Amendment-I dated 26.05.2025 to the RFP Documents for selection of bidder as Transmission Service Provider to establish intra-state transmission system for "Establishing 400kV Sub-station at Hampapura along with associated transmission lines (Mandya District)" through tariff based competitive bidding process.

Sl. No.	Clause No.	Existing Provisions	New / Revised Provisions
1.	SPECIFIC TECHNICAL REQUIREMENTS FOR SUBSTATION in RFP & TSA	-	Technical requirements for equipment of substation duly incorporating AIS elements are enclosed as **Annexure-A.**
2.	RFP, TSA & SPA	Name of the Project Specific SPV	All the reference to the name of the SPV may be read as "**HAMPAPURA POWER TRANSMISSION LIMITED**".

Annexure-A

SPECIFIC TECHNICAL REQUIREMENTS FOR SUBSTATION

The proposed **400/220kV Substation at Hampapura Substation at Mandya Taluk & District** shall be GIS type generally conforming to the requirements of CEA (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations 2022, as amended from time to time.

The proposed **extension of 765/400 kV C.N. Halli, 220/66 kV Nagamangala, 220/66 kV Maddur, 220/66kV Huygonahalli, and 220/66 kV Tubinakere** shall be conventional AIS type conforming to the requirements of CEA (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations 2022, as amended from time to time.

Other CEA Regulations/guidelines as amended up to date and MoP guidelines, as applicable, shall also be followed.

2.1 Salient features of 400/220 kV Sub Station Equipment and Facilities

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

2.2 Insulation Coordination

420kV System would be designed to limit the Switching over voltage to 2.5 p.u and is expected to decay to 1.5 p.u. in 5 to 6 cycles. Consistent with these values and protective levels provided by lightning arrestors, the following insulation levels shall be adopted for 420kV, 245kV and 36 kV systems:

SL No	Description of parameters	400kV System	220kV System	33kV System
1.	System operating voltage (rms)	400kV	220kV	33kV
2.	Maximum voltage of the system (rms)	420kV	245kV	36kV
3.	Rated frequency	50Hz	50Hz	50Hz
4.	No. of phases	3	3	3
5.	Impulse withstand voltage for - Transformer and reactors - for other Equipment - for insulator strings	1300 kVP 1425 kVP 1550 kVP	950 kVP 1050 kVP 1050 kVP	 250kVP 170kVP
6.	Switching surge withstand Voltage	1050 kVP	-NA-	-NA-
7.	Minimum creepage distance - for insulator strings - for other Equipment	 13020 mm	 7595 mm	 900 mm
8.	Max. fault current	63 kA	50 KA	31.5 KA
9.	Duration of fault	1 Sec	1 Sec	3 Sec
10.	Corona extinction voltage	320kV rms	156kV rms	NA

2.3 Switching Schemes

It is essential that the system should remain secured even under conditions of major equipment or bus- bar failure. Sub-stations being the main connection points have large influence on the security of the system as a whole. The selection of the bus switching scheme is governed by the various technical and other related factors. One & Half breaker bus scheme for 400kV system and Double bus scheme for the 220kV system, have been considered for all proposed GIS substations under present scope of work due to their merits in terms of reliability, security, operational flexibility and ease of maintenance of equipments. In 400kV substations, each circuit of a double circuit transmission line shall be terminated in different diameter. Similarly, 400kV ICTs shall also be terminated in different diameter. Accordingly, following switching schemes shall be adopted.

Voltage / Type of Substation	400kV side	220kV side
GIS Type	One & half breaker	Double bus scheme

2.4 Substation Equipment and facilities:

The switch-gear shall be designed to withstand operating conditions and duty requirements. The equipment shall be designed considering the transmission line capacity.

Sl. No	Description of Bay	400kV	220kV
1	Bus Bar	4500A	3500A
2	Line bays	3150A	1600A
3	ICT bays	3150A	1600A (for 400/220kV)
4	Bus Reactor bays	2000A	NA
5	Bus coupler bays	NA/4500A	3500A

2.5 Power Transformer

500MVA, 400/220/33kV 3-Phase Auto Transformer shall conform to CEA's "Standard Specifications and Technical Parameters for Transformers and Reactors (66 kV and above)" available on CEA website.

2.6 Shunt Reactors

125 MVAR, 420 KV, 3-Phase Reactor shall conform to CEA's "Standard Specifications and Technical Parameters for Transformers and Reactors (66 kV and above)" available on CEA website.

A. Controlled Switching Device at Bus & Line Reactor

The controlling relay shall record and monitor the switching operations and make adjustments to the switching instants to optimize the switching behavior as necessary. It shall provide self-diagnostic facilities, signaling of alarms and enable downloading of data captured from the

switching events.

The controller shall be designed to operate correctly and satisfactorily with the excursion of auxiliary A/C & DC voltages and frequency as specified below:

Normal Voltage	Variation in Voltage	Frequency in Hz	Phase/Wire	Neutral Connection
415V	±10%	50±5%	3/4 Wire	Solidly Earthed
240V	±10%	50±5%	1/2 Wire	Solidly Earthed
220V	190V to 240V	DC	-	Isolated 2 wire system

The controller shall meet the requirements of IEC-60255-4 Appendix 'E' class III regarding HF disturbance test, and fast transient test shall be as per IEC-61000 – 4 level III and insulation test as per 60255 – 5.

2.7 Gas Insulated Switchgear: Refer Technical specification for SF6 gas insulated metal enclosed switchgear (GIS).

2.8 SF6 Circuit Breakers (AIS)

The circuit breakers and accessories shall conform to IEC: 62271-100, IEC: 62271-01 and shall be of SF6 Type. The circuit breakers shall be 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 40 ms for 400kV circuit breakers and 60 ms for 220kV circuit breakers. 400kV and 220kV Circuit breakers shall be provided with single phase and three phase auto reclosing. The Circuit breakers controlling 400kV lines wherever required shall be provided with pre insertion closing resistor of about 450 ohms maximum with 8 milliseconds minimum insertion time for lines longer than 200km. The short line fault capacity shall be same as the rated capacity and this is proposed to be achieved without use of opening resistors. 400kV Circuit Breaker shall be equipped with controlled switching device for controlling of transformer and shunt reactor. The controlled switching device shall be provided in 400kV Circuit breakers of switchable line reactor bay and in Main & Tie bay circuit breakers of line with non- switchable line reactors, Bus reactors and ICTs. All the type test shall be done as per relevant IEC/IS standard. And validity of Type test report shall confirm to CEA guidelines.

The Technical Particulars / Parameters of Circuit Breakers:

Sl. No.	Parameter	400kV system	220kV system
1.	Rated voltage (Umax) kV (rms)	420	245
2.	Rated frequency (Hz)	50	50
3.	No. of poles	3	3
4.	Type of circuit breaker	SF6 gas insulated	SF6 gas insulated
5.	Rated continuous current (A) at an ambient temperature of 50°. C	3150	3150

6.	Rated short circuit capacity with percentage of DC component as per IEC-62271-100 corresponding to minimum opening time under operating conditions specified.	63kA	50 kA
7.	Symmetrical interrupting capability (rms)	63kA	50 kA
8.	Rated short circuit making current	157.5 kAp	125 kAp
9.	Short time current carrying capability (rms)	63 for one second	50 for one second
10.	Out of phase breaking current carrying capability (rms)	15.75	As per IEC
11.	Rated line charging interrupting current at 90°. Leading power factor angle (rms) (The breaker shall be able to interrupt the rated line charging current with test voltage immediately before opening equal to the product of U/√3 and 1.4 as per IEC-62271-100	600 A	As per IEC
12.	First pole to clear factor	1.3	1.3
13.	Temperature rise over an ambient temperature of 50°C	As per IEC: 62271-100	As per IEC: 62271-100
14.	Rated break time as IEC (with limiting auxiliary voltage at all duties)	40 ms	60 ms
15.	Total break time	40ms	50ms
16.	Total closing time	Not more than 110ms	Not more than 100ms
17.	Operating mechanism or a combination of these	Spring	Spring
18.	Rated operating duty cycle	O-0.3s-CO-3 min-CO	O-0.3s-CO-3 min-CO
19.	Reclosing	Single phase &Three phase auto reclosing.	Single phase &Three phase auto reclosing.
20.	Pre-insertion resistor requirement		
i)	Rating (ohms)	400(max.) with tolerance as applicable	NA
ii)	Minimum electrical (mechanical insertion time+pre-arcing time) pre-insertion time (ms)	8	NA

iii)	Opening of PIR contacts	PIR contacts should open immediately after closing of main contacts OR At least 5 ms prior to opening of main contacts at rated air/gas pressure where the PIR contacts remain closed.	NA
21.	Max. difference in the instants of closing/opening of contacts (ms) between poles at rated control voltage and rated operating & quenching media pressures	2.5 (within a pole) 3.3(opening) 5.0 (closing)	3.3(opening) 5.0(closing)
22.	Maximum allowable switching over voltage under any switching condition	2.3 p.u.	As per IEC
23.	Trip coil and closing coil voltage with variation as specified	220V DC	220V DC
24.	Noise level at base and up to 50 m distance from base of circuit breaker	140dB (max.)	140dB (max.)
25.	Rating of Auxiliary contacts	10A	10A
26.	Breaking capacity of Aux. Contacts	10A DC with circuit time constant not less than 20ms	10A DC with circuit time constant not less than 20ms
27.	Rated insulation levels		
i)	Full wave impulse withstand (1.2 /50 µs) between line terminals and ground	±1425 kVp	±1050 kVp
ii)	Full wave impulse withstand (1.2 /50 µs) between terminals with circuit breaker open	1425 kVp impulse on one terminal & 240 kVp power frequency voltage of opposite polarity on the other terminal	±1050 kVp
iii)	Rated switching impulse withstand voltage (250/2500 µs) Dry & wet between line terminals and ground	+1050 kVp .	NA
iv)	Rated switching impulse withstand voltage (250/2500 µs) Dry &wet Between terminals with circuit breaker open voltage of opposite polarity on the other terminal	900 kVp impulse on one terminal & 345 kVp power frequency	NA

v)	One minute power frequency dry withstand voltage between line terminals and ground	520 kV rms.	460 kV rms.
vi)	One minute power frequency dry withstand voltage between terminals with circuit breaker open	610 kV rms.	460 kV rms.
28.	Minimum corona extinction voltage with CB in all positions	320kV rms	156 kV rrms
29.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz (Micro volts)	1000 µV (at 266kV rms)	1000 µV (at 156kV rms)
30.	Minimum Creepage distance		
i)	Phase to ground (25mm/kV)	13020mm	7595mm
ii)	Between CB terminals	13020mm	7595mm
31.	Rated capacitance current switching duty	C2	C2
32.	Rated Mechanical Endurance duty	M2	M2

2.9 Isolators (AIS)

The isolators shall comply to IEC 62271-102 in general. 400kV& 220kV isolators shall be double break type. All Isolators and earth switches shall be motor operated. Earth switches are provided at various locations to facilitate maintenance. Isolator rated for 400kV & 220kV shall be of extended mechanical endurance class-M2 and suitable for bus transfer current switching duty as per IEC-62271-102 Main blades and earth blades shall be interlocked and interlock shall be fail safe type. 400kV & 220kV earth switch for line isolator shall be suitable for induced current switching duty as defined for Class-B as per relevant standard. All the type test shall be done as per relevant IEC/IS standard. And validity of Type test report shall confirm to CEA guidelines.

The Technical Particulars / Parameters of Isolators:

Sl. No.	Description	Unit	420kV Isolator	245kV Isolator
1	Rated voltage	kVrms	420	245
2	Rated frequency	Hz	50	50
3	No. of poles	Nos.	3	3
4	Design ambient Temperature	°C	50	50
5	Type		Outdoor, AC Motor Operated	Outdoor, AC Motor Operated

6	Rated current at 50°. C ambient temperature	A	2000A/3150A (as applicable)	1600A/2500A (as applicable)
7	Rated short time withstand current of isolator and earth switch	kA	63 for 1 sec	50 for 1 sec
8	Rated dynamic short time withstand current of isolator and earth switch	kAp	157.5 kAp	125 kAp
9	Temperature rise over design ambient temperature	-	-	-
10	Operating mechanism of isolator/earth switch		A.C. Motor operated	A.C. Motor operated
11	Max. Operating time	secs	20 secs or less	12 secs or less
12	Rated Insulation levels			
a)	Full wave impulse Withstand voltage (1.2/50 microsec.)			
i)	between line terminals and ground	kVp	±1425	±1050
ii)	between terminals with isolator open	kVp	±1425 kVp impulse on one terminal and 240 kVp power frequency voltage of opposite polarity on other terminal	±1200
b)	Switching impulse Withstand voltage (250/2500 micro- second) dry and wet			
i)	between line terminals and ground	kV peak	± 1050	-NA

ii)	between terminals with Isolator open	kV peak	900 kVp impulse on one terminal and 345 kVp power frequency voltage of opposite polarity on other terminal	-NA
c)	One minute power frequency dry withstand voltage			
i)	between line terminals and ground	kV rms	520	460
ii)	between terminals with isolator open	kV rms	610	530
13	Minimum Corona extinction voltage with Isolator in all positions	kV rms	320	156
14	Max. radio interference voltage for frequency between0.5 MHz and 2 MHz in all positions	Micro volts	500 at 320 kVrms	500 at 156 kVrms
15	Seismic acceleration		As per	As per
			IS:1893	IS:1893
16	Thermal Rating of Auxiliary Contacts	A	10 A at 220V DC	10 A at 220V DC
17	Breaking Capacity of auxiliary contacts		2 A DC with circuit time constant not less than 20 ms	2 A DC with circuit time constant not less than 20 ms
18	System neutral earthing		Effectively Earthed	Effectively Earthed

2.10 Current Transformers (AIS)

Current Transformers shall comply with IEC 61869. All ratios shall be obtained by secondary taps. Generally, Current Transformers (CT) for 400kV & 220 kV shall have six cores (four for protection and two 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 PS 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 for CTs upto 400 kV voltage class. All the type test shall be done as per relevant IEC/IS standard. And validity of Type test report shall confirm to CEA guidelines.

The Technical Particulars / Parameters of Current Transformers:

Sl. No.	Description	400kV system	220kV system
1	Rated voltage, Um (kVrms)	420	245
2	Rated frequency (Hz)	50	50
3	No. of Poles	1	1
4	Design ambient temperature (°C)	50	50
5	Rated Primary Current (A)	(i) 3000-2000/1A (ii) 2000-1000-500/1A	(i) 1600-800/1A (ii) 3000-2000/1A
6	Rated extended primary Current	125%	125%
7	Rated short time thermal withstand current (kA)	63 for 1 sec	50 for 1 sec
8	Rated dynamic current	157.5 kAp	125 kAp
i)	between line terminals and ground (kVpeak)	±1425	±1050
i)	between line terminals and ground (kVpeak)	± 1050	-NA-
i)	between line terminals and ground (kVrms)	630 (dry only)	460
9	No. of Cores	6 (4 nos. for Protection & 2 nos. for metering)	6 (4 nos. for Protection & 2 nos. for metering)

2.11Capacitor Voltage Transformers (CVT)

Capacitive Voltage transformers shall comply to IEC-61869. 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 shall be 0.2. The voltage transformers on lines shall be suitable for Carrier Coupling. The Capacitance of CVT shall be 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 100 VA for metering core) for better sensitivity and accuracy. All the type test shall be done as per relevant IEC/IS standard. And validity of Type test report shall confirm to CEA guidelines.

The Technical Particulars / Parameters of Capacitor Voltage Transformers:

Sl. No.	Description	420kV CVT	245kV CVT
1	Rated primary voltage (kV rms)	420	245

2	Rated frequency (Hz)	50	50
3	No. of Poles	1	1
4	Design ambient temperature (°C)	50	50
5	System fault level (kA for 1 sec)	63 for 1 sec	50 for 1 sec
6	Standard reference range of frequencies for which the accuracy are valid	96% to 102%for protection and 99% to 101 % for measurement	
7	High frequency capacitance for entire carrier frequency range (for CVT only)	Within 80% to 150% of rated capacitance	
8	Equivalent series resistance over entire carrier frequency range (for CVT)	Less than 40 Ohms	
9	Stray capacitance and stray conductance of HF terminal over entire carrier frequency range (for CVT)	As per IEC-60358	
10	Temperature rise over design ambient temperature	As per IEC-61869	
11	Rated Insulation levels		
a)	Full wave impulse withstand voltage (1.2/50 microsec.)		
i)	Between line terminals and ground	±1425 kVp	±1050kVp
b)	Switching impulse withstand voltage (250/2500 micro-second) dry and wet		
i)	Between line terminals and ground	±1050 kVp	-NA-
c)	One minute power frequency dry withstand voltage		
i)	between line terminals and ground (kVrms)	630 (dry only)	460
d)	One minute power frequency withstand voltage between secondary terminals & earth		
i)	Between LV (HF) terminal and earth terminal (kVrms)	10kV rms for exposed terminals and 4kV rms for terminals enclosed in a weather proof box	
ii)	For secondary winding	3kVrms	
12	Max. radio interference voltage for frequency between0.5 MHz and 2 MHz at (microvolts)	1000 at 266kV rms	1000 at 156kV rms
13	Minimum Corona extinction voltage (kVrms)	320	176
14	Partial Discharge	As per IEC	As per IEC

15	Type	Single phase Electromagnetic or Capacitor VT	
16	No. of secondaries	3 cores	3 cores
17	Rated voltage factor	1.2 - continuous 1.5 - 30seconds	1.2 - continuous 1.5 - 30seconds
18	Phase angle error	± 10 minutes (For metering core)	± 10 minutes (For metering core)
19	Capacitance (pf) (for CVT)	8800/4400 (+10%/-5%)	8800/4400 (+10%/-5%)
20	Core details	Core-1, Core-2 & Core-3	Core-1, Core-2 & Core-3
a)	Voltage Ratio	Core-1:-(400/√3)/ (0.11/√3) Core-2:-(400/√3)/ (0.11/√3) Core-3:-(400/√3)/ (0.11/√3)	Core-1:-(220/√3)/ (0.11/√3) Core-2:-(220/√3)/ (0.11/√3) Core-3:-(220/√3)/ (0.11/√3)
b)	Application	Core-1:- Protection Core-2:- Protection Core-3:-Metering	Core-1:- Protection Core-2:- Protection Core-3:-Metering
c)	Accuracy	Core-1:-3P Core-2:-3P Core-3:- 0.2	Core-1:-3P Core-2:-3P Core-3:- 0.2
d)	Min. Output burden (VA)	Core-1:- 100VA Core-2:-100VA Core- 3:- 100VA	Core-1:- 100VA Core-2:-100VA Core- 3:- 100 VA
21	Rated Total Thermal Burden (VA)	300 VA (100 VA/winding)	
22.	Minimum Cantilever Strength	500kg	

2.12 Surge Arresters (AIS)

Station class, heavy duty gapless type Surge arresters conforming to IEC 60099-4 in general shall be provided. The rated voltage of Surge arrester and other characteristics are chosen in accordance with system requirements. Surge arresters shall be provided near line entrances, Transformers & Reactor so as to achieve proper insulation coordination. Porcelain/Polymer housing if provided for SA shall be fitted with pressure relief devices and diverting ports suitable for preventing shattering of Porcelain/Polymer housing provide path for the flow of rated currents in the event of arrestor failure. A leakage current monitor with surge counter shall be provided with each surge arrestor. All the type test shall be done as per relevant IEC/IS standard. And validity of Type test report shall confirm to CEA guidelines.

The Technical Particulars / Parameters of Surge Arresters:

Sl. No.	Description	Unit	420kV SA	245kV SA

1	Nominal System Operating voltage	kV, rms	400	220
2	Rated frequency	Hz	50	50
3	No. of Poles	No.	1	1
4	Design ambient Temperature	°C	50	50
5	Rated arrester voltage	kV	336	198
6	Continuous operating voltage at 50°.C	kV	390	216
7	Nominal discharge current		20 kA of 8/20 microsecond wave	10 kA of 8/20 microsecond wave
8	Discharge current at which insulation co-ordination will be done		20 kA of 8/20 microsecon d wave	10 kA of 8/20 microsecon d wave
9	Minimum discharge capability (referred to rated arrester Voltage) or Corresponding to minimum discharge voltage as per clause-2.0(d) whichever is higher	kJ/kV	12kJ/kV	7kJ/kV
10	Max. switching surge residual voltage	kVp	670 (at 2kA) 650 (at 500A)	500 (at 1kA)
11	Max. residual voltage at			
i)	5kA	kVp	-	560
ii)	10kA nominal discharge current	kVp	800	480
iii)	20kA nominal discharge current	kVp	850	-
12	Cantilever Strength (for 1 minute withstand test)	kg	1000	1000

2.13 Protection & Control

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 (Edition-I &II, site selector) communication interface. All numerical relays shall have built in disturbance recording feature. The auto transformer protection should be provided with two no. differential relays of different make &algorithm.

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

400kV and 220kV lines shall have MAIN-I numerical four zones distance protection scheme with carrier aided inter-tripping feature. The fourth zone shall be the reverse zone. 400 kV and 220 kV lines shall also have MAIN-II numerical distance protection scheme like Main-I but from different make that of MAIN-I. However, Line Current Differential relay (with back up distance protection feature) as Main–I & Main-II may be considered, for short lines (line length less than 10 kM) having Fibre Optic communication link for which line differential relay have to be provided for remote end also. 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. 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. Associated power & control cabling and integration with SAS at remote end shall be provided by respective bay owner.

All 400kV lines shall also be provided with two stages over voltage protection. Further, all 400kV & 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 fault on transmission lines.

Over voltage protection & distance to fault locator may be provided as in-built feature of Main-I & Main- II protection relays. Auto reclose as built in 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 400kV and 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/Transformer protection:

These shall have the following protections:

(i) Numerical Differential protection
(400/220/11 kV shall have two differential protection relays. The second

differential relay shall be provided on IV side C&R panel to avoid congestion on HV side C&R panel. The differential relay shall have different make and algorithm.)

(ii) Numerical Restricted earth fault protection
(iii) Numerical Over-current and earth fault protection on HV & IV side
(iv) Numerical Over fluxing protection on HV & IV side
(v) Numerical Overload alarm
(vi) Neutral displacement

Further, Numerical Back-up Over-current and earth fault protection on HV & IV side of auto-transformer 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 BUCHOLZ relay, protection against high oil and winding temperature and pressure relief device, OSR etc. The auto transformer protection should be provided with two no. differential relays of different make & algorithm.

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) 400 kV 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
(iv) Numeric back up – over current & Earth fault protection

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

d) Numerical Bus Bar Protection

The high speed low impedance 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 400kV and 220kV buses. Duplicated bus bar protection is envisaged for 400kV bus-bar protection. 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 the complete bus bar protection for present as well for present as well as for 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. For existing substations, the existing bus bar protection shall be augmented wherever required.

e) Numerical Local Breaker Back up Protection

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

2.14 Control Concept

All the EHV breakers in substation/switching stations shall be controlled and synchronized from the switchyard control room and remote control center. Each breaker would have two sets of trip circuits which would be connected to separately fused DC supplies for greater reliability. All the isolators shall have control from remote/local whereas the earth switches shall have local control only.

2.15 Substation Automation System

(a) For all the new substations, state of art Substation Automation System (SAS) conforming to IEC- 61850 (Edition-I & II site selectable) 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 for voltage level 220 kV and above. 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 redundant Human Machine Interface (HMI) from the Control Room. Additionally IEC 61850 based annunciator system shall be provided for backup.

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

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

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

In the existing Substations where Substation automation is not provided, control functions shall be done through control panels & also interfaced to existing RTU/SCADA.

Necessary gateway and modems (as required) shall be provided to send data to RLDC/ SLDC as per their requirement and shall be provisioned with 2+2 redundancy i.e. 2 channels for Main Control Centre and 2 channels for Backup Control Centre. In order to meet this requirement, suitable redundancy at port and card level need to be ensured by the TSP to avoid any single point of failure which may lead to interruption in real-time grid operation. Accordingly, all the hardware for communication services of station as stated above shall support dual redundancy for data transmission of station to respective main and backup RLDCs. Any augmentation work at RLDC/ SLDC is in 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 and 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 and IEDs etc.

2.16 Substation Support facilities

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

2.17 AC & DC power supplies

For catering to the requirements of three phase & single phase AC supply and DC supply for various substation equipment's, the following arrangement is envisaged. However, for substation extension / augmentation, existing facilities shall be augmented as required -

i) For LT Supply at 400/220kV New Substation, one (1) no. 630kVA, 11/0.433kV Transformers shall be provided which shall be connected with 11kV bus of nearby substation and one (1) no. 1MVA, 33/0.433kV on tertiary of 400/220/33kV Auto-transformer. The maximum permissible losses shall be as per Table 6 of IS-1180.

ii) Metering arrangement with Special Energy Meters (SEMs) shall be provided by TSP at 33kV tertiary of Transformer for drawing auxiliary supply at new substation. Such SEMs may be provided by STU at the cost of the TSP. Accounting of such energy drawn by the TSP shall be done by SLDC as part of State Energy Accounting. Additionally, Active Energy Meters may be provided at the same point in the 33kV tertiary of Transformer by local SEB/DISCOM for energy accounting,

iii) 2 Sets batteries of 220V for control & protection and 2 Sets 48V batteries for PLCC/ Communication equipment shall be provided at each new Substation with at least 10 hours battery backup and extended back up as required. Each battery bank would have a float-cum- boost charger. Battery shall be of plante type.

iv) Suitable AC & DC distribution boards and associated LT Switchgear would be provided at new Substations. 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 present and future feeders as specified.

For Substation Extensions, existing facilities shall be augmented as required. For new substations following switchboards 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 no.
(b) AC distribution board – 1 no.
(c) Main lighting distribution board – 1no.

(d) Emergency lighting distribution board – 1no.
(e) 220 Volt DC distribution board – 2nos.
(f) 48 Volt DC distribution board – 2nos.

415V Main Switch Board & AC distribution board shall be provided with at least two incomers with one bus coupler and AC supply shall have redundancy.

v) In new Substations, one No. 250 KVA DG set shall be provided for emergency applications.
vii) Sizing of Auxiliary system (like battery, charger, LT switchgear) may be done considering future bay requirements to avoid replacement in future with higher sizes.

2.18 Fire Fighting System

Fire-fighting system in general conforms to fire insurance regulations of India. The fire-fighting system is proposed with both AC motor & diesel engine driven pump house in a fire fighting pump house building along with water storage tank of adequate capacity and oil soak pit of adequate capacity in line with Central Electricity Authority (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations, 2022 to drain transformer oil in case of fire or otherwise. Automatic heat actuated emulsifying system to be provided for fire protection of Transformers. However, Nitrogen Injection Fire Protection System (NIFPS) shall be required for 400 kV and 220 kV Class Transformers. In addition, for alarm system based on heat/smoke detectors are proposed to be installed at sensitive points in a substation e.g. Cable Vault, Control Room building and other buildings etc. 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.

Optical Beam type heat detection for GIS hall fire protection system shall be provided for all the GIS halls. All fire protection system shall also comply with the requirement of CEA (Measures Relating to Safety & Electric Supply) regulations.

2.19Oil 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 tanks of adequate capacities for storage of transformer oil would be provided.

2.20 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.

The entire control room building, fire-fighting pump house, other buildings (if any) and switchyard shall be done by LED based low power consumption luminaries.

2.21 Control Room & GIS Building

Substation control room shall be provided to house substation work station for station level control (SAS) along with its peripheral and recording equipment's, AC & DC distribution boards, DC batteries & associated battery chargers, Fire Protection panels, Telecommunication panels & other panels as per present 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. Modular multidiamter cable sealing system which is water proof, fire proof, rodent proof wherever the control cable/Power cable/Instrumentation cable enter or leave the control room, shall be provided.

2.22 PT Distribution Scheme

A suitable PT distribution scheme for 400kV & 220 kV has to be provided by TSP. TSP may visit the existing Sub-Stations in order to familiarize themselves with the existing system. The PT distribution board must be suitable for distributing the main bus PTs to all the feeder/transformers. The Potential transformers shall comply with the relevant codes/standards. The number of secondary cores, accuracy class and burden shall be in accordance with the requirements of the protection and metering system. Rated burden shall be nearest to the burden computed; however it shall not exceed 100 VA. The accuracy class for metering core shall be equal to or better than the accuracy class of the meter specified in the Central Electricity Authority (Installation and Operation of Meters) Regulations.

2.23 Phasor Measurement Unit (PMU)

The substations are provided with CTs on each bay of the switchyard and CVTs/PTs in each transmission line bay and on each bus. The CTs have one metering core and four protection cores. The CVTs are provided with three cores for metering/protection. The offered Phasor Measurement Unit (PMU) shall be connected to either of these CT and CVT cores. PMUs shall be suitable for measurement on both the cores (Meter & Protection).
The PMUs to be installed at the Substations / Power stations, shall communicate to the existing Phasor Data Concentrator (PDC) installed at SLDC as per IEEE C37.118.1-2011, IEEE C37.118.2-2011 & C37.118.1a-2014 standard or IEC/IEEE 60255-118-1:2018 Standard with all amendments. PMU complying IEC/IEEE 60255-118-1:2018 Standard shall be preferred. The PMU shall be capable of reporting with its full features to the existing PDC installed at SLDC under the Unified Real Time Dynamic State Monitoring (URTDSM) Project. The PMU's are to be provided for each feeder bays and transformers in 400kV substations and the data is to be transferred through single channel to SLDC.