Amendment –III dated 01.06.2020 on the Request for Proposal and Transmission Service Agreement issued for selection of bidder as Transmission Service Provider to establish "Transmission System for Transmission Scheme for Solar Energy Zone in Bidar (2500 MW), Karnataka" through tariff based competitive bidding process

Amendment in Technical Specifications of Transmission System

Sl. No.	Existing Provision	New / Revised Provision
	SPECIFIC TECHNICAL REQUIREMENTS FOR TRANSMISSION 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.	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. **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**	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.

Sl. No.	Existing Provision	New / Revised Provision
	wires.	
4.	New Point to be inserted	**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	**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.**
6.	New Point to be inserted	**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.**
SPECIFIC TECHNICAL REQUIREMENTS FOR SUBSTATION		
7.	General The proposed new substation shall be conventional AIS type generally conforming to the requirements of **CEA regulation for construction of substation.** The proposed augmentation at Maheswaram (PG) shall be GIS type	General The proposed new substation shall be conventional AIS type generally conforming to the requirements of **CEA (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations 2010, as amended from time to time.** The proposed augmentation at Maheswaram (PG) shall be GIS type

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<tr><td>8.</td><td>1.1 Insulation Coordination

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

<table>
<tr><th rowspan="2">Sl No</th><th rowspan="2">Description of parameters</th><th colspan="3">765/400/220kV Bidar PS</th><th>765kV Maheswaram (PG) GIS Extn.</th></tr>
<tr><th>765 kV System</th><th>400 kV System</th><th>220 kV System</th><th>765 kV System</th></tr>
<tr><td>10.</td><td>Max. fault current</td><td>50 kA</td><td>63kA</td><td>50 kA</td><td><u>40kA</u></td></tr>
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<tr><td>9.</td><td>1.2 ii)
Transformers of same HV rating shall be placed in different diameters.</td><td>1.2 ii)
Transformers <u>and bus reactors</u> of same HV rating shall be placed in different diameters.</td></tr>
<tr><td>10.</td><td>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:

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<tr><th rowspan="2">Sl No</th><th rowspan="2">Description of bay</th><th colspan="3">765/400/220kV Bidar PS</th><th>765kV Maheswaram (PG) GIS S/S Extn.</th></tr>
<tr><th>765 kV</th><th>400 kV</th><th>200 kV</th><th>400 kV</th></tr>
<tr><td>1.</td><td>Bus Bar</td><td>4000A</td><td>4000A</td><td>4000A</td><td><u>4000A</u></td></tr>
<tr><td>2.</td><td>Line Bar</td><td>3000A</td><td>3000A</td><td>1600A</td><td>3000A</td></tr>
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<tr><td>1.</td><td>Bus Bar</td><td>4000A</td><td>4000A</td><td>4000A</td><td><u>Same as existing</u></td></tr>
<tr><td>2.</td><td>Line Bar</td><td><u>3150A</u></td><td><u>3150A</u></td><td>1600A</td><td><u>3150A</u></td></tr>
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<tr><th>Sl. No.</th><th>Existing Provision</th><th>New / Revised Provision</th></tr>
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<tr><td>3.</td><td>ICT Bay</td><td>3000A</td><td>3000A</td><td>1600A</td><td>-</td></tr>
<tr><td>4.</td><td>Bus Reactor bay</td><td>3000A</td><td>3000A</td><td>-</td><td>-</td></tr>
<tr><td>5.</td><td>Line Reactor</td><td>3000A</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>6.</td><td>GIS Auxiliary Bus Module for Switching of Transformer</td><td>-</td><td>-</td><td>-</td><td>3000A</td></tr>
<tr><td>7.</td><td>Bus Coupler bay</td><td>-</td><td>-</td><td>4000A</td><td>-</td></tr>
<tr><td></td><td>Transfer Bus coupler bay</td><td>-</td><td>-</td><td>1600A</td><td>-</td></tr>
<tr><td></td><td>Bus sectionalizer bay</td><td>-</td><td>-</td><td>4000A</td><td>-</td></tr>
</table>
<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>

At 765kV Maheswaram GIS substation, 2 nos. of 765kV GIS complete diameters shall……..
</td><td>
<table>
<tr><td>3.</td><td>ICT Bay</td><td><u>3150A</u></td><td><u>3150A</u></td><td>1600A</td><td>-</td></tr>
<tr><td>4.</td><td>Bus Reactor bay</td><td><u>3150A</u></td><td><u>3150A</u></td><td>-</td><td>-</td></tr>
<tr><td>5.</td><td>Line Reactor</td><td><u>3150A</u></td><td>-</td><td>-</td><td>-</td></tr>
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Sl. No.	Existing Provision	New / Revised Provision
11.	**2.1 (765/√3) / (400/√3) / 33 kV Single Phase Autotransformer** Transformer shall conform to IEC-60076 in general. The transformer and all its accessories including bushing/ built in CTs etc. shall be designed to withstand thermal and mechanical stresses caused by symmetrical or asymmetrical faults on any terminals. Mechanical strength of the transformer shall be such that it can withstand 3-phase and 1- phase through fault for transformer rated voltage applied to HV and/or IV terminals of transformer. The short circuit shall alternatively be considered to be applied to each of the IV, HV and tertiary (LV) terminals of the transformer. The tertiary **is not** considered **to be** connected to source. The maximum short circuit output current at the tertiary terminals shall be limited to a safe value to make the transformer short circuit proof. The Tertiary winding shall be designed to withstand mechanical and thermal stresses due to dead short circuit on its terminals. However, the cooling for continuous thermal rating of the tertiary winding shall be of at least 5 MVA capacity. Core shall be constructed from high grade, non-ageing cold rolled super grain oriented silicon steel laminations with requisite BIS certification (HI-B or better grade). The maximum flux density in any part of the core and yoke at the rated MVA, voltage and frequency shall not exceed 1.9 Tesla at all tap positions during 10% continuous over voltage condition. The Transformers shall withstand without damage and over-heating due to over fluxing conditions of **105%** for continuous, 125% for 1 minute and 150% for 5 seconds. All the windings shall be capable of withstanding the dielectric,	**2.1 (765/√3) / (400/√3) / 33 kV Single Phase Autotransformer** Transformer shall conform to IEC-60076 in general. The transformer and all its accessories including bushing/ built in CTs etc. shall be designed to withstand thermal and mechanical stresses caused by symmetrical or asymmetrical faults on any terminals. Mechanical strength of the transformer shall be such that it can withstand 3-phase and 1- phase through fault for transformer rated voltage applied to HV and/or IV terminals of transformer. The short circuit shall alternatively be considered to be applied to each of the IV, HV and tertiary (LV) terminals of the transformer. The tertiary **shall be** considered **not** connected to source. The maximum short circuit output current at the tertiary terminals shall be limited to a safe value to make the transformer short circuit proof. The Tertiary winding shall be designed to withstand mechanical and thermal stresses due to dead short circuit on its terminals. However, the cooling for continuous thermal rating of the tertiary winding shall be of at least 5 MVA capacity. Core shall be constructed from high grade, non-ageing cold rolled super grain oriented silicon steel laminations with requisite BIS certification (HI-B or better grade). The maximum flux density in any part of the core and yoke at the rated MVA, voltage and frequency shall not exceed 1.9 Tesla at all tap positions during 10% continuous over voltage condition. The Transformers shall withstand without damage and over-heating due to over fluxing conditions of **110%** for continuous, 125% for 1 minute and 150% for 5 seconds. All the windings shall be capable of withstanding the dielectric, mechanical and thermal stresses which may be caused by switching, dead short circuit on its terminals. Transfer surge at tertiary shall not

Sl. No.	Existing Provision	New / Revised Provision
	mechanical and thermal stresses which may be caused by switching, dead short circuit on its terminals. Transfer surge at tertiary shall not exceed 250kVp during impulse from HV & IV Terminals. The air core reactance of the HV winding shall be not less than **25%**. External or internal reactors shall not be used to achieve the specified HV/IV, HV/LV and IV/LV impedances. **Transformer shall be fitted with 4x33.3 % independent cooler banks, out of which 3x33.3 % shall be capable of dissipating total losses at continuous maximum rating and 1x33.3% radiator bank shall be used as stand by. Each cooler bank (1x33.3%) shall be capable of dissipating 33.3 per cent of the loss at continuous maximum rating independently. Cooling shall be so designed that during total failure of power supply to cooling fans and oil pumps (considering only three cooler bank (3x33%), the transformer shall be able to operate at full load for at least twenty (20) minutes without the calculated winding hot spot temperature exceeding 140 deg C. Transformer shall be designed so that tank hotspot shall not exceed 110 deg C, considering maximum ambient temperature of 50 Deg. C.** The transformer shall be complete with all required accessories, Bushing CTs, Neutral CT (outdoor type), cooler control cabinet, individual and common marshalling box, **RTCC** etc. as required for satisfactory operations of transformer. **The transformer shall be provided with IEC 61850 compliant digital RTCC relay having automatic voltage regulating features using Bay control and protection unit used for SAS to operate OLTC including parallel operation of transformers. Neutral of the transformer shall be solidly grounded.**	exceed 250kVp during impulse from HV & IV Terminals. The air core reactance of the HV winding shall be not less than **20%**. External or internal reactors shall not be used to achieve the specified HV/IV, HV/LV and IV/LV impedances. **Transformer shall be fitted with two cooler banks, each capable of dissipating 50 per cent of the loss at continuous maximum rating. Transformer shall be capable of operating at full load for 20 minutes in the event of failure of the oil circulating pump or blowers associated with one cooler bank and for at least ten (10) minutes in the event of total failure of power supply to cooling fans and oil pumps, without winding hot spot temperature exceeding 140 deg C. Transformer shall be designed so that tank hotspot shall not exceed 110 deg C, considering maximum ambient temperature of 50 Deg. C.** The transformer shall be complete with all required accessories, Bushing CTs, Neutral CT (outdoor type), cooler control cabinet, individual and common marshalling box, etc. as required for satisfactory operations of transformer. **Remote tap changer control and monitoring system including parallel operation of transformers shall be carried out using Bay control unit or digital RTCC relay through Substation Automation System.** **Spare transformer unit shall be placed and connected in such a way that in case of fault any unit of any of the transformer banks** can **be replaced by spare unit without physically moving it.**

<table>
<tr><th>Sl. No.</th><th>Existing Provision</th><th>New / Revised Provision</th></tr>
<tr>
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<td>
<u>HV & IV bushings shall be porcelain / composite type and hermetically sealed oil filled condenser type. LV bushing shall be of RIP (resin impregnated</u> paper <u>condenser) with composite insulator type. 36kV Neutral bushing shall be solid or oil communicating type with porcelain housing.</u>

The Technical Particulars / Parameters of Transformer are given below:

<table>
<tr><th><u>Sr. No.</u></th><th><u>Description</u></th><th><u>Unit</u></th><th><u>Parameters</u></th></tr>
<tr><td><u>1</u></td><td><u>Rated Capacity: HV/IV</u></td><td><u>MVA</u></td><td><u>500MVA, 1- phase</u></td></tr>
<tr><td><u>2</u></td><td><u>Voltage ratio (Phase Voltage)</u></td><td><u>kV</u></td><td><u>(765/√3) / (400/√3) / 33 kV</u></td></tr>
<tr><td><u>3</u></td><td><u>Vector Group</u></td><td></td><td><u>YNaOd11</u></td></tr>
<tr><td><u>4</u></td><td><u>Cooling</u></td><td></td><td><u>ONAN/ONAF/(OFAF or ODAF)
OR
ONAN/ONAF1/ONAF2</u></td></tr>
<tr><td><u>5</u></td><td><u>Rating at different cooling</u></td><td><u>%</u></td><td><u>60/80/100</u></td></tr>
<tr><td><u>6</u></td><td><u>Frequency</u></td><td><u>Hz</u></td><td><u>50</u></td></tr>
<tr><td><u>7</u></td><td><u>Impedance at 75 Deg C</u></td><td></td><td><u>Tolerances as per IEC</u></td></tr>
<tr><td></td><td><u>HV – IV</u></td><td><u>%</u></td><td><u>At Max. / Principal / Min. Voltage tap: 12.8 / 14.0 / 16.3</u></td></tr>
<tr><td></td><td><u>HV - LV</u></td><td><u>%</u></td><td><u>At Max. / Principal / Min. Voltage tap: 160 / 195 / 240</u></td></tr>
</table>
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<td>
<u>HV, and IV bushing shall be RIP (Resin Impregnated Paper) / RIS (Resin Impregnated Synthetic) with composite insulator type. LV bushing shall be OIP/RIP/RIS. 36kV Neutral bushing shall be solid porcelain or oil communicating type.</u>

The Technical Particulars / Parameters of Transformer are given below:

<table>
<tr><th><u>S. No.</u></th><th><u>Description</u></th><th><u>Unit</u></th><th><u>Parameters</u></th></tr>
<tr><td>1.</td><td><u>Voltage ratio (Line to ground)</u></td><td><u>kV</u></td><td><u>(765/√3)/(400/√3)/ 33 kV</u></td></tr>
<tr><td>2.</td><td><u>Rated Capacity</u></td><td></td><td></td></tr>
<tr><td></td><td><u>HV</u></td><td><u>MVA</u></td><td><u>500</u></td></tr>
<tr><td></td><td><u>IV</u></td><td><u>MVA</u></td><td><u>500</u></td></tr>
<tr><td></td><td><u>LV (Tertiary)</u></td><td><u>MVA</u></td><td><u>5 MVA active loading</u></td></tr>
<tr><td>3.</td><td><u>No of phases</u></td><td></td><td><u>1 (Single)</u></td></tr>
<tr><td>4.</td><td><u>Vector Group</u></td><td></td><td><u>YNaOd11 (in 3-phase bank)</u></td></tr>
<tr><td>5.</td><td><u>Type of Transformer</u></td><td></td><td><u>Auto transformer</u></td></tr>
<tr><td>6.</td><td><u>Applicable Standard</u></td><td></td><td><u>IEC-60076 / IS 2026</u></td></tr>
<tr><td>7.</td><td><u>Cooling</u></td><td></td><td><u>ONAN / ONAF / OFAF (or)
ONAN / ONAF/ ODAF (or)
ONAN / ONAF1 / ONAF2</u></td></tr>
<tr><td>8.</td><td><u>Rating at different cooling</u></td><td><u>%</u></td><td><u>60 / 80 / 100</u></td></tr>
<tr><td>9.</td><td><u>Cooler Bank</u></td><td></td><td><u>2 X 50%</u></td></tr>
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Sl. No.	Existing Provision				New / Revised Provision			
		IV - LV	%	At Max. / Principal / Min. Voltage tap: 150 / 180 / 220		Arrangement		
	8	Temp. rise over 50deg C Ambient Temp	Deg. C	Top oil: 40, Winding: 45, Hotspot:59	10.	Frequency	Hz	50
	9	Losses			11.			
	a)	Maximum No-Load Loss at rated voltage	kW	70	12.	Impedance at 75 Deg C at highest MVA base		
	b)	Maximum Load Loss at rated current and	kW	450	i)	HV – IV	%	14.0
	c)	Maximum Auxiliary Loss at rated voltage and frequency	kW	10	ii)	HV – LV	%	195.0
	10	Windings			iii)	IV – LV	%	180.0
	i)	Insulation Level (LI/SI/PF)		kVp/kVp/kVrms	13.	Tolerance on Impedance	%	As per IEC
		HV		1950/1550/-	14.	Service		Outdoor
		IV		1300/1050/570	15.	Duty		Continuous
		LV		250/-/95	16.	Overload Capacity		IEC-60076-7
		Neutral		170/-/70	17.	Max. temperature rise over 50 deg C ambient temperature	^{o}C	
	ii)	Tan delta of windings	%	< 0.5	i)	Top oil measured by thermometer	^{o}C	45
	11	Tap Changer on the neutral side of the winding & Tapping details		OLTC with range ± 5.5% for HV variation in step of 0.5%, 22 steps	ii)	Average winding measured by resistance method	^{o}C	50
	12	Partial discharge (PD) level at 1.58 x	pC	< 100	18.	Winding hot spot rise over yearly weighted temperature of 32 ^{o}C	^{o}C	61
					19.	Tank Hotspot Temperature	^{o}C	110
					20.	Max. design Ambient temp	^{o}C	50
					21.	Windings		
					i)	Lightning Impulse Withstand Voltage		
						HV	kV_p	1950
						IV	kV_p	1300

Sl. No.	Existing Provision				New / Revised Provision			
	13	Noise level at rated voltage and at principal tap at full load	dB	< 80		LV	kV_p	250
						Neutral	kV_p	170
	14	Insulating oil		virgin high grade inhibited, conforming to IEC-60296	ii)	Chopped Wave Lightning Impulse Withstand Voltage		
						HV	kV_p	2140
						IV	kV_p	1430
	15	Bushing				LV	kV_p	275
					iii)	Switching Impulse withstand Voltage		
	A	Rated voltage HV/IV/LV/Neut	kV	800/420/52/36		HV	kV_p	1550
	B	Rated current (Min.): HV/IV/LV/Neut	A	2500/2500/3150/3150		IV	kV_p	1050
					iv)	One Minute Power Frequency Withstand Voltage		
	C	Insulation Level (LI/SI/PF)		kVp/kVp/kVrms		HV	kV_{rms}	-
		HV		2100/1550/970		IV	kV_{rms}	570
		IV		1425/1050/695		LV	kV_{rms}	95
		LV		250/-/105		Neutral	kV_{rms}	70
		Neutral		170/-/77	v)	Neutral		Solidly Earthed
	D	Tan delta of bushings	%	< 0.5	vi)	Insulation		
						HV		Graded
	E	PD Level of Bushing at Um	pC	< 10		IV		Graded
						LV		Uniform
					vii)	Tertiary Connection		Ungrounded Delta
					viii)	Tan delta of windings at ambient Temperature	%	≤ 0.5
					22.	Bushing		
					i)	Rated voltage		
						HV	kV	800
						IV	kV	420
						LV	kV	52

Sl. No.	Existing Provision	New / Revised Provision			
			Neutral	**kV**	**36**
		ii)	**Rated current**		
			HV	**A**	**2500**
			IV	**A**	**2500**
			LV	**A**	**3150**
			Neutral	**A**	**3150**
		iii)	**Lightning Impulse withstand Voltage**		
			HV	**kV_p**	**2100**
			IV	**kV_p**	**1425**
			LV	**kV_p**	**250**
			Neutral	**kV_p**	**170**
		iv)	**Switching Impulse withstand Voltage**		**(Specific creepage distance: 25mm/kV corresponding to the line to line highest system voltage)**
			HV	**kV_p**	**1550**
			IV	**kV_p**	**1050**
			LV	**kV_p**	**-**
			Neutral	**kV_p**	**-**
		v)	**One Minute Power Frequency withstand Voltage**		
			HV	**kV_{rms}**	**970**
			IV	**kV_{rms}**	**695**
			LV	**kV_{rms}**	**105**
			Neutral	**kV_{rms}**	**77**
		vi)	**Minimum total creepage distances**		
			HV	**mm**	**20000**
			IV	**mm**	**10500**
			LV	**mm**	**1300**

Sl. No.	Existing Provision	New / Revised Provision			
			Neutral	**mm**	**900**
		vii)	**Max Partial discharge level at U_m**		
			HV	**pC**	**10**
			IV	**pC**	**10**
			LV	**pC**	**10**
			Neutral	**pC**	**-**
		23.	**Max Partial discharge level at 1.58 * $U_r / \sqrt{3}$**	**pC**	**100**
		24.	**Max Noise level at rated voltage, principal tap & no load and all cooling active**		**80**
		25.	**Maximum Permissible Losses of Transformers**		
		i)	**Max. No Load Loss at rated voltage and frequency**	**kW**	**80**
		ii)	**Max. Load Loss at rated current and frequency and at 75° C for HV and IV windings, at principal tap position**	**kW**	**450**
		iii)	**Max I^2R loss at rated current and frequency and at 75° C for HV and IV windings, at principal tap position**	**kW**	**335**
		iv)	**Max. Auxiliary Loss at rated voltage and**	**kW**	**10**

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<tr><td></td><td><u>frequency</u></td><td></td><td></td></tr>
<tr><td>26.</td><td><u>Insulating oil</u></td><td></td><td><u>Unused inhibited or uninhibited transformer oil conforming to IEC - 60296: 2012.</u></td></tr>
</table>
</td></tr>
<tr><td>12.</td><td>2.2 765/√3 kV Single Phase Shunt Reactor

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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.

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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 <u>RIP (resin impregnated paper condenser)</u> with composite insulator type.</td><td>2.2 765/√3 kV Single Phase 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 <u>RIP (Resin Impregnated Paper)</u> <u>/RIS (Resin Impregnated Synthetic)</u> with composite insulator type.</td></tr>
</table>

<table>
<tr><th>Sl. No.</th><th>Existing Provision</th><th>New / Revised Provision</th></tr>
<tr>
<td></td>
<td>
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>
<tr><td>2</td><td>Rated Voltage (Ur)</td><td>kV</td><td>765/√3</td></tr>
<tr><td>3</td><td>Maximum continuous operating voltage (Um)</td><td>kV</td><td>800/√3</td></tr>
<tr><td>4</td><td>Cooling System</td><td></td><td>ONAN</td></tr>
<tr><td>5</td><td>Permissible current unbalance among different phases</td><td></td><td>±1%</td></tr>
<tr><td>6</td><td>Crest value of Third Harmonic content in phase current at rated voltage with sinusoidal wave form</td><td>%</td><td>≤ 3% of the crest value of fundamental</td></tr>
<tr><td>7</td><td>Range of constant current</td><td></td><td>Up to 1.25 p.u. voltage</td></tr>
<tr><td>8</td><td>Tolerance on current</td><td>%</td><td>(i) 0 to +5% for a single phase unit
±1% for between units</td></tr>
</table>
</td>
<td>
Spare reactor unit shall be placed and connected in such a way that in case of fault any unit of any of the line reactor banks or bus reactor banks can be replaced by spare unit without physically moving it.

The Technical Particulars / Parameters of 1-phase, 80 MVAr, 765/√3 kV Shunt Reactor are given below:
<table>
<tr><th>S. No.</th><th>Description</th><th>Unit</th><th>Technical Parameters</th></tr>
<tr><td>1.</td><td>Rated capacity at 765/√3 kV</td><td>MVAr</td><td>80</td></tr>
<tr><td>2.</td><td>Rated Voltage (Ur)</td><td>kV</td><td>765/√3</td></tr>
<tr><td>3.</td><td>Maximum continuous operating voltage (Um) (1 p.u.)</td><td>kV</td><td>800/√3</td></tr>
<tr><td>4.</td><td>Winding connection</td><td></td><td>Star with neutral (in 3 Phase Bank)</td></tr>
<tr><td>5.</td><td>Cooling type</td><td></td><td>ONAN</td></tr>
<tr><td>6.</td><td>Frequency</td><td>Hz</td><td>50</td></tr>
<tr><td>7.</td><td>No of Phases</td><td></td><td>1 (Single)</td></tr>
<tr><td>8.</td><td>Reference standard</td><td></td><td>IEC 60076-6</td></tr>
<tr><td>9.</td><td>Service</td><td></td><td>Outdoor</td></tr>
<tr><td>10.</td><td>Duty</td><td></td><td>Continuous at 800/√3kV</td></tr>
<tr><td>11.</td><td>Permissible unbalance current among phases</td><td></td><td>±1%</td></tr>
<tr><td>12.</td><td>Crest value of third harmonic content in phase current at rated</td><td></td><td>≤ 3% of the crest value of fundamental</td></tr>
</table>
</td>
</tr>
</table>

Sl. No.	Existing Provision				New / Revised Provision			
	9	Ratio of zero sequence reactance to positive reactance (X0/X1)	Range	0.9 - 1.0		voltage with sinusoidal wave form		
	10	Max. Temp. rise over 50 deg C Ambient Temp and Voltage at 800/√3 KV		Top oil/Winding/Hotspot: 40/45/59	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)
	11.	Losses						
	a)	Maximum Permissible Losses at rated Voltage, Frequency and at 75°C (kW)	kW	98	14.	Tolerance on current		(i) 0 to +5% for a single-phase unit (ii) ±1% for between units
	12	Windings			15.	Ratio of zero sequence reactance to positive reactance (X0/X1)		Between 0.9 & 1.0.
	i)	Insulation level (LI/SI/PF)		kVp / kVp / kVrms	16.	Temperature rise over 50 °C Ambient Temp. and at 800/√3 kV		
		HV		1950/1550/830 (Ph-Earth) for 5 min.	i)	Top oil measured by thermometer	°C	40
		Neutral		550/-/230	ii)	Average winding measured by resistance method	°C	45
	ii)	Tan delta of windings	%	< 0.5	17.	Winding hot spot temperature rise over yearly weighted average temperature of 32 °C	°C	61
	13	Vibration at 800/√3 kV and rated frequency	micron	≤ 200 microns peak to peak	18.	Max. tank surface temperature	°C	110
	14	Noise level at at 800/√3 kV and rated frequency	dB	< 80dBA	19.	Max design ambient temperature	°C	50
	15	Insulating Oil		virgin high grade inhibited, conforming to IEC-60296				
	16	Partial discharge (PD) level at 1.58 Ur / √3	pC	< 100				

Sl. No.	Existing Provision				New / Revised Provision			
	17	Bushing			20.	Windings		
	i)	Rated voltage: HV / Neutral	kV	800/145	i)	Lightning Impulse withstand Voltage		
	ii)	Rated current (Min.): HV / Neutral	A	2500/1250		Line end	kV_p	1950
	iii)	Insulation level (LI/SI/PF)		kVp / kVp / kVrms		Neutral	kV_p	550
		HV		2100/1550/970	ii)	Chopped Wave Lightning Impulse Withstand Voltage		
		Neutral		650/-/305		Line end	kV_p	2145
	iv)	Tan delta of bushings: HV/Neutral	%	< 0.5	iii)	Switching Impulse withstand Voltage at Line end	kV_p	1550
	v)	PD of Bushing at Um: HV/Neutral	pC	< 10	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

Sl. No.	Existing Provision	New / Revised Provision			
		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	dB	80

<table>
<tr><th>Sl. No.</th><th>Existing Provision</th><th>New / Revised Provision</th></tr>
<tr>
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Neutral Grounding Reactor (NGR) and Surge Arrester for 765kV line reactors

<u>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 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</u></td>
<td>
<table>
<tr><td></td><td><u>voltage & frequency</u></td><td></td><td></td></tr>
<tr><td>27.</td><td><u>Maximum Permissible Losses of Reactor</u></td><td></td><td></td></tr>
<tr><td>i)</td><td><u>Max. Total loss at rated current and frequency and at 75° C</u></td><td><u>kW</u></td><td><u>98</u></td></tr>
<tr><td>ii)</td><td><u>Max. I²R Loss at rated current and frequency and at 75° C</u></td><td><u>kW</u></td><td><u>52</u></td></tr>
<tr><td>28.</td><td><u>Insulating oil</u></td><td></td><td><u>Unused inhibited or uninhibited transformer oil conforming to IEC-60296:2012</u></td></tr>
</table>
……

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

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

Sl. No.	Existing Provision	New / Revised Provision
	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.**	**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.**
13.	**2.3 400/220kV, 3- Phase Transformer** Transformer shall conform to IEC 60076 in general. The 500 MVA transformers shall be designed based on design of dynamic short circuit tested 315 MVA or 500 MVA transformers. The transformer and all its accessories including bushing/ built in CTs etc shall be designed to withstand thermal and mechanical stresses caused by symmetrical or asymmetrical faults on any terminals. Mechanical strength of the transformer shall be such that it can withstand 3-phase and 1- phase through fault for transformer rated voltage applied to HV and / or IV terminals of transformer. The short circuit shall alternatively be considered to be applied to each of the HV, IV and tertiary (LV) transformer terminals. Tertiary **is not** considered **to be** connected to source.	**2.3 400/220kV, 3- Phase Transformer** Transformer shall conform to IEC 60076 in general. The 500 MVA transformers shall be designed based on design of dynamic short circuit tested 315 MVA or 500 MVA transformers. The transformer and all its accessories including bushing/ built in CTs etc shall be designed to withstand thermal and mechanical stresses caused by symmetrical or asymmetrical faults on any terminals. Mechanical strength of the transformer shall be such that it can withstand 3-phase and 1- phase through fault for transformer rated voltage applied to HV and / or IV terminals of transformer. The short circuit shall alternatively be considered to be applied to each of the HV, IV and tertiary (LV) transformer terminals. Tertiary **shall be** considered **not** connected to source. **The maximum short circuit output**

Sl. No.	Existing Provision	New / Revised Provision
		current at the tertiary terminals shall be limited to a safe value to make the transformer short circuit proof. The Tertiary winding shall be designed to withstand mechanical and thermal stresses due to dead short circuit on its terminals. However, the cooling for continuous thermal rating of the tertiary winding shall be for at least 5 MVA capacity.
	……	……..
	The transformer shall be complete with all required accessories, Bushing CTs, cooler control cabinet, individual and common marshalling box, **RTCC** etc as required for satisfactory operations of transformer. **The transformer shall be provided with IEC 61850 compliant digital RTCC relay having automatic voltage regulating features using Bay control and protection unit used for SAS, to operate OLTC including parallel operation of transformers**.	The transformer shall be complete with all required accessories, Bushing CTs, cooler control cabinet, individual and common marshalling box, etc as required for satisfactory operations of transformer. **Remote tap changer control and monitoring system including parallel operation of transformers shall be carried out using Bay control unit or digital RTCC relay through Substation Automation System.**
	Neutral of the transformer shall be solidly grounded.	Neutral of the transformer shall be solidly grounded.
	HV, IV and LV bushing shall be RIP (resin impregnated paper condenser) with composite insulator type. 36kV Neutral bushing shall be solid porcelain or oil communicating type.	**HV, IV and LV bushing shall be RIS (Resin Impregnated Synthetic)/ RIP (Resin Impregnated Paper) with composite insulator type. LV bushing shall be OIP/RIP/RIS. 36kV Neutral bushing shall be solid porcelain or oil communicating type.**

<table>
<tr><th>Sl. No.</th><th>Existing Provision</th><th>New / Revised Provision</th></tr>
<tr><td></td><td>The major technical particulars / parameters of transformer are given below:

<table><tr><th colspan="4">Technical Particulars/ Parameters of 500MVA, 400/220/33kV, 3- Phase Autotransformer</th></tr><tr><th>Sl.</th><th>Description</th><th>Unit</th><th>Technical Parameters</th></tr><tr><td>1.</td><td>Rated Capacity :
HV/IV/ LV (Tertiary)</td><td>MVA</td><td>500/500/166.67</td></tr><tr><td>2.</td><td>……..</td><td>……..</td><td>……..</td></tr><tr><td>3.</td><td>……..</td><td>……..</td><td>……..</td></tr><tr><td>…..</td><td>……..</td><td>……..</td><td>……..</td></tr><tr><td>15.</td><td>Insulating Oil</td><td></td><td><u>virgin high grade inhibited, conforming to IEC-60296</u></td></tr></table></td><td>The major technical particulars / parameters of transformer are given below:

<table><tr><th colspan="4">Technical Particulars/ Parameters of 500MVA, 400/220/33kV, 3- Phase Autotransformer</th></tr><tr><th>Sl.</th><th>Description</th><th>Unit</th><th>Technical Parameters</th></tr><tr><td>1.</td><td>Rated Capacity :
HV/IV/ LV (Tertiary)</td><td>MVA</td><td>500/500/166.67
<u>Tertiary active loading: 5 MVA</u></td></tr><tr><td>2.</td><td>……..</td><td>……..</td><td>……..</td></tr><tr><td>3.</td><td>……..</td><td>……..</td><td>……..</td></tr><tr><td>…..</td><td>……..</td><td>……..</td><td>……..</td></tr><tr><td>15.</td><td>Insulating Oil</td><td></td><td><u>Unused</u> inhibited <u>or uninhibited Transformer oil,</u> conforming to IEC-60296-<u>2012</u></td></tr></table></td></tr>
<tr><td>14.</td><td>2.4 420kV, 3-Phase, Shunt Reactor

……..

The 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 by adopting either single phase construction in separate tanks or three phase with 3 limb or 5 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-</td><td>2.4 420kV, 3-Phase, Shunt Reactor

……..

The reactor shall be of gapped core type construction. The impedance ratio (X0/X1) specified shall be achieved by adopting either single phase construction in separate tanks or three phase with 3 limb or 5 limb core construction. Core shall be constructed from non-ageing, cold rolled grain oriented silicon steel laminations with requisite BIS certification.</td></tr>
</table>

<table>
<tr><th>Sl. No.</th><th>Existing Provision</th><th>New / Revised Provision</th></tr>
<tr><td></td><td>ageing, cold rolled grain oriented silicon steel laminations with requisite BIS certification.

……

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

The Technical Particulars / Parameters of Shunt Reactor are given below:

<table>
<tr><th><u>Sl. No.</u></th><th><u>Description</u></th><th><u>Unit</u></th><th><u>Parameters</u></th></tr>
<tr><td>1.1</td><td><u>Rated Voltage, Ur (1p.u)</u></td><td><u>kV</u></td><td><u>420</u></td></tr>
<tr><td>1.2</td><td><u>Rated Capacity at 420 kV</u></td><td><u>MVAR</u></td><td><u>125</u></td></tr>
<tr><td>1.3</td><td><u>Cooling System</u></td><td></td><td><u>ONAN</u></td></tr>
<tr><td>1.4</td><td><u>Permissible current unbalance among different phases</u></td><td><u>%</u></td><td><u>± 2</u></td></tr>
<tr><td>1.5</td><td><u>Crest value of Third Harmonic content in phase current at rated voltage with sinusoidal wave form</u></td><td><u>%</u></td><td><u>≤ 3% of the crest value of fundamental</u></td></tr>
<tr><td>1.6</td><td><u>Range of constant Impedance</u></td><td></td><td><u>Up to 1.5 p.u. voltage</u></td></tr>
<tr><td>1.7</td><td><u>Tolerance on current</u></td><td><u>%</u></td><td><u>0 to +5%</u></td></tr>
<tr><td>1.8</td><td><u>Ratio of zero sequence</u></td><td><u>Range</u></td><td><u>0.9 - 1.0</u></td></tr>
</table>
</td><td>……

The reactor shall be complete with all required accessories, Bushing CTs, marshalling box etc as required for satisfactory operations of reactor. HV and Neutral bushings shall be <u>RIP (Resin Impregnated Paper)/ RIS (Resin Impregnated Synthetic)</u> with composite insulator type.

The Technical Particulars / Parameters of <u>3-phase, 125 MVAr, 420 kV</u> Shunt Reactor are given below:

<table>
<tr><th><u>S. No</u></th><th><u>Description</u></th><th><u>Unit</u></th><th><u>Technical Parameters</u></th></tr>
<tr><td>1.</td><td><u>Rated Capacity at 420kV</u></td><td><u>MVAr</u></td><td><u>125</u></td></tr>
<tr><td>2.</td><td><u>Rated Voltage (Ur) (1.0 pu)</u></td><td><u>kV</u></td><td><u>420</u></td></tr>
<tr><td>3.</td><td><u>Number of phases</u></td><td></td><td><u>3 (three)</u></td></tr>
<tr><td>4.</td><td><u>Connection</u></td><td></td><td><u>Star</u></td></tr>
<tr><td>5.</td><td><u>Cooling type</u></td><td></td><td><u>ONAN</u></td></tr>
<tr><td>6.</td><td><u>Frequency</u></td><td><u>Hz</u></td><td><u>50</u></td></tr>
<tr><td>7.</td><td><u>Reference standard</u></td><td></td><td><u>IEC 60076-6</u></td></tr>
<tr><td>8.</td><td><u>Service</u></td><td></td><td><u>Outdoor</u></td></tr>
<tr><td>9.</td><td><u>Permissible unbalance current among phases</u></td><td><u>%</u></td><td><u>±2%</u></td></tr>
<tr><td>10.</td><td><u>Crest value of third harmonic content in</u></td><td><u>%</u></td><td><u>≤ 3% of the crest value of</u></td></tr>
</table>
</td></tr>
</table>

Sl. No.	Existing Provision				New / Revised Provision			
		reactance to positive reactance (X0/X1)				**phase current at rated voltage with sinusoidal wave form**		**fundamental**
	1.9	**Max. Temperature rise over 50 deg C Ambient Temp at rated voltage**	**Deg.C**	**Top oil: 40 & Winding: 45**	**11.**	**Range of constant impedance**		**Up to 1.5 p.u voltage (However, complete saturation characteristics of the Reactors upto 2.5 p.u. Voltage shall be furnished)**
	1.10	(a) **Maximum Permissible load Losses at rated Voltage, Frequency and at 75° C (kW) for 420kV, 125 MVAR, 3-Phase Reactor**	**kW**	**160**	**12.**	**Tolerance on current**	**%**	**0 to +5%**
		(b) **Maximum Permissible I2R Losses of Reactor at rated Voltage, Frequency and at 75° C**	**kW**	**90**	**13.**	**Ratio of zero sequence reactance to positive reactance (X0/X1)**		**Between 0.9 & 1.0.**
	1.11	**Windings**			**14.**	**Temperature rise over 50 °C Ambient Temp. at 420 kV**		
	a)	**Insulation level (LI/SI/PF)**		**kVp/ kVp/kVrms**	**i)**	**Top oil measured by thermometer**	**°C**	**40**
		HV		**1300/1050/-**	**ii)**	**Average winding measured by resistance method**	**°C**	**45**
		Neutral		**550/-/230**	**15.**	**Winding hot spot temperature rise over yearly weighted average temperature of 32 °C**	**°C**	**61**
	b)	**Tan delta of windings**	**%**	**< 0.5**	**16.**	**Max. tank surface temperature**	**°C**	**110**
	1.11	**Partial discharge (PD) level at 1.58 Ur / √3**	**pC**	**< 100**	**17.**	**Max design ambient temperature**	**°C**	**50**
	1.12	**Vibration & Tank stress level at rated voltage and frequency**		**≤ 200 microns peak to peak; Average: ≤60 microns peak to peak. Stress: ≤ 2.0kg/sq.mm**				

Sl. No.	Existing Provision				New / Revised Provision			
				at any point on tank.	18.	Windings		
	1.13	Noise level at rated voltage and frequency	dB	< 80	i)	Lightning Impulse withstand Voltage		
	1.14	Bushing				Line end	kV_p	1300
	a)	Rated voltage : HV / Neutral	kV	420/145		Neutral	kV_p	550
	b)	Rated current (Min.) HV / Neutral	A	800/800	ii)	Chopped Wave Lightning Impulse Withstand Voltage		
	c)	Insulation level (LI/SI/PF)		kVp/ kVp / kVrms		Line end	kV_p	1430
		HV		1425/1050/695	iii)	Switching Impulse withstand Voltage at Line end	kV_p	1050
		Neutral		650/-/305	iv)	One Minute Power Frequency withstand Voltage		
	d)	Tan delta of bushings: HV/ Neutral	%	< 0.5		Neutral	kVrms	230
	e)	PD of bushings at level Um	pC	<10	19.	Tan-delta of windings		< 0.005
	1.15	Insulating Oil		virgin high grade inhibited, conforming to IEC-60296	20.	Neutral earthing		Solidly Earthed
					21.	Whether neutral brought out		Yes (through 145kV class bushing)
					22.	Bushing		
					i)	Rated voltage		
						Line bushing	kV	420
						Neutral bushing	kV	145
					ii)	Rated current		
						Line bushing	A	800
						Neutral bushing	A	800
					iii)	Lightning Impulse withstand Voltage		
						Line bushing	kV_p	1425

Sl. No.	Existing Provision	New / Revised Provision

	Neutral bushing	**kV_p**	**650**
iv)	**Switching Impulse withstand Voltage of Line bushing**	**kV_p**	**1050**
v)	**1minute power frequency withstand of bushings (dry)**		
	Line bushing	**kV rms**	**695**
	Neutral bushing	**kV rms**	**305**
vi)	**Minimum creepage distance**		**(Specific Creepage Distance: of 25mm/kV corresponding to highest line to line voltage)**
	Line bushing	**mm**	**10500**
	Neutral bushing	**mm**	**3625**
vii)	**Partial discharge of bushings at Ur (line end and neutral)**	**pC**	**< 10**
23.	**Maximum partial discharge level at 1.58Ur/√3**	**pC**	**100**
24.	**Vibration and tank stress at rated voltage**		**Max ≤200microns peak to peak Average ≤ 60microns peak to peak Tank stress: ≤2.0kg/sq.mm at any point of tank**

<table>
<tr><th>Sl. No.</th><th>Existing Provision</th><th>New / Revised Provision</th></tr>
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Neutral Grounding Reactor (NGR) and Surge Arrester for <u>400kV</u> Line Reactors <u>(as applicable</u>)

<u>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. NGR shall be oil filled type suitable for outdoor application. Line and ground side of NGR shall be rated for 145kV and 36kV class of insulation respectively. NGR shall be rated for continuous current of 10A and short time current of 60A r.m.s for 10 seconds. It shall be solidly connected between neutral of shunt reactor and earth.</u></td>
<td>
<table>
<tr><td><u>25.</u></td><td><u>Maximum noise pressure level at rated voltage & frequency</u></td><td><u>dB</u></td><td colspan="2"><u>80</u></td></tr>
<tr><td><u>26.</u></td><td><u>Maximum Permissible Losses of Reactor at rated current and frequency and at 75°C</u></td><td></td><td><u>Total loss</u></td><td><u>I²R Loss</u></td></tr>
<tr><td><u>i)</u></td><td><u>125MVAr 420kV</u></td><td><u>kW</u></td><td><u>160</u></td><td><u>90</u></td></tr>
<tr><td><u>27.</u></td><td><u>Insulating oil</u></td><td></td><td colspan="2"><u>Unused inhibited or uninhibited transformer oil conforming to IEC-60296:2012</u></td></tr>
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Neutral Grounding Reactor (NGR) and Surge Arrester for Line Reactors

<u>TSP shall provide NGR of suitable value (Ohm) as per actual line length. NGR shall be oil filled or dry type air core suitable 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.</u>
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Sl. No.	Existing Provision	New / Revised Provision
	The surge arresters (rated voltage 120kV) 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.	**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.**
15.	**2.5 765 kV GIS Substation equipment** GIS (Gas Insulated Switchgear) shall be Indoor type in accordance to IEC: 62271- 203. The switchgear shall be designed and specified to withstand operating conditions and duty requirements. All the switchgear such as Circuit Breaker, isolator, earth switch including CT, PT etc. shall be GIS type. **Outdoor** Surge Arrestor and Voltage Transformer shall be **AIS or** GIS type**.** The GIS assembly shall consist of separate modular compartments e.g. Circuit Breaker compartment, Bus bar compartment filled with SF6 Gas and separated by gas tight partitions so as to minimize risk to human life, allow ease of maintenance and limit the effects of gas leaks failures & internal arcs etc. These compartments shall be designed to minimize the risk of damage to adjacent sections and protection of personnel in the event of a failure occurring within the compartments. Rupture diaphragms with suitable deflectors shall be provided to prevent uncontrolled bursting pressures developing within the enclosures under worst operating conditions, thus providing controlled pressure relief in the affected compartment. The arrangement of gas sections or compartments shall be such as	**2.5 765 kV GIS Substation equipment** GIS (Gas Insulated Switchgear) shall be Indoor type in accordance to IEC: 62271- 203. The switchgear shall be designed and specified to withstand operating conditions and duty requirements. All the switchgear such as Circuit Breaker, isolator, earth switch including CT, PT etc. shall be GIS type. **The** Surge Arrestor and Voltage Transformer shall be **either** GIS **or outdoor AIS** type. The GIS assembly shall consist of separate modular compartments e.g. Circuit Breaker compartment, Bus bar compartment filled with SF6 Gas and separated by gas tight partitions so as to minimize risk to human life, allow ease of maintenance and limit the effects of gas leaks failures & internal arcs etc. These compartments shall be designed to minimize the risk of damage to adjacent sections and protection of personnel in the event of a failure occurring within the compartments. Rupture diaphragms with suitable deflectors shall be provided to prevent uncontrolled bursting pressures developing within the enclosures under worst operating conditions, thus providing controlled pressure relief in the affected compartment. The arrangement of gas sections or compartments shall be such as to

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	to facilitate future extension of any make without any drilling, cutting or welding on the existing equipment. To add equipment, it shall not be necessary to move or dislocate the existing switchgear bays. The bus bar modules including auxiliary bus modules (wherever applicable) shall be provided with suitable End Piece (Interface) module with the test link facility for future extension as per provisions of future requirement. The end piece module shall be designed in such a way so that future GIS module **may** be tested without extending test voltage to existing bus and vice-versa by removing the test link. ……..	facilitate future extension of any make without any drilling, cutting or welding on the existing equipment. To add equipment, it shall not be necessary to move or dislocate the existing switchgear bays. **The layout of Gas Insulated Bus Ducts shall be properly planned to optimize the length of bus ducts and for easy accessibility for maintenance. The length of busbars, bus ducts, isolator sections shall be optimized considering effects of fast transient voltage due to isolator operations.** The bus bar modules including auxiliary bus modules (wherever applicable) shall be provided with suitable End Piece (Interface) module with the test link facility for future extension as per provisions of future requirement. The end piece module shall be designed in such a way so that future GIS module **can** be tested without extending test voltage to existing bus and vice-versa by removing the test link. ……..
16.	**2.5.1 Circuit Breakers** GIS Circuit breakers shall in general be of C2-M2 class and comply to IEC- 62271-100. The rated break time shall not exceed 40 ms for 765kV. 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 with 9 ms insertion time or Controlled Switching Device (CSD). 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	**2.5.1 Circuit Breakers** GIS Circuit breakers shall in general be of C2-M2 class and comply to IEC- 62271-100. The rated break time shall not exceed 40 ms for 765kV. 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 with 9 ms insertion time or Controlled Switching Device (CSD). 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

Sl. No.	Existing Provision	New / Revised Provision
	breakers of line with non-switchable line reactors, Bus reactors and 765/400kV Transformers **(wherever applicable).**	line with non-switchable line reactors, Bus reactors and 765/400kV Transformers.
17.	**2.5.2 Isolators** The isolators shall comply to IEC 62271-102 in general. **Isolators shall be motor (DC powered) operated**. Earth switches are provided at various locations to facilitate maintenance. Main blades and earth blades shall be interlocked and interlock shall be fail safe type. All earth switches shall be motor operated type. Isolator shall be suitable for Bus Transfer Current Switching duty as per IEC standard. High speed earthing switches shall be provided for grounding purpose at overhead line terminations & cable terminations & cable terminations and shall have fault making capability as specified. Earth switch for line isolator shall be of earthing switch class E1 and shall be suitable for induced current switching duty as defined for Class-B as per relevant standard.	**2.5.2 Isolators** The isolators shall comply to IEC 62271-102 in general. Isolators shall be motor (DC powered) operated. Earth switches are provided at various locations to facilitate maintenance. Main blades and earth blades shall be interlocked and interlock shall be fail safe type. All **isolators and** earth switches shall be motor operated type. Isolator shall be **of extended mechanical endurance class-M2 and** suitable for Bus Transfer Current Switching duty as per IEC standard. High speed earthing switches shall be provided for grounding purpose at overhead line terminations & cable terminations & cable terminations and shall have fault making capability as specified. Earth switch for line isolator shall be of earthing switch class E1 and shall be suitable for induced current switching duty as defined for Class-B as per relevant standard.
18.	**2.5.3 Current Transformers** Current Transformers shall comply with IEC 61869 in general. All ratios shall be obtained by secondary taps only. Generally, Current Transformers (CT) shall have five cores (four for protection and one for metering) whereas; CT in Tie bays shall have six cores (four for protections & two for metering) suitably distributed on both sides of CB (for 400kV and above voltage class). 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.	**2.5.3 Current Transformers** Current Transformers shall comply with IEC 61869 in general. All ratios shall be obtained by secondary taps only. Generally, Current Transformers (CT) shall have five cores (four for protection and one for metering) whereas; CT in Tie bays shall have six cores (four for protections & two for metering) suitably distributed on both sides of CB (for 400kV and above voltage class). 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**

Sl. No.	Existing Provision	New / Revised Provision
		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.**
19.	**2.5.4 Voltage Transformers** …… The rated burden of cores shall be closer to the maximum burden requirement of metering & protection system for better sensitivity and accuracy.	**2.5.4 Voltage Transformers** …….. 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.
20.	**2.6 Circuit Breaker (AIS)** The circuit breakers and accessories shall conform to IEC: 62271-100, IEC: 62271-1 and shall be of SF6 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 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**	**2.6 Circuit Breaker (AIS)** The circuit breakers and accessories shall conform to IEC: 62271-100, IEC: 62271-1 and shall be of SF6 Type. **The circuit breakers shall be of class C2-M2 (as per IEC) with regard to restrike probability during capacitive current breaking and mechanical endurance.** The rated break time shall not exceed 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

Sl. No.	Existing Provision	New / Revised Provision
	applicable).	line reactor bay and in Main & Tie bay circuit breakers of line with non-switchable line reactors, Bus reactors and 765/400kV Transformers.
21.	**2.7 Isolator (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.	**2.7 Isolator (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
22.	**2.8 Current Transformer (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.	**2.8 Current Transformer (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**

Sl. No.	Existing Provision	New / Revised Provision
		voltage class.
23.	**2.9 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.	**2.9 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.
24.	**2.10 Surge 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	**2.10 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.
25.	**2.11 Protection Relaying & Control System** The protective relaying system proposed to be provided for transmission lines, auto-transformers, reactors and bus bars to	**2.11 Protection Relaying & Control System** The protective relaying system proposed to be provided for transmission lines, auto-transformers, reactors and bus bars to

Sl. No.	Existing Provision	New / Revised Provision
	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.	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.**
26.	**2.11** **(a) Transmission Lines Protection** 765 kV, 400kV and 220kV lines shall have Main-I numerical three zone distance protection scheme with carrier aided inter-tripping feature. 765 kV, 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 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	**2.11** **(a) Transmission Lines Protection** 765 kV, 400kV and 220kV lines shall have Main-I numerical three zone distance protection scheme with carrier aided inter-tripping feature. 765 kV, 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 **or different principle of operation.** **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

Sl. No.	Existing Provision	New / Revised Provision
	bay owner. ……..	bay owner. ……..
27.	**2.11 (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 and **open delta 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.	**2.11 (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 and **other necessary protection shal**l open delta 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.
28.	2.12 a) …….. **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	2.12 a) ..... At new substations, the Substation Automation System (SAS) shall be suitable for operation and monitoring of the complete substation including proposed future bays/elements. ……..

Sl. No.	Existing Provision	New / Revised Provision
	including proposed future bays/elements. ……	
29.	**<u>3.1</u> 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) …….. Additionally, Active Energy Meters may be provided at the same point in the 33kV tertiary of Transformer by local SEB/DISCOM for energy ii) ……. iii) Suitable AC & DC distribution boards and associated LT Switchgear shall be provided at new substation. **<u>For new substation, following switch boards with minimum rating as specified here under shall be considered with duplicate supply:</u>** (a) 415V Main Switch board – **<u>2 nos. (two sections separated by one bus coupler)</u>** (b) AC distribution board – **<u>2 nos. (two sections separated by one bus coupler)</u>** (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.	**<u>3.1</u> 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) …….. Additionally, Active Energy Meters may be provided at the same point in the 33kV tertiary of Transformer by local SEB/DISCOM for energy **<u>accounting.</u>** ii) ……. iii) Suitable AC & DC distribution boards and associated LT Switchgear shall be provided at new substation. **<u>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.</u>** **<u>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</u>**: (a) 415V Main Switch board – **<u>1 nos.</u>** (b) AC distribution board – **<u>1 nos.</u>**

Sl. No.	Existing Provision	New / Revised Provision
	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). ……	(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. ……
30.	**3.2 Fire Fighting System** …… **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.	**3.2 Fire Fighting System** …… **Optical 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.
31.	**3.8 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.**	**3.8 Visual monitoring system (VMS) for watch and ward of substation premises:** **Visual monitoring system for effective watch and ward of substation premises shall cover all the transformers and reactors, all other major AIS Equipment (such as CB, isolators, CT, CVT, SA etc. as applicable), GIS bays, panel room, all the gates of switchyard and all entry and exit points of control room building and accordingly the location of cameras shall be decided. The camera shall be high definition color CCD camera with night vision feature. The VMS data partly/completely shall be recorded (minimum for 15 days) at least @25fps (or better) and stored on network video recorder. The system shall use video signals from various cameras installed at different locations, process them for viewing on workstations/monitors in the control room and simultaneously record all the cameras.**

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	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)**	**Mouse/keyboard controllers shall be used for pan, tilt, zoom and other functions of the desired camera. The Visual Monitoring System shall have provision of WAN connectivity for remote monitoring.** **All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp. The equipment should generally conform to Electromagnetic compatibility requirement for outdoor equipment in EHV substation.** **At existing substations, the visual monitoring system if available shall be augmented as per existing or better specification as required.**
32.	4.0 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. **3000A**.	4.0 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**.
33.	**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.**

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	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.**	

Sl. No.	Existing Provision	New / Revised Provision
	<u>However, CVT & Wave trap for all the line bays under present scope shall be provided by TSP.</u> **<u>TSP shall provide/undertake necessary addition/modification/shifting/re-commissioning etc. of PLCC equipment due to LILO of transmission lines (wherever applicable).</u>** **<u>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.</u>**	
SPECIFIC TECHNICAL REQUIREMENTS FOR COMMUNICATION		
34.	……. **1. For Bidar PS- Maheshwaram (PG) 765kV D/C line** On Bidar PS – Maheshwaram (PG) 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 Bidar PS up to gantry of Maheshwaram (PG) 765kV 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 Bidar PS – Maheshwaram (PG), the OPGW (48F) connectivity from power line crossing point upto repeater station shall also be in the scope of TSP.	……. **1. For Bidar PS- Maheshwaram (PG) 765kV D/C line** **<u>OPGW:</u>** On Bidar PS – Maheshwaram (PG) 765kV D/C line **<u>under present scope</u>** 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 Bidar PS up to gantry of Maheshwaram (PG) 765kV 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 Bidar PS – Maheshwaram (PG), the OPGW (48F) connectivity from power line crossing point upto repeater station shall also be in the scope of TSP. **<u>The protection system for 765kV and higher voltage</u>**

Sl. No.	Existing Provision	New / Revised Provision
		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.
35.	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 against power frequency voltages and transient over voltage shall also be provided.**

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