

- Store the equipment in its original transport package. All the equipment has to be stored indoor.

18.2. Packing & unpacking procedure:

The equipment will be carefully inspected and packed at the assembly plant. Proper packaging prior to transport helps in preventing breakage and reduces transportation costs. Please ensure the following.

- The cabinet transport package states the center of gravity and the correct lifting points of the equipment.
- The following cautions shall be mentioned on the surface of the package.
- Keep the Equipment in upright position at all times during transport.
- Do not stack anything on top of the cabinets transport package.
- Lifting direction and lifting points
- Unpacking procedures provided by the manufacturers shall be followed.
- After unpacking the equipment shall be physically inspected for any damage incurred during transportation. If any damage noticed the same should be informed to the supplier/manufacturer.
- The wooden covers mounted on the flanges before the device leaves the factory protect the linings on the flanges during storage and transportation. Do not remove these covers until immediately before the device is installed.
- Use webbing slings slung round the two process connections. Do not use chains, as they could damage the housing.

19. SPARE PARTS, CATALOGUE AND SUPPORT DOCUMENTS

The Firm/Vendor shall furnish along with his offer a list of spares (with cost), recommended by him for maintenance of PQR installation for a period of 5 years, along with his credentials for proper after sales support. Similar works executed by the Firm/Vendor shall be furnished along with the offer giving full particulars like when erected and commissioned, ratings, type of application, performance, reliability, failures noticed/attended etc.

20. MAINTENANCE AND REPAIR SCHEDULE/PROCEDURE: The Firm shall submit the maintenance and repair schedule of PQR meeting the technical requirement of this standard along with supply to user.

21. TRAINING OF INDIAN RAILWAY'S ENGINEERS

The offer shall include the training of two engineers and four technicians of the Railway free of cost at the manufacturer's Works in India or abroad and at the traction substation of a railway system or other public utility where PQR of similar/identical design are in operation. The total duration of training for each Engineer/Technician shall be 4 weeks of which approximately 2 weeks shall be at the manufacturer Works and 2 weeks on a railway system or public utility. The cost of travel to the country of manufacture and back shall be borne by the Railway.

22. SOURCE CODE OF SOFTWARE

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Source Code of Software used by the bidder shall be owned by the bidding entity. Alternatively, undertaking of software support for the full designed life of equipment to be furnished by the bidder. In case of company being closed, complete source code shall be shared with Railways.

23. DESIGNED LIFE OF EQUIPMENT

The equipment should be designed for a working life of minimum 15 years.

24. CT FOR CONTROLLING & PROTECTION

To ensure reliability of protection, a separate CT should be used for protection (apart from the one used for measurement/control).

25. HUMIDITY MONITORING & CONTROL

System should be capable of monitoring ambient humidity & temperature and initiate suitable mitigation measures to ensure reliable operations.

26. SAFETY INDICATORS

Safety indication should be provided on PQR panel while system is in operation. Necessary interlocks should be provided, to prohibit PQR power panel/ door access when system is in power-on condition.

27. PQR CONTROL PANEL

In case the PQR is placed in a separate room/ enclosure, then a remote-control panel should be provided inside the Railway TSS Control Room to indicate the working of the PQR system, fault/ data log and execute emergency operations.

28. WARRANTY

The complete PQR with all parts and accessories supplied against a purchase order/contract against the tender in which this standard is quoted, irrespective of original individual equipment (imported/indigenous) shall be guaranteed for trouble - free and satisfactory performance for a period of 3 years. Details of warranty clause, the extent of responsibility and other relevant aspects shall be included in the contract. The manufacturer shall furnish detailed terms and conditions in this regard in his offer. The warranty shall be for complete PQR including outdoor equipment under the scope of the firm i.e., CT, PT, display, software and all other associated equipment like wiring, connectors, contactors/relays etc. The successful manufacturer shall make necessary arrangements for spare parts and other items to be kept readily available so that there is minimum disruption to the operations. The software may require up-gradation /reconfiguration from time to time as per purchaser's/CEA modified requirements. The manufacturer shall be fully responsible for this activity during warranty. Formula for costing up gradation in the same & addition of a unit/ multiple units of PQR, duly integrated with remote monitoring to be evolved and the same shall be mentioned in the offer clearly.

29. COMPREHENSIVE MAINTENANCE CONTRACT (CMC)

In order to give proper maintenance support, CMC for a period of Three years excluding warranty period of three years shall be part of the contract. The CMC shall be for complete PQR system including indoor & outdoor equipment associated for the satisfactory functioning of the PQR. Details of CMC clauses such as payment conditions, bill paying/passing authority, the extent of responsibility and other relevant aspects shall be included in tender documents. The manufacturer shall be fully responsible for effective working of PQR.

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ANNEXURE-1

SCHEDULE OF GUARANTEED PERFORMANCE
TECHNICAL AND OTHER PARTICULARS

S.No.	Description	Unit
Appendix I: SHUNT CAPACITOR TECHNICAL DETAILS (FOR HT FILTERS ALSO)		
1.	Make and type (attach data sheet of manufacturer)	
2.	Governing standards	
3.	Location of capacitor bank (outdoor/indoor)	
4.	Rated system voltage	kV
5.	Rated voltage of capacitor unit	kV
6.	Maximum voltage the capacitor unit can withstand continuously	kV
7.	Rated frequency	Hz
8.	Upper limit of temperature category	°C
9.	Capacity of individual unit at its rated voltage	kVAR
10.	Rated current (continuous) of capacitor unit	A
11.	Maximum inrush current at the instant of switching	A
12.	Basic insulation level of capacitor unit a) Power frequency withstand voltage b) 1.2/50 micro-second impulse withstand voltage	kVrms kVp
13.	Basic insulation level of complete capacitor bank a) Power frequency withstand voltage b) 1.2/50 micro-second impulse withstand voltage	kVrms kVp
14.	Transient current withstand capacity of each unit	kA
15.	Constructional details of capacitor unit a) Dielectric material b) Foil material & thickness c) Impregnating liquid used and its properties	
16.	Total maximum loss at rated voltage and at frequency 50 Hz	W/kVAR
17.	Capacitor unit a) Number of elements in series b) Number of parallel paths c) Capacitance of each unit.	μF
18.	Capacitor bank a) Number of series groups b) Number of parallel units in each group c) Capacitance of the bank	μF
19.	Type of internal fuse element of capacitor unit	
20.	Attach time/current characteristics of the fuse element	
21.	Discharge device a) Type b) Location c) Time interval between de-energization and re-energization d) Residual voltage after 10 min of de-energization	s Min V
22.	Bushings a) Make and type	

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	b) Wet-one minute power frequency withstand voltage c) Impulse withstand voltage 1.2/50 μ s full wave d) Creepage distance in air e) Number of bushings in each unit	kVrms kVp mm
23.	Overall dimensions a) Capacitor unit b) Complete capacitor bank	mm
24.	Weight per unit	kg
25.	Weight of the complete bank	kg
26.	Maximum loss in the complete capacitor bank at its normal operating voltage and current	W
27.	Temperature class/ Insulation class/ Protection class of the capacitor bank	
Appendix-II – SERIES REACTOR (FOR HT FILTERS ALSO)		
1.	Make and type (attach data sheet of manufacturer)	
2.	Governing standards	
3.	Rated system voltage	kV
4.	Rated frequency	Hz
5.	Inductance value and tolerance	mH (+/-%)
6.	Quality factor (XL/R) at 50 Hz and 75°C	(minimum)
7.	Type of reactor (type and core, cooling method, etc)	
8.	Rated current (fundamental), IN	A
9.	Rated voltage (fundamental), UN	V
10.	Continuous operating current, rms (including various harmonic currents)	A
11.	Core linearity (as a multiple of rated current IN)	
12.	Value of the peak surge voltage generated at the time of switching in of shunt capacitor	kVp
13.	Short circuit current rating for 3 seconds	kA
14.	a) Number of taps on the reactor b) Minimum inductance c) Maximum inductance	H H
15.	Basic insulation level of reactor c) Power frequency withstand voltage d) 1.2/50 micro-second impulse withstand voltage	kVrms kVp
16.	Overall dimensions of the reactor	mm
17.	Total weight of the reactor	kg
18.	Maximum loss in the reactor at its normal operating voltage and current	W
19.	Resonance frequency of the system, including shunt capacitor and series reactor (details of calculation should be enclosed with offer).	Hz
20.	Temperature class/ Insulation class/ Protection class of the reactor	
Appendix-III – CONTROL & RELAY PANEL		
1.	Name of manufacturer and address	

2.	Overall dimensions a) Length b) Width c) Height	mm
3.	a) Colour of the panel b) Colour of the mimic	
4.	Details of switches provided and their makes	
5.	Annunciations provided	
6.	Size of wires used for: a) Control circuit b) Indication circuit c) General wiring d) PT and CT circuits	mm ²
7.	Method of cable entry	
8.	Details of instruments provided	

Appendix-IV – PROTECTIVE RELAYS OF CAPACITOR BANK

1.	<u>Instantaneous overcurrent relay</u> a) Type and make of relay b) Setting range available	
2.	<u>Overcurrent</u> a) Type and make of relay b) Setting range available	
3.	<u>Overvoltage protection</u> a) Type and make of relay b) Setting range available	
4.	<u>Unbalance Protection</u> a) Whether voltage operated or current operated relays are used. b) Setting range available c) Calculations to show that the number of capacitor units which when fail shall produce the rated over-voltage on other capacitor units and the setting range available in the relay offered suits the same shall be enclosed. d) How provision of alarm in the case of failure of one or two capacitor units has been achieved. e) Details (type and make and setting range) of the time delay relay. f) Calculations to show that co-ordination between the operation of individual fuses to isolate faulty units and unbalance protection exists should be appended.	
5.	The required capacity of current transformer and potential transformer in VA	

NOTE: The tender shall be complete with technical literature and pamphlets of the relays used.

Appendix-V – PROTECTION OF 27.5 kV / 600 V or any other suitable voltage TRANSFORMER

1.	The Firm/Vendor shall furnish details of protection proposed for the IGBTs.	
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Appendix-VI – PROTECTION OF IGBT

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1.	The Firm/Vendor shall furnish details of protection proposed for the IGBTs.	
Appendix-VII – SURGE ARRESTORS		
1.	The Firm/Vendor shall furnish full technical particulars of the surge arrestors offered.	
Appendix-VIII: IGBT BASED VOLTAGE SOURCE CONVERTER PANEL		
IGBT Technical Details		
1.	Make and type (attach data sheet of manufacturer)	
2.	Governing standards	
3.	Collector-emitter voltage V_{CES}	V
4.	Gate-emitter voltage V_{GES}	V
5.	Continuous collector current at T_c of 25°C	A
6.	Continuous collector current at T_c of 80°C	A
7.	Junction operating temperature range T_j (min. and max.)	°C
8.	Collector-emitter saturation voltage $V_{CE(sat)}$	V
9.	Turn-on switching energy E_{on}	mJ
10.	Turn-off switching energy E_{off}	mJ
11.	Thermal resistance $R_{th(j-c)}$	K/W
12.	Attach data sheet of the IGBT of manufacturer	
DC Link Capacitor		
13.	Type and make (attach data sheet of manufacturer)	
14.	Governing standards	
15.	Capacitance value (and tolerance)	μF
16.	Rated voltage	V
17.	Rated current	A
18.	Dissipation factor $\tan \delta$ (Not more than 0.2% at 1 kHz and 25°C permitted)	
19.	Power loss in DC link capacitor	W
20.	Operating temperature at rated output	°C
21.	Operational life of DC link capacitor at 45 °C	h
22.	Attach ageing curve (operating temp. Vs life in hours)	
PWM Reactor		
23.	Make and type (attach data sheet of manufacturer)	
24.	Governing standards	
25.	Inductance value (and tolerance)	mH
26.	Rated voltage (fundamental)	V
27.	Rated current (fundamental)	A
28.	Switching frequency, f_s	kHz
29.	Continuous operating current, rms (including various harmonic currents)	A
30.	Type of core	

31.	Type of winding	
32.	Loss in the reactor at continuous operating current	W
Voltage Source Converter Panel Technical Details – IGBT Based		
33.	Continuous operating voltage	V
34.	Continuous operating current	A
35.	Rated output per panel	kVAR
36.	Conduction loss at rated output	W
37.	Switching frequency adopted	Hz
38.	Switching loss	W
39.	All other losses (like cooling load, diodes etc)	W
40.	Total power loss per panel at rated output	W
41.	Input ripple filter type (LC/LCL)	
42.	Noise level at 1 m distance from panel (Not more than 75 dB (A) permitted)	dB (A)
43.	Overall dimensions of the panel	mm x mm x mm
44.	Weight of each panel	kg
45.	Control of IGBTs: The Firm/Vendor shall furnish full technical particulars of the control equipment used for the control of IGBTs.	
Appendix-IX: 1-PHASE STEP-DOWN TRANSFORMER (27.5kV/600V OR 650V OR ANY OTHER SUITABLE VOLTAGE)		
1.	Standard governing specifications	
2.	Rated primary voltage	kV
3.	Rated secondary voltage(s)	V
4.	Rated output	MVA
5.	Rated impedance [MVA base is the rated MVA of the secondary winding] at 75°C.	% % %
	i) Primary to secondary winding-1 ii) Primary to secondary winding-2 iii) Secondary winding-1 to secondary winding-2	
6.	Type of cooling	
7.	Maximum temperature rise under normal operating conditions over an ambient of 45°C a) of oil by thermometer b) of winding by resistance	°C °C
8.	Iron loss at 50 Hz and 100% rated voltage (max)	W
9.	Copper loss at 75°C at rated load (max)	W
10.	Withstand time without injury with dead short-circuit at the terminals	s
11.	a) Type of core b) Flux density in the core at rated voltage and 50 Hz (Not more than 1.6 Tesla permitted)	Tesla
12.	Rated power frequency withstand voltage of windings a) Primary b) Secondary	kVrms kVrms

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13.	Rated lightning impulse withstand voltage 1.2/50 μ s a) Primary b) Secondary	kVp kVp
14.	Off-circuit tap changer on primary winding a) Number of plus taps and minus taps b) Variation per tap in %	
15.	Overall dimensions of the assembled transformer	mm x mm x mm
16.	Weight of the assembled transformer	kg
17.	Noise level at 1 m distance from transformer (Not more than 75 dB (A) permitted)	dB (A)
18.	Insulation class of the transformer	

Appendix -X: HT PASSIVE FILTERS AT 25 kV WITH CAPACITOR AND SERIES REACTOR

S.No.	Description	Harmonic filter for			Unit
		3rd	5th	7th	
1.	Value of capacitance (and tolerance)				μ F
2.	Value of inductance (and tolerance)				mH
3.	Value of capacitor reactance at the harmonic frequency, XC				ohm
4.	Value of reactance of series reactor at the harmonic frequency, XL				Ohm
5.	Series resonant frequency of the L-C combination				Hz
6.	Quality factor (XL/R) of series reactor at tuning frequency and 75°C				(minimum)

Capacitor ratings

7.	Rated fundamental current				A
8.	Continuous operating current, rms (including harmonics)				A
9.	Rated fundamental voltage				V
10.	Continuous operating voltage, rms (including harmonics)				V
11.	Rated kVAR at fundamental frequency				kVAR
12.	Maximum kVAR with harmonics (continuous duty)				kVAR

Series reactor ratings

13.	Rated fundamental current				A
14.	Continuous operating current, rms (including harmonics)				A
15.	Rated fundamental voltage				V
16.	Continuous operating voltage, rms (including harmonics)				V
17.	Rated kVAR at fundamental frequency				kVAR
18.	Maximum kVAR with harmonics (continuous duty)				kVAR

Operating parameters of the L-C filter at 25 kV bus voltage and 800A load current
[Note: Consider typical load current harmonics as: 3rd = 19%, 5th = 10%, 7th = 8%, 9th = 4%]

19.	Fundamental kVAR drawn by the L-C filter				kVAR
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20.	Total kVAR drawn (including harmonics)				kVAR
21.	RMS voltage across capacitor				V
22.	RMS voltage across reactor				V
23.	RMS current through the filter				A
24.	THD of current (source) with filter				%
25.	THD of current (source) without filter				%
Other details					
26.	Furnish details of capacitor and reactor as in A and B above (refer page 29 and 30)				
27.	Detailed simulation results should be furnished along with the offer to support the data furnished above.				

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ANNEXURE-2

RELATED EQUIPMENT AT TRACTION SUB-STATIONS

i. Traction Power Transformer

Traction Power Transformers are designed to carry short time overloads of 50% for 15 minutes and 100% for 5 minutes.

ii. 25 kV transformer & feeder circuit breakers

SF6 gas/vacuum circuit breaker, 550 MVA, 1600 A.

iii. 25 kV Potential Transformer

Ratio 25 kV/110 V or 27.5/110,

iv. 25 kV current transformer


Ratio 1500 - 750/5A, or 1600-800 A/5 A, accuracy class 5P, accuracy limit factor 15.

v. 25 kV Isolator and motorized isolator

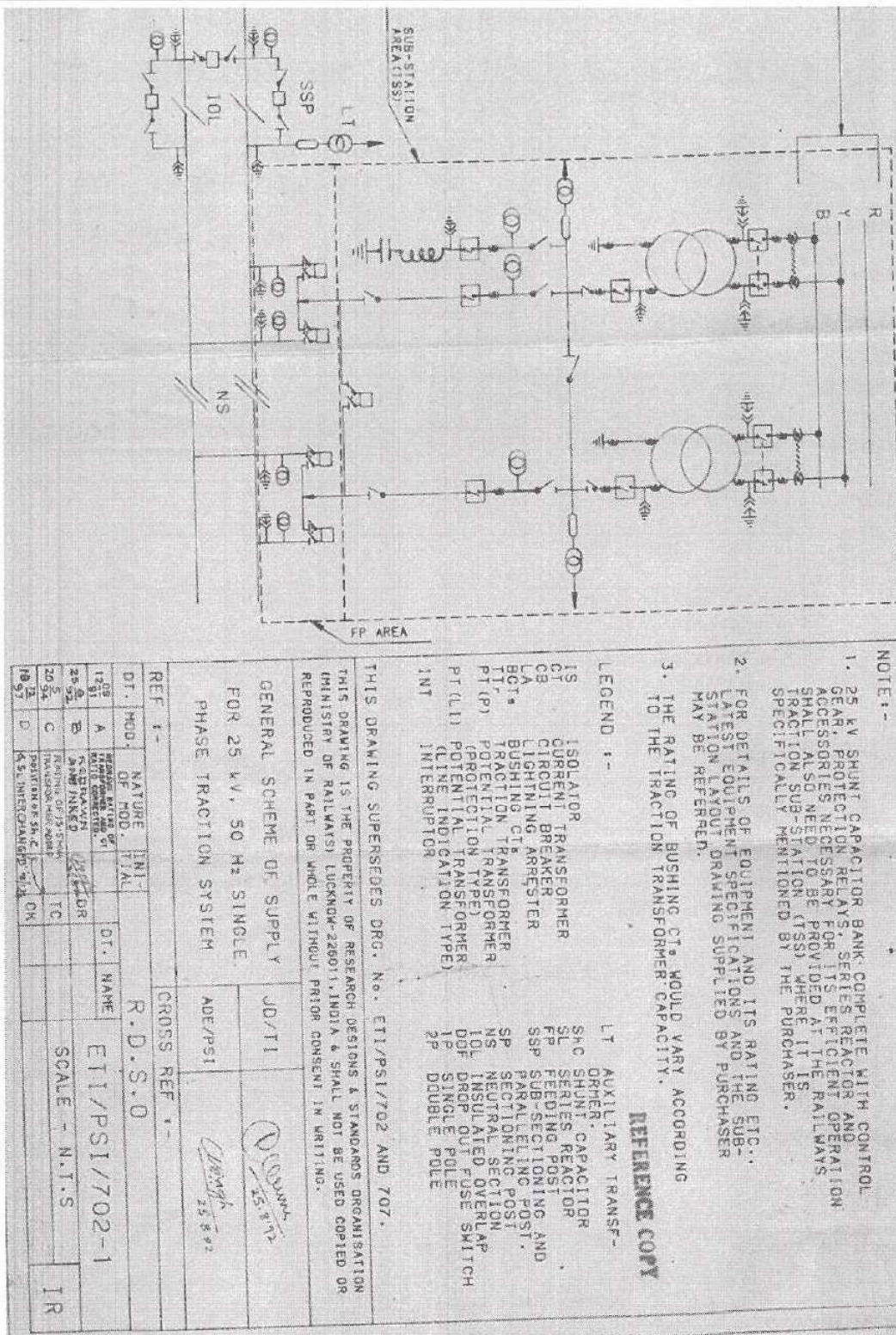
Air break, single/double pole (630/800/1250 A)

vi. 42 kV Lightning Arrestor

Non- linear metal oxide gapless type, nominal discharge current 10 kA (8/20 μ s wave). Maximum discharge voltage at nominal discharge current 125 kVp.

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ANNEXURE-4

BENEFIT/LOSS INFORMATION TO BE SUBMITTED BY THE VENDOR

(in terms of Clause 14)

Before compensation (As given by railway) (1)	Maximum demand (kVA) (2)	>120 % upto 140 % (3)	>100% upto 120 % (4)	>80% upto 100 % (5)	>60% upto 80% (6)	>40% upto 60% (7)	>20% upto 40% (8)	≤20 % (9)	Total (10)
	Hours per day								
After compensation	MD in kVA								
	Average PF (kWh/kVAh)								
Analysis of power losses (in kW)	Shunt capacitor bank losses (+)								
	IGBT Panel losses (+)								
	Losses in HT Filters (+)								
	Other losses (specify details) (+)								
	Reduction in losses in substation transformer after compensation (-)								
	Net Loss L in kWh (+)								

NOTE: For each of the above, the mid value of the range should be taken for integration, for calculation of the benefit/loss. For example, for the range above 60% up to 80% the mid-value is 70%.

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ANNEXURE-5Method For Calculation Of Capitalized CostData for calculation of capitalized cost

Net loss "L" in kWh per day as per information furnished by Firm/ Vendor in Appendix VI.

Cost of procurement, installation & commissioning of PQR including construction of covered area for housing indoor equipment as quoted by Firm/Vendor: Rs "P"

AMC charges per annum as quoted by Firm/Vendor: Rs "X_n" for nth year.

Period of capitalization assumed, N = 8 years [n = N*12 in months]

Discount rate, R = 0.07 per unit per annum [r = 7 / 1200 per unit per month]
assumed for calculation of net present value of benefits and costs.

Calculation of capitalized cost

If the monthly total saving due to reduction in fixed charges by reduction in MD, low power factor penalty charges, and harmonic surcharges arising of the installation of PQR is M, then the capitalized benefit B is given by:

$$B = \sum_{i=1}^n \left\{ \frac{M}{(1+r)^i} \right\} = \frac{M[(1+r)^n - 1]}{r(1+r)^n}$$

If the monthly cost in energy charges for net losses of L kWh/day is C_e, then the capitalized cost C₁ is given by:

$$C_1 = \sum_{i=1}^n \left\{ \frac{C_e}{(1+r)^i} \right\} = \frac{C_e[(1+r)^n - 1]}{r(1+r)^n}$$

The capitalized cost C₂ of AMC charges (for 5 years from 3rd year onwards) is given by:

$$C_2 = \frac{1}{(1+R)^x} \sum_{i=1}^{N-x} \left\{ \frac{X_i}{(1+R)^i} \right\} ; \text{ Where } x \text{ is the warranty period in years, } X_i \text{ is the AMC charge}$$

for ith year, and (N-x) is the AMC period in years.

Then the total capitalized cost C of power quality compensating equipment shall be given by:

$$C = P + C_1 + C_2 - B$$

Note: Reduction in Maximum Demand will be calculated as under:

Load power factor, cos θ = 0.8 lag (at metering point); I_R = Maximum reactive power

injection by PQR in A; Load voltage at metering point, |V| = 27 kV;

Uncompensated load current, |I₁| = 800 A or as given in tender document.

Then, compensated current, |I₂| = $\sqrt{(|I_1| \cos \theta)^2 + (|I_1| \sin \theta - |I_R|)^2}$ A

Maximum Demand Reduction = |V| . |I₁| - |V| . |I₂| kVA

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ANNEXURE-6



ANNEXURE-7



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ANNEXURE-8

SLD OF SUPPLY OF 2X25KV FOR 25KV, 50 HZ, SINGLE PHASE TRACTION SYSTEM

