Amendment – III dated 29.05.2020 on the Request for Proposal and Transmission Service Agreement issued for selection of bidder as Transmission Service Provider to establish "Transmission system strengthening for evacuation of power from solar energy zones in Rajasthan (8.1 GW) under Phase II –Part B" through tariff based competitive bidding

<table>
<tr><th>S.NO.</th><th>Existing Provision</th><th>New / Revised Provision</th></tr>
<tr><td>1</td><td>

Scope of Work

……..

<table>
<tr><th>S No</th><th>Name of Transmission Element</th><th>Scheduled COD in Months from Effective Date</th></tr>
<tr><td>…….</td><td></td><td rowspan="2">18 Months (Dec'2021 #)</td></tr>
<tr><td>3.</td><td>1x240 MVAr Switchable line reactor for each circuit at each end of Fatehgarh-II - Bhadla-II PS 765kV D/c line (2 nd)

240 MVAr, 765 kV reactor - 4 (2 reactor each at Fatehgarh-II and Bhadla-II), <u>i.e 7x80 MVAR Line Reactor each at Fatehgarh-II & Bhadla-II (with 1 common spare unit for two banks of Line Reactor)</u>

Switching equipment for 765 kV reactor - 4 (2 Switching equipments each at Fatehgarh-II and Bhadla-II)

(1x80 MVAr Spare reactor each at Fatehgarh-II and Bhadla-II to be used as spare for Fatehgarh-II - Bhadla -II 765 kV D/c line (2nd)</td></tr>
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#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:

</td><td>

Scope of Work

……..

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Switching equipment for 765 kV reactor - 4 (2 Switching equipments each at Fatehgarh-II and Bhadla-II)

(1x80 MVAr Spare* reactor each at Fatehgarh-II and Bhadla-II to be used as spare for Fatehgarh-II - Bhadla -II 765 kV D/c line (2nd)

* not under the present scope</td></tr>
</table>

#Scheduled COD in months is considering Effective Date in **July 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:

</td></tr>
</table>

	i. POWERGRID to provide space for 2 no of 765 kV bays each at Fatehgarh-II and Bhadla-II substation and space for 2 no of switchable line reactors each at Fatehgarh-II and Bhadla-II substation ii. **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 of power from solar energy zones in Rajasthan (8.1 GW) under Phase II –Part E'.**	i. POWERGRID to provide space for 2 no of 765 kV bays each at Fatehgarh-II and Bhadla-II substation and space for 2 no of switchable line reactors each at Fatehgarh-II and Bhadla-II substation ii. **Deleted.**

Amendment in Technical Specifications of Transmission System

Sl. No.	Existing Provision	New / Revised Provision
SPECIFIC TECHNICAL REQUIREMENTS FOR TRANSMISISON LINE		
1.	2.1 Steel section of grade E 250 and/or grade E 350 as per IS 2062, **are only** 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.	2.1 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.	8.0 b) Minimum ground clearance: **15 m**	8.0 b) Minimum ground clearance: **18 m**
3.	10.0 The Fault current for design of line shall be **40kA** for 1 sec for 765kV.	10.0 The Fault current for design of line shall be **50kA** for 1 sec for 765kV.
4.	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.	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.**
5.	New Point to be inserted	**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.**
6.	New Point to be inserted	**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.**
SPECIFIC TECHNICAL REQUIREMENTS FOR SUBSTATIONS		
7.	General The proposed augmentation at Fatehgarh-II & Bhadla-II) shall be AIS type generally conforming to the requirement of **CEA regulation for construction of substation.**	General 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.**
8.	**1.1 Insulation Coordination** The system design parameters for substations/switchyards shall be as given below:	**1.1 Insulation Coordination** The system design parameters for substations/switchyards shall be as given below:

<table>
<tr><th>Sl. No.</th><th>Existing Provision</th><th>New / Revised Provision</th></tr>
<tr><td></td><td>
<table>
<tr><th>Sl No</th><th>Description of parameters</th><th>765 kV Fatehgarh – II PS Extn.</th><th>765kV Bhadla-II PS Extn.</th></tr>
<tr><th></th><th></th><th>765 kV System</th><th>765 kV System</th></tr>
<tr><td>……..</td><td></td><td></td><td></td></tr>
<tr><td>9.</td><td>Minimum creepage distance for switchyard equipment <u>other than those mentioned at sl. no. 8 above</u></td><td>20000 (25mm/kV)</td><td>20000 (25mm/kV)</td></tr>
<tr><td>10.</td><td>Max. fault current (CTU to confirm)</td><td><u>40 kA</u></td><td><u>40 kA</u></td></tr>
<tr><td>…….</td><td></td><td></td><td></td></tr>
</table>
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<tr><td>……..</td><td></td><td></td><td></td></tr>
<tr><td>9.</td><td>Minimum creepage distance for switchyard equipment</td><td>20000 (25mm/kV)</td><td>20000 (25mm/kV)</td></tr>
<tr><td>10.</td><td>Max. fault current (CTU to confirm)</td><td><u>50 kA</u></td><td><u>50 kA</u></td></tr>
<tr><td>……</td><td></td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>9.</td><td>1.2 Switching Scheme
…….
i) At 765kV <u>& 400kV</u> voltage level, each circuit of a double circuit transmission line shall be terminated in different diameters.
<u>ii) Transformers of same HV rating shall be placed in different diameters.</u></td><td>1.2 Switching Scheme
……..
i) At 765kV voltage level, each circuit of a double circuit transmission line shall be terminated in different diameters.</td></tr>
<tr><td>10.</td><td>2. 0 Substation equipment & facilities (Voltage level as applicable)
…….
<table>
<tr><th>Sl No</th><th>Description of Bay</th><th>765 kV Fatehgarh – II PS Extn.</th><th>765kV Bhadla-II PS Extn.</th></tr>
<tr><th></th><th></th><th>765 kV System</th><th>400 kV System</th></tr>
<tr><td>1.</td><td>Bus Bar</td><td><u>4000A</u></td><td><u>4000A</u></td></tr>
<tr><td>2.</td><td>Line bay</td><td>3150 A</td><td>3150A</td></tr>
<tr><td>3.</td><td>Line Reactor Bay</td><td>3150 A</td><td>3150A</td></tr>
</table>
</td><td>2. 0 Substation equipment & facilities (Voltage level as applicable)
……..
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<tr><th>SlNo</th><th>Description of bay</th><th>765 kV Fatehgarh – II PS Extn.</th><th>765kV Bhadla-II PS Extn.</th></tr>
<tr><th></th><th></th><th>765 kV System</th><th>400 kV System</th></tr>
<tr><td>1.</td><td>Bus Bar</td><td><u>Same as existing</u></td><td><u>Same as existing</u></td></tr>
<tr><td>2.</td><td>Line bay</td><td>3150 A</td><td>3150A</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Sl. No.</th><th>Existing Provision</th><th>New / Revised Provision</th></tr>
<tr><td></td><td><u>Further, current rating of all equipment in one diameter shall be the highest current rating required for connected line/ICT/Reactor so that the system could operate without any constraint in case of outage of any bus bar.</u></td><td>
<table>
<tr><td>3.</td><td>Line Reactor Bay</td><td>3150 A</td><td>3150A</td></tr>
</table>
</td></tr>
<tr><td>11.</td><td>2.1 Shunt Reactor
…….
The shunt reactor shall be of <u>either</u> gapped core type <u>or magnetically shielded air core type (shell type)</u> construction. The impedance ratio (X0/X1) specified shall be achieved adopting by either single phase construction in separate tanks or 3 limb core construction. <u>In case of coreless construction, a magnetic shield shall be provided around the coreless coils and non-magnetic material sheet shall form the central core to minimize the vibrations.</u> Core shall be constructed from non-ageing, cold rolled grain oriented silicon steel laminations with requisite BIS certification.

……

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 <u>condenser</u>) with composite insulator type.

The Technical Particulars / Parameters of Reactor are given below:
<table>
<tr><th>Sr. No.</th><th>Description</th><th>Unit</th><th>Parameters</th></tr>
<tr><td>1</td><td>Rated Capacity at 765/√3 kV</td><td>MVAR</td><td>80, 1-phase</td></tr>
</table>
</td><td>2.1 Shunt Reactor
…….
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.

……..

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) <u>/RIS (Resin Impregnated Synthetic)</u> with composite insulator type.

The Technical Particulars / Parameters of Reactor are given below:
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<tr><th>S. No.</th><th>Description</th><th>Unit</th><th>Technical Parameters</th></tr>
<tr><td>1.</td><td><u>Rated capacity at 765/√3 kV</u></td><td><u>MVAr</u></td><td><u>80</u></td></tr>
<tr><td>2.</td><td><u>Rated Voltage (Ur)</u></td><td><u>kV</u></td><td><u>765/√3</u></td></tr>
</table>
</td></tr>
</table>

Sl. No.	Existing Provision				New / Revised Provision			
	2	Rated Voltage (Ur)	kV	765/√3	3.	**Maximum continuous operating voltage (Um) (1 p.u.)**	**kV**	**800/√3**
	3	Maximum continuous operating voltage (Um)	kV	800/√3	4.	**Winding connection**		**Star with neutral (in 3 Phase Bank)**
	4	Cooling System		ONAN	5.	**Cooling type**		**ONAN**
	5	Permissible current unbalance among different phases		±1%	6.	**Frequency**	**Hz**	**50**
	6	Crest value of Third Harmonic content in phase current at rated voltage with sinusoidal wave form	%	≤ 3% of the crest value of fundamental	7.	**No of Phases**		**1 (Single)**
	7	Range of constant current		Up to 1.25 p.u. voltage	8.	**Reference standard**		**IEC 60076-6**
	8	Tolerance on current	%	(i) 0 to +5% for a single phase unit (ii) ±1% for between units	9.	**Service**		**Outdoor**
	9	Ratio of zero sequence reactance to positive reactance (X0/X1)	Range	0.9 - 1.0	10.	**Duty**		**Continuous at 800/√3kV**
	10	Max. Temp. rise over 50 deg C Ambient Temp and Voltage at 800/√3 KV		Top oil/Winding/Hotspot:	11.	**Permissible unbalance current among phases**		**±1%**
	11.	Losses			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**		

Sl. No.	Existing Provision				New / Revised Provision			
	a)	Maximum Permissible Losses at rated Voltage, Frequency and at 75^0C (kW)	kW	98	i)	**Top oil measured by thermometer**	**°C**	**40**
	12	Windings			ii)	**Average winding measured by resistance method**	**°C**	**45**
	i)	Insulation level (LI/SI/PF)		kVp / kVp / kVrms	17.	**Winding hot spot temperature rise over yearly weighted average temperature of 32 °C**	**°C**	**61**
		HV		1950/1550/830 (Ph-Earth) for 5 min.	18.	**Max. tank surface temperature**	**°C**	**110**
		Neutral		550/-/230	19.	**Max design ambient temperature**	**°C**	**50**
	ii)	Tan delta of windings	%	< 0.5	20.	**Windings**		
	13	Vibration at 800/√3 kV and rated frequency	micron	≤ 200 microns peak to peak	i)	**Lightning Impulse withstand Voltage**		
	14	Noise level at at 800/√3 kV and rated frequency	dB	≤ 80dBA		**Line end**	**kV_p**	**1950**
	15	Insulating Oil		virgin high grade inhibited,		**Neutral**	**kV_p**	**550**
	16	Partial discharge (PD) level	pC	< 100	ii)	**Chopped Wave Lightning Impulse Withstand Voltage**		
	17	Bushing				**Line end**	**kV_p**	**2145**
	i)	Rated voltage: HV / Neutral	kV	800/145	iii)	**Switching Impulse withstand Voltage at Line end**	**kV_p**	**1550**
	ii)	Rated current (Min.): HV /	A	2500/1250	iv)	**Power Frequency withstand Voltage**		
	iii)	Insulation level (LI/SI/PF)		kVp / kVp / kVrms		**Line end**	**kVrms**	**830kV rms (Ph to Earth) for 5 min (to be tested)**
		HV		2100/1550/970		**Neutral**	**kVrms**	**230 (for one minute)**
		Neutral		650/-/305	21.	**Neutral earthing**		**Solidly Earthed**
	iv)	Tan delta of bushings:	%	< 0.5	22.	**Whether neutral is to be brought out**		**Yes (through 145kV class bushing)**
					23.	**Tan-delta of windings at ambient Temperature**		**< 0.005**

Sl. No.	Existing Provision				New / Revised Provision			
	v)	PD of Bushing at Um: HV/Neutral	pC	< 10	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**

Sl. No.	Existing Provision	New / Revised Provision
	…….. **Neutral Grounding Reactor (NGR) and Surge Arrester for 765kV line reactors** **The neutral grounding reactors are required for grounding of the neutral point of shunt reactors to limit the secondary arc current and the recovery voltage to a minimum value. TSP shall provide NGR of suitable value (Ohm) as per actual line length. NGR shall be dry type air core for outdoor application. Line and ground side of NGR shall be rated for 145kV and 36kV class of insulation respectively. NGR shall**	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** i) **Max. Total loss at rated current and frequency and at 75º C** — **kW** — **98** ii) **Max. I^2R Loss at rated current and frequency and at 75º C** — **kW** — **52** 28. **Insulating oil** — **Unused inhibited or uninhibited transformer oil conforming to IEC-60296:2012** …….. **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**

Sl. No.	Existing Provision	New / Revised Provision
	be rated for continuous current of 20A and short time current of 240A r.m.s for 1 minute. However, the NGR shall be designed for a short time current of 600 Amp r.m.s to ensure mechanical robustness. It shall be solidly connected between neutral of shunt reactor and earth. The 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. Further, a suitable bypass switching arrangement should be provided across NGR so that neutral of line reactor can be solidly grounded by bypassing NGR and line reactor can be used as bus reactor, if required. **The surge arresters (rated voltage 132kV) shall be of heavy duty station class type. It shall be physically located between the neutral of shunt reactor (brought out at 145kV class bushing) and neutral grounding reactor. The surge arresters shall conform in general to IEC-60099-4. Surge arresters shall be of gapless type without any series or shunt gap. Arresters shall be hermetically sealed units, of self-supporting construction, suitable for mounting on structures.**	**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.**
12.	**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 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	**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

Sl. No.	Existing Provision	New / Revised Provision
	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)**.	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.
13.	**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 **all earth switches shall be class M0** 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.	**2.3 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 **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.
14.	**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 for better sensitivity and accuracy.	**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**

Sl. No.	Existing Provision	New / Revised Provision
		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.
15.	**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 for better sensitivity and accuracy.	**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.
16.	**2.6Surge Arresters (AIS)** 624kV, 336kV & 216kV Station class, **current limiting,** 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.	**2.6 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.
17.	**2.7 Protection Relaying & Control System** The protective relaying system proposed to be provided for transmission lines, autotransformers, reactors and bus bars to minimize the damage to the equipment in the events of faults and abnormal conditions, is dealt 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.	**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.

Sl. No.	Existing Provision	New / Revised Provision
		<u>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.</u>
18.	2.7 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 **<u>& manufacturing platform</u>** 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. **……..**	2.7 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, **<u>manufacturing platform or different principle of operation.</u>** **<u>However,</u>** 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. **……**
19.	**2.7 b) Auto Transformer Protection** …….. 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 **<u>and open delta protection is required</u>** to be provided for the auxiliary transformer. These protection and control may be provided as built in feature either in the bay	**2.7 b) Auto Transformer Protection** …….. 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 **<u>and other necessary protection shall be provided</u>** for the auxiliary transformer. These protection and control may be provided as built in feature either in the bay controller to

Sl. No.	Existing Provision	New / Revised Provision
	controller to be provided for the auxiliary system or in the control & protection IEDs to be provided for autotransformer.	be provided for the auxiliary system or in the control & protection IEDs to be provided for autotransformer.
20.	**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. **The Automation System shall be provided with the facility of communication and control for remote end operation so that by providing remote HMI and suitable communication link, the substation can be controlled from a remote location. Mode of communication shall be considered as optical fibre or leased line based on IEC-60870-5-104 communication protocol.** At new substations, the Substation Automation System (SAS) shall be suitable for operation and monitoring of the complete substation including proposed future bays/elements. ……	**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. ……..
21.	**3.1 AC & DC power supplies**	**3.1 AC & DC power supplies**

Sl. No.	Existing Provision	New / Revised Provision
	For catering the requirements of three phase & single phase AC supply and DC supply for various substation equipment, the following arrangement is envisaged:- i) …….. Additionally, Active Energy Meters may be provided at the same point in the 33kV tertiary of Transformer by local SEB/DISCOM for energy …….. iii) Suitable AC & DC distribution boards and associated LT Switchgear shall be provided at new substation. **For new substation, following switch boards with minimum rating as specified here under shall be considered with duplicate supply:** (a) 415V Main Switch board **– 2 nos. (two sections separated by one bus coupler)** (b) AC distribution board – **2 nos. (two sections separated by one bus coupler)** (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).** ……	For catering the requirements of three phase & single phase AC supply and DC supply for various substation equipment, the following arrangement is envisaged:- i) …….. 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) 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.** **(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. ……..
22.	**3.2 Fire Fighting System**	**3.2 Fire Fighting System**

Sl. No.	Existing Provision	New / Revised Provision
	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.	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.
23.	**Visual monitoring system for watch and ward of substation premises:** **Visual monitoring system for effective watch and ward of substation premises covering the areas of entire switchyard, Control room building, other buildings/stores and main gate, shall be provided. The Visual Monitoring System shall have provision of WAN connectivity for remote monitoring.** **The number of cameras and their locations shall be decided in such a way that any location covered in the substation area can be scanned. The cameras shall be located in such a way to monitor at least:** **1. The operation of each and every isolator pole of the complete yard in case of AIS Sub-station.**	**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.

Sl. No.	Existing Provision	New / Revised Provision
	2. The Operation of each bay bays of GIS Hall as applicable. 3. All the Transformer and Reactors, all the Entrance doors of Control Room Building, GIS hall and any other building as applicable. **4. All the gates of switchyard.** **5. Main entrance Gate** **6. All other major AIS Equipment (such as CB, CT, CVT, SA etc. as applicable)** At existing substations, the visual monitoring system as available shall be augmented as required.	
24.	**4.0 e) General Facilities** **……..** 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. **3000A**.	**4.0 e) General Facilities** **……..** 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**.
25.	**PLCC** **PLCC & PBAX: Power line carrier communication (PLCC) equipment complete for speech, teleprotection 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.**	**Deleted.**

Sl. No.	Existing Provision	New / Revised Provision
	A telephone exchange (PABX) of 24 lines shall be provided at new substations as means of effective communication among various buildings of the substation, remote end substations and with control centers (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. Further, PLCC equipment for both ends of transmission lines not covered under present scope shall be provided by developer of lines. However, CVT &**	

Sl. No.	Existing Provision	New / Revised Provision
	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. The wave trap and CVT required for PLCC at remote end shall be provided by respective bay owner**	
SPECIFIC TECHNICAL REQUIREMENT FOR COMMUNICATION SYSTEM		
26.	Transmission system strengthening scheme for evacuation of power from solar energy zones in Rajasthan (8.1 GW) under Phase II –Part B. • **Fatehgarh-II PS – Bhadla-II PS 765kV D/c line (2nd)** On Fatehgarh-II PS – Bhadla-II PS 765kV D/c line 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 Fatehgarh-II PS up to gantry of Bhadla-II PS 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 Fatehgarh-II PS – Bhadla-II PS, the OPGW (48F) connectivity from power line crossing point upto repeater station shall also be in the scope of TSP.	Transmission system strengthening **scheme** for evacuation of power from solar energy zones in Rajasthan (8.1 GW) under Phase II –Part B. • **Fatehgarh-II PS – Bhadla-II PS 765kV D/c line (2nd)** **OPGW:** On Fatehgarh-II PS – Bhadla-II PS 765kV D/c line **under present scope** 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 Fatehgarh-II PS up to gantry of Bhadla-II PS 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 Fatehgarh-II PS – Bhadla-II PS, the OPGW (48F) connectivity from power line crossing point upto repeater station shall also be in the scope of TSP.

Sl. No.	Existing Provision	New / Revised Provision
		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.
27.	New Point to be inserted	**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 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 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**

Sl. No.	Existing Provision	New / Revised Provision
		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.**