Appendix-1 to Annexure-B Technical Specifications of Transmission System of RfP and Schedule-2 of TSA

Technical Specification of 66.67 MVA, I-phase 400/132 kV ICT

66.67 MVA, I-phase 400/132 kV ICT shall conform to CEA's "Standard Specifications and Technical Parameters for Transformers and Reactors (66 kV and above)" available on CEA website. However, the parameters shall be as given below in Table-I. As the altitude of the substation is greater than 1000 m, necessary altitude correction factor as per relevant standard shall be applicable on the above parameters

Table-I

S. No	Description	Unit	Technical Parameters	
1.	Voltage ratio (Line-to-ground)	kV	(400/√3)/(132/√3)/33	
2.	Rated Capacity			
	HV	MVA	66.67	
	IV	MVA	66.67	
	LV (Tertiary)	MVA	5 MVA (active loading)	
3.	No of phases		1-phase	
4.	Vector Group		YNaOd11 (in 3-phase bank)	
5.	Type of transformer		Auto transformer	
6.	Applicable Standard		IEC 60076/ IS 2026	
7.	Cooling type		ONAN / ONAF / OFAF or ONAN / ONAF / ODAF or ONAN / ONAF1 / ONAF2	
8.	Rating at different cooling	%	60 / 80 / 100	
9.	Cooler Bank Arrangement		2 X 50%	
10.	Frequency	Hz	50	
11.	Tap Changer (OLTC)		+10% to -10% in steps of 1.25% for IV voltage variation using variable flux variation concept	
12.	Location of tap changer		At Neutral end	
13.	Impedance at 75°C, at highest MVA base		Constant Ohmic impedance type	Constant percentage impedance type
i)	HV – IV			
	Max. Voltage tap	%	10.3	12.5
	Principal tap	%	12.5	

	Min. Voltage tap	%	15.4	
ii)	HV – LV			
	Principal tap	%	45.0 (minimum)	40.0
iii)	IV – LV			
	Principal tap	%	30.0 (minimum)	25.0
iv)	Tolerance on Impedance	%	As per IEC, unless specified otherwise	
14.	Service		Outdoor	
15.	Duty		Continuous	
16.	Overload Capacity		IEC-60076-7	
17.	Temperature rise over 50°C ambient temp.			
i)	Top oil measured by thermometer	^{o}C	45	
ii)	Average winding measured by resistance method	^{o}C	50	
18.	Winding hot spot rise over yearly weighted temperature of 32 °C	^{o}C	61	
19.	Tank Hotspot Temperature	^{o}C	110	
20.	Maximum design ambient temperature	^{o}C	50	
21.	Windings			
i)	Lightning Impulse withstand Voltage			
	HV	kV_p	1300	
	IV	kV_p	650	
	LV	kV_p	250	
	Neutral	kV_p	95	
ii)	Chopped Wave Lightning Impulse Withstand Voltage			
	HV	kV_p	1430	
	IV	kV_p	715	
	LV	kV_p	275	
iii)	Switching Impulse withstand Voltage			
	HV	kV_p	1050	
	IV	kV_p	540	

iv)	One Minute Power Frequency withstand Voltage		
	HV	kV_{rms}	570
	IV	kV_{rms}	275
	LV	kV_{rms}	95
	Neutral	kV_{rms}	38
v)	Neutral Grounding		Solidly grounded
vi)	Insulation		
	HV		Graded
	IV		Graded
	LV		Uniform
vii)	Tertiary Connection		Ungrounded Delta
viii)	Tan delta of winding	%	≤ 0.5
22.	Bushing		
i)	Rated voltage		
	HV	kV	420
	IV	kV	145
	LV	kV	52
	Neutral	kV	36
ii)	Rated current		
	HV	A	1250
	IV	A	1250
	LV	A	1250
	Neutral	A	2000
iii)	Lightning Impulse withstand Voltage		
	HV	kV_p	1425
	IV	kV_p	650
	LV	kV_p	250
	Neutral	kV_p	170
iv)	Switching Impulse withstand Voltage		
	HV	kV_p	1050
v)	One Minute Power Frequency withstand Voltage		

	HV	kV_{rms}	695
	IV	kV_{rms}	305
	LV	kV_{rms}	105
	Neutral	kV_{rms}	77
vi)	Tan delta of bushing at ambient Temperature	%	≤ 0.5
vii)	Minimum total creepage distances		(Specific creepage distance: 31mm/kV corresponding to the line to line highest system voltage)
	HV	mm	13020
	IV	mm	4495
	LV	mm	1612
	Neutral	mm	1116
viii)	Maximum Partial discharge level at U_m		
	HV	pC	10
	IV	pC	10
	LV	pC	10
23.	Maximum Partial discharge level at $1.58 * U_r / \sqrt{3}$	pC	100
24.	Maximum Noise level at rated voltage, at principal tap & no load and all cooling active	dB	80
25.	Maximum Total Permissible Losses of Transformers at principal tap position	kW	160

Technical Specification of 41.67 MVAr, 420 kV, I-Phase Bus reactor

41.67 MVAr, 420 kV, I-Phase Bus reactor shall conform to CEA's "Standard Specifications and Technical Parameters for Transformers and Reactors (66 kV and above)" available on CEA website. However, the parameters shall be as given below in Table-I:
As the altitude of the substation is greater than 1000 m, necessary altitude correction factor as per relevant standard shall be applicable on the above parameters

Table-I

S. No.	Description	Unit	Technical Parameters
1.	Rated capacity at 420/√3 kV	MVAr	41.67
2.	Rated Voltage (Ur)	kV	420/√3
3.	Winding connection		Star with neutral (in 3 Phase Bank)
4.	Cooling type		ONAN
5.	Frequency	Hz	50
6.	No of Phases		1 (Single)
7.	Reference standard		IEC 60076-6
8.	Service		Outdoor
9.	Duty		Continuous at 420/√3kV
10.	Permissible unbalance current among phases		±2%
11.	Crest value of third harmonic component in phase current when reactor is energised at rated voltage with sinusoidal wave form		≤ 3% of the crest value of fundamental
12.	Range of constant impedance (Linearity)		Up to 1.5 p.u. (However, complete saturation characteristics of the Reactors upto 2.5 p.u. Voltage shall be furnished)
13.	Tolerance on current		(i) 0 to +5% for a single-phase unit (ii) ±1% for between units
14.	Ratio of zero sequence reactance to positive reactance (X0/X1)		Between 0.9 & 1.0.
15.	Temperature rise over 50 °C Ambient Temp. and at 420/√3 kV		
i)	Top oil measured by thermometer	°C	40
ii)	Average winding measured by resistance method	°C	45
16.	Winding hot spot temperature rise over yearly weighted average temperature of 32 °C	°C	61
17.	Max. tank surface temperature	°C	110
18.	Max design ambient temperature	°C	50
19.	Windings		
i)	Lightning Impulse withstand		

	Voltage		
	Line end	kV_p	1300
	Neutral	kV_p	550
ii)	Chopped Wave Lightning Impulse Withstand Voltage		
	Line end	kV_p	1430
iii)	Switching Impulse withstand Voltage at Line end	kV_p	1050
iv)	One minute Power Frequency withstand Voltage		
	Line end	kVrms	570 kV
	Neutral	kVrms	230
20.	Neutral earthing		Solidly Earthed
21.	Whether neutral is to be brought out		Yes (through 145kV class bushing)
22.	Tan-delta of windings at ambient Temperature		< 0.005
23.	Bushing		
i)	Rated voltage		
	Line bushing	kV	420
	Neutral bushing	kV	145
ii)	Rated current		
	Line bushing	A	1250
	Neutral bushing	A	1250
iii)	Lightning Impulse withstand Voltage		
	Line bushing	kV_p	1425
	Neutral bushing	kV_p	650
iv)	Switching Impulse withstand Voltage of Line bushing	kV_p	1050
v)	One minute power frequency withstand Voltage of bushings (dry)		
	Line bushing	kV rms	695
	Neutral bushing	kV rms	305
vi)	Tan delta of bushing at ambient Temperature	%	≤ 0.5
vii)	Minimum creepage distance		(Specific Creepage Distance: of 31mm/kV corresponding to highest line to line voltage)
	Line bushing	mm	13020
	Neutral bushing	mm	4495

viii)	Partial discharge of bushings at Um (line end and neutral)	pC	< 10
24.	Vibration and tank stress at Um		Max. Amplitude ≤200microns (peak to peak) Average amplitude ≤ 60microns (peak to peak) Tank stress: ≤2.0kg/sq.mm at any point of tank
25.	Maximum Partial discharge level at 1.58 Ur/√3	pC	100
26.	Maximum noise level at rated voltage & frequency	dB	80
27.	Maximum Permissible Losses of Reactor at rated current and frequency and at 75°C	kW	65