984/IEC 540 and IEC 811 unless otherwise specified. Type testing of 33kV, 11kV and 1.1 kV cables shall include the following:

	Test	**Requirement Reference**	**Test Method as a Part of IS-10810/IEC 811**
(a)	Tests on conductor		
	Annealing test (copper)	IS-8130: 1984/IEC 502	
	Resistance test	IS-8130: 1984/IEC 502	
(b)			
(c)	Tests for thickness of insulation and sheath	IS-5831:1984/IEC 540	
(d)	Physical tests for Insulation		
	Tensile strength and elongation at break	IS-5831:1984/IEC 540	
	Ageing in air oven	IS-5831:1984/IEC 540	
	Hot test	IS-5831:1984/IEC 540	
	Shrinkage test	IS-5831:1984/IEC 540	
	Water absorption (gravimatic)	IS-5831:1984/IEC 540	
(e)	Physical tests for outer sheath		
	Tensile strength and elongation at break	IS-5831: 1984/IEC 540	
	Ageing in air oven	IS-5 831: 1984/IEC 540	
	Shrinkage test	IS-5831: 1984/IEC 540	
	Hot deformation	IS-5831: 1984/IEC 540	
	Loss of mass in air oven	IS-5831: 1984/IEC540	
	Heat shock	IS-5831: 1984/IEC540	
	Thermal stability	IS-5831: 1984/IEC540	IS-5831: 1984
(j)	Insulation resistance test (Volume resistivity)	IS-8130: 1984/IEC502	
(m)	High voltage test	As per IS / IEC	
(n)	Flammability test	As per IS / IEC	

Tests (g), (h), (j), (l) and (m) are only applicable to screened cables.

7.2 **Acceptance Tests**

The following shall constitute acceptance tests:

- Tensile test (aluminium)
- Annealing test (copper)

- Wrapping test
- Conductor resistance test
- Test for thickness of insulation and sheath
- Hot set test for insulation*
- Tensile strength and elongation at break test for insulation and outer sheath

High voltage test

- Insulation resistance (volume resistivity) test.
- PVC insulation only

** test to be completed on full drum of cable

7.3 **Routine Tests**

Routine tests shall be carried out on all of the cable on a particular order. These tests shall be carried out in accordance with the requirements of IS - 8130: 1984/IEC 502 and IS - 5831:1984/IEC 540 unless otherwise specified.

The following shall constitute routine tests.

- Conductor resistance test
- High voltage test

* Test to be completed on full drum of cable

8.0 DETAILS OF TESTS

8.1 **General**

Unless otherwise stated, the tests shall be carried out in accordance with the appropriate part of IS -10810/IEC 502: 1994 and the additional requirements as detailed in this specification.

8.3 **Bending Test**

The diameter of the test cylinder shall be 20 (d +D) ± 5% for single core cables and 15 (d+D) ± 5% for multicores, where D is the overall diameter of the completed cable in millimeters and d is the diameter of the conductor. After completing the bending operations, the test samples shall be subjected to partial discharge measurements in accordance with the requirements of this specification

8.5 **High Voltage Test**

8.5.1 For Type/ Acceptance Test

The cable shall withstand, without breakdown, at ambient temperature, an ac voltage equal to 3Uo, when applied to the sample between the conductor and screen/ armour (and between conductors in the case of unscreened cable). The voltage shall be gradually increased to the specified value and maintained for a period of 4 hours.

If while testing, interruption occurs during the 4 hour period the test shall be prolonged by the same extent. If the interruption period exceeds 30 minutes the test shall be repeated.

8.5.2 For Routine Test

Single core screened cables, shall withstand, without any failure, the test voltages given in this specification for a period of five minutes between the conductor and metallic screen.

Single core unscreened cables shall be immersed in water at room temperature for one hour and the test voltage then applied for 5 minutes between the conductor and water.

Multicore cables with individually screened cores, the test voltage shall be applied for 5 minutes between each conductor and the metallic screen or covering.

Multicore cables without individually screened cores, the test voltage shall be applied for 5 minutes in succession between each insulated conductor and all the other conductors and metallic coverings, if any.

When a DC voltage is used, the applied voltage shall be 2.4 times the power frequency test voltage. In all instances no breakdown of the insulation shall occur.

8.6 **Flammability Test**

The period for which the cable shall burn after the removal of the flame shall not exceed 60 seconds and the unaffected portion (uncharged) from the lower edge of the top clamp shall be at least 50mm.

9.0 CONTROL / LV WIRING ACCESSORIES

9.1 **Terminations**

Control wire terminations shall be made with solder less crimping type and tinned copper lugs which firmly grip the conductor. Insulated sleeves shall be provided at all the wire termination. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from terminal blocks. All wires directly connected to trip circuit breaker or device shall be distinguished by the addition of red coloured unlettered ferrule. Numbers 6 and 9 shall not be included for ferrules purposes except where underlined and identified as 6 and 9.

LVAC cable terminals shall be provided with adequate size crimp type lugs. The lugs shall be applied with the correct tool, which shall be regularly checked for correct calibration. Bi-metallic joints between the terminals and lugs shall be provided where necessary.

Terminals shall be marked with the phase colour in a clear and permanent manner.

A removable gland plate shall be provided by the contractor at every cable entry to mechanism boxes, cabinets and kiosks. The Contractor shall be responsible for drilling the cable gland plate to the required size.

10.0 GENERAL PARTICULARS AND GUARANTEES

10.1 COMPLIANCE WITH SPECIFICATION

The control cables shall comply in all respects with the requirements of this specification. However, any minor departure from the provisions of the specification shall be disclosed at the time of bidding in the Deviation Schedule in this document.

11.0 PACKING AND SHIPPING

11.1 Packing

The cable shall be wound on strong drums or reels capable of withstanding all normal transportation and handling.

Each length of cable shall be durably sealed before shipment to prevent ingress of moisture. The drums, reels or coils shall be lagged or covered with suitable material to provide physical protection for the cable during transit and during storage and handling operations.

In the case of steel drums adequate precautions shall be taken to prevent damage being caused by direct contact between the cable sheath and the steel. These precautions shall be subject to the approval of the Project Manager.

If wooden drums are used then the wood shall be treated to prevent deterioration from attack by termites and fungi.

Each drum or reel shall carry or be marked with the following information:

- Individual serial number
- Owner's name
- Destination
- Contract Number
- Manufacturer's Name
- Year of Manufacture
- Cable Size and Type
- Length of Conductor (meters)
- Net and Gross Mass of Conductor (kg)
- All necessary slinging and stacking instructions.
- Destination;
- Contractor's name;

• Name and address of Contractor's agent in Orissa;
• Country of origin;

The direction of rolling as indicated by an arrow shall be marked on a flange.

11.2 **Storage**

The site selected for the storage of cable drums shall be well drained and preferably have a concrete/firm surface which will prevent the drums sinking into the ground or being subjected to excess water thus causing flange rot.

All drums shall be stood on battens, in the upright position, and in such a manner to allow sufficient space between them for adequate air circulation. During storage the drums shall be rotated 90° every three months. In no instances shall the drums be stored "flat" on their flanges or one on top of each other.

PART – B

TECHNICAL SPECIFICATION
FOR

33kV SINGLE CORE

XLPE UG CABLE

FOR

SUBSTATION AND LINE

TECHNICAL SPECIFICATION FOR 33kV SINGLE CORE XLPE UG CABLE

1.0 SCOPE:

1.1. The scope of this specification covers the design, manufacture, stage inspection at works, inspection and testing the finished 33 kV Single Core, stranded, compact circular, Aluminum, water blocked conductor, conductor screened with extruded semiconducting compound, water tree retardant (TR) XLPE insulated, insulation screened with extruded semi conducting compound, dry cured & dry cooled using triple extrusion through common triple cross head (single point triple extrusion), in combination with semiconducting water blocking tape, cores laid up with non-hygroscopic fillers including Centre filler, corrugated aluminium metallic sheathed, bituminous tape adhesion, and overall black PE ST-7 sheathed cable conforming to IS:7098 (Part-2) 1985/IEC 60502 Part 1 with latest amendments and as per specification detailed with graphite coated conducting layer.

1.2. 33 kV single core cables will be used in the lines and also for interconnection between outdoor equipment and indoor switchgear in the sub stations. Line cables will be buried underground but cable joints will be placed in chambers. The cables in substations will be laid in open RCC trenches.

2.0 RATED VOLTAGE:

The rated voltage of the cable shall be 33 kV AC with the highest system voltage of 36 kV between phases of the effectively earthed three-phase transmission system.

3.0 APPLICABLE STANDARDS:

3.1 Unless otherwise stipulated in the specifications, the latest version of the following Standards shall be applicable:

3.1.1 IS 7098 (Part 2) – Cross-linked Polyethylene (XLPE) insulation for Cables

3.1.2 IS 8130 – Conductors for insulated electrical cables and flexible cords

3.1.3 IS 10810 (series) – Methods of tests for cables

3.1.4 IEC 60502-2 for properties of PE ST 7

3.1.5 IS 3975-Specification for mild steel wires, strips and tapes for armouring of cables

3.1.6 IS 5831 – Specification for PVC insulation sheath for electric cables

3.1.7 IS 10462 – Fictitious calculation method for determination of dimensions of protective coverings of cables Part 1 - Elastomeric and thermoplastic insulated cables

4.0 CONSTRUCTION:

4.1 Conductor: The cable conductor shall be made from H2 Grade Aluminum to form compacted stranded circular conductor having resistance within the limits specified in IS: 8130/1984 and any amendment thereof. The wires shall be laid up together with a suitable right hand lay.
The conductor shall be water blocked using semi conducting water swellable tape over compacted conductor and shall pass the water penetration test as per IEC-60502-2.

4.2 **Conductor Screen:** The conductor screen shall be extruded semiconductor XLPE, extruded by triple extrusion method in the same operation as along with the insulation and insulation screen., the IS: 7098 Part 2, The semiconductor shall be suitable for operating temperature of the cable and shall be compatible with the insulation.

4.3 **Insulation:** The insulation shall be water Tree Retardant (TR) Cross Linked Polyethylene (XLPE) insulation applied by extrusion and shall conform to the following requirements:

S. No.	**Properties**	**Requirements**
1.	Tensile Strength	12.5N/mm², Min.
2.	Elongation to break	200 percent, Min
3.	Aging in air oven: a) Treatment: Temperature: Duration: b) Tensile Strength variation: c) Elongation variation:	 135 ±3°C 7 days ±25 percent, Max ±25 percent, Max
4.	Hot set: a) Treatment: Temperature: Time under load Mechanical stress b) Elongation under load c) Permanent elongation (set) after cooling	 200±3°C 15 min 20N/cm² 175 percent, Max 15 percent, Max
5.	Shrinkage: a) Treatment: Temperature Duration b) Shrinkage	 130±3°C 1 hour 4 percent, Max
6.	Water absorption (Gravimetric): a) Treatment: Temperature: Duration: b) Water absorbed	 85±2°C 14 days 1 mg/cm², Max
7.	Volume Resistivity a) at 27°C b) at 90°C	 $1x10^{14}$ ohm-cm, Min $1x10^{12}$ ohm-cm, Min
8.	Thermal Resistivity	350 degrees C cm/W
9.	Power factor at maximum conductor temperature	0.008
10.	Dielectric strength	22 kV/mm

4.3.1 The XLPE insulation should be suitable for specified system voltage. The extrusion should be a True triple extrusion with thickness and concentricity control of all the three layers.

4.3.2 The curing process of XLPE insulation should be dry cured and dry cooled. The manufacturing process shall ensure that insulations shall be free from voids. Minimum degree of crosslinking shall be 75% as per ASTM 2765.

4.3.3 The insulation shall withstand mechanical and thermal stresses under steady state and transient operating conditions.

4.3.4 The extrusion method should give very smooth interface between semi-conducting screen and insulation.

4.3.5 The insulation of the cable shall be compatible with the continuous conductor temperature of 90°C, short time overload temperature of 130°C & short circuit temperature of 250°C.

4.3.6 The average thickness of the insulation shall not be less than as specified in IS: 7098-II. The insulation shall be so applied that it fits closely on conductor screening and it shall be possible to remove it without damaging the conductor.

4.3.7 The eccentricity of the insulation shall be less than 10% and ovality shall be less than 5%.

4.4 Insulation Screen: To confine electrical field to the insulation, non-metallic semi-conducting XLPE shield shall be put over the insulation. The insulation shield shall be extruded in the same operation as the conductor shield and the insulation by triple extrusion and shall be as IS: 7098 Part 2, A water blocking tape shall be applied over the semiconducting compound.

4.5 Metallic Sheath: The metallic sheath shall be corrugated aluminium. It should be of adequate thickness to withstand the fault currents as specified in the GTP in Chapter E24.

4.6 **Bituminious tape:**
Bituminous tape shall be applied over corrugated aluminium sheath for proper adhesion. The thickness of the bituminous tape shall be fixed during detail engineering.

4.7 Outer Sheath: Extruded HDPE ST-7 outer sheath as per IEC 60502-1, for line cables. and FR-PVC type ST2 Outer sheathed cables to be laid in substations.

4.8 The outer sheath shall be applied with suitable additives to prevent attack by rodents and termites. Outer sheathing shall be designed to offer high degree of mechanical protection and shall also be heat, oils, chemicals, abrasion and weather resistant. Common acids, alkalis, saline solutions etc., shall not have adverse effects on the sheathing material used.
There shall be a graphite coating conductive layer over the outer sheath.

4.9 The cables should be suitable for use in solidly earthed system. The total relay and breaker operating time will be within 400 milli second.

4.10 The underground cables shall be manufactured to the highest quality, best workmanship with scientific material management and quality control. The manufacturer shall furnish the quality plan, giving in detail the quality control procedure/ management system.

4.11 The cable shall be suitable for laying in covered trenches and/or buried underground to meet the outdoor application purposes.

5.0 SYSTEM AND CLIMATIC DETAILS: As per Chapter E-3 on System and Climatic Data

6.0 DESIGN CRITERIA:

6.1 The cables that are covered in these specifications are intended for use outdoor, under the climatic conditions and installation conditions described in the technical specification.

6.2 Any technical feature, not specifically mentioned here, but is necessary, for the good performance of the product, shall be incorporated in the design. Such features shall be clearly brought out under Technical deviations schedule only, in the offer made by the bidder, giving technical reasons, and justifying the need to incorporate these features.

6.3 For continuous operation of the cables, at specified rating, the maximum conductor temperature shall be limited to the permissible value as per the relevant standard, generally not exceeding 90°C under normal operation and 250°C under short – circuit conditions.

6.4 The cables in service will be subject to daily load cycles, of two peaks during a day; morning peak and evening peak, with around 25% to 50% loading during the nights.

6.5 The materials used for outer sheaths shall be resistant to oils, acids and alkalis.

6.6 The cables shall have the mechanical strength required, during handling and laying.

6.7 The cables shall be designed to withstand the thermo-mechanical forces and electrical stresses during normal operation and transient conditions.

7.0 MANUFACTURE PROCESS:

7.1 <u>PRE - QUALIFICATION REQUIREMENT OF CABLE MANUFACTURES</u>

7.1.1 The cable manufacturer must qualify all the following requirements:

7.1.2 Manufacturer should have true triple extrusion machine along with CCV line with dry curing and dry cooling in Nitrogen

7.1.3 Cable eccentricity monitoring system during triple extrusion in CCV line.

7.1.4 The manufacture should have in-house raw material testing and QA lab. Self-declaration and list of testing equipment to be submitted.

7.2 Cross-linking of the insulation materials water Tree Retardant (TR) (pre compounded polyethylene) shall be conforming to IS: 7098 (Part – II) and the proof of purchase of the above insulating material shall be submitted and is to be offered for stage inspection.

7.3 The bidder shall specify the length of curing and cooling chamber.

8 MATERIALS:

8.1 The minimum number of wires shall be as per IS 8130/ 1984.

9 METALLIC SHEATH :

The corrugated aluminium metallic sheath shall be so applied that it fits closely on the laid up cores. The thickness of the metallic sheath shall withstand the fault current specified in the GTP (E-24) for 1 second.

10 OUTER SHEATH:

10.1 The outer sheath shall be applied by extrusion. It shall be applied over the bituminous tape wound over the metallic sheath. It shall consist of PE ST-7 compound, conforming to the requirements of IEC 60502-1 for lines and FR PVC ST2 for sub station. The minimum thickness of the sheath shall be as per IS 10462 (Part 1).

11 IDENTIFICATION:

11.1 The outer sheath shall have the following information embossed or indented on it; the manufacturer's name or trade mark, the voltage grade, the year of manufacture and the letters "OPTCL- ODSSP". The identification shall repeat at every meter of the along the length of the cable. Outer sheath of cable shall be black in permanent colour.

12 INSPECTION AND QUALITY CONTROL:

12.1 The Bidder shall furnish a complete and detailed quality plan for the manufacturing process of the cable. All raw materials shall conform to relevant applicable standards and tested for compliance to quality and requirement.

13 TESTS:

13.1 The first page Type test certificates from shall be submitted along with Bid . The Type Tests should have been conducted not earlier than 5-years as on the date of Bid-Opening and should be for the same cable or higher sized cable of the same voltage grade.

13.2 All acceptance tests shall be conducted in the presence of the Owner/ representative.

13.3 The following type tests shall be conducted on the cable.

S. No	Test	Requirement
a)	Tests on conductor i) Resistance test	IS:8130
b)	Tests for armoured wires and strips	Clause 14.2 & IS:3975

c)	Test for thickness of insulation and sheath	Clause 4.3, 15.2 & 16.1
d)	Physical tests for insulation: i) Tensile strength and elongation at break ii) Aging in air oven iii) Hot test iv) Shrinkage test v) Water absorption (gravimetric)	Clause 4.3
e)	Physical tests for outer sheath i) Tensile strength and elongation at break ii) Aging in air oven iii) Shrinkage test iv) Hot deformation v) Thermal Stability for FR ST 2 vi) Carbon black content for PE ST 7 vii) Abrasion Resistance test for PE ST 7	IS: 5831 for FR PVC/ IEC 60502-2 for PE ST 7
g)	Partial discharge test	
h)	Bending test	
j)	Dielectric power factor test i) As a function of voltage ii) As a function of temperature	
k)	Insulation resistance (Volume resistivity) test	Clause 4.3
m)	Heating cycle test	Clause 21.5
n)	Impulse withstand test	Clause 21.6
p)	High voltage test	Clause 21.7
q)	Flammability test	Clause 21.8
r)	Void & Contamination Test	IS 7098 (Part-3)
s)	Degree of Cross linking of XLPE	ASTM D 2765
t)	Wafer Boil Test	ASTM D 2765
u)	Oxygen Index and Temperature Index for FR PVC ST 2	ASTM D 2863

13.4 The following test shall be performed successively on the same test sample of completed cable, not less than 10 M in length between the test accessories:

13.4.3 Partial discharge test.
13.4.4 Bending test followed by partial discharge test.
13.4.5 Dielectric power factor as a function of voltage.
13.4.6 Dielectric power factor as a function of temperature.
13.4.7 Heating cycle test followed by dielectric power factor as a function of voltage and partial discharge tests.
13.4.8 Impulse withstand test
13.4.9 High voltage test.

14 ACCEPTANCE TEST:

14.1 The sampling plan for acceptance test shall be as per IS 7098 part -II, Appendix 'A'.

14.2 The following shall constitute the acceptance test:

14.2.3 Conductor resistance test
14.2.4 Test for thickness of insulation
14.2.5 Test for thickness of inner and outer sheath
14.2.6 Hot-set test for insulation
14.2.7 Tensile strength and elongation at break test for insulation and outer sheath
14.2.8 Partial discharge test (on full drum length) - (shall be less than 20PC)
14.2.9 High voltage test
14.2.10 Insulation resistance (volume resistivity) test
14.2.11 Void & Contamination Test
14.2.12 Wafer Boil Test
14.2.13 Degree of Cross linking of XLPE
14.2.14 Oxygen and Temperature Index for FR PVC ST 2
14.2.15 Abrasion Resistance Test for PE ST 7
14.2.16 Carbon Black content for PE ST 7
14.2.17 Water penetration test as per IEC 60502-2

15 ROUTINE TEST:

15.1 The following shall constitute routine tests:

15.1.3 Conductor resistance test
15.1.4 Partial discharge test on full drum length
15.1.5 High voltage test

16 DETAILS OF TESTS:

16.1 Unless otherwise mentioned in this specification, the tests shall be carried out in accordance with appropriate part of IS: 10810.

16.2 The partial discharge magnitude at test voltage equal to 1.50 Uo shall not exceed 20 pC.

16.3 Bending test: The diameter of the test cylinder shall be 20D where D is the overall diameter of the completed cable. After completing the bending operations, the test sample shall be subjected to partial discharge measurement and shall comply with the requirements given in 22.2.

16.4 Dielectric power factor test:

16.4.3 Tan δ as a function of voltage: The measured value of Tan δ at Uo shall not exceed 0.004 and the increment of Tan δ between 0.5 Uo and 2 Uo shall not be more than 0.002.

16.4.4 Tan δ as a function of Temperature: The measured value of Tan δ at Uo shall not exceed 0.004 at the ambient temperature and 0.008 at 90°C.

16.5 Heating cycle test: The sample, which has been subjected to previous tests, shall be laid out on the floor of the test room and subjected to heating cycles. After the third cycle, the sample shall be subjected to dielectric power factor as a function of voltage, and partial discharge test.

16.6 Impulse voltage withstand test: The impulse voltage level shall be as per Clause 19.6 of IS 7098 (Part-2) 1985. No breakdown of insulation shall occur during the test.

16.7 High Voltage Test:

16.7.3 Type test and Acceptance tests: The cable shall withstand without breakdown an ac voltage equal to 3 Uo when applied to the sample between conductor and screen/armour. The voltage shall be gradually increased to the specified value and maintained for a period of 4 hours.

16.7.4 Routine test: The cable shall withstand without any failure, 2.5 Uo rms between conductors and screen/armour, when applied for a period of five minutes for each test connection.

16.8 Flammability test: Period of burning after removal of the flame shall not exceed 60 seconds and the unaffected (un charred) portion from the lower edge of the top clamp shall be at least 50-mm.

OPTCL reserves the right to select a random sample of supplied UG cable from the Manufacturer's end which are ready to dispatch and also ongoing cable laying works and the same samples will be sent to any testing laboratory as desired by OPTCL at Bidders cost. If the testing results are found to be not satisfactory OPTCL reserves the right to reject the entire batch of cable received and insists for replacement of material free of cost. The decision of OPTCL in this regard is final.

17 PACKING:

17.1 The cables, as per specified delivery lengths, shall be securely wound /packed in non-returnable steel drums, capable of withstanding rough handling during transport by Rail, Road, etc. The packing should withstand storage conditions in open yards. The dimensional drawings of steel drums shall be furnished with the bid. The drum shall be provided with circumferential lagging of strong wooden planks or high thickness Polypropylene Sheets. The end of the cable shall be sealed with good quality heat shrink or PVC caps. The packing should be able to withstand the rigorous of transport. The following information in bold letters in English shall be painted on the flanges.

17.1.3 Name & Address of the manufacturer, Trade name/Trade mark/Brand

17.1.4 Size of cable (Cross section) rated voltage, standard, insulation, cable code, drum No., and year of manufacture.

17.1.5 Length of cables (Meters)

17.1.6 Direction of rolling

17.1.7 Net weight (in Kg)

17.1.8 Gross weight (in Kg)

17.1.9 OPTCL purchase order reference.

18 SEALING OF CABLE ENDS ON DRUMS:

18.1 The cable ends shall be sealed properly so that ingress of moisture is completely prevented. The individual core endings shall be sealed effectively with water resistant compound applied over the core and provided with a suitable end cap of sufficient length with adequate cushion space so that the conductor does not puncture the cap in case of movement of the core during unwinding or laying. Before sealing, the semi conducting layer on the cores may be removed for about 2 mm at each end, to facilitate checking the insulation resistance from one end, without removing the sealing cap at the other end.

19 CABLE LENGTHS:

19.1 The cables shall be supplied in continuous lengths of 500m or more with 5% tolerance and cable shall on the non-returnable steel drums only.

20 MARKING:

20.1 The packed cable drum shall carry the following information, clearly painted or stenciled.

20.1.3 The letters – 'OPTCL'
20.1.4 Reference to Standard
20.1.5 Manufacturer's Name or trade mark
20.1.6 Type of cable & voltage grade
20.1.7 Number of cores
20.1.8 Nominal cross- sectional area of conductor
20.1.9 Cable code
20.1.10 Length of cable on the drum
20.1.11 Direction of rotation
20.1.12 Gross weight
20.1.13 Country of Manufacture
20.1.14 Year of Manufacture
20.1.15 Purchase order and date
20.1.16 Address of consignee

21 GUARANTEED TECHNICAL PARTICULARS:

21.1 The bidder shall furnish the guaranteed technical particulars of the cable offered in the GTP format provided in Chapter E-24.

22 DRAWING & LITERATURE:

The following shall be furnished.

22.1 Cross sectional drawings of the cables, giving dimensional details.
22.2 An illustrated literature on the cable, giving technical information, on current ratings, cable constants, short circuit ratings, derating factors for different types of installation, packing date, weights and other relevant information.

PART C

11 kV XLPE 3 CORE

UG CABLE

FOR

SUBSTATION AND LINE

TECHNICAL SPECIFICATION FOR 11 kV XLPE 3 CORE UG CABLE

1.0 SCOPE:

The scope of this specification covers the design, manufacture, stage inspection at works, inspection and testing the finished 11 kV Three Core, stranded, compact circular, Aluminum, water blocked conductor, conductor screened with extruded semiconducting compound, water tree retardant (TR) XLPE insulated, insulation screened with extruded semi conducting compound with copper as metallic part, dry cured & dry cooled using triple extrusion through common triple cross head (single point triple extrusion), in combination with water blocking tape , cores laid up with non-hygroscopic fillers including Centre iller, PVC ST2 inner sheathed, , galvanised steel strip/GI wire armored and overall black PE ST 7 sheathed cable conforming to IS:7098 (Part-2) 1985/IEC with latest amendments and as per specification detailed.
Line cables will be buried underground and cable joints will be placed in chambers.

2.0 RATED VOLTAGE:

The rated voltage of the cable shall be 11 kV AC with the highest system voltage of 12 kV between phases of the effectively earthed three-phase transmission system.

3.0 APPLICABLE STANDARDS:

Unless otherwise stipulated in the specifications, the latest version of the following Standards shall be applicable:

3.1.1 IS 7098 (Part 2) – Cross-linked Polyethylene (XLPE) insulation for Cables
3.1.2 IS 8130 – Conductors for insulated electrical cables and flexible cords
3.1.3 IS 10810 (series) – Methods of tests for cables
3.1.4 IEC 60502-2 for properties of PE ST 7
3.1.5 IS 3975-Specification for mild steel wires, strips and tapes for armouring of cables
3.1.6 IS 5831 – Specification for PVC insulation sheath for electric cables
3.1.7 IS 10462 – Fictitious calculation method for determination of dimensions of protective coverings of cables Part 1 - Elastomeric and thermoplastic insulated cables

4.0 CONSTRUCTION:

4.1 **Conductor:** The cable conductor shall be made from H2 Grade Aluminum to form compacted stranded circular conductor having resistance within the limits specified in IS: 8130/1984 and any amendment thereof. The wires shall be laid up together with a suitable right hand lay.

The conductor shall be water blocked using semi conducting water swellable tape over compacted conductor and shall pass the water penetration test as per IEC-60502-2.

4.2 **Conductor Screen:** The conductor screen shall be extruded semiconductor XLPE, extruded by triple extrusion method in the same operation as along with the insulation and insulation screen., the IS: 7098 Part 2, The semiconductor shall be suitable for operating temperature of the cable and shall be compatible with the insulation.

4.3 **Insulation:** The insulation shall be water Tree Retardant (TR) Cross Linked Polyethylene (XLPE) insulation applied by extrusion and shall conform to the following requirements:

S. No.	**Properties**	**Requirements**
1.	Tensile Strength	12.5N/mm², Min.
2.	Elongation to break	200 percent, Min
3.	Aging in air oven: d) Treatment: Temperature: Duration: e) Tensile Strength variation: f) Elongation variation:	 135 ±3°C 7 days ±25 percent, Max ±25 percent, Max
4.	Hot set: d) Treatment: Temperature: Time under load Mechanical stress e) Elongation under load f) Permanent elongation (set) after cooling	 200±3°C 15 min 20N/cm² 175 percent, Max 15 percent, Max
5.	Shrinkage: b) Treatment: Temperature Duration b) Shrinkage	 130±3°C 1 hour 4 percent, Max
6.	Water absorption (Gravimetric): c) Treatment: Temperature: Duration: d) Water absorbed	 85±2°C 14 days 1 mg/cm², Max
7.	Volume Resistivity c) at 27°C d) at 90°C	 $1x10^{14}$ ohm-cm, Min $1x10^{12}$ ohm-cm, Min
8.	Thermal Resistivity	350 degrees C cm/W
9.	Power factor at maximum conductor temperature	0.008
10.	Dielectric strength	22 kV/mm

4.3.1 The XLPE insulation should be suitable for specified system voltage. The extrusion should be a True triple extrusion with thickness and concentricity control of all the three layers.

4.3.2 The curing process of XLPE insulation should be dry cured and dry cooled. The manufacturing process shall ensure that insulations shall be free from voids. Minimum degree of crosslinking shall be 75% as per ASTM 2765.

4.3.3 The insulation shall withstand mechanical and thermal stresses under steady state and transient operating conditions.

4.3.4 The extrusion method should give very smooth interface between semi-conducting screen and insulation.

4.3.5 The insulation of the cable shall be compatible with the continuous conductor temperature of 90°C, short time overload temperature of 130°C & short circuit temperature of 250°C.

4.3.6 The average thickness of the insulation shall not be less than as specified in IS: 7098-II. The insulation shall be so applied that it fits closely on conductor screening and it shall be possible to remove it without damaging the conductor.

4.3.7 The eccentricity of the insulation shall be less than 10% and ovality shall be less than 5%.

4.4 Insulation Screen: To confine electrical field to the insulation, semi-conducting XLPE shield shall be put over the insulation. The insulation shield shall be extruded in the same operation as the conductor shield and the insulation by triple extrusion and shall be as IS: 7098 Part 2,Copper Tape of 10% Overlap, water blocking tape shall be applied over the semiconducting compound.

4.5 **Inner Sheath:** The sheath shall be extruded PVC Type ST2, suitable to withstand the site conditions and the desired temperature. It should be of adequate thickness as specified in IS: 7098-II, consistent quality and free from all defects.

4.6 **Armour :** Armoring shall be applied over the inner sheath with single galvanized steel flat strips / GI Wires complying with the requirements of IS: 3975/1979 for 3-Core cables as specified in the BOQ.

The joints in armour wire shall be made by brazing or welding and the surface irregularities shall be removed. Minimum armour coverage shall be 90%. A joint in any wire shall be at least 300 mm from the nearest joint in any other armour wire in the complete cable and shall be as per IS: 7098 Part 2, IS: 3975, IEC:60502 Part – 2, BS: 6622, BS: 7835.

4.7 **Outer Sheath:** Extruded HDPE ST-7 outer sheath as per IEC 60502-2, for line cables. The outer sheath shall be applied over armoring with suitable additives to prevent attack by rodents and termites. Outer sheathing shall be designed to offer high degree of mechanical protection and shall also be heat, oils, chemicals, abrasion and weather resistant. Common acids, alkalis, saline solutions etc., shall not have adverse effects on the sheathing material used.

For the cables inside the substation, the outer sheath shall be FR PVC Type ST2

4.8 The cables should be suitable for use in solidly earthed system. The total relay and breaker operating time will be within 400 milli second.

4.9 The underground cables shall be manufactured to the highest quality, best workmanship with scientific material management and quality control. The manufacturer shall furnish the quality plan, giving in detail the quality control procedure/ management system.

4.10 The cable shall be suitable for laying in covered trenches and/or buried underground to meet the outdoor application purposes.

4.11 The successful Bidder shall give sufficient advance notice to the Owner of not less than fifteen days to arrange for inspection and quality assurance program during manufacture, at the works.

5.0 SYSTEM AND CLIMATIC DETAILS: As per Chapter E-3 on System and Climatic Data

6.0 DESIGN CRITERIA:

6.1 The cables that are covered in these specifications are intended for use outdoor, under the climatic conditions and installation conditions described in the technical specification.

6.2 Any technical feature, not specifically mentioned here, but is necessary, for the good performance of the product, shall be incorporated in the design. Such features shall be clearly brought out under Technical deviations schedule only, in the offer made by the bidder, giving technical reasons, and justifying the need to incorporate these features.

6.3 For continuous operation of the cables, at specified rating, the maximum conductor temperature shall be limited to the permissible value as per the relevant standard, generally not exceeding 90°C under normal operation and 250°C under short – circuit conditions.

6.4 The cables in service will be subject to daily load cycles, of two peaks during a day; morning peak and evening peak, with around 25% to 50% loading during the nights.

6.5 The materials used for outer sheaths shall be resistant to oils, acids and alkalis.

6.6 The cables shall have the mechanical strength required, during handling and laying.

6.7 The cables shall be designed to withstand the thermo-mechanical forces and electrical stresses during normal operation and transient conditions.

7.0 MANUFACTURE PROCESS:

7.1. PRE - QUALIFICATION REQUIREMENT OF CABLE MANUFACTURES

7.1.1 The cable manufacturer must qualify all the following requirements:

7.1.2 Manufacturer should have true triple extrusion machine alongwith CCV line with dry curing and dry cooling in Nitrogen.

7.1.3 Cable eccentricity monitoring system during triple extrusion in CCV line.

7.1.4 The manufacture should have in-house raw material testing and QA lab. Self-declaration and list of testing equipment to be submitted.

7.2 Cross-linking of the insulation materials water Tree Retardant (TR) (pre compounded polyethylene) shall be conforming to IS: 7098 (Part – II) and the proof of purchase of the above insulating material shall be submitted and is to be offered for stage inspection.

7.3 The bidder shall specify the length of curing and cooling chamber.

7.4 The partial discharge shall be less than 20 pC at 1.50 Uo

8 CORE IDENTIFICATION:

8.1 Tthe core identification for 3 core cables shall be provided by application of colored polyester strips of Red, Yellow & Blue below copper tape.

9 LAYING UP OF CORES:

9.1 The cores shall be laid together with a suitable right hand lay. The interstices at the center shall be filled with PP fillers laid up together and wrapped with polyester tape.

10 INNER SHEATH (COMMON COVERING ONLY FOR 3-CORE CABLES):

10.1 The laid up cores shall be provided with PVC ST 2 inner sheath applied by extrusion. It shall be ensured that the shape is as circular as possible. The inner sheath shall be so applied that it fits closely on the laid up cores and it shall be possible to remove it without damage to the insulation.

10.2 The thickness of the inner sheath (common covering) shall be as per IS 10462 (Part 1)

10.3 When one or more layers of binder tapes are applied over the laid up cores, the thickness of such tapes shall not be construed as a part of inner sheath.

11 ARMOURING:

11.1 Armoring shall be applied over the inner sheath with galvanised steel flat strip/GI wire complying with the requirements of IS: 3975/1979 for 3-Core cables. The dimensions of the galvanized steel flat strips/GI wire shall be as specified in the IS: 7098/Part-II/1985..

11.2 The armour shall be capable to withstand the fault current mentioned in the GTP (ChapterE-24) for 1 second. Bidders shall furnish the calculation / data sheet for the short circuit carrying capability of the Armour.

12 OUTER SHEATH:

The outer sheath shall be applied by extrusion. It shall be applied over the armouring and shall consist of PE ST 7 compound, conforming to the requirements of IEC 60502-2 for lines and FR PVC ST2 for sub station . The minimum thickness of the sheath shall be as per IS 10462 (Part 1).

13 IDENTIFICATION:

13.1 The outer sheath shall have the following information embossed or indented on it; the manufacturer's name or trade mark, the voltage grade, the year of manufacture and the letters "OPTCL- ODSSP". The identification shall repeat at every meter of the along the length of the cable. Outer sheath of cable shall be black in permanent colour.

14 INSPECTION AND QUALITY CONTROL:

The Bidder shall furnish a complete and detailed quality plan for the manufacturing process of the cable. All raw materials shall conform to relevant applicable standards and tested for compliance to quality and requirement.

15 TESTS:

15.1 Type test certificates shall be submitted along with Bid. The Type Tests should have been conducted not earlier than 5-years as on the date of Bid-Opening and should be for the same cable or higher sized cable of the same voltage grade.

15.2 All acceptance tests shall be conducted in the presence of the Owner/ representative.

15.3 The following type tests shall be conducted on the cable.

S. No	**Test**	**Requirement**
a)	Tests on conductor ii) Resistance test	 IS:8130
b)	Tests for armoured wires and strips	Clause 14.2 & IS:3975
c)	Test for thickness of insulation and sheath	Clause 4.3, 15.2 & 16.1
d)	Physical tests for insulation: vi) Tensile strength and elongation at break vii) Aging in air oven viii) Hot test ix) Shrinkage test x) Water absorption (gravimetric)	Clause 4.3
e)	Physical tests for outer sheath viii) Tensile strength and elongation at break	IS: 5831 for FR PVC/ IEC 60502-2 for PE ST 7

	ix) Aging in air oven x) Shrinkage test xi) Hot deformation xii) Thermal Stability for FR ST 2 xiii) Carbon black content for PE ST 7 vii) Abrasion Resistance test for PE ST 7	
g)	Partial discharge test	
h)	Bending test	
j)	Dielectric power factor test iii) As a function of voltage iv) As a function of temperature	
k)	Insulation resistance (Volume resistivity) test	Clause 4.3
m)	Heating cycle test	Clause 21.5
n)	Impulse withstand test	Clause 21.6
p)	High voltage test	Clause 21.7
q)	Flammability test	Clause 21.8
r)	Void & Contamination Test	IS 7098 (Part-3)
s)	Degree of Cross linking of XLPE	ASTM D 2765
t)	Wafer Boil Test	ASTM D 2765
u)	Oxygen Index and Temperature Index for FR PVC ST 2	ASTM D 2863

15.4 The following test shall be performed successively on the same test sample of completed cable, not less than 10 M in length between the test accessories:

15.4.3 Partial discharge test.
15.4.4 Bending test followed by partial discharge test.
15.4.5 Dielectric power factor as a function of voltage.
15.4.6 Dielectric power factor as a function of temperature.
15.4.7 Heating cycle test followed by dielectric power factor as a function of voltage and partial discharge tests.
15.4.8 Impulse withstand test
15.4.9 High voltage test.

16 ACCEPTANCE TEST:

16.1 The sampling plan for acceptance test shall be as per IS 7098 part -II, Appendix ‘A’.

16.2 The following shall constitute the acceptance test:
16.2.3 Conductor resistance test
16.2.4 Test for thickness of insulation
16.2.5 Test for thickness of inner and outer sheath
16.2.6 Hot-set test for insulation
16.2.7 Tensile strength and elongation at break test for insulation and outer sheath
16.2.8 Partial discharge test (on full drum length) - (shall be less than 2PC)
16.2.9 High voltage test
16.2.10 Insulation resistance (volume resistivity) test
16.2.11 Void & Contamination Test

16.2.12 Wafer Boil Test
16.2.13 Degree of Cross linking of XLPE
16.2.14 Oxygen and Temperature Index for FR PVC ST 2
16.2.15 Abrasion Resistance Test for PE ST 7
16.2.16 Carbon Black content for PE ST 7
16.2.17 Water penetration test as per IEC 60502-2

17 ROUTINE TEST:

17.1 The following shall constitute routine tests:
17.1.3 Conductor resistance test
17.1.4 Partial discharge test on full drum length
17.1.5 High voltage test

18 DETAILS OF TESTS:

18.1 Unless otherwise mentioned in this specification, the tests shall be carried out in accordance with appropriate part of IS: 10810.

18.2 The partial discharge magnitude at test voltage equal to 1.50Uo shall not exceed 20 pC.

18.3 Bending test: The diameter of the test cylinder shall be 20D where D is the overall diameter of the completed cable. After completing the bending operations, the test sample shall be subjected to partial discharge measurement and shall comply with the requirements given in 22.2.

18.4 Dielectric power factor test:

18.4.3 Tan δ as a function of voltage: The measured value of Tan δ at Uo shall not exceed 0.004 and the increment of Tan δ between 0.5 Uo and 2 Uo shall not be more than 0.002.

18.4.4 Tan δ as a function of Temperature: The measured value of Tan δ at Uo shall not exceed 0.004 at the ambient temperature and 0.008 at 90°C.

18.5 Heating cycle test: The sample, which has been subjected to previous tests, shall be laid out on the floor of the test room and subjected to heating cycles. After the third cycle, the sample shall be subjected to dielectric power factor as a function of voltage, and partial discharge test.

18.6 Impulse voltage withstand test: The impulse voltage level shall be as per Clause 19.6 of IS 7098 (Part-2) 1985. No breakdown of insulation shall occur during the test.

18.7 High Voltage Test:

18.7.3 Type test and Acceptance tests: The cable shall withstand without breakdown an ac voltage equal to 3 Uo when applied to the sample between conductor and screen/armour. The voltage shall be gradually increased to the specified value and maintained for a period of 4 hours.
18.7.4 Routine test: The cable shall withstand without any failure, 2.5 Uo rms between conductors and screen/armour, when applied for a period of five minutes for each test connection.

18.8 Flammability test: Period of burning after removal of the flame shall not exceed 60 seconds and the unaffected (un charred) portion from the lower edge of the top clamp shall be at least 50-mm.

OPTCL reserves the right to select a random sample of supplied UG cable from the Manufacturer's end which are ready to dispatch and also ongoing cable laying works and the same samples will be sent to any testing laboratory as desired by OPTCL at Bidders cost. If the testing results are found to be not satisfactory OPTCL reserves the right to reject the entire batch of cable received and insists for replacement of material free of cost. The decision of OPTCL in this regard is final.

19 PACKING:

19.1 The cables, as per specified delivery lengths, shall be securely wound /packed in non-returnable steel drums, capable of withstanding rough handling during transport by Rail, Road, etc. The packing should withstand storage conditions in open yards. The dimensional drawings of steel drums shall be furnished with the bid. The drum shall be provided with circumferential lagging of strong wooden planks or high thickness Polypropylene Sheets. The end of the cable shall be sealed with good quality heat shrink or PVC caps. The packing should be able to withstand the rigorous of transport. The following information in bold letters in English shall be painted on the flanges.

19.1.3 Name & Address of the manufacturer, Trade name/Trade mark/Brand
19.1.4 Size of cable (Cross section) rated voltage, standard, insulation, cable code, drum No., and year of manufacture.
19.1.5 Length of cables (Meters)
19.1.6 Direction of rolling
19.1.7 Net weight (in Kg)
19.1.8 Gross weight (in Kg)
19.1.9 OPTCL purchase order reference.

20 SEALING OF CABLE ENDS ON DRUMS:

20.1 The cable ends shall be sealed properly so that ingress of moisture is completely prevented. The individual core endings shall be sealed effectively with water resistant compound applied over the core and provided with a suitable end cap of sufficient length with adequate cushion space so that the conductor does not puncture the cap in case of movement of the core during unwinding or laying. Before sealing, the semi conducting layer on the cores may be removed for about 2 mm at each end, to facilitate checking the insulation resistance from one end, without removing the sealing cap at the other end.

21 CABLE LENGTHS:

21.1 The cables shall be supplied in continuous lengths of 500m or more with 5% tolerance and cable shall on the non-returnable steel drums only.

22 MARKING:

22.1 The packed cable drum shall carry the following information, clearly painted or stenciled.

22.1.3 The letters – 'OPTCL'

22.1.4 Reference to Standard

22.1.5 Manufacturer's Name or trade mark

22.1.6 Type of cable & voltage grade

22.1.7 Number of cores

22.1.8 Nominal cross- sectional area of conductor

22.1.9 Cable code

22.1.10 Length of cable on the drum

22.1.11 Direction of rotation

22.1.12 Gross weight

22.1.13 Country of Manufacture

22.1.14 Year of Manufacture

22.1.15 Purchase order and date

22.1.16 Address of consignee

23 GUARANTEED TECHNICAL PARTICULARS:

23.1 The bidder shall furnish the guaranteed technical particulars of the cable offered in the GTP format provided in Chapter E-24.

24 DRAWING & LITERATURE:

The following shall be furnished.

24.1 Cross sectional drawings of the cables, giving dimensional details.

24.2 An illustrated literature on the cable, giving technical information, on current ratings, cable constants, short circuit ratings, derating factors for different types of installation, packing date, weights and other relevant information.

PART - D

TECHNICAL SPECIFICATION
FOR
LT XLPE POWER CABLES

TECHNICAL SPECIFICATION FOR LT POWER CABLES

1.0 SCOPE:

The specification covers design, manufacture, shop testing, packing and delivery of 1100 Volts grade, 3 and half core, Aluminium conductor, XLPE insulated, unarmoured, FR PVC insulated, earthed type.

2.0 SERVICE CONDITIONS:

Please refer **Chapter-E3** of Technical Specification on climatic conditions.

3.0 STANDARDS:

The rating as well as testing of the LT XLPE power cables shall conform to the latest versions of Indian standards as listed here under, but not limited to the following:

LIST OF STANDARDS
(All amended uptodate)

SL.NO.	STANDARD NO.	TITLE
1.	IS: 7098(Part 1)-1988	Specification for XLPE insulated , PVC sheathed for working voltages upto and including 1100 Volts.
2.	IS : 583 1-1984	Specification for PVC insulation and sheath of electric cables.
3.	IS: 8130-1984	Specification for conductors for insulated electric cables and flexible cords.
4.	IS: 3975-1988	Specification for Mild Steel wires, formed wires and tapes for armouring of cables.
5.	IS: 10462 (Part I) – 1983	Fictitious calculation method for determination of dimensionS of protective covering of cables.

4.0 GENERALTECHNICALREQUIREMENTS

Substaion – LT cables (Aluminium conductor)

	Conductor	Three and half core (120/95/25 sqmm) Four core (16 sqmm) Two core (16 sqmm)
1	Conductor	Stranded Compacted Circular Al. as per class-2 of IS:8130
2	Insulation Material	CrosslinkedPolyEthylene (XLPE) (Phase-Red,Yellow,Blue & Neutral-Black Colour)
3	Inner sheath	PVC as per IS : 7098PT-1
4	Outer Sheath	FR PVC Type ST2

5.0 TESTS:

5.1 TYPE TESTS:

All the type tests in accordance with IS: 7098 (Part 1) - 1988 (amended upto date) shall have been performed on cable samples drawn by Owner.

Type tests are required to be carried out from the first lot of supply on a sample of any one size of cable ordered . In case facilities of any of the type tests are not available at the works of the supplier , then such type test shall be carried out by the supplier at the independent recognized laboratory at the cost of supplier. Sample for the type test will be drawn by the Owner's representative and the type test will be witnessed by him.

5.2 ROUTINE TESTS:

All the Routine tests as per IS: 7098 (Part 1) - 1988 amended upto date shall be carried out on each and every delivery length of cable. The result should be given in test report.

The details of facility available in the manufacturer's works in this connection should be given in the bid.

5.3 ACCEPTANCE TESTS:

All Acceptance tests as per IS-7098 (Part-I) 1988 as amended upto date including the optional test as per clause no 15.4 and Flammability Test as per clause No. 16.3 shall be carried out on sample taken from the delivery lot.

6.0 PACKING AND MARKING :

6.1 a) Upto 120 sq.mm. Size :
Cables shall be supplied in continuous standard length of 500 meters with plus 5% (five percent) tolerance wound on non-returnable wooden drums of good quality or on non-returnable steel drums without any extra cost to the Owner.

b) Above 120 sq.mm. size:
Cables shall be supplied in continuous standard length of 250 meters with plus 5% (five percent) tolerance wound on non returnable wooden drums of good quality or on non-returnable steel drums without any extra cost to the Owner.

6.2 Non standard length :
5% (five percent) of the ordered quantity of respective size shall be acceptable in non-standard length which shall not be less than 100 meters in length.

6.3 The following particulars shall be properly legible embossed on the cable sheath at the intervals of not exceeding one meter throughout the length of the cable. The cables with poor and illegible embossing shall be liable for rejection.

a) Manufactures name.
b) Voltage grade.
c) Year of manufacture.
d) Name of the Owner
e) Successive Length.
f) Size of cable

6.4 Packing and marking shall be as per clause No. 18 of IS 7098 (part I)/1988 amended up to date.

6.5 Supplier should provide statistical data regarding cables of all sizes viz.-

1) Weight of one meter of finished product of cable of various sizes and ratings.

2) Weight of one meter of bare conductor used for cables of various sizes and ratings.

N.B – The Cables shall be supplied as per cross sectional views uploaded showing as per drawing no. **ODSSP/SS/24-REV-C, ODSSP/SS/27-REVA** and **ODSSP/LINE/25-REV-C** of chapter **E-21**. The Technical Particulars of the cables are furnished at chapter **E-24**.

PART - E

TECHNICAL SPECIFICATION

FOR 33 kV 3 CORE CABLE

FOR

STATION TRANSFORMER

TECHNICAL SPECIFICATION FOR 33 kV XLPE 3 CORE UG CABLE FOR STATION

1.0 SCOPE:

The scope of this specification covers the design, manufacture, stage inspection at works, inspection and testing the finished 33 kV Three Core, stranded, compact circular, Aluminum, conductor screened with extruded semiconducting compound, XLPE insulated, insulation screened with extruded semi conducting compound and copper tape as metallic part, dry cured & dry cooled using triple extrusion through common triple cross head (single point triple extrusion), in combination with water blocking tape , cores laid up with non-hygroscopic fillers including Centre iller, PVC inner sheathed, , galvanised steel strip/GI wir armored and FR PVC outersheathed cable conforming to IS:7098 (Part-2) 1985/IEC with latest amendments and as per specification detailed.

2.0 RATED VOLTAGE:

The rated voltage of the cable shall be 33 kV AC with the highest system voltage of 36 kV between phases of the effectively earthed three-phase transmission system.

3.0 APPLICABLE STANDARDS:

Unless otherwise stipulated in the specifications, the latest version of the following Standards shall be applicable:

3.1.1 IS 7098 (Part 2) – Cross-linked Polyethylene (XLPE) insulation for Cables
3.1.2 IS 8130 – Conductors for insulated electrical cables and flexible cords
3.1.3 IS 10810 (series) – Methods of tests for cables
3.1.4 IEC 60502-2 for properties of PE ST 7
3.1.5 IS 3975-Specification for mild steel wires, strips and tapes for armouring of cables
3.1.6 IS 5831 – Specification for PVC insulation sheath for electric cables
3.1.7 IS 10462 – Fictitious calculation method for determination of dimensions of protective coverings of cables Part 1 - Elastomeric and thermoplastic insulated cables

4.0 CONSTRUCTION:

4.1 **Conductor:** The cable conductor shall be made from H2 Grade Aluminum to form compacted stranded circular conductor having resistance within the limits specified in IS: 8130/1984 and any amendment thereof. The wires shall be laid up together with a suitable right hand lay.

4.2 **Conductor Screen:** The conductor screen shall be extruded semiconductor XLPE, extruded by triple extrusion method in the same operation as along with the insulation and insulation screen., the IS: 7098 Part 2, The

semiconductor shall be suitable for operating temperature of the cable and shall be compatible with the insulation.

4.3 **Insulation:** The insulation shall be water Tree Retardant (TR) Cross Linked Polyethylene (XLPE) insulation applied by extrusion and shall conform to the following requirements:

S. No.	**Properties**	**Requirements**
1.	Tensile Strength	12.5N/mm², Min.
2.	Elongation to break	200 percent, Min
3.	Aging in air oven: g) Treatment: Temperature: Duration: h) Tensile Strength variation: i) Elongation variation:	 135 ±3°C 7 days ±25 percent, Max ±25 percent, Max
4.	Hot set: g) Treatment: Temperature: Time under load Mechanical stress h) Elongation under load i) Permanent elongation (set) after cooling	 200±3°C 15 min 20N/cm² 175 percent, Max 15 percent, Max
5.	Shrinkage: c) Treatment: Temperature Duration b) Shrinkage	 130±3°C 1 hour 4 percent, Max
6.	Water absorption (Gravimetric): e) Treatment: Temperature: Duration: f) Water absorbed	 85±2°C 14 days 1 mg/cm², Max
7.	Volume Resistivity e) at 27°C f) at 90°C	 $1x10^{14}$ ohm-cm, Min $1x10^{12}$ ohm-cm, Min
8.	Thermal Resistivity	350 degrees C cm/W
9.	Power factor at maximum conductor temperature	0.008
10.	Dielectric strength	22 kV/mm

4.3.1 The XLPE insulation should be suitable for specified system voltage. The extrusion should be a True triple extrusion with thickness and concentricity control of all the three layers.

4.3.2 The curing process of XLPE insulation should be dry cured and dry cooled. The manufacturing process shall ensure that insulations shall be free from voids. Minimum degree of crosslinking shall be 75% as per ASTM 2765.

4.3.3 The insulation shall withstand mechanical and thermal stresses under steady state and transient operating conditions.

4.3.4 The extrusion method should give very smooth interface between semi-conducting screen and insulation.

4.3.5 The insulation of the cable shall be compatible with the continuous conductor temperature of 90°C, short time overload temperature of 130°C & short circuit temperature of 250°C.

4.3.6 The average thickness of the insulation shall not be less than as specified in IS: 7098-II. The insulation shall be so applied that it fits closely on conductor screening and it shall be possible to remove it without damaging the conductor.

4.3.7 The eccentricity of the insulation shall be less than 10% and ovality shall be less than 5%.

4.4 Insulation Screen: To confine electrical field to the insulation, semi-conducting XLPE shield shall be put over the insulation.apeed Copper tape shall be provided as metallic part. The insulation shield shall be extruded in the same operation as the conductor shield and the insulation by triple extrusion and shall be as IS: 7098 Part 2, water blocking tape shall be applied over the semiconducting compound.

4.5 **Inner Sheath:** The sheath shall be extruded PVC , suitable to withstand the site conditions and the desired temperature. It should be of adequate thickness as specified in IS: 7098-II, consistent quality and free from all defects.

4.6 **Armour :** Armoring shall be applied over the inner sheath with single galvanized steel flat strips/GI wire complying with the requirements of IS: 3975/1979 for 3-Core cables as specified in the BOQ.

The joints in armour wire shall be made by brazing or welding and the surface irregularities shall be removed. Minimum armour coverage shall be 90%. A joint in any wire shall be at least 300 mm from the nearest joint in any other armour wire in the complete cable and shall be as per IS: 7098 Part 2, IS: 3975, IEC:60502 Part – 2, BS: 6622, BS: 7835.

4.7 **Outer Sheath:** FR PVC ST2 outer sheath shall be applied over armoring with suitable additives to prevent attack by rodents and termites. Outer sheathing shall be designed to offer high degree of mechanical protection and shall also be heat, oils, chemicals, abrasion and weather resistant. Common acids, alkalis, saline solutions etc., shall not have adverse effects on the sheathing material used.

4.8 The cables should be suitable for use in solidly earthed system. The total relay and breaker operating time will be within 400 milli second.

4.9 The underground cables shall be manufactured to the highest quality, best workmanship with scientific material management and quality control. The manufacturer shall furnish the quality plan, giving in detail the quality control procedure/ management system.

4.10 The cable shall be suitable for laying in covered trenches and/or buried underground to meet the outdoor application purposes.

4.11 The successful Bidder shall give sufficient advance notice to the Owner of not less than fifteen days to arrange for inspection and quality assurance program during manufacture, at the works.

5.0 SYSTEM AND CLIMATIC DETAILS: As per Chapter E-3 on System and Climatic Data

6.0 DESIGN CRITERIA:

6.1 The cables that are covered in these specifications are intended for use outdoor, under the climatic conditions and installation conditions described in the technical specification.

6.2 Any technical feature, not specifically mentioned here, but is necessary, for the good performance of the product, shall be incorporated in the design. Such features shall be clearly brought out under Technical deviations schedule only, in the offer made by the bidder, giving technical reasons, and justifying the need to incorporate these features.

6.3 For continuous operation of the cables, at specified rating, the maximum conductor temperature shall be limited to the permissible value as per the relevant standard, generally not exceeding 90°C under normal operation and 250°C under short – circuit conditions.

6.4 The cables in service will be subject to daily load cycles, of two peaks during a day; morning peak and evening peak, with around 25% to 50% loading during the nights.

6.5 The materials used for outer sheaths shall be resistant to oils, acids and alkalis.

6.6 The cables shall have the mechanical strength required, during handling and laying.

6.7 The cables shall be designed to withstand the thermo-mechanical forces and electrical stresses during normal operation and transient conditions.

7.0 MANUFACTURE PROCESS:

7.1 Cross-linking of the insulation materials shall be conforming to IS: 7098 (Part – II) and the proof of purchase of the above insulating material shall be submitted and is to be offered for stage inspection.

7.2 The bidder shall specify the length of curing and cooling chamber.

7.3 The partial discharge shall be less than 20 pC at 1.50 Uo

8.0 CORE IDENTIFICATION:

8.1 Tthe core identification for 3 core cables shall be provided by application of colored polyester strips of Red, Yellow & Blue below copper tape.

9.0 LAYING UP OF CORES:

9.1 The cores shall be laid together with a suitable right hand lay. The interstices at the center shall be filled with PP fillers laid up together and wrapped with polyester tape.

10.0 INNER SHEATH (COMMON COVERING ONLY FOR 3-CORE CABLES):

10.1 The laid up cores shall be provided with PVC inner sheath applied by extrusion. It shall be ensured that the shape is as circular as possible. The inner sheath shall be so applied that it fits closely on the laid up cores and it shall be possible to remove it without damage to the insulation.

10.2 The thickness of the inner sheath (common covering) shall be as per IS 10462 (Part 1)

10.3 When one or more layers of binder tapes are applied over the laid up cores, the thickness of such tapes shall not be construed as a part of inner sheath.

11.0 ARMOURING:

11.1 Armoring shall be applied over the inner sheath with galvanised steel flat strip/GI wire complying with the requirements of IS: 3975/1979 for 3-Core cables. The dimensions of the galvanized steel flat strips shall be as specified in the IS: 7098/Part-II/1985.

11.2 The armour shall be capable to withstand the fault current mentioned in the GTP (ChapterE-24) for 1 second. Bidders shall furnish the calculation / data sheet for the short circuit carrying capability of the Armour.

12.0 OUTER SHEATH:

The outer sheath shall be FR PVC ST2, applied by extrusion. It shall be applied over the armouring and shall consist of compound, conforming to the requirements of IEC 60502-2 . The minimum thickness of the sheath shall be as per IS 10462 (Part 1).

13.0 IDENTIFICATION:

13.1 The outer sheath shall have the following information embossed or indented on it; the manufacturer's name or trade mark, the voltage grade, the year of manufacture and the letters "OPTCL- ODSSP". The identification shall repeat at every meter of the along the length of the cable. Outer sheath of cable shall be black in permanent colour.

14.0 INSPECTION AND QUALITY CONTROL:

The Bidder shall furnish a complete and detailed quality plan for the manufacturing process of the cable. All raw materials shall conform to relevant applicable standards and tested for compliance to quality and requirement.

15.0 TESTS:

15.1 Type test certificates shall be submitted along with Bid. The Type Tests should have been conducted not earlier than 5-years as on the date of Bid-Opening and should be for the same cable or higher sized cable of the same voltage grade.

15.2 All acceptance tests shall be conducted in the presence of the Owner/ representative.

15.3 The following type tests shall be conducted on the cable.

S. No	**Test**	**Requirement**
a)	Tests on conductor iii) Resistance test	 IS:8130
b)	Tests for armoured wires and strips	Clause 14.2 & IS:3975
c)	Test for thickness of insulation and sheath	Clause 4.3, 15.2 & 16.1
d)	Physical tests for insulation: xi) Tensile strength and elongation at break xii) Aging in air oven xiii) Hot test xiv) Shrinkage test xv) Water absorption (gravimetric)	Clause 4.3
e)	Physical tests for outer sheath xiv) Tensile strength and elongation at break xv) Aging in air oven xvi) Shrinkage test xvii) Hot deformation xviii) Thermal Stability for FR ST 2 xix) Carbon black content for PE ST 7 vii) Abrasion Resistance test for PE ST 7	IS: 5831 for FR PVC
g)	Partial discharge test	
h)	Bending test	
j)	Dielectric power factor test v) As a function of voltage vi) As a function of temperature	
k)	Insulation resistance (Volume resistivity) test	Clause 4.3
m)	Heating cycle test	Clause 21.5
n)	Impulse withstand test	Clause 21.6
p)	High voltage test	Clause 21.7
q)	Flammability test	Clause 21.8
r)	Void & Contamination Test	IS 7098 (Part-3)
s)	Degree of Cross linking of XLPE	ASTM D 2765
t)	Wafer Boil Test	ASTM D 2765
u)	Oxygen Index and Temperature Index for FR PVC ST 2	ASTM D 2863

15.4 The following test shall be performed successively on the same test sample of completed cable, not less than 10 M in length between the test accessories:

15.4.1 Partial discharge test.
15.4.2 Bending test followed by partial discharge test.
15.4.3 Dielectric power factor as a function of voltage.
15.4.4 Dielectric power factor as a function of temperature.
15.4.5 Heating cycle test followed by dielectric power factor as a function of voltage and partial discharge tests.
15.4.6 Impulse withstand test
15.4.7 High voltage test.

16.0 ACCEPTANCE TEST:

16.1 The sampling plan for acceptance test shall be as per IS 7098 part -II, Appendix 'A'.

16.2 The following shall constitute the acceptance test:
16.2.1 Conductor resistance test
16.2.2 Test for thickness of insulation
16.2.3 Test for thickness of inner and outer sheath
16.2.4 Hot-set test for insulation
16.2.5 Tensile strength and elongation at break test for insulation and outer sheath
16.2.6 Partial discharge test (on full drum length) - (shall be less than 2PC)
16.2.7 High voltage test
16.2.8 Insulation resistance (volume resistivity) test
16.2.9 Void & Contamination Test
16.2.10 Wafer Boil Test
16.2.11 Degree of Cross linking of XLPE
16.2.12 Oxygen and Temperature Index for FR PVC ST 2
16.2.13 Abrasion Resistance Test for PE ST 7
16.2.14 Carbon Black content for PE ST 7
16.2.15 Water penetration test as per IEC 60502-2

17.0 ROUTINE TEST:

17.1 The following shall constitute routine tests:
17.1.1 Conductor resistance test
17.1.2 Partial discharge test on full drum length
17.1.3 High voltage test

18.0 DETAILS OF TESTS:

18.1 Unless otherwise mentioned in this specification, the tests shall be carried out in accordance with appropriate part of IS: 10810.

18.2 The partial discharge magnitude at test voltage equal to 1.50Uo shall not exceed 20 pC.

18.3 Bending test: The diameter of the test cylinder shall be 20D where D is the overall diameter of the completed cable. After completing the bending operations, the test sample shall be subjected to partial discharge measurement and shall comply with the requirements given in 22.2.

18.4 Dielectric power factor test:

18.4.1 Tan δ as a function of voltage: The measured value of Tan δ at Uo shall not exceed 0.004 and the increment of Tan δ between 0.5 Uo and 2 Uo shall not be more than 0.002.

18.4.2 Tan δ as a function of Temperature: The measured value of Tan δ at Uo shall not exceed 0.004 at the ambient temperature and 0.008 at 90°C.

18.5 Heating cycle test: The sample, which has been subjected to previous tests, shall be laid out on the floor of the test room and subjected to heating cycles. After the third cycle, the sample shall be subjected to dielectric power factor as a function of voltage, and partial discharge test.

18.6 Impulse voltage withstand test: The impulse voltage level shall be as per Clause 19.6 of IS 7098 (Part-2) 1985. No breakdown of insulation shall occur during the test.

18.7 High Voltage Test:

18.7.1 Type test and Acceptance tests: The cable shall withstand without breakdown an ac voltage equal to 3 Uo when applied to the sample between conductor and screen/armour. The voltage shall be gradually increased to the specified value and maintained for a period of 4 hours.

18.7.2 Routine test: The cable shall withstand without any failure, 2.5 Uo rms between conductors and screen/armour, when applied for a period of five minutes for each test connection.

18.8 Flammability test: Period of burning after removal of the flame shall not exceed 60 seconds and the unaffected (un charred) portion from the lower edge of the top clamp shall be at least 50-mm.

OPTCL reserves the right to select a random sample of supplied UG cable from the Manufacturer's end which are ready to dispatch and also ongoing cable laying works and the same samples will be sent to any testing laboratory as desired by OPTCL at Bidders cost. If the testing results are found to be not satisfactory OPTCL reserves the right to reject the entire batch of cable received and insists for replacement of material free of cost. The decision of OPTCL in this regard is final.

19.0 PACKING:

19.1 The cables, as per specified delivery lengths, shall be securely wound /packed in non-returnable steel drums, capable of withstanding rough handling during transport by Rail, Road, etc. The packing should withstand storage conditions in open yards. The dimensional drawings of steel drums shall be furnished with the bid. The drum shall be provided with circumferential lagging of strong wooden planks or high thickness Polypropylene Sheets. The end of the cable shall be sealed with good quality heat shrink or PVC caps. The packing should be able to withstand the

rigorous of transport. The following information in bold letters in English shall be painted on the flanges.

19.1.1 Name & Address of the manufacturer, Trade name/Trade mark/Brand
19.1.2 Size of cable (Cross section) rated voltage, standard, insulation, cable code, drum No., and year of manufacture.
19.1.3 Length of cables (Meters)
19.1.4 Direction of rolling
19.1.5 Net weight (in Kg)
19.1.6 Gross weight (in Kg)
19.1.7 OPTCL purchase order reference.

20.0 SEALING OF CABLE ENDS ON DRUMS:

20.1 The cable ends shall be sealed properly so that ingress of moisture is completely prevented. The individual core endings shall be sealed effectively with water resistant compound applied over the core and provided with a suitable end cap of sufficient length with adequate cushion space so that the conductor does not puncture the cap in case of movement of the core during unwinding or laying. Before sealing, the semi conducting layer on the cores may be removed for about 2 mm at each end, to facilitate checking the insulation resistance from one end, without removing the sealing cap at the other end.

21.0 CABLE LENGTHS:

21.1 The cables shall be supplied in continuous lengths of 500m or more with 5% tolerance and cable shall on the non-returnable steel drums only.

22.0 MARKING:

22.1 The packed cable drum shall carry the following information, clearly painted or stenciled.

22.1.1 The letters – ‘OPTCL’
22.1.2 Reference to Standard
22.1.3 Manufacturer’s Name or trade mark
22.1.4 Type of cable & voltage grade
22.1.5 Number of cores
22.1.6 Nominal cross- sectional area of conductor
22.1.7 Cable code
22.1.8 Length of cable on the drum
22.1.9 Direction of rotation
22.1.10 Gross weight
22.1.11 Country of Manufacture
22.1.12 Year of Manufacture
22.1.13 Purchase order and date
22.1.14 Address of consignee

23.0 GUARANTEED TECHNICAL PARTICULARS:

23.1 The bidder shall furnish the guaranteed technical particulars of the cable offered in the GTP format provided in Chapter E-24.

24.0 DRAWING & LITERATURE:

The following shall be furnished.

24.1 Cross sectional drawings of the cables, giving dimensional details.

24.2 An illustrated literature on the cable, giving technical information, on current ratings, cable constants, short circuit ratings, derating factors for different types of installation, packing date, weights and other relevant information.

1.1.1 PRE - QUALIFICATION REQUIREMENT OF CABLE MANUFACTURES

1.1.2 The cable manufacturer must qualify all the following requirements:

25 Manufacturer should have true triple extrusion machine alongwith CCV line with dry curing and dry cooling in Nitrogen.

26 Cable eccentricity monitoring system during triple extrusion in CCV line.

27 The manufacture should have in-house raw material testing and QA lab. Self-declaration and list of testing equipment to be submitted.

CHAPTER- E9 -2

CABLE LAYING IN LINE AND SUBSTATION

TABLE OF CONTENTS

OF

CABLE LAYING

PART – A

(LINE)

LINE

1.0. LOCAL CONDITIONS :

1.1. It will be imperative on each bidder to fully inform himself of the local conditions and factors which may have any effect on the execution of the supply and services covered under these documents and specification.

1.2 It shall be understood and agreed that such factors will have been properly investigated and considered in any bid that is submitted. The Owner will entertain no claim for financial adjustment to the contract awarded under these specifications and documents. No change in the time schedule of the contract, or any financial adjustment arising thereof that are based on incorrect information, or its effect on the cost of the contract to the bidder shall be permitted by the Owner.

1.3. Bidders are advised to visit the various areas where the U.G. cables are access, road /drain / footpath crossings to enable them to make proper costing and then quote accordingly.

a) All the other materials like coarse and fine aggregate sand, joint markers, sealing, route markers, cable support clamps, terminals and inline connectors, sealing compounds etc., whether specifically mentioned or not in these specifications are deemed to have been included in the scope of supply and installation. Similarly, the contractor has to arrange for all the tools and plants required for the works at his own cost.

2.0. SERVICE CONDITIONS :

2.1 The cables are being laid in the coastal districts of Odisha.

2.2. The climatic conditions are prone to wide variations in ambient temperature, humidity etc., and the accessories offered shall be suitable for installation under the above tropical conditions, where moderately hot and humid conditions conducive to dust, rust and fungi growth, prevail at site.

2.3. The underground cables are to be laid in busy and congested localities of the Urban / semi urban where other utility services like telephone and telegraph water supply, sewerage, open and close drains are encountered.

3.0 COMPLIANCE WITH REGULATIONS :

3.1. All services carried out by the bidder / sub contractor shall be as per the requirements of the I.E.Act-2003 & Indian electricity Rules – 1956, and all

other applicable statutory laws governing the services in the state of Odisha.

3.2. Particular attention is drawn to the necessity of consulting the local authorities and the administrative heads concerned with the operation and maintenance of roads, railways, telegraph and telephone services, water supply and sewerage and other public utilities.

3.3. Statutory payment to local bodies, Government agencies for digging the public roads shall be reimbusrsed by OPTCL. However reinstatement charges, other Row comensation shall be to the contractor'ss.

4.0. INSPECTION BY ELECTRICAL INSPECTOR

4.1. All Electrical installations and equipments are to be inspected and approved by the Chief Electrical Inspector to the Government of Odisha, before commissioning.

4.2. The Contractor will arrange for the payment of the necessary fees for inspection.

4.3. Any defects pointed out by the Electrical Inspector, shall be corrected or attended by the bidder /subcontractor at his own cost and he shall pay, for subsequent inspection charges to the Electrical Inspector, for obtaining approval.

5.0. INSTALLATION OF U.G. CABLES

The drawing for cable laying are uploaded as Drg No ODSSP/Line/26-REVA for 33 kV UG cables and drawing No. ODSSP/Line/27-REVA for 11 kV UG cables.

5.1.1 Digging of trench in the ground in all types of soils including laterite and rock and laying cable(s) on virgin bedding at the bottom of the trench, and covering with riddled soil over the cable and protecting it by means of tiles, and backfilling shall be as mentioned in the drawings.

5.1.2 The desired minimum clearances are as follows:

Power cable to control cables:	0.2-m
Power cable to communication	0.3-m
Power cable to gas/water main:	0.3-m
Power cable to power cable	0.25m

5.1.3 HDPE (IS 4984)1995 pipes depending on the crossing and load should be used where cables cross roads and railway tracks depending on the requirement, and at each particular location pipes shall be used as directed by the Owner‟s representative. Spare ducts/pipes for future extension should be provided as per the directions of OPTCL. Such spare ducts/pipes shall be sealed off. The ducts/pipes shall be mechanically strong to withstand forces due to heavy traffic when they are laid across the roads/railway tracks.

5.1..4 The power cable should not be laid above the telecommunication cable, to avoid danger to the life of the person, digging to attend to the fault in telecommunication cable. For identification of power cables, the cable protective cover, such as RCC slabs shall be marked as “OPTCL”. The likely

interference to the existing telecommunication cables should be avoided by referring to and coordinating with the appropriate telecommunication authorities.

5.2. ROUTE PLANS**:** Tentative cable route plans will be furnished by the contractors, indicating the roads, and road crossings, findings by excavating trial holes for approval by the Engineer – In - Charge. The work shall be taken upon after approval of the route. The OPTCL reserves the right to change, alter deviate the route on technical reasons.

5.3. TRIAL PITS . The bidder shall excavate trial pits, for alignment purpose at appropriate distance apart as warranted by the local conditions, keep a record of the findings and close the trial holes properly to avoid hindrance / accidents to pedestrian traffic. The final route / alignment of the cables shall be decided based on the finding of the trial holes.

5.4. It is the responsibility of the bidder to maintain as far as possible the required statutory clearances from other utility services.

5. 5 Any damage caused, inadvertently to any utility services shall be the sole responsibility of the contractor.

6.0. STATUTORY NOTICES AND WAY LEAVES

The Contractor shall arrange the necessary way leaves from the concerned public utility authorities and OPTCL shall give the required assistance to the contractor in completing the project.

7.0. LAYING OF CABLES

7.1. The contractor shall excavate the cable trench using manual and mechanical modes. Most main roads are of cement concrete and/or of deep macadam surface. An air compressor driven pneumatic drill or equivalent mechanical excavating tool will be essential if the crossing is to be made with minimum delay. Where paved footpaths are to be dug to excavate the cable trench, care must be taken to carefully remove the pavement slabs and store them properly and relay them properly after the work is completed.

7.2. The contractor shall take all precautions while excavating the trench to protect the public / private property and to avoid any accidental damage. Any accidental damage should immediately be reported to the concerned utility.

7.3. The contractor is liable to pay for all damages caused by his workmen. The sides of the excavated trench shall, wherever necessary be well shored up with timber and sheeting. The width shall be sufficient for easy handling of the cables during the laying operations depending upon the method of laying.

7.4 The width shall be sufficient for easy handling of the cables during the laying operations depending upon the method of laying employed. For road crossings and railway crossings the same shall be 1.0 m. At other places the width varies from 0.85m to 1.0 m depending on number of cables to be laid in the trench.

7.5 The excavated material shall be properly stored to avoid obstruction. The bottom of the excavated trench should be carefully leveled and freed from pebbles / stones. Any gradient encountered shall be gradual.

7.6 There is a likelihood of a situation demanding that more than one cable is required to be run in the same trench the contractors shall agree to increase the width of the trench to accommodate more than one cable.

8.0. LAYING IN HDPE PIPES:

8.1. HDPE pipes shall be laid in the bored holes after horizontal boring with a machine

8.2. The excavated cable trench shall be drained of all water. The cable shall be pulled in the pipe on cable rollers spaced out at uniform intervals to prevent damage to cable. The laying out process shall be smooth and steady, without subjecting the cable abnormal tension.. All the snake bends in the cable shall be straightened out.

8.3 FLAKING

8.3.1. Wherever it is not possible to lay of the entire cable drum length, the cable should be cut and properly sealed and if it is necessary to remove the cable from the drum, it should be properly flaked. Such cable lengths should be properly stored at site.

8.4. RAILWAY CROSSINGS

8.4.1. When the cables are laid under railway tracks, the cable should be laid in HDPE pipes at such depths as may be specified by the railway authorities but not less than 1 M measured from the bottom of sleepers to the top of the pipe. Laying of 33 /11 Kv XLPE Cable Underground cable by HDD Method Under Railway Track for 30 Mtrs with Heat sink type cable end termination kit.

8.4.2. Wherever the U.G. cable has to cross the sewerage or water supply line the U.G. cable has to be taken below them maintaining adequate clearance. Further wherever the U.G. cable runs parallel to the telephone cable a separation distance of at east 300-mm shall be maintained.

9.0. ROAD CROSSING of the UG cables

9.1. The road cutting whether cement concrete, asphalt or macadam road shall be taken up after obtaining approval from civic authorities, Police, Telecom authorities and work should be planned to be completed in shortest possible time. Where necessary, the work shall be planned during night time or light traffic time.

In the excavated trench across the road the pipe of e shall be laid, excavation back filled, compacted ad surface shall be redone in shortest time to allow the traffic on the road.

10.0. FOOTPATH CUTTING of the UG cables

10.1. The pavement slabs shall be removed and neatly stacked on side before starting excavation.

11.0. REINSTATMENT

After the cables are / or pipes have been laid all joints and cable positions should be carefully plotted and preserved till such time the cable is energized and taken over by the engineer in charge..

12.0. PREVENTION OF DAMAGE DUE TO SHARP EDGES

12.1. After the cable has been laid in the trench and until the cable is covered with itsprotective covering, no sharp metal tool shall be used in the trench or placed in such a position that may fall into the trench.

12.2. Rollers used during laying of the cables shall have no sharp projecting parts liable to damage the cables.

12.3. While pulling cable through pipers, the cable shall be protected to avoid damage due to sharp edges.

13.0. CABLES AND OVER BRIDGES :

13.1. Wherever the cable route crosses bridges the cable shall be laid in the ducts, ifprovided, by removing and replacing the R.C.C. covers and filled with sand cushion.

13.2. In the absence of the cable ducts over bridges, the cable shall be laid in suitable size pipes or as directed by the engineer-In- charge and the pipe covered by cement concrete if necessary to protect from direct sunrays.

14.0. CABLE CROSSING OPEN DRAINS WITH LONG SPAN :

14.1. Wherever the cable to cross open drains with a long span, the cable shall be laid in pipe, properly jointed with suitable collars. The pipe shall be firmly supported on pillars, columns, or suitable support of R.C.C. foundation with stone masonry in cement mortar 1:4

14.2. Wherever the U.G. cable has to cross the sewerage or water supply line the U.G. cable has to be taken below them maintaining adequate clearance.

15.0. REINSTATMENT

15.1. After the cables are / or pipes have been laid and before the trench is filled in all joints and cable positions should be carefully plotted and preserved till such time the cable is energized and taken over by the engineer in charge. The requisite protective covering will then be provided, the excavated soil replaced after removing large stones and well rammed in successive layers of not more than 20cm in depth, where necessary the trench being watered to improve consolidation. It is advisable to leave a crown of earth not less than 50 mm and not more than 100 mm in the centre and tapering towards the sides of the trench.

15.2. The temporary reinstatement of roadways should be inspected at regular intervals, more frequently during the wet weather and immediately after overnight rain. In trench is to be closed overnight and settlement should be made good by further filling to be extent required, such temporary reinstatement should then be left for a time so that soil thoroughly settles down.

15.3. After the subsistence has ceased the trench may be permanently reinstated and the surface restored to the best possible condition.

15.4. If the surface is of special material like cement concrete, asphalt, or tarred macadam,resurfacing will be done by the civic authorities.

16.0 CABLE AND JOINT MARKERS

16.1. Permanent means of indicating the positions of joints on site should be provided. During the course of permanent reinstatement cable and joint markers, should be laid directly above the route of the cable and the position of the joint respectively.

16.2. Wherever it is not possible to place the marker directly over the cable route or joint the marker should be suitably placed near the cable route or joint on which the distance of the cable route or joint at right angles to and parallel to the marker should be clearly indicated.

16.3. The position of fixing the markers will be at the discretion of the Engineer-In-charge.

16.4. JOINTING OF CABLES

16.4.1. GENERAL: It shall be noted that the U.G. cables are of XLPE insulation and needs special care in jointing. The cable jointer and his assistant shall have experience in making joints / terminations. Jointing work should commence as soon as two or three lengths of cables have been laid. All care should be taken to protect the factory- plumbed

cap/seal by laying the end solid in bitumen until such time as the jointing is commenced.

16.4.2. Jointing of cables in carriage ways, drives, under costly paving, under concrete or asphalt surfaces and in proximity to telephone cables and water mains, should be avoided whenever possible.

16.5. JOINT PITS: The joint pits should be sufficient dimensions as to allow jointers to work with as much freedom of movement and comfort as cables proposed to be jointed. The sides of the pit should be draped with tarpaulin sheet to prevent loose earth from falling on the joint during the course of making. The pit should be well shored with timber, if necessary. An overlap of about 1.0 mtr of the cables to be jointed may be kept, for allowance to adjust the position of the joint. When two or more cables are laid together the joints shall be arranged to be staggered by 2 to 2.5 mtr.

16.6. SUMP PITS: When jointing cables in water logged ground or under monsoon conditions, a sump pit should be excavated at one end of the joint pit in such a position so that the accumulating water can be pumped or bailed out by buckets without causing interference to the jointing operation.

16.7. TENTS: A tent should be used in all circumstances wherever jointing work is carried out in the open irrespective of the weather conditions. The tent should be so covered as to have only one entrance and the back facing the direction of the wind. The tent cover should be properly weighted or tied down on the sides.

16.8. MEASUREMENT OF INSULATION RESISTANCE: Before jointing is commenced the insulation resistance of both sections of the cable to be jointed should be checked by insulation resistance testing instrument. An insulation resistance – testing instrument of 2.5/5 kV shall be used. The Insulation Resistance values, between phases and phase to earth shall be recorded. The actual jointing operation shall start only after the approval of the engineer in charge of works.

16.9. PRECAUTIONS BEFORE MAKING A JOINT OR CUTTING A CABLE.

The cable end seals should not be opened until all necessary precautions have been taken to prevent circumstances arising out of rainy/inclement weather conditions, which might become uncontrollable. The cable seals should be examined to ascertain if they are intact and also that the cable ends are not damaged, if the seals are found broken or the lead sheath punctured, the cable ends should not be jointed until after due examination and testing by the engineer-in-charge of the works.

16.10. PRECAUTIONS TO BE TAKEN ON LIVE CABLES IN SERVICE

Sometimes it becomes necessary that a H.V. cable, which is in service, be cut for making a straight joint with a new cable. In such cases work on joint should start only after the in service cable is properly identified, isolated, discharged, tested and effectively earthed. Search coils interrupters or cable-identifying instruments should be used for this purpose.

16.11. IDENTIFICATION NUMBERS / COLOURS AND PHASING : The cables should be laid and jointed number to number or colour to colour shown on the core identifying marks and prevent cross jointing. In all cases, the cables should be tested and phased out, and more particularly so when the cable terminates at Ring Main Unit / Sub-station.

16.12. MAKING A JOINT: The Heat shrinkable joints used shall be conform to the IS. Alternatively push-on or Tapex or cold shrinkable type can be used with the approval of OPTCL. The contractor should furnish all the technical particulars of these joints and obtain approval only in case they are found superior to the heat shrinkable joints. Epoxy based joints are not permitted. Comprehensive jointing instructions obtained from the manufacturer of joint kits shall be meticulously followed.

The connection of the earth wires should be done using flexible bonds connected to cable sheath using clips or soldering. Aluminum conductor strands shall be joined be joined by mechanical compression method, using suitable die and sleeve with a good quality tool. The joints shall conform to specification as per IS 13573-1 992.

16.13.TRANSITION JOINTS: Wherever straight through joints will have to be made with existing cables under the following conditions, the contractor shall arrange such type of joints and execute them with skilled jointers.

(1) Between cables having two different types of insulation viz., paper and XLPE

(2) Between cables having two different types of conductor material, viz. copper and aluminum.

(3) Or a combination of the above

The transition joints shall conform to IS 13705 – Transition joints for cables for working voltages from 11 KV upto and including 33 KV – performance requirements and type tests.

16.14. CABLE TERMINATIONS: Cable terminations required are both indoor and outdoor type and invariably be of heat shrinkable type conforming to the IS. The terminations shall conform to specifications as per IS 13573 – 1992. The instructions furnished by the manufacturer of termination boxes/kits should strictly be followed.

16.15. Whenever a cable raised from the pipe to end in termination, to be finally connected to an overhead line, the following instructions should be complied with –

(i) The rise of cable, immediately from the ground level should be enclosed in suitable bracket system in MS channel and angle.

(ii) The balance portion of the cable should be neatly curved, in 'S' shape.

(iii) The cable and pipe should be properly fastened by using appropriate clamps /support. The hardware of clamps shall be painted with red oxide and enamel paint or galvanized.

(iv) The lugs on the termination shall be compressed with a suitable compression tool.

17.0. EARTHING AND BONDING

The metal sheath and Armour should be efficiently bonded and earthed at all terminals to earth electrodes provided. The cross sectional area of the bond shall be such that the resistance of each bond connection shall not exceed the combined resistance of an equal length of the metal sheath and Armour of the cable.

18.0. TESTING AFTER LAYING AND JOINTING

18.1. All cables after laying and jointing works are completed, should be tested systematically and insulation and pressure tests should be made on all underground cables.

18.2. All test results should be recorded in tabular form in logbooks kept for the purpose.

18.3. The cable cores should be tested for :-

(i) Continuity

(ii) Absence of cross phasing

(iii) Insulation resistance to earth; insulation resistance between conductors.

19.0. H.V. TESTS

19.1. After the laying and jointing work is completed, a high voltage test should be applied to the cable to ensure that the cable has not been damaged during or after the laying operations and there is not defect in the joining.

19.2. The high voltage tests should be as per IS 1255 or as per international standards.The H.V. testing instruments shall be brought by the turn key contractor.

20.0. TESTING AND RECORD OF CABLE CONSTANTS :

When the cable is ready, just before commissioning, the cable constants viz, the resistance, capacitance and inductance of each conductor should be determined and recorded, along with frequency at which the values of capacitance and inductance are determined.

21.0. CABLE RECORDS

21.1. Accurate neat plans / sketches, drawn to suitable scale (1 cm = 10M) should be prepared and furnished by the contractor after the completion of each work.

21.2. All relevant information should be collected at site, during the progress of work and preserved for preparation of drawings.

21.3. The following essential data should be incorporated on all drawings

a) Size, type of cable or cables.

b) Location of the cable in relation to prominent land mark property, Kerb-line etc., with depths.

c) The cross section showing where cables are laid in piper or ducts, giving their sizes, type and depths.

d) Position and type of all joints

e) Location of other cables which run alongside or across the cable route.

f) Position and depths of all pipers, ducts, etc., which are met as obstruction to the cable route.

g) Accurate lengths from joint to joint

h) Manufacturers name and drum number of the cable, between sections / joint to joint.

Two transparencies and six blue print copies of the cable records prepared as above shall be given to the OPTCL's engineer as a part of the contract as soon as the cable is charged.

PART – B

(Sub-Station)

Sub-Station

1.0 WIRING, CABLING AND CABLE INSTALLATION IN SUB STATION

1.1 Cubicle wiring

Panels shall be complete with interconnecting wiring between all electrical devices in the panels. External connections shall be achieved through terminal blocks. Where panels are required to be located adjacent to each other all inter panel wiring and connections between the panels shall be carried out internally. The Contractor shall furnish a detailed drawing of such inter panel wiring. The Contractor shall ensure the completeness and correctness of the internal wiring and the proper functioning of the connected equipment.

All wiring shall be carried out with **1.1 kV** grade, **PVC** insulated, single core, stranded copper wires. The PVC shall have oxygen index not less than **'29'** and Temperature index not less than **250C**. The wires shall have annealed copper conductors of adequate size comprise not less than three strands

The minimum cross sectional area of the stranded copper conductor used for internal wiring shall be as follows:

a) All circuits excepting CT circuits and energy metering circuit of VT 2.5 sq.mm

b) All CT circuits and metering circuit of VT 2.5 sq. mm

All internal wiring shall be supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters and troughs shall be used for this purpose.

Cubicle connections shall be insulated with PVC to IEC 227. Wires shall not be jointed or teed between terminal points.

Bus wires shall be fully insulated and run separately from one another. Auxiliary bus wiring for AC and DC supplies, voltage transformer circuits, annunciation circuits and other common services shall be provided near the top of the panels running throughout the entire length of the panel suite. Longitudinal troughs extending throughout the full length of panel shall be preferred for inter panel wiring.

All inter connecting wires between adjacent panels shall be brought to a separate set of terminal blocks located near the slots of holes meant for the passage of the inter connecting wires. Interconnection of adjacent panels on site shall be straightforward and simple. The bus wires for this purpose shall be bunched properly inside each panel.

Wire termination shall be made with solder less crimping type and tinned copper lugs which firmly grip the conductor. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from terminal blocks. Numbers 6 and 9 shall not be included for ferrules purposes unless the ferrules have numbers underscored to enable differentiation. (i.e. 6 and 9).

Fuses and links shall be provided to enable all circuits in a cubicle, except a lighting circuit, to be isolated from the bus wires.

The DC trip and AC voltage supplies and wiring to main protective gear shall be segregated from those for back-up protection and also from protective Equipment for

special purposes. Each such group shall be fed through separate fuses from the bus wires. There shall not be more than one set of supplies to the Equipment comprising each group. All wires associated with the tripping circuits shall be provided with red ferrules marked "**Trip**".
It shall be possible to work on small wiring for maintenance or test purposes without making a switchboard dead.
The insulation material shall be suitably coloured in order to distinguish between the relevant phases of the circuit.
When connections rated at 380 volt and above are taken through junction boxes they shall be adequately screened and "**DANGER**" notices shall be affixed to the outsides of junction boxes or marshalling kiosk.
Where connections to other equipment and supervisory equipment are required the connections shall be grouped together.

2.0 LV power cabling

LVAC cable terminals shall be provided with adequately sized, hot pressed, cast or crimp type lugs. Where sweating sockets are provided they shall be without additional clamping or pinch bolts. Where crimp type lugs are provided they shall be applied with the correct tool and the crimping tool shall be checked regularly for correct calibration. Bi-metallic joints between the terminals and lugs shall be provided where necessary.
Terminals shall be marked with the phase colour in a clear and permanent manner.
A removable gland plate shall be provided by the Contractor. The Contractor shall be responsible for drilling the cable gland plate.
Armoured cables shall be provided with suitable glands for terminating the cable armour and shall be provided with an earthing ring and lug to facilitate connection of the gland to the earth bar.

3.0 Multi-core cables and conduit wiring

External multi-core cabling between items of main and ancillary equipment shall form part of the Contract Works and shall consist of un-armoured multi-core cable with stranded copper conductors PVC insulated and PVC over sheathed complying with the requirements of IEC 227 and 228 as applicable.
Multi-core cable for instrumentation and control purposes shall be supplied with 2.5 mm^2 stranded copper cores. Multi-core cables for CT and VT circuits shall be supplied with two by 2.5 mm^2 stranded copper cores and the cores shall be identified by the phase colour.
Where conduit is used the runs shall be laid with suitable falls and the lowest parts of the run shall be external to the equipment. All conduit runs shall be adequately drained and ventilated. Conduits shall not be run at or below ground level.
Multi-core cable tails shall be so bound that each wire may be traced to its cable without difficulty. Where cables are terminated in a junction box and the connections to a relay or control cubicle are continued in conduit, the spare cores shall be taken through the conduit and terminated in the cubicle. The dc trip and ac voltage circuits shall be segregated from each other as shall the circuits to main protective gear be segregated from those for back-up protection.
The screens of screened pairs of multi-core cables shall be earthed at one end of the cable only. The position of the earthing connections shall be shown clearly on the diagram.
All wires on panels and all multi-core cable cores shall be crimped with the correct size of crimp and crimping tool and will have ferrules which bear the same number at both ends. At those points of interconnection between the wiring carried out by separate contractors where a change of number cannot be avoided double ferrules

shall be provided on each wire. The change of numbering shall be shown on the appropriate diagram of the equipment. The same ferrule number shall not be used on wires in different circuits on the same panels.

The Contractor shall provide a two (2) metre loop of spare cable at both ends of all multi-core cable runs and shall leave sufficient lengths of tails at each end of the multi-core cables to connect up to the terminal boards. The Contractor shall also strip, insulate, ring through and tag the tails and shall also seal the cable boxes. The Contractor shall be responsible for re-checking the individual cores and for the final connecting up and fitting of numbered ferrules within all equipment provided on this contract.

The drilling of gland plates, supply and fitting of compression glands and connecting up of power cables included in the Contract scope of work shall be carried out under this contract.

4.0 Laying and installing of cables (33 kV, 11 kV, LT and control cables):

4.1.1 General

For cable laying the following shall apply:

a) Switchyard area - In concrete cable troughs (cable trench having cable racks as per Drg ODSSP/SS/10 – REV B uploaded.

b) Control Room - On cable racks consisting of slotted type and ladder type cable trays

c) Buildings - Conduits Directly buried cables shall be used wherever necessary with the approval of Engg. Incharge.

4.1.2 Laying of cable

Cables shall be laid in cable trenches on trays. Cables shall be arranged so as to allow the segregation of power, control (including CT and VT circuits) and communications cables onto different layers of cable supports. All cable supports shall be earthed in accordance with IS 3043.

The cable support system shall be designed and constructed to carry the required cables without undue crowding of the supports and without overloading the supports. The maximum number of layers of cable that shall be permitted on a single cable support shall be three. The width of the cable supports shall be selected to ensure that the supports are not crowded, the cable supports are not overloaded and that sufficient space is provided in the cable trough to allow for personnel access during and after cable installation.

Where required, ables shall be laid direct in the ground only at the discretion of the Engg. Incharge. All cables laid direct in the ground outside buildings shall be laid in a trench and protected by reinforced concrete slabs or cable tiles.

The running of communications and power cables along the same route shall be avoided as far as possible. Where this is not possible they shall be segregated, the one group from the other. Power and communication cables shall be laid in separate tiers. For other than directly buried cables the order of laying of various cables shall be as follows:

Power cables on top tiers.

Control/ instrumentation and other service cables in bottom tiers.

4.1.3 Cable tags and markers

Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule.

The tag shall be of aluminium with the number punched on it and securely attached to the cable conduit by not less than two turns of 20 SWG GI wire conforming to IS 280. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables.

Location of cables laid directly in the ground shall be clearly indicated with cable marker made of galvanised iron plate.

Location of buried cable joints shall be indicated with a cable marker having an additional inscription "**Cable joint**".

Cable markers shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road and drain crossings.

Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct, conduit entry and at every twenty meters (20 m) in cable tray/trench runs. Cable tags shall be provided inside switchgear, motor control centres, control and relay panels etc.. and wherever required for cable identification when a number of cables enter together through a gland plate.

The price of cable tags and markers shall be included in the installation rates for cables/conduits quoted by the Bidder.

4.1.4 Cable supports and cable tray mounting arrangements in control room

The control room will normally be provided with embedded steel inserts on concrete floors/walls for the purpose of cabling in the control room. The supports shall be secured by welding to these inserts or available building steel structures. However, in cases where no such embedded steel inserts are available, the same shall have to secured to the supports on walls or floors by suitable anchoring .

4.1.5 Cable support structure in switchyard cable trenches

The contractor shall fabricate and install cable support structures in cable trenches. These supports shall be provided at 750 mm spacing along the run of cable trenches.

Cable supports and cable racks shall be fabricated from standard structural steel members, channels, angles and flats of required size. The fabrication, welding and erection of these structures shall conform to the relevant clauses of this Specification, in addition to the specification given herein.

5.0 Termination of cables and wires

Where cables leave the Equipment in an upward direction the cable boxes shall be provided with a barrier joint to prevent leakage of cable oil or compound into the Equipment. Where cable cores are liable to contact with oil or oil vapour the insulation shall be unaffected by oil.

PVC sheathed cables shall be terminated by compression glands complying with BS 6121 (or equivalent).

Auxiliary PVC insulated cables shall be terminated with compression type glands, clamps or armour clamps complete with all the necessary fittings.

Colours shall be marked on the cable box, cable tail ends and single core cables at all connecting points and/or any positions the Engg. Incharge may determine. Cable boxes shall be provided with suitable labels indicating the purpose of the supply where such supply is not obvious or where the Engg. Incharge may determine.

All cables shall be identified and shall have phase colours marked at their termination.

All incoming and outgoing connections shall be terminated at a terminal block. Direct termination into auxiliary switches will not be accepted.

CHAPTER- E9 - 3

TECHNICAL SPECIFICATIONS

FOR

CABLE TERMINATIONS AND JOINTING KITS

TABLE OF CONTENTS
OF
CABLE TERMINATIONS AND JOINTING KITS

TECHNICAL SPECIFICATIONS FOR HEAT SHRINKABLE CABLE JOINT KITS FOR CABLE TERMINATIONS AND JOINTS

1.0 GENERAL:

1 .1 The term heat shrink refers to extruded or molded polymeric materials which are cross linked to develop elastic memory and supplied in expanded or deformed size or shape. The manufacturer of kits besides stating the properties of each component of the kit as indicated below and as per the detailed specifications should also state the source of origin of each component viz; whether locally manufactured or imported in raw material form and processed. The manufacturing activity carried out on each component should be stated. Also, in case the kit is assembled with components imported from two or more foreign suppliers, the manufacturers should give documentary proof supported by the foreign manufacturers confirming that the kit assembled utilizing components of different suppliers are guaranteed by them.

2.0 QUALIFYING EXPERIENCE:

2.1. The kits should have satisfactory performance record in India in excess of 5 years

Supported with proof of customers having had satisfactory use of these kits in excess of 5 years.

3.0 HEAT SHRINKABLE MATERIAL:

3.1. The heat shrinkable material component used in the joint shall have been produced in a systematic procedure as follows:

a) The required materials shall be mixed and extruded into the required shape and then cross- linked by irradiation or any other appropriate chemical process. The components are then warmed and stretched by a predetermined amount and allowed to cool in the extruded shape. The cross-linking shall create a memory and when heated again, the same shall come back to its original shape at which it was cross-linked. Heat shrinkable tubes can be reduced to 30% of its expanded dimension by heating.

b) The volume resistivity of the sleeves shall be 10^8 ohm-cm and the dielectric constant of around 15 to 30. The limiting temperature shall not be less than 100°C for longer duration and 250°C for one minute.

4.0 TYPE TEST REPORTS:

The Joints and terminations should have been subjected to all the type tests and type test reports not later than 5 years on the day of Bid opening shall be furnished for verification. The front page of type test report showing the evidence of successful type test of the items asked for in our Tender Specification can be uploaded with the signature of bidder. The full text of the type test report is to be submitted at the time of signing the agreement or within one month of LOA.

If required, OPTCL will do the type test. The transportation charges to type test laboratory and type test charges shall be borne by OPTCL. But if there is significant design difference between the one tested and are to be supplied, the cost of such test to Contractor's account.

5.0 ELECTRICAL CLEARANCES:

The electrical clearances required for a Indoor/Outdoor termination and a straight through joint is shall be as per standards

6.0 COMPRESSION TYPE TUBULAR TERMINAL ENDS:

The materials used in the terminals shall be Aluminum of grade 19501 conforming to IS 5082 - Specifications for wrought aluminum and aluminum alloys bars, rods, tubes and sections for electrical purposes. The finish inside the barrel shall either be suitably roughened throughout the crimping length of terminal end or provided with suitable greasebased compound with abrasive action. Edges and corners shall be free from burrs and sharp edges. The terminals shall meet the requirements of IS 8309 - Specification for Compression type tubular terminal ends for aluminum conductors of insulated cables.

7.0 JOINT KITS:

The requirements contained in a typical joint Kit are as follows:

a) Heat shrinkable type

b) Stress control tubing where necessary

c) Ferrule insulating tubing for joints.

d) Conductive cable break outs for terminations, non tracking, erosion and

e) Weather resistant tubing both outer / inner

f) Non tracking erosions and weather resistant outdoor sheds in case of terminations

g) High permittivity mastic wedge Insulating mastic.

h) Aluminum crimping lugs of ISI specification.

i) Tinned copper braids

j) Wrap around mechanical protection for joints.

k) Cleaning solvents, abrasive strips.

l) Plumbing metal.

m) Binding wire etc. adequate in quantity and dimensions to meet the service and test conditions.

n) Suitable for jointing single core cables with corrugated aluminium metallic inner sheath

o) The kit shall contain a leaflet consisting of detailed installation instructions and shall be properly packed with shelf life of over 3 years.

8.0 LIST OF MANUFACTURERS:

The bidders can offer the above equipment from manufactures as per the Vender list (Chapter - **E23**) only.

9.0 PROPERTIES OF JOINTING KIT COMPNENTS:

The manufacturer of kits besides stating the properties of each component of the kit as indicated below and as per the detailed specifications given in **Enclosures-I(A), I(B) & I(C)** should also state the source of origin of each component in raw material form and processed. The manufacturing activity carried out on each component should be stated.

10.0 PERFORMANCE TESTING AT CPRI, BANGALORE:

Cable termination & Jointing Kit shall have been type tested during last 5 years. If required further, type test will be done at CPRI/ ERDA/ NABL accredited Laboratory or any Govt. approved testing Laboratory. The type test charges and transportation charges to type test laboratory shall be borne by OPTCL. But if there is significant design difference between the one tested and the material to be supplied, the cost of such test shall be to the Contractor's account.

Test sequence				
Sl No	Test Sequence		Test Voltage	Test results shall be as
1	Impact a wedge shaped weight of 4kg having a 90^{O} angle with a 2 mm radius shall be dropped freely 6 times from a height of 2.0M. On to the sample. The drops shall			No visual damage
2	AC voltage withstand (IEC Pub 60)	1 min	35 kV	Shall withstand satisfactorily
		10 positive and	Indoor -75 kV	

	withstand test (IEC Pub 60 & 230)	10 negative 1.2/50 micro seconds between each conductor & the grounded sheath or screen	Outdoor95 kV	
4	Load Cycling	63 cycles, 5 hrs heating, 3hrs cooling conductor temperature screened : 75^{o} C	15 kV	-do-
5	Thermal short circuit	1 Sec. symmetrical fault with sheath temp. as per		-do-
6	Load Cycling	Repeat	15 kV	-do-
7	A/C voltage withstand	4 hrs	24 kV	-do-
8	Impulse voltage withstand	Repeat	Indoor -75 kV Outdoor95 kV	-do-
9	D/C voltage withstand	30 Min.	48 kV	-do-
10	Humidity indoor termination	Conductivity 800 M/h	7.5 kV	-do-
11	Dynamic short circuit (VDE 0278)	63 kA		-do-
12	Salt frog outdoor terminations	224 Kg/m^3	7.5 kV	-do-

ENCLOSURE – I (A)

MATERIAL SPECIFICATION FOR HEAT SHRINKABLE TUBING

Test	Test Method	Requirement				
		Non-Tracking Tubing	Stress Control Tubing	Ferrule insulating tubing	Clear insulating tubing	Inner Outer tubing for Joint
Tensile Strength	ISO 37	8 N/mm^2 Min.	14 N/mm^2 Min.	10 N/mm^2 Min.	12 N/mm^2 Min.	14 MPa Min.
Ultimate Elongation	ISO 37	300 % Min.	250 % Min.	300 % Min.	200 % Min.	500 % Min.
Accelerate d Ageing 168 Hrs. $^{\circ}$	ISO 188					
- Tensile Strength	ISO 37 Min.	7.5 N/mm^2 Min.	13 N/mm^2 Min.	10 N/mm^2 Min.	12 N/mm^2 Min.	14 MPa Min.
- Ultimate Elongatio	ISO 37	200 % Min.	130 % Min.	300 % Min.	200 % Min.	300 % Min.
Thermal Enduranc e	IEC 216	110° C Min.	90° C Min.	105° C Min.	110° C Min.	120° C Min.
Electri c Strengt	IEC 243	Wall Thkn. Elec. Strn. (Normal) KV/CM	-	Wall Thkn. Elec. Strn. (Normal)KV/C M	Wall Thkn. Elec. Strn. (Normal)KV/C M	100 kV/CM Min.

		3.0 100 mm. Min.		3.0 100 mm. Min.	*1.3 100 mm. Min.	
Volume Resitivity	IEC 93	1×10^{8} OHM- CM Min.	$5 \times 10^{1^{\circ}}$ OHM-CM	1×10^{13} OHM- CM Min.	1×10^{16} OHM- CM Min.	1×10^{12} OHM-CM
Dielectric	IEC 250	5.0 Max.	15.0 Min.	5.0 Max.	3.5 Max.	5.0 Max.
Tracking and erosion resistance	ASTM D2303	No tracking erosion to top surface or flame failure after: 1 HR at 2.5 kV 1 HR at 2.75 kV 1 HR at 3.0 kV 20 Mins at 3.25kV	-	KA 3C		KA 1
Water absorption	ISO/R 62 Procedu re A	1 % Max. AFT. 14 days at (23 ± 2)°C	1 % Max. AFT. 14 days at (23 ± 2)°C	1 % Max. AFT. 14 days at (23 ± 2)°C	0.5 % Max. AFT. 14 days at (23 ± 2)° C	0.2 % Max. AFT. 14 days at °
Resistance to liquids	ISO 1817					
- Transforme r oil to VDE 0370 immersion & days						
- Tensile Strengt	ISO 37	5 N/mm^2 Min.	13 N/mm^2 Min.	7.5 N/mm^2 Min.	-	14 MPa Min.

- Ultimate Elongatio	ISO 37	250 % Min.	250 % Min.	250 % Min.	-	300 % Min.

ENCLOSURE – I (B)
MATERIAL SPECIFICATION FOR HEAT SHRINKABLE MOULDED PARTS

Sl No	Test	Test Method	Requirement	
			Sheds	**Conductive Break-outs**
1	Tensile Strength	ISO 37	8 N/mm^2	9 N/mm^2
2	Ultimate Elongation	ISO 37	300 % Minimum.	230%
3	Accelerated Ageing 168	ISO 188		
4	Tensile Strength	ISO 37	7.5 N/mm^2 Minimum.	9 N/mm^2 Minimum.
5	Ultimate Elongation	ISO 37	200 % Minimum.	150 % Minimum.
6	Thermal Endurance	IEC 216	110ºC Minimum.	105ºC Minimum.
7	Electric Strength	IEC 243	Wall Thkn. Elec. Strn. (Normal) KV/CM	-
			<3.0 100 mm. Minimum.	
8	Volume Resistivity	IEC 93	1×10^{13} OHM-CM Minimum.	200 OHM-CM Max.
9	Dielectric constant	IEC 250	5.0 Maximum.	-
10	Tracking and erosion resistance	ASTM D2303	No tracking erosion to top surface or flame failure after: 1 HR at 2.5 kV	-

11	Water absorption	ISO/R 62Procedure A	1 % Max. AFTER. 14 days at	1 % Max. AFTER. 14
12	Resistance to liquids	ISO 1817		
13	Transformer oil to VDE 0370 immersion & days at (23 ± 2)º C			
14	Tensile Strength	ISO 37	5 N/mm^2 Minimum.	7.5 N/mm^2 Minimum.
	Ultimate Elongation	ISO 37	250 % Minimum.	150 % Minimum.

ENCLOSURE- I(C)

MATERIAL SPECIFICATION FOR HEAT SHRINKABLE ADHESIVE/SEALANTS			
Test	Test Method	Requirement	
		Black Insulator Mastic	Sealant break-out and sheds
Softening Point	ASTM E28	$(115 \pm 10)^0$ C	
Electric Strength	IEC 243	130 kV/CM Min.	80 kV/CM Min.
Volume resistivity	IEC 93	1 X 10^{14} OHM-CM Min.	
Water absorption	ISO/R 62 Procedure A	1 % Max. AFT. 1 day at $(23 \pm 2)^0$ C	1 % Max. AFT. 1 day at $(23 \pm 2)^0$ C

Corrosive effect 16 Hrs. at 121^{o} C	ASTM D2671 Method-B	No corrosion	
Adhesive peel strength substrate 2/1	as detailed in master Spec.	-	

			Below- 30^{O} C
NTR/ NTR			25N/25 mm Min.
NTR/ CON			20N/25 mm Min.
NTR/ AL			20N/25 mm Min.
NTR/ Pb			20N/25 mm Min.
T.E.R.T	ASTM D2303	-	No tracking erosion to top surface or flame failure after : 1 HR at 2.0 kV

CHAPTER – E10- 1

TECHNICAL SPECIFICATION

FOR

33kV NBLS Towers & Erection

TABLE OF CONTENTS

OF

33kV NBLS TOWERS & ERECTION

PART – A

(TOWER SUPPLY AND STORAGE)

TECHNICAL SPECIFICATIONS FOR 33kV NBLS Towers

1.0 TYPE OF TOWERS

The Narrow based Lattice Structure (NBLS) GI towers have been proposed to withstand a wind velocity of 300 km/hr when double ckt 148 sq mm conductors are strung on it with a normal span length of 150 mtr. The weights of three types of towers to be used are mentioned below. These tower drawings have been uploaded in the website (Tower Drawings: As per Drawing No. ODSSP/LINE/22, ODSSP/LINE/23 & ODSSP/LINE/24),and the weights mentioned in the Price Schedule.

Sl No.	Deviation angle	Type of tower	Struct.Wt in Metric ton	Nut and bolts wt in Metric ton	Total weight in Metric ton
1	0^0 to 5^0	HX	1.049	0.04899	1.098
2		Stub for HX	0.142272	0.000512	0.142784
3		+3m Extn. to HX	0.311	0.006	0.317
4		MS template for HX	0.189	0.008	0197
5	5^0 to 30^0	HY	1.843	0.089	1.932
6		Stub for HY	0.387	0.001	0.388
7		+3m Extn. to HY	0.557	0.017	0.574
8		MS template for HY	0.213	0.012	0.225
9	30^0 to 60^0	HZ	2.578	0.149	2.727
10		Stub for HZ	0.550	0.001	0.551
11		+3m Extn. to HZ	0.757	0.024	0.781
12		MS template for HZ	0.269	0.013	0.282

2.0 STANDARDS FOR STRUCTURAL STEEL WORK

IS: 800 Code of practice for general construction in steel

IS: 606 Code of practice for use of steel tubes in general building construction

IS: 808 Rolled steel beams, Channels and angle sections

IS: 813 Scheme of symbols for welding

IS: 814 Covered electrodes for metal are welding of structural steel

IS: 816 Code of practice for use of metal arc welding for general construction in mild steel

IS: 1200 Method of measurement of steel work and iron work (Part 8)

IS: 1236 Mild steel Tubes

IS: 1363 Black hexagon bolts, nuts and lock nuts (dia 6 to 30mm) and black hexagon Screws (dia 6 to 24mm)

IS: 1364 Precision and semi-precision hexagon bolts, screws, nuts and lock nuts (dia range 6 to 39mm)

IS: 1367 Technical supply conditions for threaded fasteners

IS: 1730 Dimensions for steel plate, sheet and strip for structural and general engineering purposes

IS: 1977 Specification for structural steel (ORDINARY QUALITY)

IS: 2062 Steel for general structural purposes

3.0 MATERIALS

The materials are to be procured from the enlisted vendors of OPTCL mentioned in chapter E-23. For other works, as detailed below

The Contractor shall furnish all materials and fabricate all steelwork in accordance with the Drawings uploaded

All bolts shall be property class 5.6, and nuts shall be of properly class 5.0 HRH and shall conform to the requirements of Indian standard Specification IS: 1367(Part 3) – 1991, IS: 6639-1972 and galvanizing quality shall be as per IS: 538. All bolts and nuts shall be of minimum diameter of 16 mm. unless otherwise stated. All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 kg/sq.mm and a minimum elongation of 23 percent on a gauge length of 5.6 A, where 'A' is the cross sectional area of the test specimen. Washers shall be made of steel conforming to IS: 961 as may be applicable under the provisions of the contract. Zinc reached Epoxy Paints to be used for shop coat of fabricated steel (other than galvanized).

- Steel materials shall be free from all imperfections, mill scale, slag intrusions, laminations, pitting, rusts, etc. that may impair their strength, durability and appearance.
- All materials shall be of tested quality only.
- **Mild Steel:** When tested in accordance with the following Indian Standard Specifications all mild steel for bolts and nuts shall have a tensile strength of not less than 44 Kg/mm^2 and a minimum elongation of 23 percent on a gauge length of 5.6 A, where —'A' is the cross sectional area of the testspecimen:-

  IS: 1367 Technical supply conditions for threaded fasteners

  IS: 1608 Method for tensile testing of steel products other than sheet, strip, and wire tube

- **High Tensile Steel:** The material used for the manufacturer of high tensile steel

bolts and nuts shall have the requirements of **IS:1367**

- **Washers:** Washers shall be made of steel conforming to the appropriate Indian Standard Specifications including, but not limited to **IS: 1977, IS: 2062, IS: 6649**

The steel structures shall be galvanized with minimum zinc coating of 610 gms / Sq.Mtr.

The materials must conform to IS: 800. The test on materials and fabrication etc will be as per the relevant Indian standards.

The method of painting, marking, packing and delivery of all fabricated materials shall be strictly in accordance with the provisions of the Specification and/or as approved by the Engineer.

4.0 The HX, HY and HZ type towers have been designed with following limitations.

4.1 EFFECTIVE SLENDERNESS RATIO

The effective slenderness (L/R) ratio of members shall meet the following limits.

Leg members, Gantry chords, main compression:	120
Member and ground wire peaks.	
Other members having computed compressive Stress:	200
Tension members:	400

Where

L: Length of the unsupported panel of member.

R: Radius of gyration of members.

In order to facilitate transportation and hauling, the length of any structural member shall not exceed 6 m.

4.2 MINIMUM THICKNESS AND SIZE OF STEEL MEMBERS

Minimum thickness of steel members of structures shall be as follows:-

For leg members and compressive chords in Gantries:	6 mm
For other members without calculated stress:	5 mm
For redundant members	5 mm
Gusset plates:	6 mm Minimum
Bolt diameter for main members:	16 mm
Minimum bolt diameter for bracing member:	12 mm without

4.3 Step bolts

Step bolts shall be of 16-mm. diameters and shall have round or hexagonal head. Each step bolt shall be provided with two hexagonal nuts. The minimum bolt length and

length of unthreaded portion shall be150 and 100 mm. respectively. Step bolts shall not be used as connection bolts.

The step bolts shall be spread alternately on the inner gauge line on each face of the angle about 40 cm. Centers. They shall be furnished for one leg of each steel structure column from its base elevation.

5.0 QUALITY CONTROL

The contractor shall establish and maintain quality control procedures in accordance with the specifications and best modern practice.

Materials or workmanship not in reasonable conformance with the provisions of these specifications maybe rejected at any time during the progress of the work. The quality control procedure shall cover but not be limited to the following items of work:

Steel: Quality, manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.

Bolts, nuts & washers: Manufacturer's certificate, dimension & washers, check, material testing.

Paints: Manufacturer's certificate, physical inspection reports.

Galvanizing: Tests in accordance with IS: 2633 – Methods of testing weight, thickness and uniformity of coating on hot dipped galvanizing articles.

6.0 FABRICATION

WORKMANSHIP

All workmanship shall be equal to the best practice in modern structural shop and shall conform to the provisions of IS: 800 – 1984 & IS: 802 (Part II) 1978.

Rolled materials before being laid off or worked, must be clean free from sharp kinks, bends, or swifts and straight within the tolerances allowed by IS: 1852. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat not exceeding 600 deg. C.

Cutting shall be affected by shearing, cropping or sawing. Use of mechanically controlled Gas Cutting Torch may be permitted for mild steel only. Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. To determine the effective size of members, cut by gas, 3 mm. shall be deducted from each cut edge.

The erection clearance for cleared ends of members connecting steel to steel shall preferably be not greater than 2 mm. at each end. The erection clearance at ends of beams without cleats shall not be more than 3 mm. at each end, but where for practical reasons greater clearance is necessary suitably designed clearings shall be used. All members shall consist of rolled steel sections.

Holes for bolts shall not be more than 1.5 mm. large than the diameter of the bolt passing through them. All members shall be cut to jig and all holes shall be punched and drilled to jig. All parts shall be carefully cut and holes accurately located after the members are assembled and tightly clamped or bolted together. Drifting or rimming of holes shall not be allowed. Holes for bolts shall not be formed by gas cutting process. Punching of holes will not be permitted for M.S. members up to 8 mm. thick and in no case shall a hole be punched where the thickness of the material exceed the diameter of the punched hole.

Built members shall, when finished, be true and free from all kinds of twists and open joints and the material shall not be defective or strained in anyway.

All bolts shall be galvanized including the threaded portion. The threads of all bolts shall be cleared of smelter by spinning or brushing. A die shall not be used for cleaning the threads unless special approved by the OPTCL. All nuts shall be galvanized with the exception of the threads, which shall be oiled.

When in position all bolts shall project through the corresponding nuts but not exceeding 10 mm.

The nuts of all bolt attaching insulator sets and earth conductor clamps to the structure shall be carefully positioned as directed by the Engineer-in-charge. Bolts and nuts shall be placed in such a way so that they are accessible by means of an ordinary spanner.

Foundation bolts and tubes shall be fitted with washer plates or anchor angles and flats, nuts, etc and shall be manufactured from mild or special steel.

Washers shall be tapered or otherwise suitably shaped, where necessary to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project out through the nut at least one thread. In all cases, the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the washer, one spring washer or lock nut shall be provided for each bolt shall project out through the nut at least one thread. In all cases, the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the washer, one spring washer or lock nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified in the drawings.

7.0 CLEANING AND GALVANIZING

7.1 Cleaning

After fabrication as been completed and accepted, all materials shall be clear of rust, loose scale, dirt, oil grease and other foreign substances.

7.2 Galvanizing

All materials shall be hot-dip galvanized after fabrication and cleaning. Re- tapping of nuts after galvanizing is not permitted. Galvanizing or structural mild steel products shall meet the requirements of IS: 4759-1 984.All holes in materials shall be free of excess shelter after galvanizing. Galvanizing for fasteners shall meet the requirements of IS: 1367 (Part – 3)-

1983. The spring washers shall be electro galvanized as per IS: 1573 – 1986. Finished materials shall be dipped into the solution of dichromate after. Galvanizing for white

rust protection during transportation. All galvanizing shall be uniform and of standard quality.

7.3 Straightening after Galvanizing

All plates and shapes which have been warped by the galvanizing process shall be straightened by being re rolled of pressed. The materials shall not be hammered or otherwise straightened in a manner that will injure the protective coating. If, in the opinion of OPTCL the material has been forcibly bent or warped in the process of galvanizing of fabrication such defects shall be cause for rejection.

7.4 Repair of Galvanizing

Materials on which galvanizing has been damaged shall be acid stripped and regularized, unless, in the opinion of OPTCL, the damage is local and can be repaired by zinc spraying or by applying a coating of galvanizing repair compound. Where regularizing is required, any member which becomes damaged after having been dipped twice shall be rejected.

8.0 STORAGE OF MATERIAL

8.1 General

All materials shall be as stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any materials which has deteriorated or has been damaged shall be removed from the Contractors yard immediately, failing which the Engineer shall be at liberty to arrange for removal of the material and the cost incurred thereof shall be realized from the Contractor. The Contractor shall maintain up to date accounts in respect of receipt, use and balance of all sizes and sections of steels and other materials. Where fabrication is carried out in Contractors fabrication shop or site and where fabrication works for their other projects are also carried out, all materials allocated for use on these projects shall be stored separately with easily identifiable marks.

PART – B

(NBLS TOWER ERECTION)

NBLS TOWER ERECTION

1.0 ERECTION WORK

Erection of transmission line by the contractor shall include all necessary works as detailed below but not limited to:

> Detailed survey including location marking.

> Submission of Soil Testing/investigation Report where required

> Stub template setting, concreting of stubs, curing and coping.

>Earthing of tower.

> Erection of super structure and accessories.

> Fixing of Insulator and accessories, paving out and stringing of conductors with all accessories, fittings, dampers etc. complete for power conductors.

> Paving out and stringing of earth wire with all accessories, fittings of dampers etc. complete for earth wire.

> Checking and commissioning of the line after completion of all erection works.

> Getting clearance from Chief Electrical Inspector (CEI) Govt. of Orissa.

> Solving all type of ROW problem and payment of compensation to make the location free for construction erection and stringing work.

> Payment of all type of crop compensation .

> The contractor shall arrange the security for watch and ward for the entire work including the work already done till handing over of the line at his own cost.

> Any incidental work not covered in the specification but are required for completion of

> All other materials required for satisfactory construction of Transmission lines such as cement sand, coarse aggregate, all type of fine aggregates, jelly, explosives, earth pit filling, materials like charcoal and salt etc, form boxes, shutters, tools and Plants of approved quality shall be inclusive other expenses incidental to execution of this contract shall be borne by the contractor.

In different crossings the contractor shall take into consideration the prevailing regulations of the respective authorities before finalizing type and location of the towers. While carrying out survey work, the contractor has to collect all relevant data, prepare and submit drawings in requisite number for obtaining clearance from road, aviation, railways, and river and forest authorities.

2.0 EARTH WORK FOR TOWER FOUNDATIONS

General Requirements

The contractor shall provide all tools, plants, instruments, qualified supervisory personnel, labour materials, any temporary workers, consumables, and everything necessary, whether or not such items are specifically stated herein, for completion of the project in accordance with specification requirement. The excavation shall be done in accordance with the design and drawing. This shall also includes, where ever required, proper shoring shuttering to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades around excavated areas and warning lamps at night for ensuring safety of lives and property.

- Scope also includes dumping of excavated materials in regular heaps, bunds, rip rap with regular slope as directed by Engineer-in-charge within the lead specified and leveling the same so as to provide natural drainage. Rock/soil excavated shall be stacked properly. All softer materials shall be laid along the center of the herpes, the harder and more weather resisting materials forming the casing on the sides and the top. Rocks shall be stacked separately.

- The area to be excavated /filled shall be cleared of trees, plants, stumps, bush, vegetation rubbish etc. and other objectionable matter. If any roots or stumps or trees are met during excavation, they shall be removed as directed by Engineer-in-charge.

- **Normal Soil:**

  These shall include all kinds of soils containing Sand, Silt and small pellets, which are removable by ordinary pick axes, shovel and spade and which are not classified under hard soil or soft rock

- **Hard soil :**

  Spoil removable by pick-axe, crowbar etc. Morrum or shingle, gravel, clay, loam peat etc.

- **Soft & Decomposed / Dis- integrated Rock:**

  This shall include rock, boulders, shale, chalk, slate, hard mica, schist, laetrile and all other materials which in the opinion of the Engineer-in- charge is rock, does not need blasting and could be removed with picks, hammer, craw bars, wedges and pneumatic breaking work. This shall also include rock boulders not longer than one meter in any direction and not more than 500 mm in any one of the other two directions.

- **Wet Soil**

  Where the subsoil water table is encountered within the range of after a ofdepth of 1 mtr from ground levelor where for a substantial period water is logged for example paddy field.

  - Where soil at a tower foundation is of composite nature, classification will be according to the type of soil, which is preponderant in the footing and the rate for the same will apply for the composite foundation. The decision of the

OPTCL/Engineer-in charge shall be final and binding with reference to classification of soils.

- All surplus excavated soil along with left over gradients if any "should beremoved from work site and dumped at any suitable place in such a manner that the landowner will not object. A thin layer of nearly 200mm of surplus earthy can be stacked over the excavated pits for future compaction".
- Standard penetration test to be carried out for long line one in ten support sites.

Back filling has to be done by borrowed earth if required.

All organic or other foreign materials shall be removed from back fill earth. The earth shall be deposited in maximum 200mm. Layers, leveled and watered and rammed properly before another layer is deposited.

The back filling should be such that enough moisture would be available for curing of the concrete embedded. Sufficient water shall be poured over the back filled earth for proper consolidation. All surplus excavated soil shall be stacked around the tower legs. In case of wet locations, de-watering, shoring and shuttering etc. if required shall be paid for based on unit rates indicated. The actual quantity shall be as approved by the Engineer-in charge. The shoring and shuttering is to be done by very good quality planks and supports as approved by Engineer-in-charge.

Stub-Template setting, concreting of stubs and copping:

- The stub shall be set correctly in accordance with approved method at the exact location and alignment with the help of stub setting templates as per the standards. The levels and alignment shall be checked and approved by Engineer-in-charge for whichadequate advance intimation shall be given by the contractor. The approval shall not, however, relieve the contractor of his responsibility of correctness of setting.
- The bottom of the pits shall be free from loose earth and shall have about 150mm. Thick layer of sand or concrete [1:2:4] mat, before stubs are set for concreting. The concrete shall be as specified in relevant I.S.S. for such work or as directed by the Engineer-in-charge. It shall be 1:2:4 mix with proper quality of sand, cement and granite chips as stated below: The concreting of stubs shall not be made in parts and it should be a continuous process till completion.Reinforcement, as per approved drawings. In no case the bottom most portion clits of stub should be more or less than 75mm from the bottom finished level.
- **Concreting:**

Sand—

The sand to be used for concreting shall be coarse and from available Local River beds free from clay and other undesirable organic & inorganic materials like dust, lump, loam, mica, saline and other deleterious substances.

Coarse Aggregate—

The coarse aggregate to be used shall be of broken granite rock varying in size from 20mm. to 40mm. to be approved by the Engineer-in-charge provided the resultant concrete shall meet the requirement of IS:456-1964 M150 quality.

Water—

Clear non-saline, free from oils, acids alkalis and organic materials water from river, tank or well shall be used in concreting.

Cconsumption of cement shall be made as detailed below:

1:1.5:3	Mix	410 kg/cum
1:2:4	Mix	330kg/cum
1:3:6	Mix	225kg/cum
1:5	Cement mortar	87kg/cum
1:4:8	Mix	115kg/cum

- Before laying the concrete the stub shall be cleaned of rust, scale, mud etc with a steel wire brush. The method of placement of concrete shall be such as not to result in loss of workability or in segregation of concrete mix.
- In wet locations, the site must be kept completely dewatered, both during the placing of the concrete and for 24 hours thereafter to protect the concrete from water during this period.

•Reinforced Cement Concrete:

The steel reinforcement bar shall be fabricated and placed in pile legs, caps, tie beams .Before the steel reinforcement bars are placed in position, the surface of the bars shall be cleared of rust, scale, dirt, grease or other objectionable foreign substance. The bending and fixing of bars for concrete reinforcements shall conform to IS:

2502/1963 and IS: 5525/1969. Sufficient concrete coverage as indicated in the foundation drawing or as per relevant ISS, where not shown in the drawing, should be provided.

Copping —

After completion of back-filling the coping over the top surface of the chimney shall be done as per the approved foundation drawing with 1:2:4 concrete with a slight slope towards the outer edge to drain off any rain water falling on the coping. The coping shall have a smooth and geometrical finish. In no case the height of copping more or less than 350mm above the actual ground level.

Black Bitumen paint of 2 coat of a length 400mm above the copping should be provided by the contractor by his own cost.

- **Curing —**

Full care should be taken for curing of the concrete exposed over ground by any conventional method. 15 days curing is required depending on weather and location. The concrete underground is expected to be cured from the moisture in the backfill earth.

.EARTHING —

Every tower shall be suitably earthed so that the tower footing resistance does not exceed 10 Ohms. Depending on the earth resistively of soil it is to be decided by the Engineer-in charge whether pipe type Earthing or counterpoise Earthing is to be provided, details of which shall be indicated in the approved drawings. The earth electrode shall be 50mm. dia 3 mtr. Long heavy duty GI pipe. The contractor shall supply 560 kg. of common salt and 50 kg. Charcoal for each earth pit. The contractor is required to take soil resistively reading at each location before start of work.

3.0 ERECTION OF SUPER STRUCTURE WITH ACCESSORIES

- The super structure shall be erected as per approved structural drawings to be furnished by the Contractor. All members shall be carefully handled during transport and erection so that the galvanizing is not scratched and the interior steel not exposed. In storage and at tower site all tower steels shall be kept clear of the ground in a clean and dry condition. Contact with brackish water or other substances likely to attach galvanizing shall be avoided. All superficial rust stains, corrosive salts and other corrosive foreign materials deposited prior to or during installation of the tower shall be removed without causing damage to the protective surfaces. Towers shall be erected in a workman likemanner and tower members shall not be strained or deformed during course of erection.

- The method followed for the erection of towers shall ensure the points mentioned below:-

  Straining of the members shall not be permitted for bringing them into position. It may, however, be necessary to match hole positions at joints and to facilitate this, Tommy bars not more than 450 mm. long may be used.

  Before starting erection of an upper section, the lower section shall be completely braced and all bolts provided in accordance with approved drawings.

  All plan diagonals relevant to section of tower shall be placed in position before assembly of upper section is taken up.

All bolts will have their bolt heads facing outside/inside of the tower as convenient, for horizontal or nearly horizontal bolt connection and upwards for vertical bolt connections.

Slings and other works used for picking up members, portions of towers or complete towers, shall be protected in such a manner as to prevent cuttings into the corners of members, damaged the finish or portions of towers shall be raised in such a manner that no dragging on the ground surface or against portions of the towers already erected will occur.

- The method of erection is left to the contractor subject to his responsibility for any damage done to the materials due to any cause. The erection of towers should not be started earlier than 15 days after back fill of the stubs so that there is no disturbance or damage to the concrete and also to allow it to acquire its full strength. Approval of the Engineer-in-charge to start erection work shall be obtained. After the final tightening of bolts and nuts the treads shall be punched so as to prevent loosening under temperature changes or vibrations. The towers must be truly vertical after erection and no straining will be permitted to bring them so. Towers

shall be so erected that the vertical axis through the center of the gravity shall not be out of plumb by more than one centimeter for every 500 centimeter of height.

- **TIGHTENING AND PUNCHING OF BOLTS AND NUTS —**

All nuts shall be tightened properly using correct size spanners or torque wrenches. Before tightening, it shall be seen that filler washers and plates are placed in relevant gaps between members bolts of proper size and length are inserted under each nut and in case of steps bolts, spring washers have been placed under the outer nut. The tightening shall progressively be carried out from the top down wards and checked back from bottom upwards before punching care being taken that all bolts at every level are tightened simultaneously. The minimum 3 thread should be projected after final tightening. After final tightening, the projected threadshould be riveted by using hammer. In the complete tower, the nuts for bots shall be tightened to the following torque.

Size of bolts	**Tightening torque**
12 mm dia	600-800 kg-m
16 mm dia	1000-1200 kg-m

- **FIXATION OF INSULATORS AND HARDWARES —** Insulators shall be handled carefully in all stages of handling and be individually checked for cracks, damage, and loss of glaze etc. before assembly and erection at site, which shall be according to the drawings approved by OPTCL. The rigging and hoisting of insulator strings shall be done very carefully so that no damage is caused to the insulators and hard wares. Discs with hairline cracks and chips and also those having glazing defects exceeding 1/2 cm sq. shall not be used. At all major high ways, Main River and utility line crossing double string of insulators shall be used.

The entire stringing work of conductor and earth wire shall be carried out by tension stringing technique. The contractor shall indicate in their offer, the sets of tension stringing equipment he is having in his possession and the sets of the stringing equipment he would deploy exclusively for this package which under no circumstance shall be less than thenumber and capacity requirement indicated in Qualifying Requirements for Bidder.

Materials:

The Bidder should have assured access to supply Earth wire, hardware fittings and Conductor & Earth wire accessories from qualified manufacturers. Type test certificate from CPRI/Govt. testing laboratory should be attached with the offer.

- **Earth wire:** Galvanized steel ground wire of size 7/3.15 mm or above from any reputed manufacturer.
- **Hardware Fittings:** 90KN/ 120 KNHardwarefittings.
- **Insulator String Hardware (As may be applicable)**
  I. Anchor shackle
  II. Chain Link

III. Ball Clevis
IV. Arcing horn holding plate
V. Yoke plate
VI. Socket clevis
VIII. Arcing horns
IX. Clevis Eye
X. Free center type/ Amour grip suspension clamp for suspensionstrings.
XI. Compression type dead end clamp.

- **Accessories for Conductor & Earth wire (As may be applicable)**
    1. Performed Amour rods
    2. Mid Span compression joint
    3. Repair Sleeves
    4. Flexible copper bonds
    5. Vibration dampers
    6. Suspension clamp for earth wire.
    7. Tension clamp for earth wire

- **Access to the Line and Right of Way:**

  Right of way and way leave clearance shall be arranged by the Contractor in accordance with work schedules. Owner will secure way leave and Right of way in the Forest area but the contractor shall maintain the same for the entire period of the contract.

- **Clearance from Ground, Building, Trees etc**

  Clearance from ground, buildings, trees and telephone lines shall be provided in conformity with the Indian Electricity Rules, 1956 as amended up to date. The tree cutting shall be the responsibility of the Owner except for that required during survey. However, the Contractor shall count, mark and put proper numbers with suitable quality of paint at his own cost on all the trees that are to be cut by the Owner at the time of actual execution of the work as detailed below. Contractor may please note that Owner shall not pay any compensation for any loss or damage to the properties or for tree cutting due to Contractor's work.

4.0 STRINGING OF OVERHEAD GROUND WIRE

- **GENERAL**

  The overhead ground wire(s) shall be strung for the entire length of the transmission line, and shall be attached to the towers in accordance with the details same as for conductor(s). The work, methods, and limitations used for installing the overhead ground wire shall be the same as for installing the conductor.

- **STRINGING OF OVERHEAD GROUND WIRE**

  The overhead ground wire shall be strung in advance of the conductors, and the method shall be the same as for conductor string. The same degree of care shall be

exercised to avoid damage or injury of the overhead ground wire. If damaged, thecontractor in a manner approved by the Engineer-in-charge shall replace them.

- **JOINTING OF OVERHEAD GROUND WIRE**

Compression type joints and clamps shall be installed in accordance with the printed instructions of the manufactures. Galvanized tension sleeves shall, after jointing, be coated effectively with an approved rust preventive paint and shall further be furnished with a repair coat of paint after final passage through snatch blocks.

- **SAGGING OF OVERHEAD GROUND WIRE**

After being sagged, the overhead ground wire shall be clipped in the same manner as for conductor. Suspension clamps of overhead ground wire shall be installed in such a manner that earthling bond wires shall all face a given direction. The ends of bond wires shall be clamped with terminal clamps in an approved manner. In no case the sagging of the ground wire will be more than the conductor sag. The mid-span clearance between ground wire and power conductor should be more than the clearance near the tower in order to avoid flashover during lightening surge.

- **FIXING OF CONDUCTOR AND GROUND WIRE ACCESSORIES** Vibration dampers and other conductor and ground wire accessories shall be installed by the contractor as per the design requirement and as per the respective manufactures instruction. Dampers shall be fastened securely, so that all dampers will hang in vertical planes. Vibration dampers shall be installed within 24 hours after the conductor has been clipped in.

- **FIXING OF TOWER ACCESSORIES**

All towers accessories such as anti-climbing devices phase plate, number plate, danger plate etc. shall be fixed in an approved manner. The bird guard should be fixed in all X arms of tangent tower at the time of erection of tower.

- **SPECIAL WORKS**

Special works which are not within the scope of this contract but come up during the execution of the works shall be carried out by the contractor at mutually agreed methods and rates to be decided before the commencement of such works. All nuts up to the bottom cross arm shall be welded continuously to the bolt by the contractor using his own welding rod and skilled welder as per schedule of quantity.

CHAPTER - E10- 2

TECHNICAL SPECIFICATION

FOR

RS JOIST & PSC POLE

TABLE OF CONTENTS
OF
RS JOIST & PSC POLE

PART – A

TECHNICAL SPECIFICATION
OF
11 mtr, R.S Joist Pole

TECHNICAL SPECIFICATION OF 11 mtr, R.S Joist Pole

1.0 Scope Of Work:

This specification covers design, manufacture, testing and supply of 150mm x 150mm GI RS Joist 11 Meter long having unit weight of 34.6kg. Per Meter. Thickness of the web shall be 11.8 mm. All steel structures including RS joist for Line & Outdoor structures in Substations shall be Galvanized type.

150x150mm RS joist			
1	150 x 150 mm R.S. Joist length:-11 mtr, 34.6kg/mtr	MT	0.3806

Applicable Standards:

This specification covers the manufacturing, testing before dispatch and delivery of above R.S Joists.

2.0 Standards:

The RS JOISTS shall comply with the requirements of latest issue of IS – 2062 Gr – A except where specified otherwise.

3.0 Climatic Conditions :

Please refer chapter E3 of Technical Specification on climatic conditions.

4.0 Rolled Steel Joists

RSJ DESIGNATION	150 x 150 mm ISHB
Length of Joist in Mtr with +100mm/- 0% Tolerance	11mtr
Weight kg/m with±2.5% Tolerance	34.6
Sectional Area (cm^2)	44.1
Depth(D) of Section (mm) with +3.0mm/ -2.0mm Tolerance as per IS 1852-1985	150.00

Width (B)of Flange (mm) with ±2.5mm Tolerance for116 x 100 mm ISMB & ±4.0mm Tolerance for 150 x 150 mm ISHB IS 1852-1985	150.00
Thickness of Flange (Tf) (mm) with±1 .5mm Tolerance	9.00
Thickness of Web(Tw) (mm) with±1 .0mm Tolerance	11.8
Corner Radius of fillet or root (R1) (mm)	8.00
Corner Radius of Tow (R2) (mm)	4.00
Moment of Inertia Ixx (cm^4) Iyy (cm^4)	 1640.00 495.00
Radius of Gyration (cm) Rxx Ryy	 6.09 3.35
Flange Slope(a) in Degree	94.0
Tolerance in Dimension	As per IS:1852

4.1Dimensions and Properties

4.2 MECHANICAL PROPERTIES:

Tensile Test :	Requirement as perIS:2062/ 1999 Grade-A
Yeild Stress(MPa)	Min250
Tensile Strength(MPa)	Min410

Lo=(5.65ISo)Elongation%	Min23
Bend Test	Shall not Crack

4.3. CHEMICAL PROPERTIES:

Chemical Composition	Requirement as perIS:2062/ 1999 Grade-A	Permissiblevariation over the Specified Limit,Percent,Max
Grade	A	-
Chemical Name	Fe-410W A	-
Carbon(%Max.)	0.23	0.02
Manganese(%Max.)	1.5	0.05
Sulphur(%Max.)	0.050	0.005
Phosphorous(%Max.)	0.050	0.005
Silicon(%Max.)	0.40	0.03
Carbon Equivalent(%Max.)	0.42	-
De-oxidation Mode	Semi-killed or killed	-
Supply condition	As rolled	-

4.4. However, In case of any discrepancy between the above data & the relevant ISS, the values indicated in the IS shall prevail.

4.5. The Acceptance Tests shall be Carried out as per Relevant ISS.

5.0.150x150mm RS Joists:

RS Joists of Specific Weight 30.6kg/mtr with length of each type of pole being 11 mtr pole weighing 336.6Kg for specified number of poles with specified weight in MT as given in the NIT table given above shall have to be supplied as per IS:2062;2006 Grade"A" , IS:808;1989/2001, IS1608:1995 & IS:12779-1989 and their latest amendment if any complying the required Dimension, Weight, Chemical & Mechanical properties confirming to the relevant IS, as per the Tolerrance given Below.

6.0 APPLICABLETOLLERANCES:

1. Length of each pole = + 100mm / - 0 % As per relevant IS: 12779-1989(with proportionate change in no of Poles)
2. Specific Weight of RS Joists = ±2.5% As per relevant IS: 1852/1 985
3. Weight for whole lot of supply for all categories = ±3.0% As per relevant IS: 12779-1989 for both type of RS Joists.

7.0. EMBOSSING ON EACH R.S JOIST :

Following distinct non-erasable embossing is to be made on each R.S Joists

a) Name & Logo of the Manufacturer.

b) B.I.S Logo (ISI Mark) if applicable.

c) Size of the R.S Joists

8.0 Chemical Properties :

Tensile Test :	Requirement as per IS:2062/ 1999 Grade-A	Manufacturer's Data
Yeild Stress(MPa)	Min250	
Tensile Strength(MPa)	Min410	
Lo=(5.65ISo)Elongation%	Min23	
Bend Test	Shall not Crack	

9.0 Mechanical Properties :

Chemical Composition	Requirement as per IS:2062/ 1999 Grade- A	Permissible variation over the Specified Limit, Percent, Max	Manufacturer's Data
Grade	A	-	
Chemical Name	Fe-410W A	-	
Carbon(%Max.)	0.23	0.02	
Manganese(%Max.)	1.5	0.05	
Sulphur(%Max.)	0.050	0.005	
Phosphorous(%Max.)	0.050	0.005	
Silicon(%Max.)	0.40	0.03	
Carbon Equivalent (%Max.)	0.42	-	
Deoxidation Mode	Semi-killed or killed	-	
Supply condition	As rolled	-	

However, In case of any discrepancy between the above data & the relevant ISS, the values indicated in the IS shall prevail.

The Acceptance Tests shall be Carried out as per Relevant ISS.

The RS Joists shall be manufactured confirming to the relevant IS with Manufacturer's name/logo & B.I.S Logo if applicable embossed on it.

10.0 JOINTING IN G.I. JOISTS- The total steel structures should be Galvanized with minimum zinc coating of 610 gms / Sq. Mts .Joints in G.I Joist will be allowed, subject to OPTCL approval, where 11mtr & 13mtr G.I Joist can not be transported to the site, by making two pieces of galvanized G.I Joist with single joint **in lines only**. For 11Mtr. Long, (6mtr + 5 mtr), (7mtr + 4mtr) and For 13mtr long (7mtr + 6 mtr), (8mtr + 5mtr) G.I Joist Pole are permissible. Jointing is to be done through nuts & bolts of plates of adequate size along with required size GI bolt nuts & spring washers is to be adopted plates as per the drawings uploaded.

11.0 **GUARANTEED TECHNICAL PARTICULARS:** GTP for RS Joists of sizes 150mmX150mm is furnished at chapter- **E21** of this T.S. Bidders are requested to submit the GTP as per the format only.

PART - B

PSC POLE

(10mtr x 400Kg& 10mtr x 300kg)

TECHNICAL SPECIFICATIONS FOR PSC Pole (10mtr x 400Kg)

1.0 SCOPE :-

This specification covers design, manufacture, inspection and testing supply of 10mtr x 300Kg & 10mtr x 400Kg PSC Poles before dispatch packing and delivery FOR (destination) for Indian manufacturers of as per technical requirements furnished in this specification.

2.0 Applicable Standard :

The Poles shall comply with latest standards as under:
REC Specification No. 15/1979, REC Specification No. 24/1983, IS 1678, IS 2905, IS 7321.

3.0 Materials :

a. Cement

Cement to be used in the manufacture of pre-stressed concrete poles shall be ordinary for rapid hardening Portland cement confirming to IS: 269-1976 (Specification for ordinary and low heat Portland cement) or IS: 8041 E-1978 (Specification for rapid hardening Portland cement).

b. Aggregates

Aggregates to be used for the manufacture of pre-stressed concrete poles shall confirm to IS: 383 (Specification for coarse and fine aggregates from natural sources for concrete) .The nominal maximum sizes of aggregates shall in no case exceed 12 mm.

c. Water

Water should be free from chlorides, sulphates, other salts and organic matter. Potable water will be generally suitable.

d. Admixture

Admixture should not contain Calcium Chloride or other chlorides and salts which are likely to promote corrosion of pre-stressing steel. The admixture shall conform to IS: 9103.

e. Pres-Stressing Steel

Pre-stressing steel wires including those used as un tensioned wires should conform to IS:1785 (Part-I)(Specification for plain hard-drawn steel wire for pre-stressed concrete, Part-I cold drawn stress relieved wire).IS: 1785 (Part-II)(Specification for plain hard-drawn steel wire) or IS:6003 (Specification for indented wire for pre-stressed concrete).The type design given in the annexure arefor plain wires of 4 mm diameter with a guaranteed ultimate strength of 160 kg/mm^2. All pre-stressing steel shall be free from splits, harmful scratches, surface flaw, rough, aged and imperfect edges and other defects likely to impair its use in pre-stressed concrete.

f. Concrete Mix

Concrete mix shall be designed to the requirements laid down for controlled concrete (also called design mix concrete) in IS: 1343-1980 (Code of practice for pre-stressed concrete) and IS: 456 – 1978 (Code of practice for plain and reinforced concrete) subject to the following special conditions: Minimum works cube strength at 28 days should be at least 420 Kg/cm^2.

The concrete strength at transfer should be at least 210 Kg/cm^2.

The mix should contain at least 380 Kg of cement per cubic meter of concrete.
The mix should contain as low water content as is consistent with adequate workability. It becomes necessary to add water to increase the workability the cement content also should be raised in such a way that the original value of water cement ratio is maintained.

4.0 Design Requirements

The poles shall be designed for the following requirements:

The poles shall be planted directly in the ground with a planting depth as per IS: 1678. Wherever, planting depth is required to be increased beyond the specified limits or alternative arrangements are required to be made on account of ground conditions e.g. water logging etc., the same shall be in the scope of the bidder at no extra cost to owner. The bidder shall furnish necessary design calculations/details of alternative arrangements in this regard.

The working load on the poles should correspond to those that are likely to come on the pole during their service life.

The factor of safety for all poles 9.0Mts. Shall not be less than 2.0 and for 8.0 M poles, the factor of safety shall not be less than 2.5.
The average permanent load shall be 40% of the working load.
The F.O.S. against first load shall be 1.0.
At average permanent load, permissible tensile stress in concrete shall be 30 kg/cm^2.
At the design value of first crack load, the modulus of rupture shall not exceed 53.0kg/cm^2 for M-40. The ultimate moment capacity in the longitudinal direction should be at least one fourth of that in the transverse direction.
The maximum compressive stress in concrete at the time of transfer of pre-stress should not exceed 0.8 times the cube strength.
The concrete strength at transfer shall not be less than half, the 28 days strength ensured in the design, i.e. 420x0.5=210kg/cm^2. For model check calculations on the design of poles,

referred to in the annexure, a reference may be made to the REC “Manual on Manufacturing of solid PCC poles, Part-IDesign Aspects”.

5.0 Dimensions and Reinforcements

5.1 The cross-sectional dimensions and the details of pre-stressing wires should conform to the particulars given in the enclosed drawing. The provisions of holes for fixing cross-arms and other fixtures should conform to the REC specification No.15/1979.

All pre-stressing wires and reinforcements shall be accurately fixed as shown in drawings and maintained in position during manufacture. The un-tensioned reinforcement as indicated in the drawings should be held in position by the use of stirrups which should go round all the wires.

All wires shall be accurately stretched with uniform pre-stressed in each wire. Each wire or group of wires shall be anchored positively during casing. Care should be taken to see that the anchorages do not yield before the concrete attains the necessary strength.

5.2 The poles shall then be lifted to the pit with the help of wooden supports. The pole shall then be kept in the vertical position with the help of 25 mm (min.) manila ropes, which will act as the temporary anchor. The verticality of the pole shall be checked by spirit level in both longitudinal &transverse directions. The temporary anchor shall be removed only when **poles set properly in the pit for foundation concreting & backfilling with proper compacting the soil. The backfilling should be done in layers (maxm. 0.5 mts at a time with sprinkling of water and by using wooden hammer. No stone more than 75 mm should be used during back filling.**

5.3 Suspension type H/W fittings in all tangent locations and Four pair bolted type tension H/W fittings should be used in all new 33 &11 kV lines 70 KN normal B&S insulators will be used in suspension & tension locations respectively.

5.4 Concreting of foundation up to a minimum height of 1.8 mtrs from the bottom of the pit with a circular cross-section of radius 0.25 mtrs. (volume of 0.3 cu.mtr. per pole) in the ratio of 1:2:4 shall be done at the following locations: The **depth** has to be increased to 2mtr or as required at site condition if poles more than 11 Mts. are to be used.

i) At all the tapping points and dead end poles.

ii) At all the points as per REC construction dwg. No. A-10 (for the diversion angle of 10-60 degree) or **better there of as per the instruction of Engineer in charge. The decision of Engineer in charge will be final.**

iii) Both side poles at all the crossing for road, Nallaha railway crossings etc.

iv) Where Rail poles, Joist poles, double pole and four pole structures are to be erected.

5.5 Each tower/structures should be earthed by providing 2.5 mts.50x6 GI flat and 40 x 3000 mm heavy gauge ISI mark earthing pipe. The top of the earthing pipe should remain 600 mm below ground level. All railway X-ing locations two nos. earthing should be provided.

In case the required footing resistance is not achieved on measurement, counterpoise earthing has to be provided as per the standard.

6.0 C o v e r

The cover of concrete measured from the outside of pre-stressing tendon shall be normally 20 mm.

7.0 Welding and Lapping of Steel

The high tensile steel wire shall be continuous over the entire length of the tendon. Welding shall not be allowed in any case. However, joining or coupling may be permitted provided the strength of the joint or coupling is not less than the strength of each individual wire.

8.0 Compacting

Concrete shall be compacted by spinning, vibrating, shocking or other suitable mechanical means. Hand compacting shall not be permitted.

9.0 Curing

The concrete shall be covered with a layer of sacking, canvass, Hessian or similar absorbent material and kept constantly wet up to the time when the strength of concrete is at least equal to the minimum strength of concrete at transfer of pre-stress. Thereafter, the pole may be removed from the mould and watered at intervals to prevent surface cracking of the unit the interval should depend on the atmospheric humidity and temperature. The pre-stressing wires shall be de-tensioned only after the concrete has attained the specified strength at transfer (i.e. 200 or 210 kg/cm^2 as applicable).The cubes cast for the purpose of determining the strength at transfer should be coursed, a sear as possible, under condition similar to those under which the poles are cured. The transfer stage shall be determined based on the daily tests carried out on concrete cubes till the specified strength indicated above is reached. Thereafter the test on concrete shall be carried out as detailed in IS: 1 343(code of practice for pre-stressed concrete). The manufacture shall supply, when required by the owner or his representative, result of compressive test conducted in accordance with IS: 456 (Code of practice for plain and reinforced concrete) on concrete cubes made from the concrete used for the poles. If the manufacture so desired, the manufacture shall supply cubes for test purpose and such cubes shall be tested in accordance with IS: 456 (Code of practice for plain and reinforced concrete).

10.0 Lifting Eye-Hooks or Holes

Separate eye-hooks or hoes shall be provided for handling the transport, one each at a distance of 0.15 times the overall length, from either end of the pole. Eye-hooks, if provided, should be properly anchored and should be on the face that has the shorter dimension of the cross-section. Holes, if provided for lifting purpose, should be perpendicular to the broad face of the pole.

11.0 Holes for Cross Arms etc

Sufficient number of holes shall be provided in the poles for attachment of cross arms and other equipments.

12.0 Stacking & Transportation

Stacking should be done in such a manner that the broad side of the pole is vertical. Each tier in the stack should be supported on timber sleeper located as 0.15 times the overall length, measured from the end. The timber supported in the stack should be aligned in vertical line.

13.0 Earthing

(a) Earthing shall be provided by having length of 6 SWG GI wire embedded in Concrete during manufacture and the ends of the wires left projecting from the pole to a length of 100mm at 250 mm from top and 1000 mm below ground level.

(b) Earth wire shall not be allowed to come in contract with the pre-stressing wires.

14.0 Earthing of Support

14.1 Each pole shall be earthed with coil type earthing as per REC Construction Standard J-1.

14.2 All DP & Four pole structures & the poles on both sides of railway crossing shall be earthed by providing two nos. **pipe earthing as per Drawing provided by OPTCL.**

15.0 GUARANTEED TECHNICAL PARTICULARS : GTP is furnished at chapter- E21 of this T.S. Bidders are requested to submit the GTP as per the format only.

CHAPTER - E10- 2

TECHNICAL SPECIFICATION
FOR
“V” CROSS ARM, BACK CLAMP & F CLAMP

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OF
"V" CROSS ARM, BACK CLAMP & F CLAMP

33 KV,11 KV "V" CROSS ARM

1.0 Qualification Criteria of Manufacturer:-

a) Hot Dip Galvanised Cross arms a for both 33kV & 11kV construction at intermediate and light angle pole shall be fabricated from grade 43A mild steel of GI channel section and for heavy angle poles, end poles and section poles fabricated from grade 43A mild steel of GI angle section. The grades of structural steel shall conform to IS – 226: 1975.

b) The 33 KV & 11 KV ' V ' Cross arm shall be made out of 100x 50x6 mm MS GI Channel of (9.56 kg/mtr weight) .

Except where otherwise indicated, all dimensions are subject to the following tolerances:

dimensions up to and including 50mm: +1mm: and dimensions greater than 50mm: +2%

All steel members and other parts of fabricated material as delivered shall be free of warps, local deformation, unauthorized splices, or unauthorized bends. Bending of flat strap shall be carried out cold. Straightening shall be carried out by pressure and not by hammering.

Straightness is of particular importance if the alignment of bolt holes along a member is referred to its edges.

Holes and other provisions for field assembly shall be properly marked and cross referenced. Where required, either by notations on the drawing or by the necessity of proper identification and fittings for field assembly, the connection shall be match marked. A tolerance of not more than 1mm shall be permitted in the distance between the center lines of bolt holes.

The holes may be either drilled or punched and, unless otherwise stated, shall be not more than 2mm greater in diameter than the bolts. When assembling the components force may be used to bring the bolt holes together (provided neither members nor holes are thereby distorted) but all force must be removed before the bolt is inserted. Otherwise strain shall be deemed to be present and the structure may be rejected even though it may be, in all other respects, in conformity with the specification.

The back of the inner angle irons of lap joints shall be chamfered and the ends of the members cut where necessary and such other measures taken as will ensure that all members can be bolted together without strain or distortion. In particular, steps shall be taken to relieve stress in cold worked steel so as to prevent the onset of embitterment during galvanizing.
Similar parts shall be interchangeable.

Shapes and plates shall be fabricated and assembled in the shop to the greatest extent practicable. Shearing flame cutting and chipping shall be done carefully, neatly and accurately. Holes shall be cut, drilled or punched at right angles to the surface and shall not be made or enlarged by burning. Holes shall be clean-cut without torn or ragged edges, and burrs resulting from drilling or reaming operations shall be removed with the proper tool.

Shapes and plates shall be fabricated to the tolerance that will permit field erection within tolerance, except as otherwise specified. All fabrication shall be carried out in a neat and workmanlike manner so as to facilitate cleaning, painting, galvanizing and inspection and to avoid areas in which water and other matter can lodge.

Contact surfaces at all connections shall be free of loose scale, dirt, burrs, oil and other foreign materials that might prevent solid seating of the parts.

2.0 Fabrication has to be made as per drg. of ' V ' X-arm

GALVANISING

All type of cross arms & stay clamps shall be hot dip galvanized, are as following:

All galvanizing shall be carried out by the hot dip process, in accordance with Specification IS 2629. However, high tensile steel nuts, bolts and spring washer shall be electro galvanized to Service Condition 4. The zinc coating (610 gms per sq.mt) shall be smooth, continuous and uniform. It shall be free from acid spot and shall not scale, blister or be removable by handling or packing.

There shall be no impurities in the zinc or additives to the galvanic bath which could have a detrimental effect on the durability of the zinc coating.

Before picking, all welding, drilling, cutting, grinding and other finishing operations must be completed and all grease, paints, varnish, oil, welding slag and other foreign matter completely removed. All protuberances which would affect the life of galvanizing shall also be removed.

The weight of zinc deposited shall be in accordance with that stated in Standard IS 2629 and shall not less than 0.61kg/m² with a minimum thickness of 86 microns for items of thickness more than 5mm, 0.46kg/m² (64 microns) for items of thickness between 2mm and 5mm and 0.33kg/m² (47 microns) for items less than 2mm thick.

Parts shall not be galvanized if their shapes are such that the pickling solutions cannot be removed with certainty or if galvanizing would be unsatisfactory or if their mechanical strength would be reduced. Surfaces in contact with oil shall not be galvanized unless they are subsequently coated with an oil resistant varnish or paint.

In the event of damage to the galvanizing the method used for repair shall be subject to the approval of the Engineer in Charge or that of his representative. **In no case the repair of galvanisation on site will be permitted.**

The threads of all galvanized bolts and screwed rods shall be cleared of spelter by spinning or brushing. A die shall not be used for cleaning the threads unless specifically approved by the Engineer in Charge. All nuts shall be galvanized. The threads of nuts shall be cleaned with a tap and the threads oiled.

Partial immersion of the work shall not be permitted and the galvanizing tank must therefore be sufficiently large to permit galvanizing to be carried out by one immersion.

After galvanizing no drilling or welding shall be performed on the galvanized parts of the equipment excepting that nuts may be threaded after galvanizing. To avoid the formation of white rust galvanized materials shall be stacked during transport and stored in such a manner as to permit adequate ventilation. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.

The galvanized steel shall be subjected to test as per IS-2633.

The bidder shall filup the guaranteed technical particurars in the **Chapter 24.**

3.0 Fixing of Cross Arms

After the erection of supports and providing guys, the cross-arms are to be mounted on the support with necessary clamps, bolts and nuts. The practice of fixing the cross arms before the pole erection should be followed.

CHAPTER -E10 - 3

TECHNICAL SPECIFICATION
FOR
HT STAY SETS & STAY WIRES

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OF

33kV NBLS TOWERS & ERECTION

PART – A

TECHNICAL SPECIFICATION
FOR
HT STAY SETS

TECHNICAL SPECIFICATION FOR HT STAY SETS

1.0 SCOPE

This specification covers design, manufacture, testing and dispatch of HT stay sets 20 mm dia**.**

2.0 GENERAL REQUIREMENTS

This stay sets (Line Guy set) for 33 and kV line with H pole will consist of the following components:-

2.120 mm Dia Stays Sets for 33 kV&11 kV Lines (Galvanized) HT Stay Set

The Stay Set (Line Guy Set) will consist of the following components:

2.1.1 Anchor Rod with one Washer and Nut

Overall length of Rod should be 1800mm to be made out of 20 mm dia GI rod oneend threaded up to 40 mm length with a pitch of threads per cm. And provided with one square G.I Washer of Size 50x50x1.6mm and one GIHexagonal nut conforming to IS: 1363:1967 & IS:1367:1967. Both washer and nut to suit the threaded rod of 20mm.The other end of the rod to be made into a round eye having an inner dia of 40mm with best quality of welding. Dimensional and other details are indicated and submitted by bidders for owner'sapproval before start of manufacturing.

2.1.2Anchor Plate Size 300 x 300 x 8 mm

To be made out of G.S. Plate of 8 mm thickness. The anchor plate to have at its centre 22mm dia hole.

2.1.3 Turn Buckle, Eye Bolt with 2 Nuts.

To be made of 20 mm dia G.I Rod having an overall length of 450 mm. One end of the rod to be threaded up to 300 mm length with a pitch of 4 threads per cm. The 20 mm dia bolt so made shall be provided with two G.I Hexagonal nuts of suitable size conforming to IS: 1363:1967 & IS: 1367:1967.The other end of the rod shall be rounded into a circular eye of 40mm inner dia with proper and good quality of welding. Welding details are to be indicated by the bidder separately for approval.

2.1.4 Bow with Welded Channel:

To be made out of 16mm diaGIRod. The finished bow shall have and overall length of 995 mm ad height of 450 mm. The apex or top of the bow shall be bent at an angle of 10R. he other end shall be welded with proper and good quality welding to a G.I Channel 200 mm long having a dimension of

100x50x4.7 mm. The Channel shall have 2 holes of 18 mm dia and 22 dia hole at its centre as per drawing No.3 enclosed herewith.

2.1.5 Thimble 2 Nos

To be made of 1.5 mm thick GIsheet into a size of 75x22x40mm and shape as per standard.

3.0 Galvanizing

The complete assembly shall be hot dip galvanized.Galvanisation shall be made in accordance with IS

3.1 Welding

The minimum strength of welding provided on various components of stay sets shall be 3100 kg & 4900 kg respectively. Minimum 6mm filet weld or its equivalent weld area should be deposited in all positions of the job i.e. at any point of the weld length. The welding shall be conforming to relevant IS:823/1964 or its latest amendment.

3.2 Threading

The threads on the Anchor Rods, Eye Bolts and Nuts shall be as per specification IS; 4218:1967 (ISO Metric Screw Threads). The Nuts shall be conforming to the requirements of IS: 1367:1967 and have dimension as per IS 1363:1967. The mechanical property requirement of fasteners shall confirm to the properly clause 4.6 each for anchor rods and Eye bolt and property clause 4 for nuts as per IS: 1367:1967.

Average weight of finished 20 mm Stays Set: 14.523 Kg(Min) (Excluding Nuts Thimble & Washer) :15.569 Kg.(Max.)

4.0 TESTS

The contractor shall be required to conduct testing of materials at Govt./Recognized testing laboratory during pre-dispatch inspection for Tensile Load of 3100 Kg/4900Kg. applied for one minute on the welding and maintained for one minute for 16 mm and 20mm dia stay sets respectively.

5.0. IDENTIFICATION MARK

All stay sets should carry the identification mark of the Purchaser (OWNER)applicable.

This should be engraved on the body of stay rods to ensure proper identification of the materials. The nuts should be of a size compatible with threaded portion of rods and there should be not play or slippage of nuts.

Welding wherever required should be perfect and should not give way after erection.

6.0 TOLERANCES

The tolerances for various components of the stay sets are indicated below subject to the condition that the average weight of finished stay sets of 16mm dia excluding nuts, thimbles and washers shall not be less than the weight specified above:-

PART – B

TECHNICAL SPECIFICATIONS

FOR

STAY WIRE (7/8 SWG &7/10 SWG)

TECHNICAL SPECIFICATIONS FOR STAY WIRE (7/8 SWG for 33 kV &7/10 SWG for 11 kV lines)

1.0 Application Standards

Except when they conflict with the specific requirements of this specification, the G.I Stay Stranded Wires shall comply with the specific requirements of IS: 2141-1979. IS: 4826-1979 & IS: 6594-1974 or the latest versions thereof.

2.0 Application and Sizes

The G.I. stranded wires covered in this Specification are intended for use on the overhead power line poles, distribution transformer structures etc.
The G.I stranded wires shall be of 7/10SWG (7/3.15 mm).

3.0 Materials

The wires shall be drawn from steel made by the open hearth basic oxygen or electric furnace process and of such quality that when drawn to the size of wire specified and coated with zinc, the finished strand and the individual wires shall be of uniform quality and have the properties and characteristics as specified in this specification. The wires shall not contain sulphur and phosphorus exceeding 0.060% each.

4.0 Tensile Grade

The wires shall be of tensile grade 4, having minimum tensile strength of 700 N/mm² conforming to 1S:2141.

5.0 General Requirements

The outer wire of strands shall have a right-hand lay.
The lay length of wire strands shall be 12 to 18 times the strand diameter.

6.0 Minimum Breaking Load

The minimum breaking load of the wires before and after stranding shall be as follows:

No. of Wires & Const.	Wire Dia (mm)	Min. breaking load of the Single wire before stranding (KN)	Min. breaking load of the standard wire (KN)
7 (6/1) for 11 kV line	3.15	5.46	34.00
7 (6/1) for 33 kV line	4.0	8.80	54.9

7.0 Construction

The galvanized stay wire shall be of 7-wire construction. The wires shall be so stranded together that when an evenly distributed pull is applied at the ends of completed strand, each wire shall take an equal share of the pull. Joints are permitted in the individual wires during stranding but such joints shall not be less than 15 meters apart in the finished strands.
The wire shall be circular and free from scale, irregularities, imperfection, flaws, splits and other defects.

8.0 Tolerances

A tolerance of (+) 2.5% on the diameter of wires before stranding shall be permitted.

9.0 Sampling Criteria

The sampling criteria shall be in accordance with IS :2141.

10.0 Tests on Wires before Manufacture

The wires shall be subjected to the following tests in accordance with IS: 2141.

Ductility Test Tolerance on Wire Diameter

11.0 Tests on Completed Strand

The completed strand shall be tested for the following tests in accordance withIS:2141.Tensile and Elongation Test: The percentage elongation of the stranded wire shall not be less than 6%.

Chemical analysis Galvanizing Test

The Zinc Coating shall conform to "Heavy Coating" as laid down in 1S:4826

12.0 Marking

Each coil shall carry a metallic tag, securely attached to the inner part of the coil bearing the followinginformation:
a) Manufacturers name or trade mark
b) Lot number and coil number
c) Size
d) Construction
e) Tensile Designation
f) Lay
g) Coating
h) Length
i) Mass
j) ISI certification mark, if any

13.0 Packing

The wires shall be supplied in 75-100 Kg. coils. The packing should be done in accordance with the provisions of IS:6594

14.0 Other Items:

For remaining items of stay sets mentioned in the enclosed drawing, relevant applicable Indian standards shall be applicable.

15.0 Guaranteed Technical Particulars: The GTP shall be filled by bidder, which is furnished in Chapter- E24

CHAPTER - E11

TECHNICAL SPECIFICATION

FOR

RTU FOR SCADA COMPATIBILITY

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OF
RTU FOR SCADA COMPATIBILITY

RTU FOR SCADA COMPATIBILITY

1.0 SCOPE OF SCADA

33/11kV S/S will be unmanned and remote controlled from the Distribution System Operation Control Centre (DSOCC) of each DISCOM with overall supervision monitoring facilities at SLDC, Bhubaneswar. The DSOCC of each DISCOM is located as under:

CESU at Bhubaneswar	**SOUTHCO at Berhampur**
NESCO at Balasore	**WESCO at Burla**

The Remote Terminal Unit (RTU) of each Primary S/S shall be in 2-way communication through **GPRS** with DSOCCs of DISCOMs for control purpose with further integration of existing communication link of DSOCCs with SLDC at Bhubaneswar. It shall be under open protocol (preferably IEC 104 protocol) under overall SCADA system. The SCADA system of DSOCC and SLDC under this scheme shall also be capable of augmentation for integrating existing 570 number of Primary S/Ss as well as for 20% expansions in future years.

The manufacturer may provide the Programming language (software) to configure & maintain the RTU in future if needed by the Utitility.

It is expected that the 3 DSOCCs along with 5 Primary S/Ss for each DISCOM shall be completed within 6 months from the date of award and 5 Primary S/S of each DISCOM shall be added for control functions from DSOCCs and overall monitoring with SLDC at every 2 months.

Requirement Specification of 33/11 KV Outdoor, Unmanned, Remote Controlled S/Ss.

The capacity of S/S shall be 2X3.15, 2X5 MVA or 2X8 MVA with a provision of 3rd Transformer Bay for future expansion. There will be one incoming 33 KV bays and minimum two outgoing 11 KV bays with a provision of one 33kV spare feeder bay and one spare 11 KV feeder bay for future expansions along with provision of Bus coupler on 11 kV side.

33 KV Auto-Reclosing CB (ARCB) in some case.

The status indications and data for all the CBs, Transformers, Isolators and Metering Units shall be passed on to DSOCC through GPRS via RTU .

In the receiving stations i.e. at DSOCC, the information will be routed through a secured gate way and to be integrated with the SCADA provided by the vender or with any 3rd party SCADA. At present, control from local PC connected with RTU should be provided for communication.

All control functions of Circuit Breakers operations including OFF/ON for the transformers, incoming and outgoing feeders operation shall be carried out from DSOCC. The status indication of Isolators and the Metering Data for energy auditing, billing, asset management etc. shall be done at DSOCC.

The Isolators could be kept normally ON position and the ON/OFF operation for maintenance purpose shall be done manually.

The data in a proper format shall be transmitted to SLDC from DSOCCs for monitoring and information purpose.

The SCADA and communication architecture shall be on open protocol, so that the Primary S/Ss along with RTU established by any 3rd Party can be integrated with control functions at DSOCC and monitoring functions of SLDC.

Each Primary S/s shall be associated with erection, testing and commissioning of incoming 33 KV lines of about 30 Kms. and outgoing 11 KV feeders of about 20 Kms.

Each Primary S/s shall also have one 33/0.4 KV, 63/100 KVA Station Transformer.

The vender of the DSOCC will be responsible for operational training to the DISCOM's Operators and will hand-hold the operation control of the unmanned S/S for the project period of 2 years.

Each primary S/S along with construction of associated 33 KV and 11 KV lines shall be on turn-key basis for supply, erection, testing, commissioning and preventive maintenance for a period of 2 years.

As this project is conceived for utility (DISCOM) for system automation purpose, with remote operation of the feeder in the Control Room along with energy management functions for energy audit as well as distribution loss reductions, the vender should be well equipped for taking of the turn key contract along with the supply, erection, testing and commissioning of electrical equipments like CB, Transformer, Line Materials along with sufficient experience in the Energy Management Software, SCADA, RTU function and communication protocol. The manufacturer who have relevant Circuit Breakers, Relays, Meters, RTU with IEC 104 protocol and SCADA – DMS software supporting GPS (for control and monitoring of the Sub-stations from a common Control Room) only eligible to bid. The bidder should have a Project Engineering Centre so that this solution can be provided by them by integrating all equipments in SCADA DMS though open protocol as IEC-104 with adequate site training to the utility officers and staff.

2.0 TECHNICAL REQUIREMENTS OF RTU

2.1 General

The Remote Terminal Unit (RTU) shall be installed at primary substation to acquire data from Multifunction Transducers (MFTs), discrete transducers & status input devices such as CMRs etc. RTU & shall also be used for control of Substation devices from Master station(s). The supplied RTUs shall be interfaced with the substation equipment, communication equipment, power supply distribution boards such as, 33kV GIS, 33kV AIS, 11kV AIS, Outdoor CT/PT, Isolators , Transformer, Multi function Transducers / Meters, IED's; for which all the interface cables, TBs, wires, lugs, glands etc. shall be supplied, installed & terminated by the Contractor.

2.1 Design Standards

The RTUs shall be designed in accordance with applicable International Electrotechnical Commission (IEC), Institute of Electrical and Electronics Engineer (IEEE),unless otherwise specified in this Technical specification. In all cases the provisions of the latest edition or revision of the applicable standards in effect shall apply. The RTU shall be designed around microprocessor technology. For easy maintenance, the Substation RTU has to be **rack based with pluggable modules on backplane or Dinrail mounted type**. The field wiring shall be terminated such that these are easily detachable from the I/O module.

3.0 RTU Functions

All functional capability described herein shall be provided by the Contractor even if a function is not initially implemented.

As a minimum, the RTU shall be capable of performing the following functions:

(a) Acquiring analog values from Multifunction Transducers Multi function meters or alternatively through transducer- less modules and the status inputs of devices from the substation, processing and transmitting to Master stations. The Display of Mult - Function Meter is either LCD or LED.

(b) Receiving and processing digital commands from the master station(s)

(c) Data transmission rates - **300 to 19200 bps** for Serial ports for MODBUS and 10/100 mbps for TCP/IP Ethernet ports

(d) IEC 60870-5-104 protocol to communicate with the Master station(s) ,IEC 60870-5-101 for slave devices. & MODBUS protocol over RS485 interface , to communicate with the MFTs/IEDs.

(e) RTU shall have the capability of automatic start-up and initialisation following restoration of power after an outage without need of manual intervention. All restarts shall be reported to the connected master stations.

(f) Remote database downloading of RTU from master station/SCADA/DMS control centre

(g) Act as data concentrator on IEC60870-5-101/104/MODBUS protocols

(h) Internal battery backup to hold data in SOE buffer memory & also maintaining the time & date.

(i) As the SCADA/DMS system will use public domain such GPRS/CDMA etc, therefore it mandatory to guard the data/ equipment from intrusion/damage/breach of security & shall have SSL/VPN based security.

(j) Shall have SNMP Support Feature:

All support feature as mentioned below will not be used now & may require in future . However, the same shall be tested in routine /Factory Tests. Further, it should be possible to have following capabilities in the RTU by way of addition of required hardware limited to addition of I/O modules & communication card only & using the same firmware at later date:

I) Support for Analog output in form of standard current loops viz 4-20Ma etc

II) Support for IEC 60870-5-103, IEC 61850 protocols & ability to act as a gateway for Numerical relays may have to be interfaced in future with numerical relays with future vision of Smart grid.

III) Have required number of communication ports for simultaneous communication with Master station(s), /MFTs and RTU configuration & maintenance tool.

IV) Communication with at least two master stations simultaneously on IEC 60870-5-104

V) Receiving and processing analog commands from master station(s) and Capability of driving analog output card.

VI) RTU shall be capable of acquiring analog values through transducers having output as 4-20 mA, 0-10 mA, 0-+10 mA or +/- 5 volts etc using analog input modules.

VII) Capability of time synchronisation with GPS receiver which may be required future at the time of SMART GRID.

4.0 Communication ports

The RTUs shall have following communication ports to communicate with master station, existing /MFTs and configuration & maintenance terminal.

_ RTU shall have two TCP/IP Ethernet ports for communication with Master station(s) using IEC 60870-5-104.

_ RTU shall have required number of RS 485 ports for communication with MFTs to be connected in daisy chain using MODBUS protocol . Minimum 15 analog values (including 4 energy values) to be considered per energy meter . The RTU shall be designed to connect minimum 8nos of MFT and provision should be there to integrate up to 12nos. of MFT. Further , bidder to demonstrate during testing that all analog values updated within 2 sec. The updation time shall be demonstrated during FAT(routine) & SAT testing . The bidder can offer MFT on IEC 60870-101/104 protocol to communicate with RTU. In addition, if weather transducer & DC transducers are also having RS485 MODBUS port., the same can be also added in the daisy.

_ RTU shall have one port for connecting the portable configuration and maintenance tool for RTU.

_ RTU as a data concentrator, then RTU shall have additional communication ports Ethernet or serial for IEC60870-5-104/101.

_ SSL/VPN ,NERC/CIP compliant

It shall be possible to increase the number of communication ports in the RTU by addition of cards, if required in future. The RTU shall support the use of a different communication data exchange rate (bits per second) and scanning cycle on each port & different database for each master station

RTU should have following communication ports-

1. Master Station communication port (IEC 104) - 2nos.
2. LDMS with maintenance port (IEC 104) - 1no.
3. Ports for connecting MFTs – Serial ports as per Station requirement.
4. Ports to connect with Protection Relays on IEC 61850 as per Station requirement.

5.0 Master Station Communication Protocol

5.1 RTU shall use IEC 60870-5-104 communication protocol for communicating to master station. The RTU communication protocol shall be configured to report analog (except energy values) & status changes by exception to master stations. However, RTU shall support periodic reporting of analog data and periodicity shall be configurable from 2 sec to 1 hour. Digital status data shall have higher priority than the Analog data. The dead-band for reporting Analog value by exception shall be initially set to 1% (user configurable) of the full scale value. In addition, analog values shall also be reported to Master station by exception on violation of a defined threshold limit. All the analog values and status data shall also be assigned to scan groups for integrity check by Master stations at every 10 minutes configurable up to 60 minutes RTU wise.

RTU shall report energy values to master station periodically. The periodicity shall be configurable from 5 minutes to 24 hours (initially set for 15 minutes)

6.0 Communication Protocol between RTU & MFTs

The RTU shall acquire data from the MFTs using the MODBUS protocol. Inaddition, usage of IEC 60870-5-101/104 protocols is also permitted. The MFT will act as slave to the RTU. The RTU shall transmit these values to the master station in the frame of IEC 60870-5-104/101 protocol. As an alternate approach the utility/contractor may use RTU as a data concentrator & acquire all the required analog data from DCU installed & connected to energy meters using MODBUS protocol under IT scheme under R-APDRP. However, DCU is not considered at

present. The present scheme is to provide a RTU interfacing MFTs in each feeders. MFTs should be interfaced with RTU in IEC 101 and the performance, functional, availability & update time requirement shall be met in this case also. It is the responsibility of utility /contractor to assess this option & only opt in case it is found feasible and all serial port must have galvanic isolation against power voltage surges.

7.0 Analog Inputs

The real time values like, Active power, Reactive Power, Apparent power three phase Current & Voltage and frequency, power factor & accumulated values of import /export energy values will be acquired RTU from the following in the given manner:

1. MFTs installed in substations

2. RTU shall also take 4-20 mA, 0-20mA, 0- -10mA, 0-+10mA, 0-5V etc as analog inputs to acquire transformer tap position, DC power supply voltage, weather transducer etc.

The RTU analog-to-digital (A/D) converters shall have a digital resolution of at least twelve (12) bits plus sign. The overall accuracy of the analog input system shall be at least ±0.2%(i.e. 99.8%) at 25 ºC of full scale . Mean accuracy shall not drift more than 0.002% per degree C within the temperature range of –5 to +55 degree Linearity shall be better than ±0.05%. The RTU shall be designed to reject common mode voltages up to 150 Vac (50 Hz). For dc inputs, normal mode noise voltages up to 5 Vac shall be rejected while maintaining the specified accuracy. Each input shall have suitable protection and filtering to provide protection against voltage spikes and residual current at 50 Hz, 0.1 ma (peak-to-peak) and overload.

Loading upto 150% of the input value shall not sustain any failures to the RTU input.

The ability of the RTU to accommodate dc inputs shall include the following signal ranges:

Unipolar Voltage:0-0.5V, 0-1V, 0-5V, 0-10V,

Unipolar Current: 0-1mA, 0-10mA, 0-20mA, 4-20Ma,

Bipolar Voltage: 0.5V, 2.5V, 5V, -20-0-20mA (- to +)

The total burden imposed by the RTU/DC analog input circuit shall not exceed 0.5

volt-ampere for current and voltage inputs. As an option, contractor may also provide transducer less solution to connect direct CT/PT secondaries.

8.0 Status input

RTU shall be capable of accepting isolated dry (potential free) contact status inputs. The RTU shall provide necessary sensing voltage, current, optical isolation and de-bounce filtering independently for each status input. The sensing voltage shall not exceed 48Vdc. The RTU shall be set to capture contact operations of 20 ms or more duration. Operations of less than 20 ms duration shall be considered no change (contact bounce condition). The RTU shall accept two types of status inputs i.e. Single point Status inputs and Double point status inputs. To take care of status contact chattering, a time period for each point and the allowable number of operations per time period shall be defined. If the allowable number of operations exceed within this time period, the status change shall not be accepted as valid Single point status input will be from a normally-open (NO) or normally-closed (NC) contact which is represented by 1-bit in the protocol message. The Double point status input will be from two

complementary contacts (one NO and one NC) which is represented by 2-bits in the protocol message. A switching device status is valid only when one contact is closed and the other contact is open. Invalid states shall be reported when both contacts are open or both contacts are closed.

All status inputs shall be scanned by the RTU from the field at 1 millisecond periodicity.

9.0 Sequence of Events (SOE) feature

To analyse the chronology or sequence of events occurring in the power system, time tagging of data is required which shall be achieved through SOE feature of RTU. The RTU shall have an internal clock with the stability of 10 ppm or less than 10 ppm. The RTU time shall be set from time synchronization messages received from master station using IEC 60870-5- 104 protocol. In addition, the message can be transmitted using NTP/SNTP. SOE time resolution shall be 1ms or better The RTU shall maintain a clock and shall time-stamp the digital status data. Any digital status input data point in the RTU shall be assignable as an SOE point.

Each time a SOE status indication point changes the state, the RTU shall time-tag the change and store in SOE buffer within the RTU. A minimum of 1000 events can be stored in the SOE buffer. SOE shall be transferred to Master Station as per IEC 60870-5-104 protocol. SOE buffer & time shall be maintained by RTU on power supply interruption.

9.1 IED pass through the Master Station user shall be able to perform a virtual connection with any IED connected to the RTU/DC, provided the communication protocol functionality, to support the information transfer from and to the IEDs. For example, the Master Station shall gather on-demand IED data, visualize IED configuration parameters, and IED source code depending upon the IED capabilities. On the other hand, the Master Station shall be able to download to the IEDs configuration parameters, code changes, etc. depending upon the IED capabilities. This feature is a support function considering in future SMART GRID implementation (Remote parametrisation / control is not considered at present. However, RTU should have provision to communicate with Control Centre in future). At present, control from local PC connected with RTU should be provided for communication.

The capability can be demonstrated with the upload & download of data from master station with IEDs connected to the RTUs using the support of protocols specified in this chapter.

Numerical relays Analog data viz voltage ,current, sag swell instantaneous, momentary, temporary, over voltage, under voltage , over current , phasor measurement , THD, current TDD & current unbalance ratio etc at numerical relays if installed at bay of S/S

10.0 Control Outputs

The RTU shall provide the capability for a master station to select and change the state of digital output points. These control outputs shall be used to control power system devices such as Circuit breakers relay disable/enable and other two-state devices, which shall be supported by the RTU. A set of control outputs shall be provided for each controllable device. On receipt of command from a master station using the select check-before-execute operate (SCBO) sequence, the appropriate control output shall be operated for a preset time period which is adjustable for each point from 0.1 to 2 seconds.

Each control output shall consist of one set of potential free NO contact. The output contacts shall be rated for atleast 0.2 Amp. at 48 Vdc. These output contact shall be used to drive heavy duty relays. In case Control output module of RTU does not provide

potential free control output contact of this rating, then separate control output relays shall be provided by the contractor. These relay coils shall be shunted with diodes to suppress inductive transients associated with energizing and de-energizing of the relay coils & shall conform to the relevant IEC requirements.

11.0 Heavy duty control output relays

The control output contact from the RTU shall be used for initiating heavy duty relays for trip/close of switching devices and energising relays of OLTC raise lower. The contractor shall provide heavy duty relays. Each control output relays shall consist of atleast 2 NO contacts. The output contacts shall be rated for at least 5 Amps Continuous at 220Vdc and shall provide arc suppression to permit interruptions of an inductive load. Relay coils shall be shunted with diodes to suppress inductive transients associated with energizing and de-energizing of the relay coils. The relays shall conform to the IEC255-1-00 and IEC 255-5 requirements.

12.0 Control Security and Safety Requirements

The RTU shall include the following security and safety features as a minimum for control outputs:

(a) Select- check-before-operate operate (SCBO) sequence for control output.

(b) No more than one control point shall be select ed/executed at any given time.

(c) The control selection shall be automatically cancelled if after receiving the "control selection" message, the "control execute" command is not received within the set time period.

(d) No control command shall be generated during power up or power down of RTU.

12.1 **Local/Remote selector switch**

A manual Local/Remote selector switch shall be provided for each RTU to disable all control outputs by breaking the power supply connection to the control output s. When in the "Local" position, the Local/Remote switch shall allow testing of all the control outputs of RTU without activating the control outputs to field devices. A status input indication shall be provided for the Local/Remote switch to allow the SCADA system to monitor the position of the switch.

13.0 Dummy breaker latching relay

The Contractor shall provide a latching relay to be used to simulate and test supervisory control from the Master station. The latching relay shall accept the control signals from the RTU to open and close, and shall provide the correct indication response through a single point status input.

14.0 Contact Multiplying Relays (CMRs)

Contact Multiplying Relays (CMRs) are required to multiply the contacts of breaker, isolators and protection relays etc. the Protection relays should be interfaced with RTU in IEC 61850 and RTU shall also have KEMA or equivalent certification of IEC 61850.The contacts of these relays shall be used to provide status inputs to the RTUs.

The relays shall be DC operated, self reset type. The rated voltage for relay operation shall be on 24/48/110/220V DC depending on the station DC supply.

The relay shall be able to operate for +/-20% variation from nominal voltage.

The relay shall have a minimum of two change over contacts, out of which one shall be used for telemetry purposes. The contacts shall be rated to carry minimum current capacity of 5A.

The relay shall conform to following requirement.

a) Power Frequency withstand voltage–2KV for 1 minute as per IEC 255-5.

b) Insulation Resistance of 100M ohms measured using 500V DC megger.

c) 5KV Impulse test as per IEC 255-5

The relays coils shall be shunted with diodes to suppress inductive transients associated with energizing and de-enegizing of the relay coils. The relays shall conform to the IEC 255-1-00 and IEC 255-5 requirements or provisions of latest edition or revision of the applicable standard as per Sec-2 Chapter 1 CLAUSE 1.1 of MTS. The relays must be protected against the effects of humidity, corrosion & provide with a dust tight cover. The connecting terminals shall be screw type & legibly marked. The relays may optionally have a visual operation indicator. The relays are to be mounted in Control & Relay (C&R) panels and therefore shall be equipped with suitable mounting arrangements. In case suitable space is not available in C&R panel the same shall be mounted in RTU panel or suitable panels , which shall be supplied & mounted on the top of the C&R panel by the contractor.

14.1 **Time facility**

The internal RTU time base shall have a stability of 10 ppm or less than 10 ppm. The RTU shall be synchronised through synchronisation message from master station at every 15 minutes (configurable from 15 minutes to 24hrs) over IEC 60870-5-104/101/NTP/SNTP. The RTU shall also carry out time stamping of the events which are not received as time stamped from connected IEDs/ FPIs etc.

15.0 Diagnostic Software

Diagnostic Software shall be provided to continuously monitor operation of the RTU and report RTU hardware errors to the connected master stations. The software shall check for memory, processor, and input/output ports errors and failures of other functional areas defined in the specification of the RTU.

The RTU will be powered from a 48 V DC power supply system. The RTU shall not place additional ground on the input power source.

The characteristics of the input DC power supply shall be

(a) Nominal voltage of 48 Vdc with variation between 40.8 and 57.6 Vdc.(i.e. 48(+20%/-15%)

(b) Maximum AC component of frequency equal to or greater than 100 Hz and 0.012 times the rated voltage peak-to-peak.

The RTU shall have adequate protection against reversed polarity, over current and under voltage conditions, to prevent the RTU internal logic from being damaged and becoming unstable causing mal-operation. The specification for DCPS is given in respective section of MTS.

15.1 **Environmental Requirements**

The RTU will be installed in control room buildings with no temperature or humidity control. The RTUs shall be capable of operating in ambient temperature from 0 to +55 degree C with rate of temperature change of 20 degree C/hour and relative humidity less than 95%, non-condensing.

15.2 **RTU Size and Expandability**

RTU shall be equipped for the point counts defined in the BOQ (Basic+20% spare (wired & hardware). It shall be possible to expand the RTU capability for additional 100 % of the basic point counts by way of addition of hardware such as modules, racks,

panels, , however, RTU software and database shall be sized to accommodate such growth without requiring software or database regeneration.

15.3 **RTU Panels**

At least 50% of the space inside each enclosure shall be unused (spare) space that shall be reserved for future use. The Contractor shall provide required panels conforming to IEC 529 for housing the RTU modules/racks, relays etc. and other required hardware. The panels shall meet the following requirements:

(a) shall be free-standing, floor mounted and height shall not exceed 2200 mm.

All doors and removable panels shall be fitted with long life rubber beading.

All non load bearing panels/doors shall be fabricated from minimum 1.6 mm thickness steel sheet and all load bearing panels, frames, top & bottom panels shall be fabricated from minimum 2.0 mm thickness steel sheet

(b) shall have maintenance access to the hardware and wiring through lockable full height doors.

(c) shall have the provisions for bottom cable entry

(d) The safety ground shall be isolated from the signal ground and shall be connected to the ground network. Safety ground shall be a copper bus bar.

The contractor shall connect the panel's safety ground of to the owner's grounding network. Signal ground shall be connected to the communication equipment signal ground.

(e) All panels shall be supplied with 230 Vac, 50 Hz, single-phase switch and 15/5A duplex socket arrangement for maintenance.

(f) All panels shall be provided with an internal maintenance lamp, space heaters and gaskets.

(g) All panels shall be indoor, dust-proof with rodent protection, and meet IP41 class of protection.

(h) There shall be no sharp corners or edges. All edges shall be rounded to prevent injury.

(i) Document Holder shall be provided inside the cabinet to keep test report, drawing, maintenance register etc.

(j) All materials used in the enclosures including cable insulation or sheathing,wire troughs, terminal blocks, and enclosure trim shall be made of flame retardant material and shall not produce toxic gasses under fire conditions.

15.4 **Wiring/Cabling requirements**

The RTU panels shall gather all signals from and to the devices located in Control & Relay panels in the substation control room. All wires that carry low-level signals shall be adequately protected and separated as far as possible from power wiring. All wires shall be identified either by using ferrules or by colour coding. In addition, cables shall be provided with cable numbers at both ends, attached to the cable itself at the floor plate where it enters the cubicles. Shielded cables shall be used for external Cabling from the RTU panels. The external cables (except communication cables) shall have the following characteristics:

a) All cables shall have stranded copper conductor.

b) Minimum core cross-section of 2.5 mm2 for PT cables, 4 mm2 for CT cables, if applicable and 2.5 mm2 for Control outputs and 1.5mm2 for Status inputs

c) Rated voltage Uo/U of 0.6/1.1KV

d) External sheathing of cable shall have oxygen index not less than 29 & temperature index not less than 250. Cable sheath shall meet fire resistance test as per IS 1554 Part- I.

e) Shielding, longitudinally laid with overlap.

f) Dielectric withstand 2.5 kV at 50 Hz for 5 minutes

g) External marking with manufacture's name, type, core quantity, crosssection, and year of manufacture.

Armoured. Cables shall be used in the area where cable will pass through open area which may experience loading.

The Communication cable shall be of shielded twisted pairs and of minimum 0.22sq mm size.

15.5 **Terminal Blocks (TBs)**

Terminal blocks shall be having provision for disconnection (isolation), with fulldepth insulating barriers made from moulded self-extinguishing material. Terminal blocks shall be appropriately sized and rated for the electrical capacity of the circuit and wire used. No more than two wires shall be connected to any terminal. Required number of TBs shall be provided for common shield termination for each cable. All terminal blocks shall be suitably arranged for easy identification of its usages such as CT circuits, PT circuits, analog inputs, status inputs, control outputs,auxiliary power supply circuits, communication signals etc. TBs for CT circuits shall have feature for CT shorting (on CT side) & disconnection (from load side) to facilitate testing by current injection. Similarly, TBs for PT circuit shall have feature for disconnection to facilitate voltage injection for testing.

16.0 RTU Architecture

Bidder has the option to offer RTUs having following architectural design:

a) Centralized RTU design where all I/O modules are housed in RTU panels and communicating with master station through communication port.

b) Distributed RTU design where distributed I/O modules/processor with I/O modules are housed in respective bay panels/RTU panel. All these distributed I/O modules / I/O modules with processor shall be connected to a central processor for further communication with master station. The bidder shall asses the requirement of RTU panels for such design and supply panels accordingly . In both cases the RTU requirements as envisaged in this specification shall be followed.

17.0 LOCAL DATA MONITORING SYSTEM (LDMS)

The LDMS is a client workstation of main SCADA/ DMS control centre connected on 2Mbps or 64kbps leased line for local monitoring of SCADA/DMS system . The hardware & software specification, features shall be same as of remote VDU defined for SCADA/DMS system.

18.0 RTU CONFIGURATION

18.1	RTU	RTU panel should use advanced 32-bit main microprocessor along with co-processors. The power supply & main processor should be redundant. Internal battery backup to hold data in SOE buffer memory & also maintaining the time & date.

		The co processors are responsible to communicate with IEDs on RS485 connectivity . RTU should have provision for communicating with MFTs in MODBUS protocol over RS485 interface . The co processors should have the licenses of IEC103, MODBUS RTU MASTER & PLC. Main Processor should have at least two nos of ports that will be connected to LANSwitch(TobeprovidedbyOPTCL)forcommunication with Master Control Centre. These are responsible for communication between the RTU with MCC the protocol for two way communication between RTU & MCC should be IEC 104.
18.2	Digital inputs	RTU Panel should have provisions for interfacing multiples of Digital inputs as per filed requirements. All Inputs should be suitable for 48V DC. They will be connected through potential free contact with field inputs like CB,Isolator open/close.
18.3	Digital outputs	RTU Panel should have provisions for multiples pf Digital outputs as per field requirement. Output to be connected to CMRs of 48 V DC mounted in RTU Panel. Its potential free contact will be connected in the field for remote operation of breakers/isolator.
18.4	Analog Inputs	RTU panel should have provisions for interfacing with analog inputs. Analog signals are to be configurable either 0-10 V DC or 4-20 mA as required.
18.5	Control voltage	Control Voltage to be provided to RTU panel will be 48V DC.
18.6	Air-conditioning	RTU Panel should have air conditioner and the panel should be double door front open able. Air Conditioner is the part of Sub-station Control room.
18.7	Front door	The RTU hardware mounted in the panel should be visible from glass door/window without opening the panel door.

19.0 SCADA INTERFACE PHILOSOPHY

19.1	Status/Alarm signals to RTU	RTU will read all the signals coming from(IEDs MFMs, MFTs,Numerical relays, Transformer REGDA relays, Battery Charger. However, Presently RTU does not need to be interfaced with Battery Charger) as Soft signals on standard protocols. RTU need input from Transformer, Multi function Transducers / Meters, IED's.
19.2	Commands from RTU	RTU will execute commands from SCADA as soft commands through numerical relays on standard protocol.
19.3	Numerical relay integration	Numerical relays should be IEC 103 compatible. All the hardware required to extend the relay signals to the RTU shall be supplied along with the switchboards. All hardware or protocol converters required for compatibility with SCADA shall be in bidder's scope.
19.4	Signals and Commands	Following signals are to taken from the various devices to the RTU. This list is indicative and signals should not be limited to this. Additional signals can be taken based on requirement.

19.4.1	Soft signals from numerical relays to RTU (Status/Alarms)	On line Currents / Voltage/Power/Pf Relay General Trip signalRelay Internal Fault Post Fault currents (R,Yand Bphase separately) Unbalance Current (In case of Neutral displacement relay of capacitor feeders) Breaker closed Breaker Opened LOCAL/SCADA enabled. Isolator Close and open Earth Switch close and open Auto Trip I Trip circuit healthy Breaker in Test / Service (for indoor breakers only) SF6 Gas pressure low & lockout Spring charged All relay alarms when tripped on specific fault. VT fuse Failure Differential relay operated REF / back up earth fault relay operated Distance relay operated WTI Alarm WTI Trip OTI Alarm OTI Trip
	Design	aa. MOG bb. OSR Main Tank cc. PRD Trip dd. OLTC OSR ee. Main DC Fail ff. Under/Over voltage relay operated gg. Neutral displacement relay operated(for capacitor banks) hh. All relay internal fault

19.4.2	Soft Commands from RTU to numerical relays	Breaker close Breaker Open Isolator close Isolator open Relay reset
19.4.3	Status/Alarm signals from battery charger controller to RTU	Battery/Charger Load current Battery/Charger Load Voltage Battery charger main fail Battery charger failure DC system earth fault
19.4.4	Status/Alarm signals from Transformer monitoring relay to RTU	Transformer Tap Position Transformer WTI
19.4.5	Soft commands from RTU to Transformer monitoring relay	X'mer Tap Raise X'mer Tap Lower
19.5	Communication hardware	All hardware like Star coupler, FO glass/plastic, cables, RS 485 Belden class cables and protocol converters required for interfacing IEDs like protection relays, multifunction meters, transformer monitoring relays, battery charger controllers etc. to RTU should be included in scope of supply.
19.6	Configuration Software and Tools	All software and configuration tools required for configuration of RTU and Network, should be included in scope of supply.
19.7	Marshalling panel	The Marshalling box to be supplied by the vendor, if required.
19.8	Interface work details	Installation, testing and commissioning of RTU and Marshalling Panel. Laying & termination of control cable Laying and termination of communication cable through PVC conduit pipe Installation testing commissioning of protocol converter, connection converter, star coupler

20.0 PRESENT ARRANGEMENT:

Only RTUs and be installed. Local displays to be made in PCs from RTUs.