SPECIFIC TECHNICAL REQUIREMENTS FOR TRANSMISSION LINE

1.0 The design, routing and construction of transmission lines shall be in accordance with Chapter-V, Part-A of CEA (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations 2010, as amended from time to time.

2.0 Selection of tower type shall be made as per CEA Regulations, however in case lattice type towers are used, the following shall also be applicable:

2.1 Steel section of grade E 250 and/or grade E 350 as per IS 2062, only are permitted for use in towers, extensions, gantry structures and stub setting templates. For towers in snowbound areas, steel sections shall conform to Grade-C of IS-2062.

2.2 Towers shall be designed as per IS-802:2015, however the drag coefficient of the tower shall be as follows:-

Solidity Ratio	**Drag Coefficient**
Upto 0.05	3.6
0.1	3.4
0.2	2.9
0.3	2.5
0.4	2.2
0.5 and above	2.0

3.0 Transmission Service Provider (TSP) shall adopt any additional loading/design criteria for ensuring reliability of the line, if so desired and /or deemed necessary.

4.0 Transmission line shall be designed considering wind zones as specified in wind map given in National Building Code 2016, Vol.1. The developer shall also make his own assessment of local wind conditions and frequent occurrences of high intensity winds (HIW) due to thunderstorms, dust-storms, downburst etc. along the line route and wherever required, higher wind zone than that given in wind map shall be considered for tower design for ensuring reliability of line.

5.0 Triple and quadruple circuit towers and towers with more than two sub-conductors per phase up to 400 kV shall be designed for reliability level 2.

6.0 A) For power line crossing of 400 kV or above voltage level, large angle & dead end towers (i.e. D/DD/QD) shall be used on either side of power line crossing.

B) For power line crossing of 132 kV and 220 kV voltage level, angle towers (B/C/D/DB/DC/DD/QB/QC/QD) shall be used on either side of power line crossing depending upon the merit of the prevailing site condition and line deviation requirement.

C) For power line crossing of 66 kV and below voltage level, suspension/tension towers shall be provided on either side of power line crossing depending upon the merit of the prevailing site condition and line deviation requirement.

D) For crossing of railways, national highways and state highways, Regulations of appropriate authorities shall be followed.

7.0 The relevant conductor configuration shall be as follows:-

Transmission line	**ACSR Conductor specified**	**Equivalent AAAC conductor based on 53.5% conductivity of Al Alloy**	**Equivalent AL59 conductor based on 59% conductivity of AL Alloy**	**Sub-conductor Spacing**
400kV D/C (Twin Moose) transmission lines	**Moose : Stranding** 54/3.53mm-Al + 7/3.53 mm- Steel, 31.77 mm diameter 528.5 sq mm, Aluminium area, Maximum DC Resistance at 20°C (Ω/km): 0.05552 Minimum UTS : 161.20 kN	**Stranding details:** 61/3.55mm, 31.95mm diameter; 604 sq. mm, Aluminium alloy area Maximum DC Resistance at 20°C (Ω/km) : 0.05506 Minimum UTS : 159.80 kN	**Stranding details:** 61/3.52 mm, 31.7 mm diameter; 593 sq. mm Aluminium alloy area Maximum DC Resistance at 20°C (Ω/km) : 0.0501 Minimum UTS : 135.40 kN	450 mm
132kV D/C (Panther) transmission lines	**Panther : Stranding** 30/3.0mm-Al + 7/3.0 mm- Steel, 21.00 mm diameter 212.05 sq mm, Aluminium area, Maximum DC Resistance at 20°C (Ω/km): 0.1390 Minimum UTS : 89.67 kN	**Stranding details:** 37/3.15mm, 22.05mm diameter; 288.3 sq. mm, Aluminium alloy area Maximum DC Resistance at 20°C (Ω/km) : 0.1182 Minimum UTS : 84.71 kN	**Stranding details:** 37/3.08 mm, 21.56 mm diameter; 275.66 sq. mm, Aluminium alloy area Maximum DC Resistance at 20°C (Ω/km) : 0.1075 Minimum UTS : 66.47 kN	Not Applicable

Note: The transmission lines shall have to be designed for a maximum operating conductor temperature of 85 deg C for ACSR as well as AAAC and AL59.

8.0 The required phase to phase spacing and horizontal spacing for 400kV line shall be governed by the tower design as well as minimum live metal clearances for 400kV voltage level under different insulator swing angles. However, the phase to phase spacing for 400kV lines shall not be less than 8m.

9.0 All electrical clearances including minimum live metal clearance, ground clearance and minimum mid span separation between earth wire and conductor shall be as per Central Electricity Authority (Measures Relating to Safety & Electric Supply) Regulations as amended from time to time and IS: 5613.

A) Minimum live metal clearances for 400 kV line:

a).(i) Under stationary conditions:

From tower body: 3.05m

a).(ii) Under Swing conditions

Wind Pressure Condition	Minimum Electrical Clearance
a) Swing angle (22º)	3.05 mtrs
b) Swing angle (44º)	1.86 mtrs

b) Minimum ground clearance: 8.84 m

c) Minimum mid span separation between earthwire and conductor: 9.0 m

B) Minimum live metal clearances for 132 kV line:

a).(i) Under stationary conditions:

From tower body: 1.53m

a).(ii) Under Swing conditions

Wind Pressure Condition	Minimum Electrical Clearance
a) Swing angle (15º)	1.53 mtrs
b) Swing angle (30º)	1.37 mtrs
c) Swing angle (45º)	1.22 mtrs
d) Swing angle (60º)	1.07 mtrs

b) Minimum ground clearance: 6.1 m

c) Minimum mid span separation between earthwire and conductor: 6.1 m

10.0 Shielding angle shall not exceed 20 deg for 400kV D/C Line transmission line and 30 deg for 132 kV transmission lines.

11.0 The Fault current for design of line shall be 63kA for 1 sec for 400kV and 40kA for 1 sec for 132kV.

12.0 In case of 400kV voltage class lines, at least one out of two earth wires shall be OPGW and second earth wire, if not OPGW, shall be either of galvanized standard steel (GSS) or AACSR or any other suitable conductor type depending upon span length and other technical consideration. In case of 132kV voltage class lines, single earth wire shall be used and that shall be OPGW.

13.0 Each tower shall be earthed such that tower footing impedance does not exceed 10 ohms. Pipe type or Counterpoise type earthing shall be provided in accordance with relevant IS. Additional earthing shall be provided on every 7 to 8 kms distance at tension tower for direct earthing of both shield wires. If site condition demands, multiple earthing or use of earthing enhancement compound shall be used. The line surge arrester, if required, may be used in lightning prone areas.

14.0 The transmission lines shall be designed with porcelain disc insulators or porcelain long rod insulators with the specific creepage distance required as per Site Pollution Severity level in the concerned area provided that the specific creepage distance shall not be less than 25 mm/kV.

15.0 Pile type foundation shall be used for towers located in river or creek bed or on bank of river having scourable strata or in areas where river flow or change in river course is anticipated, based on detailed soil investigation and previous years' maximum flood discharge of the river, maximum velocity of water, highest flood level, scour depth & anticipated change in course of river based on river morphology data of at least past 20 years to ensure availability and reliability of the transmission line.

16.0 Transmission line route shall be finalized, in consultation with appropriate authorities so as to avoid the habitant zones of endangered species and other protected species. Bird diverters, wherever required, shall be provided on the line.

SPECIFIC TECHNICAL REQUIREMENTS FOR SUBSTATION

The proposed new substation at Nangalbibra shall be conventional AIS type and the proposed augmentation of Bongaigaon substation shall be Gas Insulated Switchgear (GIS) type. The substations shall conform to the requirements of CEA (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations 2010, as amended from time to time.

1.0 Salient features of Substation Equipment and Facilities

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

1.1 Insulation Coordination

The system design parameters for substations/switchyards shall be as given below:

S. No.	Description of parameters	220/132kV Nangalbibra s/s (new)		220kV Bongaigaon (GIS) S/s extn
		220 kV System	**132 kV System**	**220 kV System**
1.	System operating voltage	220kV	132kV	220kV
2.	Maximum voltage of the system (rms)	245kV	145kV	245kV
3.	Rated frequency	50Hz	50Hz	50Hz
4.	No. of phase	3	3	3
5.	Rated Insulation levels			
i)	Impulse withstand voltage for (1.2/50 micro sec.) - for Equipment other than Transformer and Reactors - for Insulator String	1050 kV_p 1050 kV_p	650 kV_p 650 kV_p	1050 kV_p 1050 kV_p
iv)	One minute power frequency dry and wet withstand voltage (rms)	460kV	275kV	460kV
6.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz	1000 microvolts at 156kV rms	500 microvolts at 92kV rms	1000 microvolts at 156kV rms
7.	Minimum creepage distance for insulator string/ longrod insulators/ outdoor bushings	7595 mm (31mm/kV)	4495 mm (31mm/kV)	7595 mm (31mm/kV)
8.	Minimum creepage distance for switchyard equipment	6125 mm (25mm/kV)	3625 mm (25mm/kV)	6125 mm (25mm/kV)

S. No.	Description of parameters	220/132kV Nangalbibra s/s (new)		220kV Bongaigaon (GIS) S/s extn
		220 kV System	132 kV System	220 kV System
9.	Max. fault current	50 kA	40 kA	50 kA
10.	Duration of fault	1 Sec	1 Sec	1 Sec

1.2 Switching Scheme

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

Substation	220kV side	132kV side
220/132kV **Nangalbibra** s/s (New)	Double Main and Transfer (AIS)	Single Main and Transfer (AIS)
220kV **Bongaigaon (GIS)** S/s (Extn)	Double Main (GIS)	-NA-

For implementation of the above switching scheme, additional no. of bays like (2 bays: B/C + B/T bays at 220 kV level & one bay: B/ C bay at 132 kV level) in addition to the ones specified in the main scope of works would be required to be implemented by TSP.

For space requirement of future 400kV level at Nangal Bibra, switching scheme shall be considered as one and half breaker scheme.

2.0 Substation Equipment and facilities (Voltage level as applicable):

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

Sl. No	Description of bay	220/132kV Nangalbibra s/s (New)		220kV Bongaigaon (GIS) S/s (Extn)
		220kV	132kV	220kV
1.	Bus Bar	3000A	3000A	3000A
2.	Line bay	1600A	1250A	1600A
3.	ICT bay	1600A	1250A	-
4.	Bus Reactor bay	1600A	-	-
5.	Bus Coupler Bay	2500A	-	-
6.	Transfer Bus Coupler Bay	1600A	1250A	-

2.1 Power Transformers

2.1.1 220/132kV, 3-phase Autotransformer

Transformer shall conform to IEC 60076 in general. The transformer should have been successfully tested for short circuit withstand capability as per the requirement of CEA (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations. The transformer and all its accessories including bushing/ in-

built CTs etc shall be designed to withstand thermal and mechanical stresses caused by symmetrical or asymmetrical faults on any terminals. Mechanical strength of the transformer shall be such that it can withstand 3-phase and 1-phase through fault for transformer rated voltage applied to HV and/or IV terminals of transformer. The short circuit shall alternatively be considered to be applied to each of the HV, IV and tertiary (LV) transformer terminals. Tertiary is not considered to be connected to source. The maximum short circuit output current at the tertiary terminals shall be limited to a safe value to make the transformer short circuit proof. The Tertiary winding shall be designed to withstand mechanical and thermal stresses due to dead short circuit on its terminals. However, the cooling for continuous thermal rating of the tertiary winding shall be for at least 5 MVA capacity.

Core shall be constructed from non-ageing, cold rolled high permeability grade or better grain oriented silicon steel laminations with requisite BIS certification. The maximum flux density in any part of the core and yoke at the rated MVA, voltage and frequency shall not exceed 1.9 Tesla at all tap positions during 10% continuous over voltage condition. Transformers shall withstand without damage and over-heating due to over fluxing conditions of 110% for continuous, 125% for 1 minute and 140% for 5 seconds.

All the windings shall be capable of withstanding the dielectric, mechanical and thermal stresses which may be caused by switching, dead short circuit on its terminals. Transfer surge at tertiary shall not exceed 250kVp during impulse from HV & IV Terminals. The tertiary windings shall be suitable for connection of reactors or capacitors which would be subjected to frequent switching and shall be suitable for connection to LT Transformer for auxiliary supply. External or internal reactors shall not be used to achieve the specified HV/IV, HV/LV and IV/LV impedances.

Transformers shall be fitted with two cooler banks, each capable of dissipating 50 per cent of the loss at continuous maximum rating. Transformer shall be capable of operating at full load for 20 minutes in the event of failure of the oil circulating pump or blowers associated with one cooler bank and for at least ten (10) minutes in the event of total failure of power supply to cooling fans and oil pumps, without winding hot spot temperature exceeding 140 deg C. Transformer shall be designed so that tank hotspot shall not exceed 110 deg C, considering maximum ambient temperature of 50 Deg. C.

The transformer shall be complete with all required accessories, Bushing CTs, cooler control cabinet, individual and common marshalling box, etc. as required for satisfactory operations of transformer. Remote tap changer control and monitoring system including parallel operation of transformer shall be carried out using Bay control unit or digital RTCC relay through Substation Automation System.

Neutral of the transformer shall be solidly grounded.

HV and IV bushing shall be RIP (Resin Impregnated Paper)/RIS (Resin Impregnated Synthetic) with composite insulator type. LV bushing shall be OIP/RIP/RIS. 36kV Neutral bushing shall be solid porcelain or oil communicating type.

The major technical particulars / parameters of transformer are given below:

S. No.	Description	Unit	Technical Parameters
1.	Voltage ratio (line to line)	kV	220/132/33
2.	Rated Capacity		
	HV	MVA	160
	IV	MVA	160
	LV (Tertiary)	MVA	5 MVA Active Loading
3.	No of phases		3
4.	Vector Group		YNa0d11
5.	Type of transformer		Auto Transformer
6.	Applicable Standard		IEC 60076 /IS 2026
7.	Cooling type		ONAN / ONAF / OFAF or ONAN / ONAF / ODAF or ONAN / ONAF1 / ONAF2
8.	Frequency	Hz	50
9.	Rating at different cooling	%	60 / 80 / 100
10.	Cooler Bank Arrangement		2 X 50%
11.	Tap changer		
i)	Type		OLTC
ii)	Tap Range & steps		–5% to +15% in steps of 1.25% for 132 kV variation
iii)	Location of Tap changer		On the 132 kV line end
12.	HV-LV Impedance at 75 °C, at highest MVA base		
i)	Max. Voltage tap	%	9.5
ii)	Principal tap	%	12.5
iii)	Min. Voltage tap	%	14.0
iv)	Tolerance on Impedance	%	As per IEC
13.	Service		Outdoor
14.	Duty		Continuous
15.	Overload Capacity		IEC 60076-7
16.	Temperature rise over 50°C ambient Temp		
i)	Top oil measured by thermometer	^{o}C	45
ii)	Average winding measured by resistance method	^{o}C	50
17.	Winding hot spot rise over yearly weighted temperature of 32 °C	^{o}C	61
18.	Tank Hotspot Temperature	^{o}C	110
19.	Maximum design ambient temperature	^{o}C	50
20.	Windings		
i)	Lightning Impulse withstand		

S. No.	Description	Unit	Technical Parameters
	Voltage		
	HV	kV_p	950
	IV	kV_p	650
	LV	kV_p	250
	Neutral	kV_p	95
ii)	Chopped Wave Lightning Impulse Withstand Voltage		
	HV	kV_p	1045
	IV	kV_p	715
iii)	Switching Impulse withstand Voltage		
	HV	kV_p	750
	IV	kV_p	540
iv)	One Minute Power Frequency withstand Voltage		
	HV	kVrms	395
	IV	kVrms	275
	LV	kVrms	95
	Neutral	kVrms	38
v)	Neutral Grounding		Solidly grounded
vi)	Insulation		
	HV & IV		Graded
	LV		Uniform
vii)	Tan delta of winding	%	≤0.5%
21.	Bushings		
i)	Rated voltage		
	HV	kV	245
	IV	kV	145
	LV	kV	52
	Neutral	kV	36
ii)	Rated current		
	HV	A	1250
	IV	A	1250
	LV	A	1250
	Neutral	A	2000
iii)	Lightning Impulse withstand Voltage		
	HV	kVp	1050
	IV	kVp	650
	LV	kVp	250
	Neutral	kVp	170
iv)	Switching Impulse withstand Voltage on HV	kVp	850
v)	One Minute Power Frequency		

S. No.	Description	Unit	Technical Parameters
	withstand Voltage		
	HV	$kVrm_s$	505
	IV	$kVrm_s$	305
	LV	$kVrm_s$	105
	Neutral	$kVrm_s$	77
vi)	Tan delta of bushing at ambient Temperature	%	≤ 0.5
vii)	Minimum total creepage distances		(Specific creepage distance: 31mm/kV corresponding to the line to line highest system voltage)
	HV	mm	7595
	IV	mm	4495
	LV	mm	1612
	Neutral	mm	1116
viii)	Maximum Partial discharge level at U_m		
	HV	pC	10
	IV	pC	10
	LV	pC	10
22.	Maximum Partial discharge level at 1.58*Ur/√3	pC	100
23.	Maximum Noise level at rated voltage, principal tap & no load and all cooling active	dB	75
24.	**Maximum Permissible Losses of Transformers**		
i)	Max. No Load Loss at rated voltage and frequency	kW	**30**
ii)	Max. Load Loss at rated current and at 75°C for HV and LV windings at principal tap position	kW	**200**
iii)	Max. I^2R Loss at rated current and at 75°C for HV and LV windings, at principal tap position	kW	**145**
iv)	Max. Auxiliary Loss at rated voltage and frequency	kW	**6**
25.	Insulating Oil		Unused uninhibited (Type A, High Grade) or uninhibited Transformer oil conforming to IEC – 60396: 2020

2.2 Shunt Reactors

2.2.1 245kV, 3-Phase, Shunt Reactor

Reactor shall conform to IEC 60076-6 in general. The reactor shall be designed to withstand the over-voltages repeatedly without risk of failure at 1.05 Ur continuously, 1.25 Ur for 1 minute and 1.50 Ur for 5 seconds (where Ur is 245kV). The reactors shall be designed for switching surge overvoltage of 2.5 p.u. and temporary overvoltage of 2.3 p.u. for few cycles followed by power frequency overvoltage up to 1.5 p.u. The reactor must withstand the stress due to above transient dynamic conditions which may cause additional current flow as a result of changed saturation characteristics/slope beyond 1.5 p.u. voltage.

The reactor shall be of gapped core type construction. Core shall be constructed from non-ageing, cold rolled grain oriented silicon steel laminations with requisite BIS certification.

Shunt Reactors shall be capable of operating continuously at a voltage 5% higher than their rated voltage without exceeding winding and tank hot spot temperature 140 Deg and 110 Deg Celsius respectively, considering maximum ambient temperature as 50 Deg C.

The reactor shall be complete with all required accessories, Bushing CTs, marshalling box etc as required for satisfactory operations of reactor. HV and Neutral bushings shall be RIP (resin impregnated paper condenser) with composite insulator type.

The neutral of bus reactor shall be solidly grounded.

The Technical Particulars / Parameters of 3-phase, 31.5 MVAr, 245kV Shunt Reactor are given below:

S. No.	Description	Unit	Technical Parameters
1.	Rated Capacity at 245kV	MVAr	31.5
2.	Rated Voltage (Ur) (1.0 pu)	kV	245
3.	Number of phases		3 (three)
4.	Connection		star
5.	Cooling type		ONAN
6.	Frequency	Hz	50
7.	Reference standard		IEC 60076-6
8.	Service		Outdoor
9.	Permissible unbalance current among phases	%	±2%
10.	Crest value of third harmonic content in phase current at rated voltage with sinusoidal wave form	%	≤ 3% of the crest value of fundamental
11.	Range of constant impedance		Up to 1.4 p.u voltage (However, complete saturation characteristics of the Reactors upto 2.5 p.u. voltage shall be furnished)

S. No.	Description	Unit	Technical Parameters
12.	Tolerance on current	%	0 to +5%
13.	Ratio of zero sequence reactance to positive reactance (X0/X1)	Range	0.9 - 1.0
14.	Temperature rise over 50 °C Ambient Temp. at 245kV		
i)	Top oil measured by thermometer	°C	40
ii)	Average winding measured by resistance method	°C	45
15.	Winding hot spot temperature rise over yearly weighted average temperature of 32 °C	°C	61
16.	Max. tank surface temperature	°C	110
17.	Max design ambient temperature	°C	50
18.	**Windings**		
a)	Lightning Impulse withstand Voltage		
i)	HV	kVp	950
ii)	Neutral	kVp	170
b)	Switching Impulse withstand Voltage		
i)	HV	kVp	750
c)	Power Frequency withstand Voltage		
i)	Neutral	kVrms	70
d)	Tan-delta of windings		< 0.005
19.	Neutral earthing		Solidly Earthed
20.	**Bushing**		
a)	Rated voltage		
i)	HV bushing	kV	245
ii)	Neutral bushing	kV	36
b)	Rated current		
i)	HV bushing	A	800
ii)	Neutral bushing	A	800
c)	Lightning Impulse withstand Voltage		
i)	HV bushing	kVp	1050
ii)	Neutral bushing	kVp	170
d)	Power frequency withstand voltage		

S. No.	Description	Unit	Technical Parameters
i)	HV bushing	kV rms	505
ii)	Neutral bushing	kV rms	77
f)	Minimum creepage distance		
i)	HV bushing	mm	7595
ii)	Neutral bushing	mm	1116
g)	Partial discharge of bushings at Ur (line end and neutral)	pC	< 10
21.	Maximum partial discharge level at 1.58Ur/√3	pC	100
22.	Vibration and tank stress at rated voltage		Max ≤200microns peak to peak Average ≤ 60microns peak to peak Tank stress: ≤2.0kg/sq.mm at any point of tank
23.	Maximum noise pressure level at rated voltage & frequency	dB	75
24.	Insulating oil		Unused uninhibited (Type A, High Grade) or uninhibited Transformer oil conforming to IEC – 60396: 2020

2.3 220kV GIS Substation equipment

GIS (Gas Insulated Switchgear) shall be Indoor type in accordance to IEC: 62271-203. The switchgear shall be designed and specified to withstand operating conditions and duty requirements. All the switchgear such as Circuit Breaker, isolator, earth switch including CT, PT etc. shall be GIS type. The Surge Arrestor and Voltage Transformer shall be either GIS or outdoor AIS type.

The GIS assembly shall consist of separate modular compartments e.g. Circuit Breaker compartment, Bus bar compartment filled with SF_6 Gas and separated by gas tight partitions so as to minimize risk to human life, allow ease of maintenance and limit the effects of gas leaks failures & internal arcs etc. These compartments shall be designed to minimize the risk of damage to adjacent sections and protection of personnel in the event of a failure occurring within the compartments. Rupture diaphragms with suitable deflectors shall be provided to prevent uncontrolled bursting pressures developing within the enclosures under worst operating conditions, thus providing controlled pressure relief in the affected compartment. The arrangement of gas sections or compartments shall be such as to facilitate future extension of any make without any drilling, cutting or welding on the existing equipment. To add equipment, it shall not be necessary to move or dislocate the existing switchgear bays. The layout of Gas Insulated Bus Ducts shall be properly planned to optimize the length of bus ducts and for easy accessibility for maintenance. The length of busbars, bus ducts, isolator sections shall be optimized considering effects of fast transient voltage due to isolator operations.

The bus bar modules including auxiliary bus modules (wherever applicable) shall be provided with suitable End Piece (Interface) module with the test link facility for future extension as per provisions of future requirement. The end piece module shall be designed in such a way so that future GIS module may be tested without extending test voltage to existing bus and vice-versa by removing the test link.

TSP shall make available the complete details for the design of interface module such as cross section, enclosure material, enclosure dimensions (inner & outer), Flange diameter (inner & outer), conductor cross-section & connection arrangement, bolt spacing & dimension, rated gas pressure, Gasket detail etc. Further, adequate space for GIS busbar interface module shall be taken into account for future scope.

Each section shall have plug-in or easily removable connection pieces to allow for easy replacement of any component with the minimum disturbance to the remainder of the equipment. Inspection windows (View Ports) shall be provided for Disconnector Switches and both type of earth switches i.e. Maintenance and fast operating.

Local control cabinets (LCC) shall be provided as per requirement. The alarm & annunciation of GIS equipment shall be wired to SCADA System.

The material and thickness of the enclosures shall be such as to withstand an internal flash over without burns through for a period of 300 ms at rated short time withstand current. The material shall be such that it has no effect of environment as well as from the by-products of SF_6 breakdown under arcing condition. This shall be validated with Type Test.

Service continuity requirement for GIS:

The GIS equipment with the given bus switching arrangement shall be divided into different gas compartments. During the work such as a fault repair or major maintenance, requiring the dismantling of a gas compartment for which more than one compartments may need to be de-gassed.

TSP shall meet following Service continuity conditions (to the extent possible) with ensuring equipment and operating personnel's safety:

- For Double Main bus switching scheme, during a fault in Circuit Breaker compartment, no bus bar is permitted out of service during maintenance and repair/replacement.

- During a fault in GIS compartment other than Circuit Breaker compartment, maximum one bus bar and/or one feeder is permitted out of service during maintenance and repair/replacement.

UHF sensors in GIS for PD (Partial Discharge) detection:

Adequate number of UHF sensors shall be provided in the offered GIS for detection of Partial discharge (of 5 pC and above as per IEC 60270). The number and location of these sensors shall be based on laboratory test on typical design of GIS as per recommendations of CIGRE Document No. 654 (Application Guide for sensitivity verification for UHF Partial discharge detection system for GIS).

2.3.1 Circuit Breakers (GIS)

GIS Circuit breakers shall in general be of C2-M2 class and comply with IEC-62271-100. The rated break time shall not exceed 60 ms for 220kV. Circuit breakers shall be suitable for single phase and three phase auto reclosing duty.

2.3.2 Isolators (GIS)

The isolators shall comply with IEC 62271-102 in general. 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 isolators and earth switches shall be motor operated type.

Isolator shall be of extended mechanical endurance class-M2 and suitable for Bus Transfer Current Switching duty as per IEC standard. High speed earthing switches shall be provided for grounding purpose at overhead line terminations & cable terminations and shall have fault making capability as specified. Earth switch for line isolator shall be of earthing switch class E1 and shall be suitable for induced current switching duty as defined for Class-B as per relevant standard.

2.3.3 Current Transformers (GIS)

Current Transformers shall comply with IEC 61869 in general. All ratios shall be obtained by secondary taps only. Generally, Current Transformers (CT) shall have five cores (four for protection and one for metering). 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 PX and for metering core it shall be 0.2S. The rated burden of cores shall be closer to the maximum burden requirement of metering & protection system (not more than 20VA for metering core) for better sensitivity and accuracy. The instrument security factor shall be less than 5.

2.3.4 Voltage Transformer (if GIS type is used)

The voltage transformers shall conform to IEC-61869. Voltage transformers shall be of electromagnetic type with SF_6 gas insulation. The earth end of the high voltage winding and the ends of the secondary winding shall be brought out in the terminal box. The voltage transformers shall be located as a separate bay module and will be connected phase to ground and shall be used for protection, metering and synchronization. The voltage transformers shall be of inductive type, nonresistant and shall be contained in their own-SF_6 compartment, separated from other parts of installation. The voltage transformer shall be effectively shielded against high frequency electromagnetic transients. The voltage transformer shall have three secondary windings (two for protection and one for metering). The voltage transformer should be thermally and dielectrically safe when the secondary terminals are loaded with the guaranteed thermal burdens. The accuracy class for protection cores shall be 3P. The accuracy of 0.2 on metering core should be maintained throughout the entire burden range on all the three windings without any adjustments during operation. The rated burden of cores shall be closer to the maximum burden requirement of metering & protection system (not more than 50VA for metering core) for better sensitivity and accuracy.

2.3.5 Outdoor Voltage Transformer / CVT

The outdoor voltage transformers shall conform to IEC-61869. The earth end of the high voltage winding and the ends of the secondary winding shall be brought out in the terminal box. The voltage transformer shall have three secondary windings (two for protection and one for metering). The voltage transformer should be thermally and dielectrically safe when the secondary terminals are loaded with the guaranteed thermal burdens. The accuracy class for protection cores shall be 3P. The accuracy of 0.2 on metering core should be maintained throughout the entire burden range on all the three windings without any adjustments during operation. The rated burden of cores shall be closer to the maximum burden requirement of metering & protection system (not more than 50VA for metering core) for better sensitivity and accuracy. If outdoor CVT is used, then it shall confirm to Clause No. 2.4.4.

2.3.6 Surge Arresters (if GIS type is used)

216kV & 120kV Station Medium (SM) duty gapless type Surge arresters conforming to IEC 60099-4 in general shall be provided for 220 kV & 132 kV systems respectively. Other characteristics of Surge arrester shall be chosen in accordance with system requirements. Surge arresters shall be provided at line entrances, near transformers & Reactor so as to achieve proper insulation coordination. A leakage current monitor with surge counter shall be provided with each surge arrester.

2.3.7 Surge Arresters (if AIS type is used)

216kV & 120kV Station Medium (SM) class duty gapless type Surge arresters conforming to IEC 60099-4 in general shall be provided for 220 kV & 132 kV systems respectively. Other characteristics of Surge arrester shall be chosen in accordance with system requirements. Surge arresters shall be provided at line entrances, near transformers & Reactor 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 surge counter shall be provided with each surge arrester.

2.3.8 SF_6 to Air Bushing

Outdoor bushings, for the connection of conventional external conductors to the SF_6 metal enclosed switchgear, shall be provided. Bushings shall generally be in accordance with the requirements of IEC-60137. The creepage distance over the external surface of outdoor bushings shall not be less than 31 mm/kV. SF_6 to air Bushing shall be of Polymer / composite type and shall be robust and designed for adequate cantilever strength to meet the requirement of seismic condition. The electrical and mechanical characteristics of bushings shall be in accordance with IEC 60137. Polymer/composite insulator shall be seamless sheath of silicone rubber compound. The housing & weather sheds should have silicon content of minimum 30% by weight. It should protect the bushing against environmental influences, external pollution and humidity. The hollow silicone composite insulators shall comply with the requirements of IEC 61462 and the relevant parts of IEC 62217.

2.4 220kV, 132kV AIS Substation equipment

2.4.1 Circuit Breakers (AIS)

The circuit breakers and accessories shall conform to IEC: 62271-100, IEC: 62271-1 and shall be of SF6 Type. The circuit breakers shall be of class C2-M2 (as per IEC) with regard to restrike probability during capacitive current breaking and mechanical endurance. The rated break time shall not exceed 60 ms for 220kV and 132kV circuit breakers. 220kV and 132kV Circuit breakers shall be suitable for single phase and three phase auto reclosing duty.

2.4.2 Isolators (AIS)

The isolators shall comply with IEC 62271-102 in general. 220kV and 132kV Isolators shall be double break type. All Isolators and earth switches shall be motor operated. Earth switches shall be provided at various locations to facilitate maintenance. Isolator rated for 220kV and 132kV shall be of extended mechanical endurance class-M2 and suitable for bus transfer current switching duty. Main blades and earth blades shall be interlocked and interlock shall be fail safe type. 220kV & 132kV earth switch for line isolator shall be suitable for induced current switching duty as defined for Class-B.

2.4.3 Current Transformers (AIS)

Current Transformers shall comply with IEC 61869 in general. All ratios shall be obtained by secondary taps only. 220kV and 132kV Current Transformers shall have five cores (four for protection and one for metering). 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 PX and for metering core it shall be 0.2S. The rated burden of cores shall be closer to the maximum burden requirement of metering & protection system (not more than 20VA for metering core) for better sensitivity and accuracy. The instrument security factor shall be less than 5.

2.4.4 Capacitor 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. 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 220kV and 132kV shall be of 4400/8800 pF depending on PLCC requirements. The rated burden of cores shall be closer to the maximum burden requirement of metering & protection system (not more than 50VA for metering core) for better sensitivity and accuracy.

2.4.5 Surge Arresters (AIS)

216kV & 120kV Station Medium (SM) class, duty gapless type Surge arresters conforming to IEC 60099-4 in general shall be provided for 220 kV & 132kV systems respectively. Other characteristics of Surge arrester shall be chosen in accordance with system requirements. Surge arresters shall be provided at line entrances, near transformers & Reactor 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 surge counter shall be provided with each surge arrester.

2.5 Protection Relaying & Control System

The protective relaying system proposed to be provided for transmission lines, auto-transformers, reactors and bus bars to minimize the damage to the equipment in the events of faults and abnormal conditions, is dealt in this section. All main protective relays shall be numerical type with IEC 61850 communication interface. All numerical relays shall have in-built disturbance recording feature.

The protection circuits and relays of 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.

a) Transmission Lines Protection

220kV lines shall have Main-I numerical three zone distance protection scheme with carrier aided inter-tripping feature Main-II numerical distance protection scheme like Main-I but from different make that of Main-I. The Main-I and Main-II protection relays of same make may be provided only if they are of different hardware & manufacturing platform or different principle of operation. 132kV lines shall have Main-I numerical three zone distance protection scheme with carrier aided inter-tripping feature. 132 kV lines shall also have independent back up over current & earth fault protection.

However, Line Current Differential relay (with back up 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. Differential relay at remote end shall be provided by the TSP. Associated power & control cabling and integration with SAS at remote end shall be provided by respective bay owner.

In case of loop in loop out of transmission lines, the existing protection scheme shall be studied and suitable up-gradation (if required) shall be carried out.

Further, all 220kV & 132kV 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 fault on transmission lines. Auto reclose as in-built function of Bay Control Unit (BCU) is also acceptable.

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

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

b) Auto Transformer Protection

These shall have the following protections:

i) Numerical Differential protection
ii) Numerical Restricted earth fault protection
iii) Numerical Back-up Over-current and earth fault protection on 220 kV & 132 kV side
iv) Numerical Over fluxing protection on 220 kV & 132 kV side
v) Numerical Overload alarm

Further, Numerical Back-up Over-current and earth fault protection on 220 kV & 132 kV side of autotransformer shall not be combined with other protective functions in the main relays and shall be independent relays. Besides these, power transformers shall also be provided with Buchholz relay, protection against high oil and winding temperature and pressure relief device etc.

Suitable monitoring, control (operation of associated circuit breaker & isolator) and protection for LT auxiliary transformer connected to tertiary winding of auto-transformer for the purpose of auxiliary supply shall be provided. The Over current and other necessary protection shall be provided for the auxiliary transformer. These protection and control may be provided as built in feature either in the bay controller to be provided for the auxiliary system or in the control & protection IEDs to be provided for autotransformer.

c) Reactor Protection

Reactor shall be provided with the following protections:

i) Numerical Differential protection.
ii) Numerical Restricted earth fault protection
iii) Numerical Back-up impedance protection

Besides these, reactors shall also be provided with Buchholz relay, MOG with low oil level alarm, protection against oil and winding temperatures & pressure relief device, etc.

d) Bus bar Protection

The high speed low impedance type bus bar differential protection, which is essential to minimize the damage and maintain system stability at the time of bus bar faults, shall be provided for 220kV and 132kVbuses. Bus bar protection scheme shall be such that it operates selectively for each bus and incorporate necessary features required for ensuring security. The scheme shall have complete bus bar protection for present as well as future bays envisaged i.e. input / output modules for future bays shall also be provided.

Bus Bar protection system for new substation shall be de-centralized (distributed) type.

In case, the bus section is provided, then each side of bus section shall have separate set of bus bar protection schemes.

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

e) Local Breaker Back up Protection

This shall be provided for each 220kV and 132kVcircuit 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 transformer differential relay.*
2. *LBB relay may also be provided as in-built protection function of distributed bus bar protection scheme.*
3. *Over fluxing & overload protection can be provided as in-built feature of differential relay.*

2.6 Substation Automation System

a) For all the new substations, state of art Substation Automation System (SAS) conforming to IEC-61850 shall be provided. The distributed architecture shall be used for Substation Automation system, where the controls shall be provided through Bay control units. The Bay control unit is to be provided bay wise. All bay control units as well as protection units are normally connected through an Optical fibre high speed network. The control and monitoring of circuit breaker, dis-connector, re-setting of relays etc. can be done from 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 Substation Automation System.

At new substations, the Substation Automation System (SAS) shall be suitable for operation and monitoring of the complete substation including proposed future bays/elements.

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

In existing Substations where Substation automation is not provided, control functions shall be done through control panels.

Necessary gateway & modems (as required) shall be provided to send data to RLDC/SLDC as per their requirement. Any augmentation work at RLDC/SLDC is excluded from TSP's scope. However, all the configuration work at substation end required to send data to RLDC/SLDC shall be in the scope of TSP.

b) Time synchronisation equipment

Time synchronization equipment complete in all respect including antenna, cable, processing equipment required to receive time signal through GPS or from National Physical Laboratory (NPL) through INSAT shall be provided at new substations. This equipment shall be used to synchronize SAS & IEDs etc.

3.0 Substation Support facilities

Certain facilities required for operation & maintenance of substations as described below shall be provided at new substation. In existing substation, these facilities have already been provided and would be extended/ augmented as per requirement.

3.1 AC & DC power supplies

For catering the requirements of three phase & single phase AC supply and DC supply for various substation equipment, the following arrangement is envisaged:-

(i) For LT Supply at each new Substation, two (2) nos. of LT Transformers (minimum 630kVA) shall be provided out of which one shall be connected with SEB/DISCOM supply and other one shall be connected to tertiary of Transformer.

(ii) Metering arrangement with Special Energy Meters (SEMs) shall be provided by TSP at 33kV tertiary of 220/132kV Transformer for drawing auxiliary supply at new substation. Such SEMs shall be provided by CTU at the cost of the TSP. Accounting of such energy drawn by the TSP shall be done by RLDC/RPC as part of Regional Energy Accounting.

(iii) Additionally, Active Energy Meters may be provided at the same point in the 33kV tertiary of 220/132/33kV Transformer by local SEB/DISCOM for energy accounting.

(iv) 2 sets of 220V battery banks for control & protection and 2 sets of 48 V battery banks for PLCC/ communication equipment shall be provided at each new Substation. Each battery bank shall have a float-cum-boost charger. Battery shall be of VRLA type. At new substation, sizing of battery and battery charger shall be done based on the number of bays specified (including future bays) as per CEA Regulations and relevant IS.

(v) Suitable AC & DC distribution boards and associated LT Switchgear shall be provided at new substation.

For new substation, following switch boards shall be considered with duplicate supply with bus coupler/ sectionalizer and duplicate outgoing feeders except for Emergency lighting distribution board which shall have only one incoming feeder:

(a) 415V Main Switch board – 1 nos.
(b) AC distribution board – 1 nos.
(c) Main lighting distribution board – 1 no.
(d) Emergency lighting distribution board – 1 no.
(e) 220 Volt DC distribution board – 2 nos.
(f) 48 Volt DC distribution board – 2 nos.

Sizing of LT Switchgear shall be suitable to cater the requirement for all present and future bays. AC & DC distribution boards shall have modules for all the feeders (including future as specified).

(vi) At new Substation, one no. of DG set (minimum 250kVA) shall be provided for emergency applications.

(vii) For substation extensions, existing facilities shall be augmented as required.

3.2 Fire Fighting System

Fire-fighting system 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 firefighting system shall be suitable for extension to bays covered under the future scope; 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.

3.3 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 new substations. Oil storage tanks of adequate capacities for storage of transformer oil would be provided.

3.4 Illumination

Normal & emergency AC & DC illumination shall be provided adequately in the control room & other buildings of the substation. The switchyard shall also be provided with adequate illumination.

Lighting of the entire control room building, fire-fighting pump house, other building (if any) and switchyard shall be done by LED based luminaries.

3.5 Control Room

For new substation, substation control room shall be provided to house substation work stations for station level control (SAS) along with its peripheral and recording equipment, AC & DC distribution boards, DC batteries & associated battery chargers, Fire Protection panels, Telecommunication panels & other panels as per requirements. Air conditioning shall be provided in the building as functional requirements. Main cable trenches from the control room shall have adequate space provision for laying of cables from control room for all the future bays also.

At existing substations, the adequacy of size of control room shall be ascertained and the same shall be augmented as per requirement.

3.6 GIS hall

For extension of existing GIS, existing facilities shall be suitably augmented/ extended for GIS equipment under present scope.

3.7 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.

3.8 Visual monitoring system (VMS) for watch and ward of substation premises:

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), GIS bays, 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 night vision feature. The VMS data partly/completely shall be recorded (minimum for 15 days) at least @25fps (or better) and stored on 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. The Visual Monitoring System shall have provision of WAN connectivity for remote monitoring.

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.

At existing substations, the visual monitoring system if available shall be augmented as per existing or better specification as required.

4.0 General Facilities

a) Line Gantry/Towers are envisaged for bays under present scope only. However, for adjacent future line bay, tower shall be designed for extension (considering single conductor for 220kV & 132kV future lines) wherever applicable.

b) Bay extension works at existing substation shall be executed by TSP 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) TSP has to arrange for construction power and water on its own.

d) 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.

5.0 Extension of Existing Substation

The following drawings/details of existing substation is attached with the RFP documents for further engineering by the bidder.

S. No.	Drawing Title	Drawing No./Details	Rev. No.
A.	**220kV Bongaigaon s/s**		
1.0	Single Line Diagram	C/ENG/TBCB/BONGAIGAON/ 220KV-X/SLD	Rev-0
2.0	General Arrangement	C/ENG/TBCB/BONGAIGAON/ 220KV-X/GA	Rev-0
3.0	Earthmat Layout	CG/PGCIL-KTS/110 Rev-R2	Rev-2
4.0	Visual Monitoring System (VMS)	*VMS is not Existing at Bongaigaon s/s*	-NA-
5.0	Bus Bar Protection (220kV System)	Make : M/s GE Model: P741	-NA-
6.0	Substation Automation System (SAS)	M/s GE	-NA-
7.0	Make of existing 220kV GIS	M/s GE	-NA-

Bidder is also advised to visit the substation sites and acquaint themselves with the topography, infrastructure such as requirement of roads, cable trench, drainage etc. and also the design philosophy.

6.0 Drawings for Bay Extension at Bongaigaon (Powergrid) 400/220 kV Sub-Station

The following drawings are attached at **Annexure-A** for bay extension at Bongaigaon (Powergrid) 400/220 kV sub-station for reference only. However, bidders are advised to visit the site and ascertain the requirement for implementation of bay extension works at Bongaigaon (Powergrid) 400/220 kV sub-station:

i) Earthing Layout of Existing Bongaigaon (Powergrid) 400/220 kV sub-station

ii) SLD and GA for bay allocation at existing Bongaigaon (Powergrid) 400/220 kV sub-station for Nangalbibra- Bongaigaon 400 kV D/C line (initially charged at 220KV) at 220 kV Bongaigaon GIS s/s

SPECIFIC TECHNICAL REQUIREMENTS FOR COMMUNICATION

In order to meet the requirement for grid management and operation of substations, Transmission Service Provider (TSP) shall conform to the following requirements**.** The protections for transmission line and the line compensating equipment shall have hundred percent back up communication channels i.e.one tele- protection channel through PLCC and one tele- protection channel over FOTE in addition to one channel for speech plus data for each direction.

1. Bongaigaon (PG) – Nangalbibra 400 kV D/c line (initially operated at 220kV)

On Bongaigaon (PG)– Nangalbibra 400 kV D/c line (initially operated at 220kV) line one (1) OPGW cable containing 24 Fibres is to be installed & commissioned by the TSP on one E/W peak and on other peak conventional earth wire (or OPGW, if desired by TSP) to be installed. The TSP shall install this OPGW from gantry of Bongaigaon (PG) up to the gantry of Nangalbibra S/s with all associated hardware including Vibration Dampers, mid-way Joint Boxes and finally, termination in Joint Boxes (called OPGW Hardware hereafter) at both S/s.

The transmission line length is 140 kms which can be managed as a repeater less link, hence repeater equipment is not envisaged.

Maintenance of OPGW Cable and OPGW Hardware shall be responsibility of TSP.

2. Hatsinghmari (Assam) – Ampati (Meghalaya) 132 kV D/c line.

On Hatsinghmari (Assam) – Ampati (Meghalaya) 132 kV D/c line one (1) OPGW cable containing 24 Fibres is to be installed & commissioned by the TSP in place of conventional earth wire. The TSP shall install this OPGW from gantry of Hatsinghmari (Assam) S/s up to the gantry of Ampati (Meghalaya) S/s with all associated hardware including Vibration Dampers, mid-way Joint Boxes and finally termination in Joint Boxes (called OPGW Hardware hereafter) at both S/s.

The transmission line length is 30 kms which can be managed as a repeater less link, hence repeater equipment is not envisaged.

Maintenance of OPGW Cable and OPGW Hardware shall be responsibility of TSP.

3. Establishment of new 220/132kV, 2X160MVA substation at Nangalbibra.

(I) TSP shall provide 1 no. FODP (96 F) with panel and one (1) no. Approach Cable (24F) with all associated hardware fittings at Nangalbibra S/s.

(II) TSP shall provide STM-16 (FOTE) with panel at the control room of Nangalbibra supporting minimum three (3) MSP (Multiplex Section Protection) with suitable DC Power Supply & necessary interfaces to meet the voice and data communication requirement between Nangalbibra & Bongaigaon S/s.

(III) The integration of Communication equipment with centralized NMS at regional level shall be the responsibility of TSP. Configuration work in existing centralized NMS for integration of new Communication equipment is not in scope of TSP, however all necessary support to integrate new Communication equipment with the existing Centralized NMS shall be ensured by TSP.

(IV) The maintenance of all the communication equipment including FOTE, FODP, approach cable, DCPS along with suitable Battery Bank shall be the responsibility of TSP.

(V) Control Room/Relay panel room (for GIS s/s) shall be designed/planned to have space to accommodate the FOTE & FODP panels required for the line bays as mentioned in the future scope of this project.

4. 2 Nos. of 220kV line bays at Bongaigaon (PG) SS for termination of Bongaigaon (PG) – Nangalbibra 400 kV D/c line (initially operated at 220kV)

(I) TSP shall provide 1 no. FODP (96 F) with panel and 1 no. Approach Cable (24F) with all associated hardware fittings at Bongaigaon (PG) S/s.

(II) TSP shall install FODP & FOTE panels in the existing control room of 400/220kV Bongaigaon (PG) S/s.

(III) TSP shall provide STM-16 (FOTE) with panel at 400/220kV Bongaigaon (PG) S/s supporting minimum three (3) MSP (Multiplex Section Protection) with suitable DC Power Supply & necessary interfaces to meet the voice and data communication requirement between Bongaigaon (PG) & Nangalbibra stations.

(IV) The FOTE mentioned above in (II) shall be integrated by TSP with the existing FOTE at Bongaigaon (PG) S/s which is already communicating with respective control center with necessary interface.

(V) The integration of Communication equipment with centralized NMS at regional level shall be the responsibility of TSP. Configuration work in existing centralized NMS for integration of new Communication equipment is not in scope of TSP, however all necessary support to integrate new Communication equipment with the existing Centralized NMS shall be ensured by TSP.

(VI) The maintenance of all the communication equipment including FOTE, FODP, approach cable, DCPS alongwith Battery Bank shall be the responsibility of TSP.

5. 2 Nos. of 132kV line bays at Hatsinghmari (Assam) for termination of Hatsinghmari (Assam) – Ampati (Meghalaya) 132 kV D/c line.

(I) TSP shall provide 1 no. FODP (96 F) with panel and 1 no. Approach Cable (24F) with all associated hardware fittings at Hatsinghmari (Assam) S/s.

(II) TSP shall carry out survey of 132kV Hatsinghmari (Assam) S/s for space requirement of FODP & FOTE panels and availability of DC power supply required for FOTE in the existing Control Room.

In case space is not available in the existing control room for FOTE & FODP panels, TSP shall accommodate the said panels either by extension of existing control room or other arrangements. TSP shall connect with the existing FOTE in order to commission the communication link.

(III) TSP shall provide STM-16 (FOTE) with panel at Hatsinghmari (Assam) S/s supporting minimum three (3) MSP (Multiplex Section Protection) with suitable DC Power Supply & necessary interfaces to meet the voice and data communication requirement between Hatsinghmari (Assam) & Ampati (Meghalaya) Stations.

(IV) The FOTE mentioned above in (III) shall be integrated by TSP with the existing FOTE at Hatsinghmari (Assam) S/s (if available) which is already communicating with respective control centre. In case spare optical direction is not available in the existing equipment for voice and data communication, TSP to provide new FOTE with suitable interfaces.

(V) The integration of Communication equipment with centralized NMS at regional level shall be the responsibility of TSP. Configuration work in existing centralized NMS for integration of new Communication equipment is not in scope of TSP, however all necessary support to integrate new Communication equipment with the Centralized NMS shall be ensured by TSP.

(VI) The maintenance of all the communication equipment including FOTE, FODP, approach cable, DCPS alongwith Battery Bank shall be the responsibility of TSP.

6. 2 Nos. of 132kV line bays at Ampati (Meghalaya) for termination of Hatsinghmari (Assam) – Ampati (Meghalaya) 132 kV D/c line.

(I) TSP shall provide 1 no. FODP (96 F) with panel and 1 no. Approach Cable (24F) with all associated hardware fittings at Ampati (Meghalaya) S/s.

(II) TSP shall carry out survey of 132kV Ampati (Meghalaya) S/s for space requirement of FODP & FOTE panels and availability of DC power supply required for FOTE in the existing Control Room.

In case space is not available in the existing control room for FOTE & FODP panels, TSP shall accommodate the said panels either by extension of existing control room or other arrangements. TSP shall connect with the existing FOTE in order to commission the communication link.

(III) TSP shall provide STM-16 (FOTE) with panel at Ampati (Meghalaya) S/s supporting minimum three (3) MSP (Multiplex Section Protection) with suitable DC Power Supply & necessary interfaces to meet the voice and data communication requirement between Hatsinghmari (Assam) & Ampati (Meghalaya) Stations.

(IV) The FOTE mentioned above in (III) shall be integrated by TSP with the existing FOTE at Ampati (Meghalaya) S/s (if available) which is already communicating with respective control centre. In case spare optical direction is not available in the existing equipment for voice and data communication, TSP to provide new FOTE with suitable interfaces.

(V) The integration of Communication equipment with centralized NMS at regional level shall be the responsibility of TSP. Configuration work in existing centralized NMS for integration of new Communication equipment is not in scope of TSP, however all necessary support to integrate new Communication equipment with the Centralized NMS shall be ensured by TSP.

(VI) The maintenance of all the communication equipment including FOTE, FODP, approach cable, DCPS alongwith Battery Bank shall be the responsibility of TSP.

7. **PLCC & PBAX:**

Power line carrier communication (PLCC) equipment complete for speech, tele-protection commands and data channels shall be provided on each transmission line. The PLCC equipment shall in brief include the following:-

- Coupling device, line traps, carrier terminals, protection couplers, HF cables, PABX (if applicable) and maintenance and testing instruments.

- At new substation, a telephone exchange (PABX) of 24 lines shall be provided at as means of effective communication among various buildings of the substation, remote end substations and with control centres (RLDC/SLDC) etc.

- Coupling devices shall be suitable for inter-circuit coupling for 220kV & 132kV D/C Transmission lines. The pass band of coupling devices shall have sufficient margin for adding communication channel in future if required. Necessary protection devices for safety of personnel and low voltage part against power frequency voltages and transient over voltage shall also be provided.

- The line traps shall be broad band 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. Decoupling network consisting of line traps and coupling capacitors may also be required at certain substation in case of extreme frequency congestion.

- The carrier terminals shall be of single side-band (SSB) amplitude modulation (AM) type and shall have 4 kHz band width. PLCC Carrier terminals and Protection couplers shall be considered for both ends of the line.

- PLCC equipment for all the transmission lines covered under the scheme (consisting of one set of analog PLCC channel along with circuit protection coupler and one set of Digital protection coupler for both ends) shall be provided by TSP. CVT & Wave trap for all the line bays under present scope shall be provided by TSP.

- TSP shall provide/ undertake necessary addition/ modification/ shifting/ re-commissioning etc. of PLCC equipment due to LILO of transmission lines (wherever applicable).

- All other associated equipment like cabling, coupling device and HF cable shall also be provided by the TSP.

- 2 sets of 48 V battery banks for PLCC/ communication equipment shall be provided at each new Substation with at least 10 hour battery backup and extended backup, if required

FREQUENTLY ASKED QUERIES

1.0 Transmission Line:

1.1 Please clarify that whether shutdowns for crossing of existing transmission lines of POWERGRID/STUs/ Power Evacuation Lines from Generation Plants/ Any other Transmission Licensee will be given to TSP on chargeable basis or free of cost.

Reply: Shutdowns for crossing of existing transmission lines of POWERGRID/ STUs/ Power Evacuation Lines from Generation Plants/ Any other Transmission Licensee will be given to TSP by the concerned owner of the lines as per their own terms & conditions. As far as shutdown of ISTS lines are concerned the same can be availed by approaching respective Regional Power Committee.

1.2 We understand that the suggested swing angle criteria are applicable for Suspension Insulator in Suspension Tower. Further, you are requested to provide similar swing angle and clearance criteria for Pilot Insulator with Jumper & Jumper.

Reply: It is clarified that the swing angle criteria (as mentioned in RFP) for transmission lines is applicable for Suspension Insulator in Suspension Tower. Further, as per Clause 3.0 of Specific Technical Requirements for transmission lines, Transmission service Provider (TSP) shall adopt any additional loading/design criteria for ensuring reliability of the line, if so desired and /or deemed necessary.

1.3 We request you to kindly allow that use of diamond configuration at Power line crossings and the existing owner of the lines may be directed to allow the same for the successful bidders.

Reply: Power line crossing including Diamond configuration is responsibility of the TSP. TSP shall formally submit the profile of the crossing section to the owner of the existing line suggesting proposed crossing alternatives. The crossing will have to be carried out as per approval of owner of the existing line.

1.4 It is requested you to kindly provide present status of Forest Clearances if any transmission line corridor area falling in wildlife forest / reserve forest/ mangroves.

Reply: Based on the preliminary route survey, the process of initiation of forest clearance for the forest stretches, if any, enroute the proposed line alignment will be initiated by way of writing letters to the concerned authority (ies). However, it may be noted that it will be the responsibility of TSP for obtaining forest clearance for the forest stretches as provided in the survey report and also for any forest area encountered during detailed survey.

2.0 Substation

2.1 We understand that space for storage of O&M spare shall be provided by existing owner within the station boundary without any cost. Kindly confirm.

Reply: Space for storage of O&M spares shall be arranged by TSP on its own.

2.2 We presume that the O&M for the end Termination bays will be in the scope of the TSP and TSP shall not be liable for any payment towards O&M to the existing owner of the substation. Kindly confirm.

Reply: Operation and maintenance of the bays is solely responsibility of the TSP.

2.3 With reference to subject scheme of existing sub-station, we assumed following scope of work:

(a) We assumed internal road is available and need not to consider in the present scope of work.

(b) Drainage is available and need not to consider in the present scope of work.

(c) Cable trench extension in adjacent to Main cable trench only under present scope of work.

(d) Levelled area being provided by developer for bay extension.

Reply: Regarding requirement of internal road, drainage, cable trench, leveling of the bay extension area, bidder is advised to visit site and acquaint themselves with the provisions/facilities available at substation.

2.4 Kindly provide the soil investigation report of soil parameters of existing substation.

Reply: Bidder is advised to visit the substation site and ascertain the requisite parameters.

2.5 Kindly confirm, energy accounting of aux. power consumption. Whether it will be on chargeable basis or part of transmission loss.

Reply: It will be on chargeable basis.

2.6 We understand that VMS requirement is for unmanned stations only. For Manned stations VMS is not compulsory.

Reply: VMS shall be provided by TSP in line with requirements of RfP document.

2.7 It is understood that Construction water and power shall be provided free of cost to TSP by respective substation owner for construction of new bays.

Reply: Arrangement of construction power & water is in the scope of TSP.

2.8 It is understood that existing fire hydrant system shall be extended by the TSP for bay extension.

Reply: Existing fire hydrant system shall be extended from existing system (if required)

2.9 Please clarify that Status of land acquisition for Substations. Whether the lands have been acquired by BPC and will be transferred to TSP.

Reply: The acquisition of land for substation is in the scope of TSP.

2.10 We understood that no any dedicated metering CT & CVT required for Line/feeders. Further, we understood that requisite Energy meters for various 765kV, 400kV & 220kV Feeders shall be provided & installed by CTU free of cost to TSP.

Reply: Dedicated metering CT and CVT are not required for line/feeders. Metering core of existing CT/CVT can be used provided accuracy class is matching with metering requirement. Requisite Special Energy Meters shall be provided and installed by CTU in C&P panel subject to space availability, else, in separate metering panel (to be provided by TSP at its cost).

3.0 <u>Communication</u>

3.1 What are the usage of OPGW, FOTE, PMU etc. under communication requirement of RFP?

Reply: User shall be responsible for providing compatible equipment along with appropriate interface for uninterrupted communication with the concerned control center and shall be responsible for successful integration with the communication system provided by CTU.

Communication systems comprising OPGW, FOTE, PMU etc. are required for grid operation through RLDC/SLDC, speech communication, tele-protection and tele-metering.

3.2 Is space for installation of communication panels are provided to TSP in existing Substations incase new bays are in the scope of TSP?

Reply: The space related issues are deliberated in the RFP itself. TSP to carry out survey of the existing substation for physical space requirement. In case space is not available in the existing substation then TSP shall accommodate the same in the respective bay SPR (Switchyard Panel Room)/Bay Kiosk/ Relay panel room in case of GIS s/s. Further, TSP to connect and integrate the proposed FOTE with the existing FOTE in the control room.

In Case 132kV Substation TSP shall accommodate the said panels either by extension of existing control room or other arrangements.

3.3 How is the OPGW laying done in case of LILO lines?

Reply: In case LILO lines are on same towers (e.g. both Line in and Line Out portion are on same towers, generally done LILO of S/C lines), then 2x24F OPGW shall be required to install by TSP on both earthwire peak on 400kV & 765kV lines where two E/W peaks are available. On 220 & 133kV lines where only one E/W peak is available TSP to install one no. 48F OPGW.

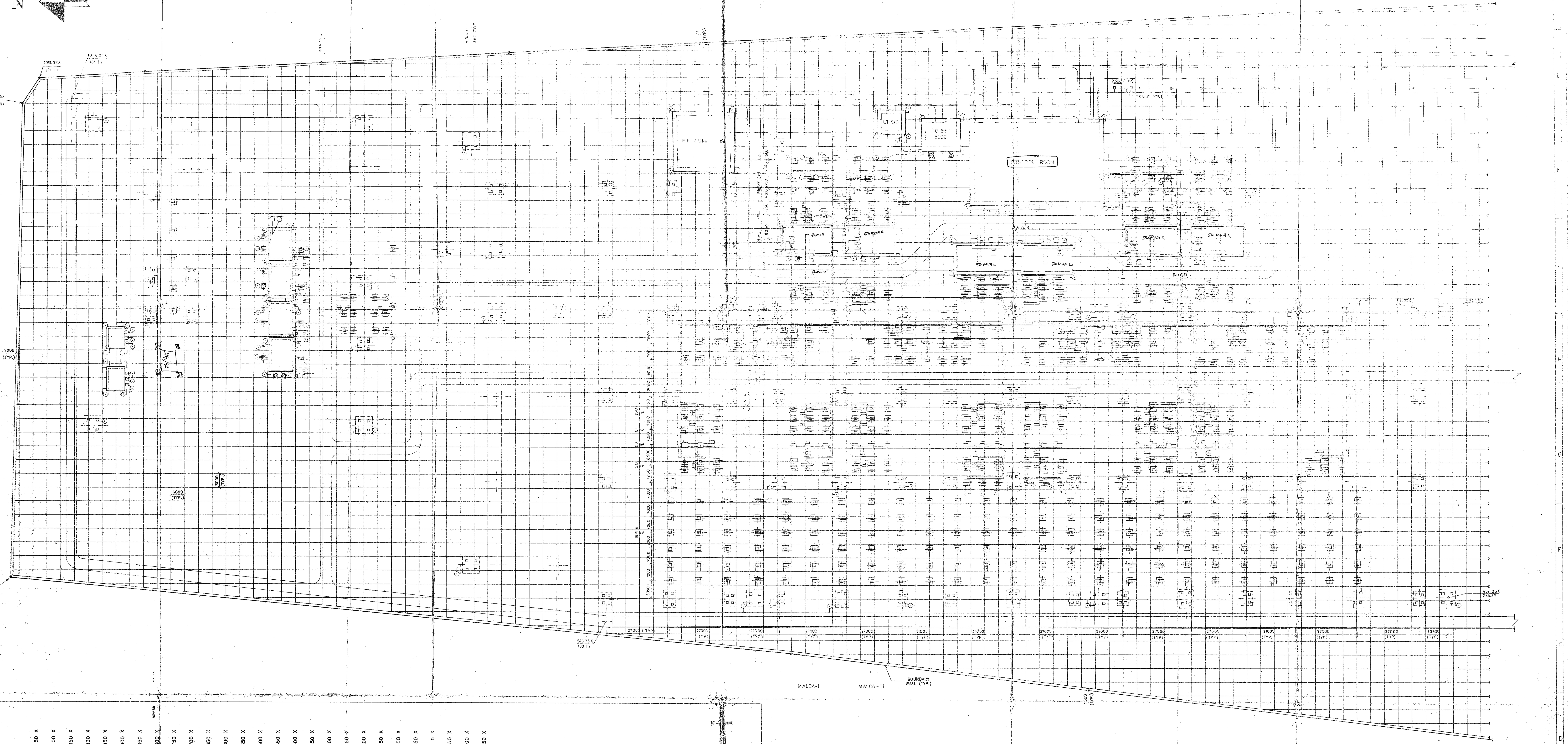
Incase LILO lines are on different towers (e.g. both Line In and Line Out portion are on different towers, generally done LILO of D/C lines), then 1x24F OPGW shall be required to install by TSP on one earthwire peak, on both Line In and

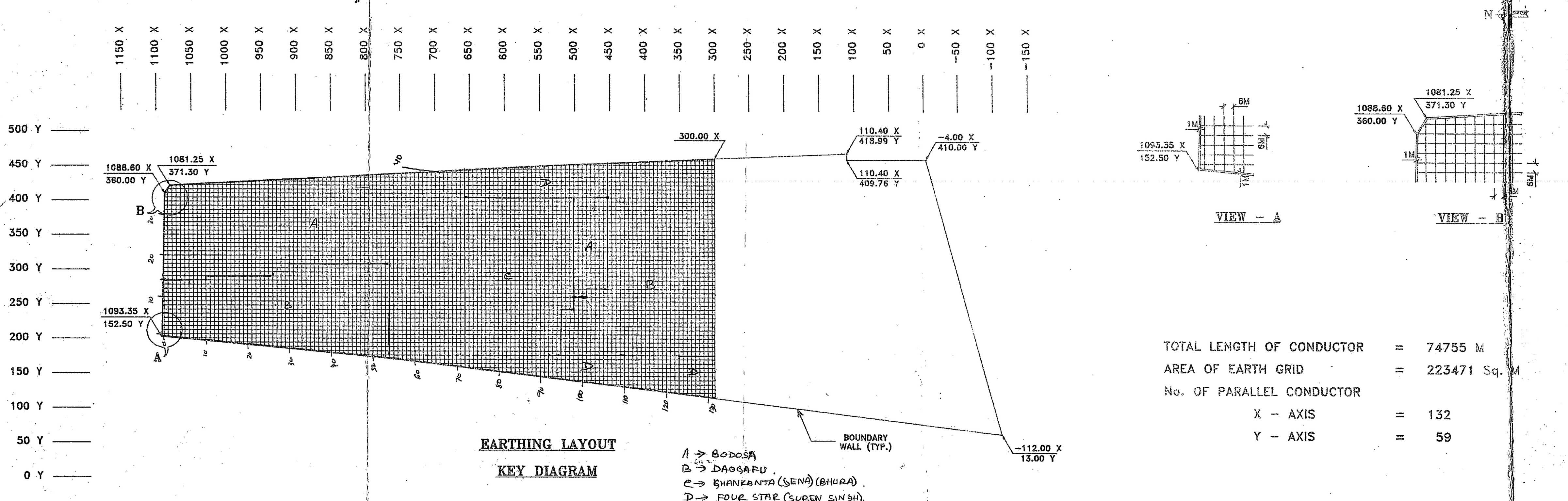
Line Out portions of 400kV & 765kV lines. On 220 &133kV lines where only one E/W peak is available TSP to install one no. 24F OPGW in place of conventional earthwire.

3.4 How is the OPGW laying done in case Multi circuit Towers?

Reply: In case two different lines are using common multi circuit portion for some distance (originating from different stations, may be terminating on same or on different stations), two no. 24F OPGW to be installed on both E/W peaks for common M/C portion of 765kV & 400kV lines.

In case 220/132kV lines using multi circuit portion where single E/W peak is available one no. 48F may be installed for common multi circuit portion.





EARTHING LAYOUT

KEY DIAGRAM

TOTAL LENGTH OF CONDUCTOR = 74755 M
AREA OF EARTH GRID = 223471 Sq. M
No. OF PARALLEL CONDUCTOR
X - AXIS = 132
Y - AXIS = 59

ALL DIMENSIONS ARE IN METRES ONLY

ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SPECIFIED

NOTES:-

1. THIS DWG. IS BASED ON DESIGN CALCULATION OF EARTHING FOR 400/220kV SUBSTATION AT BONGAIGAON.
2. DEPTH OF LAYING OF MAIN EARTHING CONDUCTOR SHALL BE 600mm BELOW THE FINISHED LEVEL.
3. WHERE-EVER EARTHING CONDUCTORS CROSS TRENCHES/PIPES/FOUNDATION/RAIL TRACKS IT SHALL BE LAID MIN. 300mm BELOW THEM OR RE-ROUTED TO SUIT SITE CONDITION.
4. EARTHING CONDUCTORS CROSSING THE ROAD SHALL BE LAID IN GREATER DEPTH TO SUIT SITE CONDITION.
5. ALL CONNECTIONS ABOVE GROUND SHALL BE BOLTED TYPE & ALL CONNECTIONS BELOW GROUND SHALL BE WELDED TYPE. FOR RUST PROTECTION WELDS SHOULD BE TREATED WITH RED LEAD & AFTERWARDS COATED WITH BITUMEN COMPOUND TO PREVENT CORROSION.
6. GATE / EVERY ALTERNATIVE FENCE POST SHALL BE CONNECTED TO MAIN GRID BY ONE EARTHING LEAD.
7. ALL GROUND CONNECTION BELOW G.L. SHALL BE MADE BY ELECTRIC ARC WELDING.
8. AUX. EARTHMAT OF 1500x1500 (300x300 SPACING) AT A DEPTH OF 300mm SHALL BE PROVIDED BELOW OPERATING MECH. OF ISOLATORS. OPERATING MECH. SHALL BE DIRECTLY CONNECTED TO AUXILIARY EARTHMAT.
9. TAP CONNECTIONS FROM MAIN MAT SHALL BE BROUGHT 300mm ABOVE GROUND LEVEL.
10. DOWN CONNECTIONS SHALL BE CLEATED ON STRUCTURES AT 2000mm INTERVAL.
11. RISERS FROM STRUCTURES SHOULD BE CONNECTED TO NEAREST MAIN GRID.
12. EARTHING CONDUCTOR AROUND THE BUILDING SHALL BE BURIED IN EARTH AT A MINIMUM DISTANCE OF 1500mm FROM OUTER BOUNDARY OF THE BUILDING.
13. THE LOCATION OF AUX. MATS FOR ISOLATORS SHOWN IN THIS DRG. ARE INDICATIVE. THE ACTUAL LOCATION W.R.T. THE MECH. BOX LOCATION FOR EACH ISOLATOR SHALL BE AS PER SITE CONDITION.
14. ALL E.H.V. EQUIPMENTS SHALL BE EARTHED BY TWO SEPARATE EARTHING LEADS OF EACH 75x12mm G.S. FLAT (ABOVE GROUND LEVEL) CONNECTED TO THE RISERS (40ø M.S. ROD).
15. ALL STRUCTURES & LIGHTNING MASTS SHALL BE EARTHED BY 75x12mm G.S. FLAT.
16. LOCATION OF RISERS CONNECTIONS SHOWN FOR EQUIPMENTS/TOWERS/STRUCTURES ARE INDICATIVE. EXACT LOCATION MAY BE DECIDED AT SITE.
17. 50x6mm G.S. FLAT EARTH CONDUCTORS ALONG THEIR RUN ON CABLE TRENCH SHALL BE SUPPORTED BY WELDING/CLEATING AT AN INTERVALS OF 750mm. CABLE TRAYS AND SUPPORTS SHALL BE CONNECTED TO EARTHMAT AT EVERY 30 METRES INTERVAL BY 50x6mm G.S. FLAT.
18. OPERATING BOXES & JUNCTION BOXES SHALL BE EARTHED AS PER EQUIPMENT EARTHING DETAILS.
19. REFER SEPARATE DRG. FOR EQUIPMENTS EARTHING DETAILS (DRG.NO. CG/PGCIL-KTS/111 TO 131).

LEGEND :-

- 40ø 3M LONG ROD EARTH ELECTRODE
- ISOLATOR AUXILIARY EARTH MAT 40ø MS ROD
- MAIN EARTHING CONDUCTOR 40ø MS ROD
- RISER EARTHING CONDUCTOR 75x12mm G.S. FLAT (ABOVE GL)
- FENCE POST (TYP.)
- 40ø 3M LONG PIPE EARTH ELECTRODE - 20 No.s (2 No.s FOR ICT's; 8 No.s FOR LINE REACTORS; 4 No.s FOR BUS REACTORS; 4 No.s FOR 4 LT TRANSFORMERS & 2 No.s FOR DG SET.)

REFERENCE DRG. No.:-

1. 400/220kV SUBSTATION PLOT PLAN - CG/PGCIL-KTS/101
2. 400/220kV SUBSTATION LAYOUT-PLAN - CG/PGCIL-KTS/103
3. 400/220kV SUBSTATION LAYOUT-SECTION - CG/PGCIL-KTS/104
4. FOR DETAILS OF EQUIPMENT EARTHING REFER DRG. NO. - CG/PGCIL-KTS/111 TO 131

3 m leg, 40 ø M.S. rods
1) LA=

REV. No.	DESCRIPTION	APPROVED	DATE
2.	DRG. REVISED BASED ON REVISED EARTHING DESIGN	[signature]	28-02-95
1.	DRG. REVISED BASED ON PGCIL COMMENTS LETTER DT. 16.8.94	[signature]	12:10:94

APPROVED IN CATEGORY-I
VIDE LETTER DT. 9.3.95

PROJECT 400/220kV SUBSTATION AT BONGAIGAON KATHALGURI TRANSMISSION PROJECT
CONTRACT No. C-60103-S119-3C DATED 26-11-92
TITLE EARTHING LAYOUT

Crompton Greaves LIMITED
ENGINEERING PROJECTS DIVISION - MADRAS

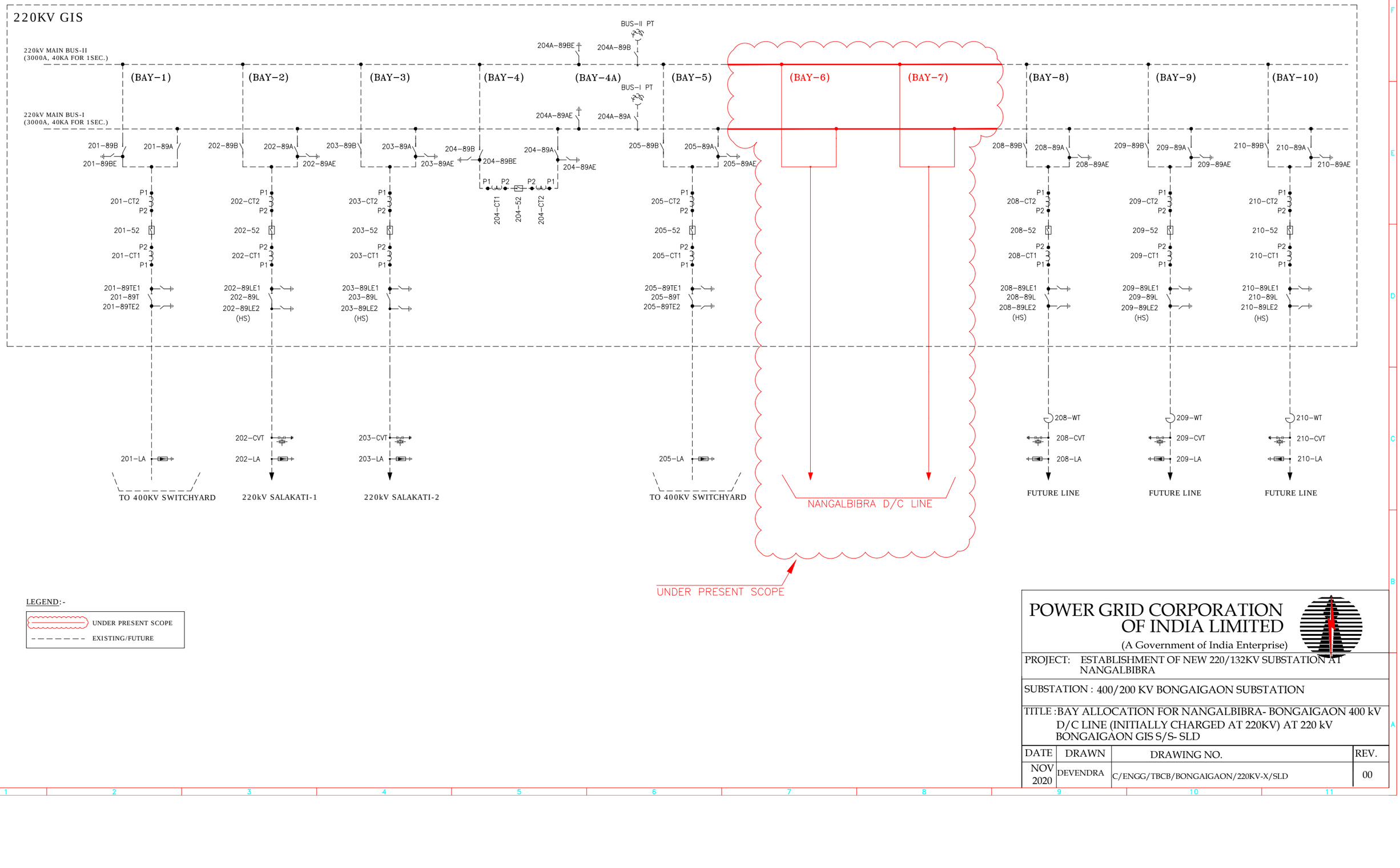
CUSTOMER POWER GRID CORPORATION OF INDIA LTD.

DRAWN	T.Narendran	DATE	29-07-94
CHECKED	[signature]	SCALE	1 : 600
APPROVED	[signature]		
PASSED		SHEET No. 1	OF 1
DRG. No.	CG/PGCIL-KTS/110	REV.	R2

1188 X 841 - A0 PGCIGL01/C-05-03

2160

Bongaigaon



LEGEND:-

- UNDER PRESENT SCOPE
- EXISTING/FUTURE

POWER GRID CORPORATION OF INDIA LIMITED

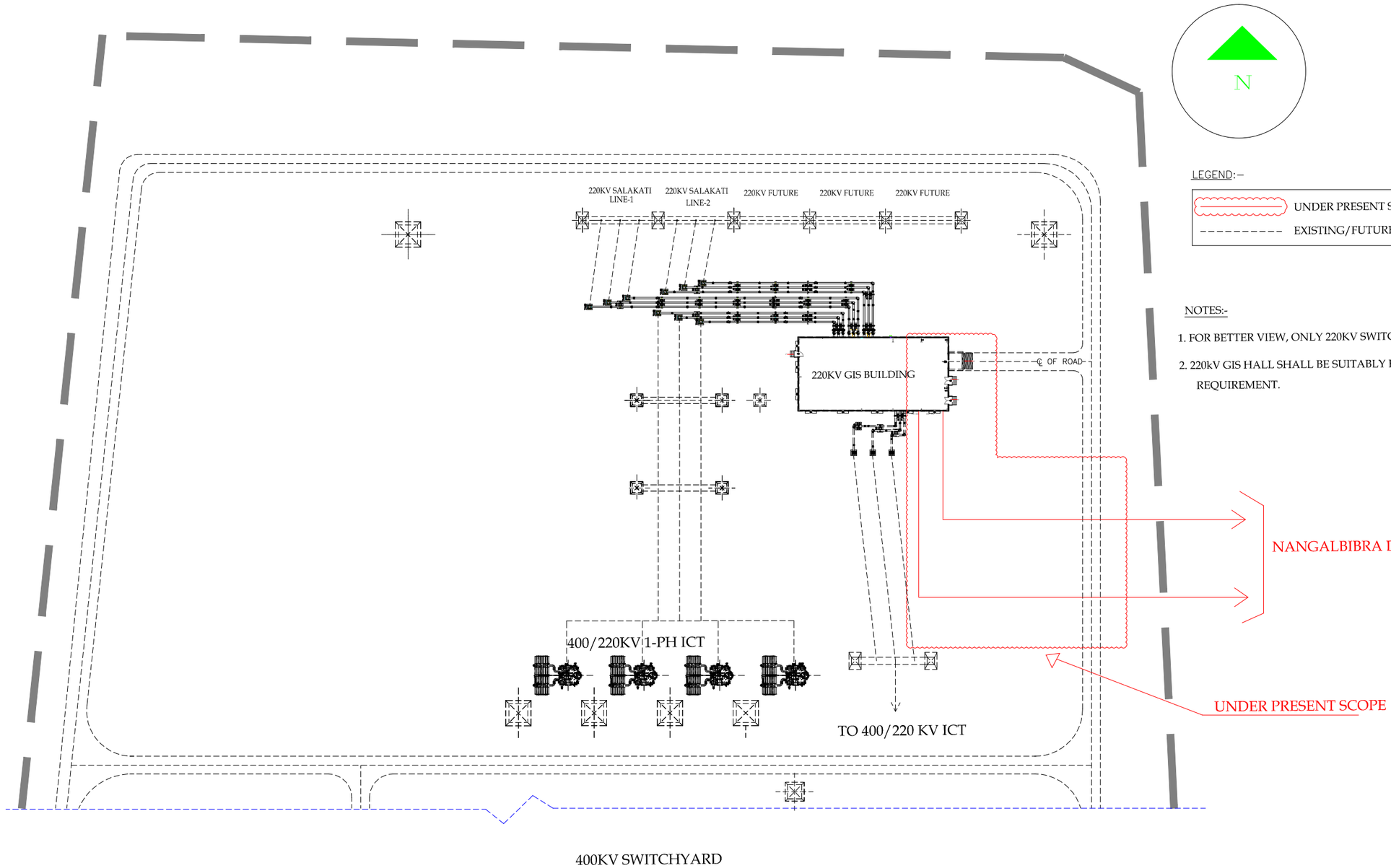
(A Government of India Enterprise)

PROJECT: ESTABLISHMENT OF NEW 220/132KV SUBSTATION AT NANGALBIBRA

SUBSTATION : 400/200 KV BONGAIGAON SUBSTATION

TITLE : BAY ALLOCATION FOR NANGALBIBRA- BONGAIGAON 400 kV D/C LINE (INITIALLY CHARGED AT 220KV) AT 220 kV BONGAIGAON GIS S/S- SLD

DATE	DRAWN	DRAWING NO.	REV.
NOV 2020	DEVENDRA	C/ENGG/TBCB/BONGAIGAON/220KV-X/SLD	00



LEGEND:–

- UNDER PRESENT SCOPE
- EXISTING/FUTURE

NOTES:-

1. FOR BETTER VIEW, ONLY 220KV SWITCHYARD IS SHOWN.
2. 220kV GIS HALL SHALL BE SUITABLY EXTENDED BY TSP AS PER REQUIREMENT.

POWER GRID CORPORATION OF INDIA LIMITED
(A Government of India Enterprise)

PROJECT: ESTABLISHMENT OF NEW 220/132KV SUBSTATION AT NANGALBIBRA

SUBSTATION : 400/200 KV BONGAIGAON SUBSTATION

TITLE : BAY ALLOCATION FOR NANGALBIBRA- BONGAIGAON 400 kV D/C LINE (INITIALLY CHARGED AT 220KV) AT 220 kV BONGAIGAON GIS S/S- GA

DATE	DRAWN	DRAWING NO.	REV.
NOV 2020	DEVENDRA	C/ENGG/TBCB/BONGAIGAON/220KV-X/GA	00