Amendment No. 3 dated 09.06.2020 to Request for Proposal (RfP) and Transmission Service Agreement (TSA) for selection of Transmission Service Provider through tariff based competitive bidding process to establish "Transmission System Strengthening Scheme for Evacuation of Power from Solar Energy Zones in Rajasthan (8.1 GW) under Phase-II Part-E"

<table>
<tr><th>S.No.</th><th>Existing Provision</th><th>Amended Provision</th></tr>
<tr><td colspan="3">Request for Proposal (RFP) / Transmission Service Agreement (TSA)</td></tr>
<tr><td>1.</td><td>Request for Proposal Notification Sl. No. 2, Transmission Element of Introduction in Clause 1.2, Project Schedule in Clause No. 2.6.1, Bidders undertaking in Annexure-8 of the RfP and Detailed Scope of Work of Schedule-2 &Schedule-3 of TSA
<table>
<tr><th>S.No</th><th>Name of Transmission Element</th><th>Capacity/km</th><th>Scheduled COD in months from Effective Date</th></tr>
<tr><td>1.</td><td>Bhadla-II PS – Sikar-II 765kV D/c line(2nd)</td><td>Length- 310 km</td><td rowspan="4">18 Months (Dec' 2021)#</td></tr>
<tr><td>2.</td><td>2 no. of 765 kV line bays each at Bhadla- II and Sikar-II for Bhadla-II PS – Sikar-II 765kV D/c line</td><td>765 kV line bays – 4*</td></tr>
<tr><td>3.</td><td>1x330 MVAr switchable line reactor for each circuit at Sikar-II end of Bhadla-II PS – Sikar-II 765kV D/c line</td><td>330 MVAr, 765 kV reactor- 2

Switching equipment for 765 kV reactor - 2</td></tr>
<tr><td>4.</td><td>1x240MVAr switchable line reactor for each circuit at Bhadla-II end of Bhadla-II PS – Sikar-II 765kV D/c line</td><td>240 MVAr, 765 kV reactor- 2

Switching equipment for 765 kV reactor - 2</td></tr>
</table>
#Scheduled COD in months is considering Effective Date in June 2020, It is clarified that in case there is delay in achieving Effective Date, the schedule shall be compressed accordingly to achieve Scheduled COD by December, 2021.

Note:
i. As per MoM of 6th NCT held on 30.09.2019, it was decided that the scheme is to be implemented by December 2021.
ii. POWERGRID to provide space for 2 no of 765 kV bays and space for 2 no of</td><td>Request for Proposal Notification Sl. No. 2, Transmission Element of Introduction in Clause 1.2, Project Schedule in Clause No. 2.6.1, Bidders undertaking in Annexure-8 of the RfP and Detailed Scope of Work of Schedule-2 &Schedule-3 of TSA
<table>
<tr><th>Sl. No.</th><th>Name of the Transmission Element</th><th>Scheduled COD from Effective Date</th><th>Conductor Per Phase</th></tr>
<tr><td>1.</td><td>Bhadla-II PS – Sikar-II 765kV D/c line(2nd)</td><td rowspan="4">March 2022</td><td>Hexa Zebra ACSR

The transmission lines shall consist of either ACSR or equivalent AAAC or equivalent Al59 conductor as specified under specific technical requirements in RfP.</td></tr>
<tr><td>2.</td><td>2 no. of 765 kV line bays each at Bhadla- II and Sikar-II for Bhadla-II PS – Sikar-II 765kV D/c line</td><td></td></tr>
<tr><td>3.</td><td>1x330 MVAr switchable line reactor for each circuit at Sikar-II end of Bhadla-II PS – Sikar-II 765kV D/c line</td><td></td></tr>
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</table>
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Note:</td></tr>
</table>

S.No.	Existing Provision	Amended Provision
	line reactors at Bhadla II substation iii. Developer of Sikar-II PS to provide space for 2 no of 765 kV bays and space for 2 no of line reactors at Sikar-II PS iv. The spare unit of 765kV, 1x80 MVAR Reactor proposed to be provided at Bhadla II PS under 'Transmission system strengthening for evacuation of power from solar energy zones in Rajasthan (8.1 GW) under Phase II –Part B' shall be utilized as common spare for 6x80 MVAR Switchable Line Reactors to be provided at Bhadla-II PS each under 'Transmission system strengthening for evacuation of power from solar energy zones in Rajasthan (8.1 GW) under Phase II –Part C' and 'Transmission system strengthening for evacuation ofpower from solar energy zones in Rajasthan (8.1 GW) under Phase II –Part E'. v. The spare unit of 765kV, 1x110 MVAR Reactor being provided at Sikar-II PS under 'Transmission system strengthening for evacuation of power from solar energy zones in Rajasthan (8.1 GW) under Phase II –Part C' shall be utilized as common spare for 6x110 MVAR Switchable Line Reactors to be provided at Sikar-II PS each under 'Transmission system strengthening for evacuation of power from solar energy zones in Rajasthan (8.1 GW) under Phase II –Part D' and 'Transmission system strengthening for evacuation of power from solar energy zones in Rajasthan (8.1 GW) under Phase II –Part E'. vi. The line lengths mentioned above are approximate as the exact length shall be obtained after the detailed survey	i. **Deleted** ii. POWERGRID to provide space for 2 no of 765 kV bays and space for 2 no of line reactors at Bhadla II substation iii. Developer of Sikar-II PS to provide space for 2 no of 765 kV bays and space for 2 no of line reactors at Sikar-II PS iv. **Deleted** v. The spare unit of 765kV, 1x110 MVAR Reactor being provided at Sikar-II PS under 'Transmission system strengthening for evacuation of power from solar energy zones in Rajasthan (8.1 GW) under Phase II –Part C' shall be utilized as common spare for 6x110 MVAR Switchable Line Reactors to be provided at Sikar-II PS each under 'Transmission system strengthening for evacuation of power from solar energy zones in Rajasthan (8.1 GW) under Phase II –Part D' and 'Transmission system strengthening for evacuation of power from solar energy zones in Rajasthan (8.1 GW) under Phase II –Part E'. vi. **Deleted**
2.	**Annexure-B Technical Specifications of Transmission System of RfP and Schedule-2 of TSA**	**Annexure-B Technical Specifications of Transmission System of RfP and Schedule-2 of TSA** **Revised Specific Technical Requirements for Transmission Lines 400/230 kV Substation & Communication System are enclosed at Annex-1.**
3.	**Annexure-16 - Format of Checklist for Technical Bid Submission Requirements** Sl. No. 23 – Contract Performance Guarantee	**Annexure-16 - Format of Checklist for Technical Bid Submission Requirements** Sl. No. 23 – **Deleted**
4.	**Annexure-11A - Illustration for Applicable Board Resolution Requirements under Clause 2.5.2** Heading at Column 4 - Requirement of Undertaking (Annexure 10A)	**Annexure-11A - Illustration for Applicable Board Resolution Requirements under Clause 2.5.2** Heading at Column 4 - Requirement of Undertaking **(Annexure 10)**
5.	**Annexure-23** **Tariff Illustration Sheet**	**Annexure-23** **Tariff Illustration Sheet** The MS Excel sheet is attached at **Annex-2** for reference only.

REVISED 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 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.

6.0 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
765kV D/C (Hexa Zebra) transmission lines	Zebra : Stranding 54/3.18 mm-Al + 7/3.18 mm-Steel, 428 sq mm, Aluminium area, 28.62 mm diameter Minimum UTS : 130.32 kN	Stranding details: 61/3.19mm 28.71 mm diameter; 487.5 sq.mm Aluminium alloy area Minimum UTS : 135.6 kN	Stranding details: 61/3.08mm 27.7 mm diameter; 454 sq.mm Aluminium alloy area Minimum UTS : 108 kN	457 mm

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

7.0 The required phase to phase spacing and horizontal spacing for 765kV line shall be governed by the tower design as well as minimum live metal clearances for 765kV voltage level under different insulator swing angles. However, the phase to phase spacing for 765kV line shall not be less than 15 m.

8.0 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. Since these clearances for 765kV are not included in CEA Regulation/ Indian Standard, following values shall be considered:

a) Minimum live metal clearances for 765 kV line:

(i) Under stationary conditions

From tower body: For 765 kV D/C: 6.1 m

For 765 kV S/C: 5.6 m

(ii) Under swing conditions

Wind pressure Condition	Minimum electrical clearance
a) Swing angle (25º)	4.4 mtrs
b) Swing angle (55º)	1.3 mtrs

b) Minimum ground clearance: 18 m

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

9.0 Shielding angle shall not exceed 10deg for 765kV D/C Line transmission line.

10.0 The Fault current for design of line shall be 50kA for 1 sec for 765kV

11.0 In case of 765kV 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.

12.0 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.

13.0 Pile foundation shall be used for towers located in the river bed, or on river banks or in areas where river flow or river course is anticipated to change based on previous years' hydrology data.

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

REVISED SPECIFIC TECHNICAL REQUIREMENTS FOR SUBSTATION

The proposed augmentation at Fatehgarh-II & Bhadla-II) shall be AIS type generally conforming to the requirement 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:

Sl No	**Description of parameters**	**765 kV Sikar – II Extn.**	**765kV Bhadla-II Extn.**
		765 kV System	**765 kV System**
1.	System operating voltage	765kV	765kV
2.	Maximum voltage of the system (rms)	800kV	800kV
3.	Rated frequency	50Hz	50Hz
4.	No. of phase	3	3
5.	Rated Insulation levels		
i)	Impulse withstand voltage for (1.2/50 micro sec.) - Transformer and Reactors - for Other Equipment - for Insulator String	 1950kVp 2100kVp 2100kVp	 1950kVp 2100kVp 2100kVp
ii)	Switching impulse withstand voltage (250/2500 micro sec.) dry and wet	1550kVp	1550kVp
iii)	One minute power frequency dry withstand voltage (rms)	830kV	830kV
iv)	One minute power frequency dry and wet withstand voltage (rms)	-	-
6.	Corona extinction voltage	508 kV	508 kV
7.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz	2500 micro-volts at 508 kV rms	2500 micro-volts at 508 kV rms
8.	Minimum creepage distance for insulator string/ longrod	24800 mm (31mm/kV)	24800 mm (31mm/kV)

Sl No	Description of parameters	765 kV Sikar – II Extn.	765kV Bhadla-II Extn.
		765 kV System	**765 kV System**
	insulators		
9.	Minimum creepage distance for switchyard equipment other than those mentioned at sl. no. 8 above	20000 (25mm/kV)	20000 (25mm/kV)
10.	**Max. fault current**	**50 kA**	**50kA**
11.	Duration of fault	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	765kV side
765 kV Sikar-II Extn.	One & half breaker (AIS)
765 kV Bhadla-II Extn.	One & half breaker (AIS)

i) At 765kV voltage level, each circuit of a double circuit transmission line shall be terminated in different diameters. Transformers / bus reactors of same HV rating shall be placed in different diameters.

2.0 Substation Equipment and Facilities:

The switchgear shall be designed and specified to withstand operating conditions and duty requirements. The rated current of equipment shall be as mentioned below:

Sl. No	Description of bay	765 kV Sikar-II Extn.	765kV Bhadla-II Extn.
		765kV	**400kV**
1.	Bus Bar	4000A	4000A
2.	Line bay	3150 A	3150A
3.	Switchable Line Reactor Bay	3150 A	3150 A

2.1 765/√3 kV Single Phase Shunt Reactor

Reactor shall conform to IEC-60076 in general. The reactor shall be designed to withstand the over-voltages repeatedly without risk of failure at 1.05 Um continuously, 1.25 Um for 1 minute and 1.50 Um for 5 seconds (where Um is 800/√3 kV). The reactors shall be designed for switching surge overvoltage of 1.9 p.u. and temporary over voltage of the order of 1.4 p.u. for about 10 cycles followed by power frequency overvoltage upto 830 kVrms for about five minutes. The reactor shall withstand the stress due to above transient dynamic conditions which may cause additional current flow as a result of changed saturation characteristics/slope beyond 1.25 p.u. voltage.

The shunt reactor shall be of gapped core type construction. The impedance ratio (X0/X1) specified shall be achieved adopting by either single phase construction in separate tanks or 3 limb core 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 and the thermal & cooling system shall be designed accordingly considering maximum ambient temperature as 50 Deg C.

Reactor shall be designed so that tank hotspot shall not exceed 110 deg C, considering maximum ambient temperature of 50 Deg. C.

The reactor shall be complete with all required accessories, Bushing CTs, Neutral CT (outdoor type) (if required), individual and common marshalling box etc. as required for satisfactory operations of reactor. HV bushing shall be porcelain/composite type and hermetically sealed oil filled condenser type. Neutral Bushing shall be 145kV RIP (Resin Impregnated Paper) /RIS (Resin Impregnated Synthetic) with composite insulator type.

Spare unit of 765 kV, 1x110 MVAr reactor being provided at Sikar-II PS under "Transmission system strengthening for evacuation of power from solar energy zones in Rajasthan (8.1 GW) under phase-II part-C" shall be utilised as common spare for switchable line reactor to be provided at Sikar-II PS under this package. The TSP shall coordinate with the developer of Sikar-II PS so that spare unit can be utilized for all the reactor banks without physical movement of the spare unit.

The Technical Particulars / Parameters of single phase, 765/√3 kV, 80 MVAr & 110 MVAr Shunt Reactor are given below:

S. No.	Description	Unit	Technical Parameters	
1.	Rated capacity at 765/√3 kV	MVAr	80	110
2.	Rated Voltage (Ur)	kV	765/√3	
3.	Maximum continuous operating voltage (Um) (1 p.u.)	kV	800/√3	

4.	Winding connection		Star with neutral (in 3 Phase Bank)
5.	Cooling type		ONAN
6.	Frequency	Hz	50
7.	No of Phases		1 (Single)
8.	Reference standard		IEC 60076-6
9.	Service		Outdoor
10.	Duty		Continuous at 800/√3kV
11.	Permissible unbalance current among phases		±1%
12.	Crest value of third harmonic content in phase current at rated voltage with sinusoidal wave form		≤ 3% of the crest value of fundamental
13.	Range of constant impedance		Up to 1.25 p.u. (However, complete saturation characteristics of the Reactors upto 1.5 p.u. Voltage shall be furnished)
14.	Tolerance on current		(i) 0 to +5% for a single-phase unit (ii) ±1% for between units
15.	Ratio of zero sequence reactance to positive reactance (X0/X1)		Between 0.9 & 1.0.
16.	Temperature rise over 50 °C Ambient Temp. and at 800/√3 kV		
i)	Top oil measured by thermometer	°C	40
ii)	Average winding measured by resistance method	°C	45
17.	Winding hot spot temperature rise over yearly weighted average temperature of 32 °C	°C	61
18.	Max. tank surface temperature	°C	110
19.	Max design ambient temperature	°C	50
20.	Windings		
i)	Lightning Impulse withstand Voltage		
	Line end	kV_p	1950
	Neutral	kV_p	550
ii)	Chopped Wave Lightning Impulse Withstand Voltage		
	Line end	kV_p	2145
iii)	Switching Impulse withstand Voltage at Line end	kV_p	1550
iv)	Power Frequency withstand Voltage		
	Line end	kVrms	830kV rms (Ph to Earth) for 5 min (to be tested)
	Neutral	kVrms	230 (for one minute)

21.	Neutral earthing		Solidly Earthed	
22.	Whether neutral is to be brought out		Yes (through 145kV class bushing)	
23.	Tan-delta of windings at ambient Temperature		< 0.005	
24.	Bushing			
i)	Rated voltage			
	Line bushing	kV	800	
	Neutral bushing	kV	145	
ii)	Rated current			
	Line bushing	A	2500	
	Neutral bushing	A	1250	
iii)	Lightning Impulse withstand Voltage			
	Line bushing	kV_p	2100	
	Neutral bushing	kV_p	650	
iv)	Switching Impulse withstand Voltage of Line bushing	kV_p	1550	
v)	One minute power frequency withstand of bushings (dry)			
	Line bushing	kV rms	970	
	Neutral bushing	kV rms	305	
v)	Minimum creepage distance		(Specific Creepage Distance: of 25mm/kV corresponding to highest line to line voltage)	
	Line bushing	mm	20000	
	Neutral bushing	mm	3625	
vi)	Partial discharge of bushings at Um (line end and neutral)	pC	< 10	
25.	Vibration and tank stress at Um		Max ≤200microns peak to peak Average ≤ 60microns peak to peak Tank stress: ≤2.0kg/sq.mm at any point of tank	
26.	Maximum noise pressure level at rated voltage & frequency	dB	80	
27.	**Maximum Permissible Losses of Reactor**		**80MVAr**	**110MVAr**
i)	Max. Total loss at rated current and frequency and at 75^O C	kW	98	120
ii)	Max. I^2R Loss at rated current and frequency and at 75^O C	kW	52	60
28.	Insulating oil		Unused inhibited or uninhibited transformer oil	

			conforming to IEC-60296:2012

The neutral of shunt reactor shall be insulated to 550 kVp for lightning impulse. The neutral of the line reactors (wherever provided) shall be grounded through adequately rated Neutral Grounding Reactors (NGR) to facilitate single phase auto-reclosure, provided that the NGR shall be provided with bypass arrangement through a breaker so that the line reactor can be used as Bus Reactor as and when required. The neutral of Bus Reactor shall be solidly grounded.

Neutral Grounding Reactor (NGR) and Surge Arrester for 765kV line reactors

TSP shall provide NGR of suitable value (Ohm) as per actual line length. NGR shall be oil filled or dry type air core for outdoor application. Line and ground side of NGR shall be rated for 145kV and 36kV class of insulation respectively. Oil filled NGR shall be rated for continuous current of 10A and short time current of 60A r.m.s for 10 seconds while air core NGR shall be rated for continuous current of 20A and short time current of 240A r.m.s for 1 minute. However, the air core NGR shall be designed for a short time current of 600 Amp r.m.s to ensure mechanical robustness. The air core NGR shall be mounted on support structure (non-magnetic material) high above ground level (2.55 meter) to allow free and safe access at ground level for personnel.

The surge arresters (rated voltage 120kV) shall be provided & physically located between the neutral of shunt reactor (brought out at 145kV class bushing) and neutral grounding reactor. The surge arresters shall be of heavy duty station class gapless Metal oxide (ZnO) type conforming in general to IEC-60099-4. Arresters shall be hermetically sealed units, of self-supporting construction, suitable for mounting on structures

2.2 Circuit Breakers (AIS)

The circuit breakers and accessories shall conform to IEC: 62271-100, IEC: 62271-1 and shall be of SF_6 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 40 ms for 765kV & 400kV circuit breakers and 60 ms for 220kV circuit breakers. 765kV, 400kV and 220kV Circuit breakers shall be provided with single phase and three phase auto reclosing. The Circuit breakers controlling 765kV lines shall be provided with pre insertion closing resistor of about 450 ohms maximum with 9 ms minimum insertion time or Controlled Switching Device. The Circuit breakers controlling 400kV lines of more than 200km length shall be provided with pre insertion closing resistor of about 400 ohms maximum with 8 ms minimum insertion time or Controlled Switching Device. The short line fault capacity shall be same as the rated capacity and this is proposed to be achieved without use of opening resistors. Control switching device shall be provided in Circuit Breaker of switchable line reactor bay and in Main & Tie bay circuit breakers

of line with non-switchable line reactors, Bus reactors and 765/400kV Transformers (wherever applicable).

2.3 Isolators (AIS)

The isolators shall comply to IEC 62271-102 in general. 765kV Isolator design shall be double break or vertical break or knee-type. 400 kV and 220kV 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 765kV, 400kV and 220kV shall be of extended mechanical endurance class-M2 and 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. 765kV, 400kV and 220kV earth switch for line isolator shall be suitable for induced current switching duty as defined for Class-B.

2.4 Current Transformers (AIS)

Current Transformers shall comply with IEC 61869 in general. All ratios shall be obtained by secondary taps only. Generally, Current Transformers (CT) for 765kV & 400kV shall have six cores (four for protection and two for metering). 220kV 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 for CTs upto 400 kV voltage class and less than 10 for CTs of 765 kV voltage class.

2.5 Capacitor Voltage Transformers (AIS)

Capacitive Voltage transformers shall comply to 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 765kV shall be 8800 pF. The Capacitance of CVT for 400kV and 220kV 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.

2.6 Surge Arresters (AIS)

624kV, 336kV & 216kV Station class, , heavy duty gapless type Surge arresters conforming to IEC 60099-4 in general shall be provided for 800kV, 420kV & 245kV systems respectively. 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. 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.

2.7 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 built in 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

765kV, 400kV and 220kV lines shall have Main-I numerical three zone distance protection scheme with carrier aided inter-tripping feature. 765kV, 400kV and 220kV lines shall also have 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.

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 220kV line bays where the line lengths are not indicated, Numerical Distance protection relay as Main–I and Line Current differential relay (with back up distance protection feature) as Main-II shall be provided. Further, in such case, the matching line current differential relay for remote end shall be provided by the remote end 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 765kV, 400kV and 220kV lines shall be provided with single and three phase auto-reclosing facility to allow reclosing of circuit breakers in case of transient faults. These lines shall also be provided with distance to fault locators to identify the location of fault on transmission lines.

All 765kV & 400kV lines shall also be provided with two stages over voltage protection. 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 765kV, 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

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 HV & MV side

iv) Numerical Over fluxing protection on HV & MV side

v) Numerical Overload alarm

vi) Numerical Back up Impedance protection on HV& MV sides for 765/400/33kV ICT and on HV side for 400/220/33kV ICT.

Further, Numerical Back-up Over-current and earth fault protection on HV & MV side of autotransformer shall not be combined with other protective functions (except back up Impedance protection) 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 is required to 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) 765kV & 400kV 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 765kV, 400kV and 220kV buses. Duplicated bus bar protection is envisaged for 765kV & 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 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 765kV, 400kV and 220kV circuit breakers and will be connected to de-energize the affected stuck breaker from both sides.

Notes:

1. LBB & REF relays shall be provided separately from transformer differential relay.
2. LBB relay may also be provided as built-in protection function of distributed bus bar protection scheme; however in such case separate LBB relay shall be provided for tie bays (in case of One and Half breaker scheme).
3. Over fluxing & overload protection can be provided as built-in feature of differential relay.
4. In 765kV & 400kV switchyard, if spare bay of half diameter is identified as future, Tie CB relay panel shall be provided with Auto-reclosure feature.

2.8 Substation Automation System

a) For 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 for voltage level 220kV 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 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.

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

At 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 800kVA for substations with highest voltage rating as 765kV and minimum 630kVA for substations with highest voltage rating as 400kV) shall be provided out of which one shall be connected with SEB/DISCOM supply and other one shall be connected to tertiary of Transformer.

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 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.

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

ii) 2 sets of 220V battery banks for control & protection and 2 sets of 48V 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.

iii) Suitable AC & DC distribution boards and associated LT Switchgear shall be provided at new substation. 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 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. 1
(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.

iv) At new Substation, one no. of DG set (minimum 500 kVA for substations with highest voltage rating as 765kV and minimum 250kVA for substations with highest voltage rating as 400kV) shall be provided for emergency applications.

v) At new substation, sizing of battery and battery charger shall be done based on the number of bays specified (including future bays).

vi) 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.

Beam type heat detection for GIS hall fire protection system shall be provided for all the GIS halls.

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 low power consumption luminaries.

3.5 Control Room

For new substation, substation control room shall be provided to house substation work stations for station level control (SAS) alongwith 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 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.

3.7 Visual monitoring system for watch and ward of substation premises:

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 Quad conductors for 400kV future lines and single conductor for 220kV 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.

e) In 765 & 400kV switchyard, if spare bay of half diameter is identified as future, all the equipment for Tie & Future bay shall be designed considering the current rating of line bay i.e. 3150A.

REVISED SPECIFIC TECHNICAL REQUIREMENTS FOR COMMUNICATION SYSTEM

In order to meet the requirement for grid management and operation of substations, Transmission Service Provider (TSP) shall conform to the following requirements:

Transmission system strengthening scheme for evacuation of power from solar energy zones in Rajasthan (8.1 GW) under Phase II –Part E

1. Bhadla-II PS – Sikar-II 765kV D/c line (2nd)

OPGW:

On Bhadla-II PS – Sikar-II 765kV D/c line (2^{nd}) one OPGW containing 24 Fibres is to be installed by the TSP in place of conventional earth wire during the construction of line. The installation of OPGW shall be done from gantry of Bhadla-II PS up to gantry of Sikar-II and shall be terminated in a Joint Box to be provided by TSP at both the ends. In case of requirement of repeater to establish link between Bhadla-II PS – Sikar-II, the OPGW (48F) connectivity from power line crossing point upto repeater station shall also be in the scope of TSP.

The protection system for 400kV and higher voltage transmission line and the line compensating equipment shall have one hundred percent back up communication channels i.e. two channels for tele- protection in addition to one channel for speech plus data for each direction.

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 protections for transmission line and the line compensating equipment shall have hundred percent back up communication channels i.e. two channels for tele- protection in addition to one channel for speech plus data for each direction.. 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 substations, a telephone exchange (PABX) of 24 lines shall be provided 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 phase to phase coupling for 765kV & 400kV 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. 2 no. of 765 kV line bays each at Bhadla-II and Sikar-II for Bhadla-II PS – Sikar-II 765kV D/c line

(I) TSP shall provide FODP(96 F) and Approach Cable (24F) at Bhadla-II PS, Sikar-II and repeater station (if any) which shall be connected with OPGW fibres to be installed on Bhadla-II PS – Sikar-II 765kV D/c line.

(II) TSP (Transmission Service Provider) shall provide optical interface and/or new STM-16 SDH equipment for Bhadla-II PS, Sikar-II S/s and for repeater stations (if required) along with necessary interfaces to meet the voice and data communication requirement of these stations

(III) In case of repeater requirement, TSP shall provide Repeater shelter alongwith DG set, provisioning for AC and DC supply and other associated systems.

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

(V) TSP shall install required no. of Phasor Measurement Units (PMUs) for all 765kV feeders (under the scope of this project) at Bhadla-II PS, Sikar-II S/s and PMUs shall support latest IEEE C-37.118 protocols. These PMUs shall be integrated with the PDC (Phasor Data Concentrator) located at respective RLDC/SLDC

(VI) TSP shall install RTU/SAS with necessary interfaces which shall be integrated with respective RLDC SCADA System on IEC 60870-5-101/104 protocol.

(VII) The maintenance of all the communication equipments including FODP and approach cable, PMUs, RTU/SAS & repeater stations shall be the responsibility of TSP.