

TECHNICAL SPECIFICATION FOR AUGMENTATION OF PRITHALA (GIS) SUBSTATION - ELECTRICAL WORKS

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1. GENERAL

- The Contractor shall ensure that the design, drawings, supply, construction, testing, and commissioning of all equipments, facilities, components, and systems of the Project shall be in accordance with Relevant Indian Standards (IS) and Codes issued by the Bureau of Indian Standards only.
- In case IS and Codes are not available for any specific equipments, the other equivalent internationally recognized Standards, and Codes shall be followed, with prior approval of the Employer.
- It shall be the responsibility of all the bidders to acquaint themselves with the existing Prithala Substation site conditions, approach road, availability of water & electricity, the area earmarked for Augmentation Work, and other associated necessities for successful commissioning & operation of the system defined in the scope of work.
- The proposed augmentation shall be conventional GIS type generally conforming as per the requirement of Technical Specification, CEA (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations 2010, as amended from time to time including revised regulations released in 2022.
- The mentioned scope of works shall be executed in accordance with the technical specifications specified below and existing Prithala Substation equipments whose drawings or details shall be provided to bidders if required. However, the tentative SLD and plan layout marking the extension scope of work have been attached for reference purposes.
- Connection between GIS and line side equipment shall be via 220KV cable. Suitable type/size of HV cable including but not limited to cable termination unit, jointing, cable bonding and all necessary accessories shall be considered as per relevant standards along with termination units.
 - i. Design, supply, laying, termination, jointing, bonding, testing, along with supply of all necessary material shall be in contractor scope.
 - ii. The cable route length provided below is tentative, contractor shall visit the site and estimate as per requirement.

Circuit 1 – 110 meters

Circuit 2 - 150 meters
 - iii. Cable size and type and number of run to meet the current rating shall be selected by contractor. Cable sizing/selection calculation shall be provided during detailed engineering for approval.

2. EXISTING CONFIGURATION OF PRITHALA SUBSTATION

400/ 220 kV GIS substation at Prithala in Palwal area is part of ISTS system. The current configuration of Prithala (GIS) S/s is defined below:

1. 2X500MVA, 400/220kV ICT
400kV ICT bay – 2 no.
220kV ICT bay – 2 no.
400kV line bay – 4 no.
220kV line bay – 8 no.
2. 1x125 MVar Bus Reactor
400kV reactor bay – 1 no.

The above substation is in operation.

3. SUBSTATION TECHNICAL SPECIFICATION (FOR AUGMENTATION WORK)

The design and specification of substation equipment are to be governed by the following factors:

3.1. Insulation Coordination:

S. No.	Description of parameters	220kV Prithala Substation
		220 kV System
1.	System operating voltage	220kV
2.	Maximum voltage of the system (rms)	245kV
3.	Rated frequency	50Hz
4.	No. of phase	3
5.	Rated Insulation levels	
i)	Impulse withstand voltage for (1.2/50 micro sec.) - For equipments other than Transformers and Reactors - for Insulator Strings	1050kVp 1050kVp
ii)	Switching impulse withstand voltage (250/2500 micro sec.) dry and wet	-
iii)	One-minute power frequency dry withstand voltage (rms)	-
iv)	One minute power frequency dry and wet withstand voltage (rms)	460kV

S. No.	Description of parameters	220kV Prithala Substation
6.	Corona extinction voltage	-
7.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz	1000 μ V at 156kV rms
8.	Minimum creepage distance for insulator string/ longrod insulators/ outdoor bushings	7595 mm (31mm/kV)
9.	Minimum creepage distance for switchyard equipment	7595 mm (31mm/kV)
10.	Max. fault current	50kA
11.	Duration of fault	1 Sec

3.2. Switching Schemes

The switching schemes, as mentioned below, shall be adopted at various voltage levels of the substation/switchyard:

Substation	220kV side
400/220kV Prithala Substation	Double Main (GIS)

3.3. Substation Equipment and facilities

The switchgear shall be designed and specified to withstand operating conditions and duty requirements. All equipment shall be designed considering the transmission line capacity.

S. No.	Description of bay	220kV Prithala Substation
1.	Bus Bar	4000A
2.	Line bay	2000A

3.4. 400/220KV GIS Substation equipments

The SF6 gas insulated switchgear (50 Hz) shall be of the indoor metal-enclosed type and in accordance to IEC: 62271-203. The switchgear shall be designed and specified to withstand operating conditions and duty requirements.

The existing 220kV SF6 gas insulated switchgear (Make: GE) shall be extended by providing a suitable interface module with isolating link. 220kV SF6 gas insulated switchgear shall have Double Main Bus arrangement. The Switchgear shall be complete with all necessary terminal boxes, SF6 gas filling, interconnecting power and control

wiring, grounding connections, gas monitoring equipment & piping and support structures along with necessary base plate & foundation bolts. In addition, all necessary platforms, supports, ladders and catwalks etc. as required for operation & maintenance work shall also be provided. The alarm & annunciation of GIS equipment shall be wired to SCADA System.

245kV GIS modules/Equipment description given at Annexure-A.

3.4.1 Circuit Breakers

GIS Circuit breakers shall in general be of C2-M2 class and comply to IEC- 62271-100. The rated break time shall not exceed 40 ms for 420KV and 60 ms for 245kV and 145KV circuit breakers. 420 kV & 245 kV Circuit breakers shall be provided with single phase and three phase auto reclosing. The Circuit breakers controlling 420 KV lines wherever required shall be provided with pre insertion closing resistor of about 400 ohms with 8 ms insertion time for lines longer than 200 kM. The short line fault capacity shall be same as the rated capacity, and this is proposed to be achieved without use of opening resistors. Control switching device shall be provided in Circuit breaker of switchable line reactor and in Main & Tie circuit breakers of Transformers, line with non-switchable line reactors and Bus reactors. Further, it shall be possible to use line reactors as bus reactors, in case of outage of line.

3.4.2 Isolators

The isolators shall comply to IEC 62271-102 in general. Isolators shall be motor operated. Earth switches are provided at various locations to facilitate maintenance. Main blades and earth blades shall be interlocked, and interlock shall be fail safe type. All earth switches shall be motor operated type.

3.4.3 Current Transformers

Current Transformers shall comply with IEC 61869 in general. All ratios shall be obtained by secondary taps. Generally, Current Transformers (CT) shall have five cores (four for protection and one for metering) whereas, CT in Tie bays shall have six cores (four for protections & two for metering) suitably distributed on both sides of CB. The burden and knee point voltage shall be in accordance with the requirements of the system including possible feeds for telemetry. Accuracy class for protection core shall be PS and for metering core it shall be 0.2S.

3.4.4 Voltage Transformer

Clause Deleted

3.4.5 Sf6 to Cable termination and Cable to air termination

Suitable termination type shall be considered as per IEC / relevant standards to meet project requirement.

3.5. Capacitive Voltage Transformers (AIS)

Capacitive Voltage transformers shall comply with IEC 61869 in general. These shall have three secondaries out of which two shall be used for protection and one for metering. The accuracy class for protection cores shall be 3P and for metering core, it shall be 0.2. The Capacitive voltage transformers on lines shall be suitable for Carrier Coupling. The Capacitance of CVT for 400kV and 220kV shall be 4400/8800 pF depending on PLCC requirements. The rated burden of cores shall be closer to the maximum burden requirement of the metering & protection system (not more than 50VA for metering core) for better sensitivity and accuracy.

For more details, existing CVT details must be referred to by the contractor during the detailed engineering.

3.6. Surge Arresters (AIS)

336kV Station High (SH type) class gapless type Surge arresters & 216kV Station Medium (SM type) class gapless type Surge arresters conforming to IEC 60099-4, in general, shall be provided for 420kV & 245kV systems respectively. Other characteristics of the Surge arrester shall be chosen in accordance with system requirements. Surge arresters shall be provided near line entrances, transformers & reactors so as to achieve proper insulation coordination. Surge Arresters shall be provided with porcelain/polymer housing fitted with pressure relief devices. A leakage current monitor with a surge counter shall be provided with each surge arrester.

3.7. Protection Relaying & Control System

The protective relaying system proposed to be provided for transmission lines, autotransformers, reactors, and bus bars to minimize the damage to the equipment in the events of faults and abnormal conditions, is dealt with in this section. All main protective relays shall be the numerical type with IEC 61850 communication interface and should have Interoperability during the integration of numerical relays to communicate over the IEC 61850 protocol with RTU/SAS/IEDs of different OEMs. All numerical relays shall have a built-in disturbance recording feature.

The protection circuits and relays of the transformer and reactor shall be electrically and physically segregated into two groups each being independent and capable of providing uninterrupted protection even in the event of one of the protection groups failing, to obtain redundancy, and to take protection systems out for maintenance while the equipment remains in service.

i. Transmission Line Protection

400kV and 220kV lines shall have Main-I numerical three-zone distance protection scheme with a carrier-aided inter-tripping feature. 400kV and 220kV lines shall also have Main-II numerical distance protection schemes like Main-I but from a different make than of Main-I. The Main-I and Main-II protection relays of the same make may be provided only if they are of different hardware, manufacturing platform, or different principle of operation.

However, Line Current Differential relay (with backup distance protection feature) as Main-I and Main-II shall be considered at both ends for short lines (line length below 30km) having Fibre Optic communication link. The differential relay at the remote end shall be provided by the contractor. Associated power & control cabling and integration with SAS at the remote end shall be provided by the respective bay owner.

In the case of 220kV line bays where the line lengths are not indicated, the Numerical Distance protection relay as Main-I and Line Current differential relay (with backup distance protection feature) as Main-II shall be provided. Further, in such cases, the matching line current differential relay for the remote end shall be provided by the remote end bay owner.

Further, all 400kV and 220kV lines shall be provided with single and three-phase auto-reclosing facility to allow reclosing of circuit breakers in case of transient faults. These lines shall also be provided with distance to fault locators to identify the location of faults on transmission lines.

The Main-I and Main-II protection relays shall be fed from separate DC sources and shall be mounted in separate panels.

For 400 kV and 220 kV transmission lines, a directional IDMT earth fault relay should be provided as a standalone unit or in-built feature of the Main-I and Main-II feature.

ii. Busbar Protection

For existing substations, the existing bus bar protection shall be augmented as per requirement.

The Busbar protection Centralized unit and peripheral units (PUs) of each bay under the present scope of work are already available in Prithala Substation in a spare panel. These available PUs shall be taken out from that spare panel and shall be mounted in the new CRP panels to be provided by the contractor. This work including integration shall be in the Contractor's scope or work.

iii. Local Breaker Backup Protection

This shall be provided for each 400kV and 220kV circuit breakers and will be connected to de-energize the affected stuck breaker from both sides.

Notes:

1. LBB & REF relays shall be provided separately from the transformer differential relay.
2. LBB relay may also be provided as a built-in protection function of distributed bus bar protection scheme; however, in such case, a separate LBB relay shall be provided for tie bays (in case of One and a Half breaker scheme).
3. Over-fluxing & overload protection can be provided as a built-in feature of the differential relay.
4. In the 400kV switchyard, if a spare bay of half diameter is identified as future, the Tie CB relay panel shall be provided with Auto-reclosure feature.

3.8. Substation Automation System

The Bay control unit is to be provided bay-wise for voltage levels 220kV and above. All bay control units as well as protection units are normally connected through an Optical fiber high-speed network. The control and monitoring of circuit breaker, dis-connector, re-setting of relays, etc. can be done from the Human Machine Interface (HMI) from the control room.

The functions of control, annunciation, disturbance recording, event logging, and measurement of electrical parameters shall be integrated in the Substation Automation System.

In existing substations with a Substation automation system (SAS), augmentation of existing SAS shall be done for bays under the present scope.

The existing Prithala Substation SAS architecture drawing is attached in the drawings section which shall be referred to by the contractor to supply the items for the new scope of work/bays. The integration of these new supply items with the existing SAS shall be within the scope of the contractor.

3.9. AC & DC power supplies

The modules/feeders in LTDB required for the present scope of work are available in the existing Prithala Substation . For substation extension/augmentation, existing facilities shall be augmented as further required.

The capacity of existing 220V and 48V batteries is sufficient to cater to the LT load required for the proposed scope of work.

LT cabling (including AC and DC) in complete sense shall be ensured by the contractor for the successful commissioning of the proposed scope of work.

3.10. Fire Fighting System

Fire-fighting systems for substation including transformer & reactor shall conform to CEA (Measures Relating to Safety & Electric Supply) Regulations.

Further, adequate water hydrants and portable fire extinguishers shall be provided in the substations.

The main header of the firefighting system is suitable for extension to bays covered under the present scope; the necessary piping interface in this regard shall be provided.

At existing substations, the fire-fighting systems as available shall be extended to meet the additional requirements.

3.11. Oil evacuating, filtering, testing & filling apparatus.

To monitor the quality of oil for satisfactory performance of transformers, shunt reactors, and for periodical maintenance necessary oil evacuating, filtering, testing, and filling apparatus would be provided at substation. Oil storage tanks of adequate capacities for the storage of transformer oil would be provided.

3.12. Illumination System

The complete illumination system including switchyard lighting, street lighting, indoor lighting, JBs, poles, panels etc. shall be provided strictly based on the existing Prithala Substation specification/installation/practice.

The lighting of the outdoor switchyard, street lighting, switchyard panel rooms (SPR), and any other building, if any, shall be done by LED based low power consumption luminaries. Indoor illumination shall be as per the requirement of false ceiling and non-false ceilings of buildings.

Firewall mounted Flood Light has been envisaged for Transformers & Reactors.

AC Emergency Lighting in SPR and switchyard area has to be provided.

Stainless steel Panels/Junction Boxes of thickness 1.5 mm for Outdoor application must be considered.

The bottom of the Outdoor Lighting Panels mounting height shall be 1000mm from FGL.

For the Outdoor Switchyard area, LED fixtures shall be installed at gantry structures (For 400kV & below voltage level) & available lightning masts (if any).

For other outdoor areas and street lighting, the lighting poles & nearby buildings (if any) shall be used for the installation of LED fixtures.

Approximately 25 % of lighting fixtures (distributed over all above areas) shall be connected to an AC emergency lighting system.

A suitable heat sink with proper thermal management shall be provided in

the luminaries. All LED Luminaries shall be Employer approved make. The marking on luminaries & safety requirements of luminaries shall be as per IS standards.

The Contractor shall supply, store and install the following types of galvanized steel tubular lighting poles required for street lighting:

Type L1 Street Lighting Pole of 6 meters - for SL-L1 type fixture

Type D1 Post top lantern pole of 4 meters - for SI-D1 type fixture

The distance of the center of the pole from the street edge should be approximate 1000 to 1200 mm or as per site conditions.

Earthing of the poles should be connected to the switchyard main earth mat wherever it is available, else, the same should be earthed through 3M long, 20 mm Dia, earth electrode.

Lighting Panels, Receptacles, Junction Boxes, etc. shall conform to the following degree of protection:

- Installed outdoor: IP- 55
- Installed indoor in air-conditioned area: IP-31
- Installed in the covered area: IP-52
- Installed indoor in a non-air-conditioned area where the possibility of entry of water is limited: IP-41.

Contractor shall be required to submit LM-79 & LM-80 reports for LED Luminaries.

Lighting panels shall be supplied in accordance with the existing Prithala Substation panel and best industry practices.

3.13. Control Room and SPRs

Air conditioning shall be provided in the buildings as a functional requirement. Main cable trenches from the existing control room have adequate space provision for laying cables from the control room for all the current scope bays also. However, the existing cable trenches shall be extended in a complete sense till the present area of installation/erection as per the trench sections considered in existing Prithala Substation .

Bidders have to visit the site to understand the space available in the existing CRP room for the bay under the present scope.

3.14. Control Concept

All the EHV circuit breakers in substation/switching stations shall be controlled and synchronized from the switchyard control room/remote control center. Each breaker would have two sets of trip circuits which would be connected to separate DC supplies

for greater reliability. All the isolators shall have control from remote/local whereas the earth switches shall have local control only.

3.15. Visual Monitoring System (VMS) for watch and ward of substation premises

At existing substations, the visual monitoring system is available and shall be augmented as per existing or better specifications.

Visual monitoring system for effective watch and ward of substation premises shall cover all the transformers and reactors, all other major AIS Equipment (such as CB, isolators, CT, CVT, SA etc. as applicable), panel room, all the gates of switchyard and all entry and exit points of control room building and accordingly, the location of cameras shall be decided. The camera shall be high-definition color CCD camera with a night vision feature. The VMS data partly/completely shall be recorded (minimum for 15 days) at least @25fps (or better) and stored on the network video recorder. The system shall use video signals from various cameras installed at different locations, process them for viewing on workstations/monitors in the control room and simultaneously record all the cameras. Mouse/keyboard controllers shall be used for pan, tilt, zoom and other functions of the desired camera.

All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp. The equipment should generally conform to Electromagnetic compatibility requirement for outdoor equipment in EHV substation.

3.16. General Facilities

- a) Gantry/Towers are envisaged for bays under the present scope only. However, for the adjacent future bays, the towers shall be designed for extension considering single conductor for 220kV future lines.
- b) Bay extension works at the existing substation shall be carried out by the Contractor in accordance with the requirement/provisions mentioned above. However, interface points shall be considered keeping in view the existing design/arrangement at the substation.
- c) Contractor is advised to visit the site to make them acquaint for any modification required in existing building for LV (AC, DC) cabling /HV cabling to fulfill present scope of work as defined in scope of work (SOW) document.
- d) Contractor has to arrange for construction power and water on its own.
- e) All outdoor steel structures including anchor/foundation bolts shall be fully galvanized. The weight of the zinc coating shall be at least 610 gm/sq.m.

- f) Fencing, similar to the existing one, shall be provided to contain the proposed scope of work.
- g) The lightning protection of the switchyard shall be provided using the shield wires/spikes on the towers in line with IEEE 998 and the buildings lightning protection shall be provided as per IEC 62305.

3.17. PLCC Equipments

The line traps for all the lines under the present scope of work shall be provided by the contractor. The lines under the present scope shall have phase-to-phase coupling and wave traps installed in any of the two phases or as directed by Employer at the time of detailed engineering.

The line traps shall be broadband tuned suitable for blocking the complete range of carrier frequencies. Line Trap shall have necessary protective devices such as lightning arresters for the protection of tuning device. A decoupling network consisting of line traps and coupling capacitors may also be required at certain substations in case of extreme frequency congestion.

3.18. Roads

The new roads and the extension of existing ones shall be as per civil drawings attached and the decision of different widths applicable shall be based on the widths available in the attached existing electrical plan layout.

3.19. Earthing of Switchyard and Associated works

The earthing system of the existing Prithala Substation shall be followed by the contractor for the extension of the main mat and the size of the risers.

3.20. Post Insulators

The cantilever strength of all types of post-insulators is as follows:

S. No.	Post Insulator Application	220kV
1	Post Insulators for Isolators	10kN
2	Post Insulators for Bus Support	8kN

The corona ring shall be provided for all 400kV post insulators.

3.21. Marshaling and Junction Boxes

The bay marshaling box (BMK) and junction box (JB) for the proposed scope of work shall be as per the existing Prithala Substation .

3.22. Applicable Tests, Mandatory Spares & Monitoring Instruments

i. Type Tests Validity

The validity of the equipment's type test reports shall be governed by the latest CEA's "Guidelines for the Type Tests for Major Equipment in Power Sector" from the date of LOA of the project to the successful bidder.

ii. Performance Tests

The performance guarantees or ratings/parameters specified in the IEEE/IEC/IS standards or CEA specifications applicable to all the equipments to be supplied under the ambit of the scope of work shall be ensured by the contractor.

iii. Mandatory Spare Parts

The mandatory spares w.r.t extension scope of work shall be provided as per Annexure-B (SOW) and shall not be used by the contractor in consumables during the erection.

iv. Condition Monitoring Instruments

Additionally, the list of equipment condition monitoring instruments has been provided in Annexure-C (SOW) which is also part of the supply in this augmentation scope of work.

ANNEXURE-A: Description of GIS Bay Module & Equipment

4. 245 kV Gas Insulated Switchgear (Double Main Busbar Scheme):

The SF6 gas insulated switchgear (50 Hz) shall be of the indoor metal-enclosed type, comprising of following modules:

i) GIS Bus bar Module Extension (Make of Existing GIS: GE)

Extension of 3-single (isolated) phase/Three phase, SF6 gas-insulated metal enclosed bus bar module, each set comprising of the following:

- i. Bus bars enclosures running across the length of the switchgear to interconnect each of the bay modules in Double Main Bus bar system. GIS shall be extended in such a way so as to maintain minimum possible inter connection space between GIS supplied under present scope and the GIS being extended.
- ii. Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structure etc. as required.
- iii. Interface modules with the isolating test link for Future extension (on one side) of Bus bar module. The interface piece module shall be designed in such a way so that future GIS module may be tested without extending voltage to existing bus by removing the test link. **End piece interface module for both the buses shall be in one alignment and drawing of same shall be submitted for approval.**
- iv. Three (3) numbers single(isolated) phase / One (1) number three phase, SF6 ducts (as required) inside GIS hall.

ii) GIS Line Bay module:

SF6 gas-insulated metal enclosed Line feeder bay module, each set comprising of the following:

- i One (1) number 3-phase, SF6 insulated circuit breaker complete with operating mechanism.
- ii Three (3) numbers 1-phase, 5-core, multi ratio, current transformers.
- iii Three (3) numbers 3-phase, group operated isolator switches, complete with manual and motor driven operating mechanisms.
- iv Two (2) numbers 3-phase, group operated safety grounding switches, complete with manual and motor driven operating mechanisms.

- v One (1) number 3-phase, group operated high speed fault making grounding switch, complete with manual and motor driven operating mechanisms.
- vi Three nos. 1-phase (isolated)/one no. 3-phase SF6 ducts inside GIS hall.
- vii Gas monitoring devices, barriers, pressure switches, UHF PD Sensors, support structures etc. as required.
- viii Local Control Cubicle.
- ix Gas Insulated SF6 to Cable Termination: For making connections of GIS switchgear/duct with XLPE Cable, GIS Interface module along with associated active parts to facilitate the connection of GIS switchgear/duct with XLPE Cable as per IEC-62271-209 is under the present scope of subject package which is as specified below:

For 245kV: 1-phase / 3-Phase Gas Insulated SF6 to cable connection module along with associated active parts to interconnect GIS with XLPE Cable. The Support Structure required to support the XLPE cable upto the GIS termination point is also in the present scope of subject package.

Supply of XLPE Cable along with termination kit is in the scope of Cable Manufacturer. The limits of supply of the GIS switchgear manufacturer and Cable termination shall be as per IEC 62271-209. The drawings/details of XLPE cable along with termination kit shall be provided during detailed engineering for approval.

ANNEXURE-B: Approved Makes/OEMs for Project

5. List of Approved Makes/OEMs & Their Inspection Categories

A. List of Approved Makes for Augmentation in Prithala

- The makes of equipment already installed in Prithala Substation have been listed in the table below and it is recommended to the bidders that the equipments Makes under the augmentation work in Prithala Substation shall be the same as the OEM of existing equipments. In case of unavailability of the equipment with the OEM (under-installed makes) in the existing Substation, the Contractor shall refer to Approved Makes/OEM of such equipment.
- Material Inspection shall be carried out as per Material Category defined in the table below.
- The validity of the type test of equipments shall be applicable as per the periodicity (In Years) mentioned in the latest CEA's "Guidelines for the Validity Period of Type Test(s) conducted on Major Equipment in Power Sector" amended time to time from the date of LOA.

S. No.	Equipment	Material Category	Installed Makes in Existing Prithala Substation	Employer Approved Makes/OEMs	Remarks
1	Al. Tube	C	Hindalco	1.Sudal 2. Balco Aluminium 3. Jindal (Subject to availability of type test reports as per CEA, from date of LOA)	
2	BPI	B	Modern	1.Modern 2.Aditya Birla 3.IEC 4.Sarvana (Subject to availability of type test reports as per CEA, from date of LOA.)	
3	Capacitive Voltage Transformer	A	GE	1.Siemens 2.GE 3.ABB 4.Mehru 5.CGL	
4	Conductor	A	JSK	1.Apar 2.Lumino (Subject to	

S. No.	Equipment	Material Category	Installed Makes in Existing Prithala Substation	Employer Approved Makes/OEMs	Remarks
				availability of type test reports as per CEA, from date of LOA.) 3. Gupta Power (Subject to availability of type test reports as per CEA, from date of LOA.) 4.JSK 5.Sterlite	
5	Clamps & Connectors	C	PEEVEE Engineering	1.Legion 2.Exalt 3.Vensun Techno 4. Klemmen	
6	Control & Relay Panel including SAS	A	GE	1.GE 2.Siemens 3.ABB	
7	Earthing Materials	C	-	1.Swastika 2.VSP 3.SES 4.Balaji Metacast	
8	Fire Protection System	B	-	1.BCSFL (Subject to availability of type test reports as per CEA, from date of LOA) 2.AON 3.Flowgain	
9	Shield / Earth Wire	C	Bharat Wire	1.Nirmal Wire 2.Cabcon	
10	Insulator Hardware Fittings	C	Rashtra Udhog Ltd.	1.Rashtra Udhog Ltd. 2. Legion 3.ITL	Make of the Insulator and Insulator Hardware should be selected in such a way that combination of two makes are type tested

S. No.	Equipment	Material Category	Installed Makes in Existing Prithala Substation	Employer Approved Makes/OEMs	Remarks
					together as a single unit.
11	HVAC System	B	-	1.Laxmi cool zone 2.AON 3.Flowgain	1. Component Manufacturer of Following items:- i) High wall split AC ii)VRF Outdoor Unit iii) Compressor iv) Condenser Fan v) Cassette type Indoor Unit shall be from any of the below makes. a) VOLTAS b) HITACHI c) BLUE STAR
12	Illumination System	B	Bajaj	1.Forus Electrical 2.Avaids 3.Instapower	Following Makes shall be considered for Luminaires: - PHILIPS/BAJAJ/ WIPRO.
13	Long Rod Insulators	B	Goldstone Infratech	1.Deccan 2.Olectra 3. Modern	Make of the Insulator and Insulator Hardware should be selected in such a way that combination of two makes is type tested together as a single unit.
14	LT Cable	B	KEI	1. KEC 2.Nitya 3. Special (Subject to approval of credential	

S. No.	Equipment	Material Category	Installed Makes in Existing Prithala Substation	Employer Approved Makes/OEMs	Remarks
				by KTL)	
15	Surge / Line Arrester	A	GE	1. Oblum 2. CGL 3. Lamco	
16	VMS (Visual Monitoring System)	C	-	1. Sam Infortech 2. Delcom 3. Toshniwal	
17	Wave / Line Trap	A	GE	1. GE 2. Quality Power 3. Siemens	
18	Power/Auto Transformer	A1	GE	1.Toshiba, 2. Siemens, 3.ABB 4. GE	Component Manufacturers List of Power Transformers & Reactors up to 420 KV Class, shall be submitted to Employer for approval.
19	Reactors	A1	GE	1. Siemens 2. GE 3. ABB	
20	GIS	A1	GE	1. Siemens 2. GE 3. ABB 4. Hyosung	
21	220 kV EHV Cable	A1	NA	1. LS Cables 2. Universal Cables 3. KEI Industries	

B. Inspection Plan based on Material/Equipment Category:

Cat A: MQP (Material Quality Plan) is envisaged with its approval by Employer. Inspection by Employer / Employer 's Third-Party Inspection authorized agency. If the Inspection and test results are found satisfactory, formal Clearance is to be issued. Material can be dispatched from the factory based on the clearance issued.

If Employer provides a waiver, Supplier/ Supplier Quality Services shall conduct the inspection and submit the reports for review.

Cat A1: MQP is envisaged with its approval by Employer. In stage Inspection and final inspection by Employer / Employer 's appointed third-party Inspection authorized

agency. If the Inspection and test results are found satisfactory, formal Clearance is to be issued. Material can be dispatched from the factory based on the clearance issued.

If Employer provides a waiver, Supplier/ Supplier Quality Services shall conduct the inspection and submit the reports for review.

Cat B: MQP is envisaged with its approval by Employer. Inspection by Supplier/ Supplier's Third- party Inspection authorized agency. Advance inspection call anticipated prior to inspection. The inspection report will be submitted to Employer for clearance.

Cat C: MQP is not envisaged. No Physical Inspection is envisaged. Dispatch clearance shall be provided based on Material Test Reports / Certificates/ Factory Acceptance Test (FAT). Inspection call to be submitted along with Test Certificates. Based on the certificates from Supplier, Employer will provide clearance after reviewing reports.

Important Note(s):

- i. Employer reserves the right to change the inspection category of any material during the project.
- ii. The inspection category of any items required in the project and not explicitly mentioned in the above list shall be decided by Employer and communicated to the Contractor accordingly.

ANNEXURE-C: 220kV HV Cable Specification

6. TECHNICAL SPECIFICATION FOR 220 kV XLPE CABLE

6.1 SCOPE

Scope includes manufacture, testing before dispatch and delivery FOR destination of 220 kV, single core, circular stranded, copper conductor XLPE power cable conforming to the IEC 62067 / IS 7098 (Part - III).

6.2 STANDARDS

6.2.1 Unless otherwise stated hereafter, rating, characteristics, test and procedures etc. concerning the 220 kV XLPE cable shall be preferably as per IS, IEC standards given below and shall be in compliance with the latest edition or revisions thereof and meeting the constructional details and testing requirement as stipulated in foregoing also.

IEC-60228	Conductor for insulated cable.
IEC-60229	Tests on cable over sheaths.
IEC-60230	Impulse tests on cables and their accessories.
IEC-60270	Partial discharge measurements.
IEC-60287-1-1	Calculation of continuous current carrying capacity.
IEC-60502	Power Cables with extruded insulation and their accessories.
IEC-60067	Tests for Power cables with extruded insulation for rated voltage above 150 kV upto 500 kV.
BIS: 7098 (Part-3)	XLPE Cable specification for working voltages from 66 kV upto and including 220 kV.
IEEE:48	Tests procedures and requirements for high voltage cable terminations.

6.2.2 The 220 kV XLPE cable may conform to any other authorities 'standards, which ensures an equal or better quality than the standard mentioned above. The equivalence of IS or IEC be mentioned/ indicated by bidder (wherever only one of them are mentioned in the specification) to ensure that the required technical parameters/ tests as per specifications are complied. The bidder must specifically indicate the standards to which the cable conforms and indicate all deviations (if any) from the preferred IS/IEC codes that affect performance and rating.

6.2.3 Compliance of the 220 kV XLPE cable manufactured with the provisions of this specification does not relieve him of the responsibility of furnishing 220 kV XLPE cable and accessories of proper design, electrically and mechanically suited to meet the operating guarantees at the specified service conditions.

- 6.2.4 If there are, in the opinion of the bidder, any conflicts between these codes and this specification, these contradictions shall be brought to the attention of the purchaser.

6.3 DESIGN & TECHNICAL DETAILS

- 6.3.1 Single Core XLPE cable suitable for 220 kV nominal system shall have construction as under. The cable shall be made of stranded, compacted circular conductor, electrolytic grade copper, taped with semi conducting tape. Conductor screening shall be with extruded semi conducting thermosetting compound layer. The cable shall be insulated with completely dry cured XLPE insulation (of 245 kV highest system voltage). Insulation screening for non-metallic part shall be with extruded semi-conducting thermosetting compound layer. Taping with semi conducting water swellable tape shall be provided for longitudinal water sealing. Screening for metallic part shall be with corrugated Aluminum or Lead Alloy 'E' sheathed in combination with bedding of semiconducting tape(s) followed by annealed copper wires screen and taped with open helix copper tape binder, if required followed by suitable non-metallic tape binder and overall extruded black, PE or PVC sheath with outer conductive coating. Power cable shall conform to the IS 7098 (Part-III)/ IEC-62067 and foregoing paras of this specification.
- 6.3.2 The covering shall be watertight, electrically insulated, rodent proof and vermin proof.
- 6.3.3 The offered XLPE cable for 220 kV earthed system shall meet the technical particulars indicated in clause 3.1.
- 6.3.4 The XLPE Cable shall be suitable or used where combined ambient temperature and temperature rise due to load result in conductor temperature not exceeding 90°C under normal operation and 250°C under short circuit conditions.
- 6.3.5 Offered XLPE cable end termination as well as jointing kits shall be of rated short circuits current of 50 kV for duration of 1 second.
- 6.3.6 220 kV XLPE cable shall be designed to withstand the mechanical, electrical and thermal stresses under the steady state transient/ fault conditions and shall be suitable for proposed method of installation.
- 6.3.7 The cable shall be suitable for underground buried installation with uncontrolled back film and some areas to be flooded by water in the rainy season.

- 6.3.8 The sheath/ screen bonding system shall provide a continuous current path through the cable sheath and jointing kits and shall be bonded. The bonding ends shall be suitably earthed with/ without SVL as per the approved configuration/ design.
- 6.3.9 The sheath voltage under full load conditions shall not exceed the voltage specified/allowed in relevant standards for safety of personal as well satisfactory working of cable. Sheath shall be solidly grounded at suitable location (middle as well as at terminals substations) with/ without SVL. Bidder must indicate details of configuration proposed along with sufficiency calculation with the bid to limit induced voltage of sheath within 65 V.
- 6.3.10 The charging current of the cable shall be as low as possible.
- 6.3.11 The XLPE cable shall be capable of withstanding the normal stress associated with transportation, erection, reeling and unreeling operation without getting deformed.
- 6.3.12 The XLPE cable shall be used on system voltage of 220 kV for 3-phase AC earthed system. The cables shall be suitable for continuous operation at a power frequency voltage 10% higher than system voltage.
- 6.3.13 Cables will be protected from over voltage caused by lightning strikes switching surges by means of station type lightning arrestors located at terminal point/ substations. The terminal substation yard equipment and all overhead 220 kV transmission lines will be shielded against direct lightning strikes by overhead ground wires.
- 6.3.14 Repaired cables shall not be acceptable.

6.4 MATERIAL AND CABLE CONSTRUCTION

6.4.1 Conductor

- i. The stranded, very well compacted, round conductor shall be made of annealed plain copper wires complying with the requirements of flexibility class-2 of IEC-60228/ IS 8130. The conductor shall have high compactness and smooth surface finish.
- ii. The minimum number of wires in the conductor and D.C. resistance shall be as per table-II of IEC-60228/ IS 8130. The grade and quality of the copper used for the conductor shall be as per IEC/ IS standard but shall not be less than the International

Annealed Copper Standard (IACS) of 100% conductivity with purity of the order of 99.9%.

iii. The nominal area of conductor shall be decided by supplier/contractor based on current rating and method of laying.

6.4.2 Conductor Screen

i. The conductor screen consisting of semi conducting compound layer conforming IEC, shall be provided over the conductor by extrusion which will not only eliminate the risk of electric discharge at the interface between conductor and insulation but will also present a very smooth protrusion free interface with the insulation to eliminate any localized stress concentration. The screen shall be firmly bonded to XLPE insulation.

ii. The minimum thickness of the extruded conductor screen shall be 1.0 mm. The outer surface of the conductor screen shall be circular and free from irregularities. A non-hygroscopic semi-conducting tape, if required, shall be applied to the conductor under extruded layer to prevent penetration of compound into the conductor interstices.

6.4.3 Insulation

i. The insulation composed of a special super clean grade layer of cross-linked polyethylene (XLPE) shall comply with the requirement of IS-7098 (Part-3)/ IEC 62067.

ii. The eccentricity of insulation should not be more than 10%.

6.4.4 Insulation Screening

The insulation screening shall consist of two parts, namely, non-metallic and metallic.

6.4.5 Non-Metallic Part (Extrusion)

i. A non-metallic insulation screen of semi-conducting compound similar to conductor screen (clause 5.2) for similar purpose shall be applied directly over the insulation core by extrusion and shall be continuous and cover whole surface area of insulation. It shall be firmly bonded to the insulation.

ii. The minimum thickness of extruded insulation screen layer shall be 0.8 mm, the ovality of the core shall be not more than 5%.

6.4.6 Non-Metallic Part (Taped)-Longitudinal Water Barrier

i. Under-sheath, water barrier shall consist of a synthetic semi-conducting moisture swellable layer (non-woven synthetic tape with suitable water swellable absorbent tape with suitable overlap) covering the whole surface area of the insulation screen. The

barrier shall restrict longitudinal water penetration under the metallic sheath. The nominal thickness of water swellable tape shall be 0.3 mm.

ii. The semi conducting compound and the semi conducting tape shall be compatible with the insulating material and suitable for the operating temperature of the cable.

6.4.7 Metallic Part-Radial Water Barrier

The metallic sheath of corrugated Aluminum sheath or Lead alloy E shall be provided over the non-metallic part of the insulation screening. Metallic sheath, together with copper screen (if required) shall be able to withstand short circuit current of 50 kA for duration of one second. The details of metallic sheath are as under:

6.4.7.1 Lead Alloy E Sheath

i) The lead alloy sheath shall have composition as per IS: 692. The lead alloy 'E' sheath shall be extruded using a continuous screw press and shall be free from all extrusion defects. The nominal thickness of lead alloy E sheath shall be as per IEC-60502-2/ IS: 7098 (Part-3).

ii) The bedding over the Metallic sheath shall be of semiconducting tape(s).

iii) Copper wire screen of annealed plain copper wires with gap shall be helically applied over the Radial Water Barrier lead alloy metallic sheath.

iv) The diameter of copper wire in the screen shall not be less than 0.8 mm. The perpendicular gap between two adjacent wires shall not be more than 4.0 mm.

v) An open helix copper tape binder shall be applied over the copper wire screen. The nominal thickness of the tape shall not be less than 0.1 mm. The minimum thickness shall not fall below the nominal value by more than 10%. Suitable non-metallic binder tape may also be applied over the copper screen to prevent the penetration of the outer sheath into the screen.

6.4.7.2 Corrugated Aluminum Sheath

i) When the corrugated aluminum sheath is used, it shall be applied by extrusion/ seam-weld and passing through a corrugating head. The corrugating head contains rotating dies to form the valleys between the ribs like sine wave and produce to correct diameter of sheath to fit over the insulation. The sheath shall be free from pinholes flaws and other imperfections.

ii) Anti-corrosive compound shall be applied over the aluminum sheath.

6.4.8 Outer Sheath

- i. The outer sheath shall consist of an extruded layer of black, PE or PVC type ST-2 as per IEC-62067/ IS-7098 (Part-3).
- ii. The nominal thickness of outer sheath shall not be less than the value calculated as per the recommendation of IEC 60502-2/ IS-7098 (Part-3). The outer sheath shall be of sufficient hardness to discourage termite and rodent attack.

6.4.9 Outer Conductive Coating/ Layer

The outer conductive layer shall be of Graphite coating applied at works. This conductive layer/ coating must facilitate testing of the non-metallic outer sheath. This test is important to ensure the physical integrity of the cable from time to time be it at the factory, after transportation, directly after laying upon completion of the installation, or periodically thereafter.

6.5 Climatic conditions

The XLPE Power cable shall be suitable for continuous and satisfactory operation under conditions as defined in clause 4.3 of Scope of Work (SOP).

6.6 Quality Assurance

6.6.1 Raw materials used for manufacture of cable shall be of highest quality and material received by manufacturer should be checked/ tested to ensure that it meets manufacturer's material specification. The materials shall be clean and packed in moisture and dustproof packing.

6.6.2 As the quality control of EHV XLPE cables while manufacturing is very critical, expert supervision is required for raw material testing, in process checks and also for final testing. A specially trained quality assurance team should be in place for maintenance of the quality at an optimum level at the plant. Complete details of manufacturing process along with details of automatic manufacturing plant, list of officers/ staff to supervise the manufacturing and other details desired as per specification shall be furnished by bidder in the bid.

6.6.3 Quality assurance plan indicating test/ checks of raw material, process of manufacturer and final inspection with customer hold point shall be submitted to the purchaser for approval.

6.7 Testing

Type, Routine and Site Tests shall be in accordance with IEC 62067 and any other relevant standards.

6.7.1 Type Test

The following type test approval tests shall be carried out in accordance with appropriate standards including, but not limited to IEC 60502, unless documented evidence is provided to confirm successful completion.

- a. Prequalification tests
- b. Type tests (including water penetration tests)

6.7.2 Factory (routine) Test

The following factory tests are to be carried out in accordance with appropriate standards including, but not limited to IEC 60502

- a. Sample test
- b. Routine tests (including factory acceptance tests)

6.7.3 Site Test

After cable laying, termination and backfilling the following site tests shall be performed on the power cables as a minimum:

- a. Time Domain Reflectometer (TDR) test.
- b. 5kV DC insulation resistance test.
- c. High voltage withstand test carried out in accordance with IEC 60287. Supplier to propose test voltage and duration subject to acceptance by the Client.
- d. Partial discharge (PD) test at terminations
- e. Cable conductor resistance measurement
- f. Cable over sheath /serving test.
- g. Verification of cross-bonded sheath system (if used) and earthing connections.
- h. Checks on the contact resistance of the links
- i. Measurement of positive and zero sequence impedances

6.8 Documentation

- a. Cable Drawing with detailed cross section and technical parameters (including value of resistance, capacitance, inductance, and Minimum bending radius etc)

- b. Installation guidance Note including Maximum pulling force, recommended spacing for cleats and Minimum bending radius.
- c. Works Test Proposals for Cable
- d. Cable Accessory Drawings, Works Test Proposals for Accessory
- e. Cable thrust forces, loading data for foundation design.
- f. Estimated Drum Lengths and Shipping Specification
- g. Technical Data Sheet
- h. Project plan
- i. Test plan
- j. Quality plan
- k. Type & routine test reports
- l. Installation, operation & maintenance manual

6.9 INSPECTION & TRAINING AT MANUFACTURER'S WORKS

- a. The 220 kV XLPE cable should be manufactured and tested while manufacturing as per the approved quality assurance plan and foregoing specification. Supplier shall intimate the programme of manufacturing of the XLPE cable in advance. The inspection during manufacturing shall be carried out by the UPPTCL engineers at various stages of manufacture. The successful bidder shall grant free access to the purchaser's representative at a reasonable time when the work is in progress.
- b. Inspection and acceptance of any equipment/ material under this specification by the purchaser shall not relieve the supplier of his obligation of furnishing equipment in accordance with the specification and shall not prevent subsequent rejection if the equipment/ material is found to be defective.
- c. The supplier shall present the latest Calibration Certificate(s) of testing instruments/equipments to be used for the testing of the material covered in the purchase order to the authorized inspecting officer/ inspecting agency of the purchaser. The testing instruments/ meters/ apparatus etc. should be got calibrated by the supplier from time to time from independent test laboratory/ house having valid accreditation from National Accreditation Board for Testing and Calibrating Laboratories for the testing equipments/ original manufacturer having credibility to NABL/ NPL or equivalent.
- d. The calibration certificate(s) should not in any case be older than one year at the time of presenting the same to the inspecting officer/ inspecting agency of the purchaser. The testing instruments/ equipments should be duly sealed by the Calibrating Agency and mentioned thereof should be indicated in the calibration certificate(s).

- e. The purchaser reserves the right to insist for witnessing the sample/ routine tests of the bought out raw material/ items used in manufacturing of cables.

TECHNICAL PARTICULARS OF XLPE CABLE

S.NO.	PARTICULARS	TECHNICAL DETAILS
	Cable	Single Core, Copper Conductor XLPE cable.
1.	Applicable Standard	Conforming to IEC 60502-2 and IEC 60840: 2004-04 or IS 7098 (Part - 3) amended up to date.
2.	System voltage & frequency	220 \pm 10% kV, 50Hz \pm 3%
3.	Rated & Highest System Voltage	245 kV
4.	Suitable for earthed system	Yes
5.	CONDUCTOR	
(i)	Material	Annealed Plain Copper wires Conforming. to IEC 60228/ IS 8130
(ii)	Nominal cross-sectional area	To be suggested by supplier/ contractor
(iii)	Construction of conductor / flexibility class	Class -2, IEC 228/ IS: 8130
(iv)	Shape and formation	Circular, stranded & very well compacted
(v)	Approx. overall diameter of conductor	To be indicated
6.	CONDUCTOR SCREENING	
(i)	Material & Type	Extruded, semi conducting compound layer
(ii)	Grade	As per IEC/ IS
(iii)	Thickness	1.0 mm
7.	INSULATION	
(i)	Material	Cross linked polyethylene (XLPE)
(ii)	Special Super clean grade Normal thickness of insulation	As per IEC 6207/ IS 7098 (Part-3)
8.	INSULATION SCREENING	
A.	Non-metallic part (extruded)	
(i)	Material	Extruded semi conducting compound layer
(ii)	Grade	As per IEC/ IS 7098 (Part-3)
(iii)	Min. Thickness	0.8 mm
B	Non-metallic part (taped) longitudinal water barrier over insulation screen	
(i)	Material	Synthetic Non-woven semi conducting Water swell-able tape
(ii)	Min thickness	As per standard
C	METALLIC SHEATH	

(i)	Material	Corrugated Aluminium/ Lead alloy “E” sheath IS 692
(ii)	Min. Thickness(mm)	Conforming to IEC 60502-2/ IS 7098 (Part-3) Table 6A/6B

(iii)	Short Circuit Current Withstand (Metallic sheath, together with copper screen (if required))	50 kA for one second
(D)	Bedding over lead sheath	Semi conducting tape(s)
(E)	CONCENTRIC COPPER WIRE SCREEN (IF REQUIRED)	
(i)	Material and type	Annealed plain copper wires applied helically with gap followed by open helix of copper tape binder.
(ii)	Min. area (sq. mm.)	This and lead alloy E sheath shall meet earth fault current of 50 kA for a duration of 1 second.
9.	OUTER SHEATH	
(i)	Material	Extruded Layer of Black PE or PVC type ST-2 as per IEC 62067/ IS 7098 (Part-3)
(ii)	Min. thickness of outer sheath	As per standard
10.	Conducting layer over outer sheath	Graphite coating
11.	Approx. weight overall diameter of cable (mm)	To be indicated
12.	Approx. weight per meter of cable (kg/m)	To be indicated
13.	Recommended minimum installation radius.	To be indicated
14.	Maximum D.C. Resistance of conductor at 90°C in ohm/km	As per standard
15.	Minimum continuous current rating for each circuit when laid in ground in trefoil formation and other condition given in specification.	650 Amps. after all de-rated factors.
16.	Maximum allowable temperature for cable and accessories.	
(i)	At rated full load and at site conditions.	90° C
(ii)	The conductor temperature after a short circuit for one second shall not exceed (with conductor temperature at start of short circuit as 90°C).	250°C
17.	Basic impulse insulation level (1.2 / 50 micro second wave)	650 kV
18.	Power frequency withstand voltage	As per standard

19.	Symmetrical Short circuit rating for one second duration for lead sheath and copper screened combined	50 kA for 1 sec.
20.	Drum Length	500-600 mtr. / As per requirement.
21.	Expected cable life.	35 years.