Before

UTTARAKHAND ELECTRICITY REGULATORY COMMISSION Petition No. 43 of 2024

In the Matter of:

<u>Application seeking approval for the investment on the project for</u> <u>"Installation of Automatic Reactive Power Solution (Capacitor Bank) on</u> <u>33/11 kV Substations in the State of Uttarakhand."</u>

And

In the Matter of:

Uttarakhand Power Corporation Ltd., Victoria Cross Vijeta Gabar Singh Urja Bhawan, Kanwali Road, Dehradun.

...Petitioner

Coram

Shri M.L. Prasad Shri Anurag Sharma Member (Technical)/Chairman(I/c) Member (Law)

Date of Order: September 02, 2024

<u>ORDER</u>

This Order relates to the Petition filed by Uttarakhand Power Corporation Limited (UPCL) (hereinafter referred to as "UPCL" or "the Petitioner" or "the licensee") seeking prior approval of the Commission for 'Investment on the project for Installation of Automatic Reactive Power Solution (Capacitor Bank) on 33/11 kV Substations in the State of Uttarakhand'.

Background

2. The Petitioner vide its letter No. 1405/Dir.(Project)/UPCL/UERC(C-4) dated 10.07.2024 filed its Petition for investment approval under the provisions of Clause 11 of Distribution and Retail Supply Licence and Clause 40 of UERC (Conduct of Business) Regulations, 2014 read with relevant provision of the Electricity Act, 2003, and the Rules and Regulations made thereunder.

- 3. The Petitioner under 'Facts of the case' has submitted that:
 - "
 - (i) With a view to ensure reliable power supply, improved voltage profile and to meet future load growth, the applicant company has proposed Installation of Reactive Power Solution on 33/11 kV Substations in the State of Uttarakhand. The Total Capital cost of the proposed work is 68.81 Cr. (Capital Cost of Installation is Rs. 64.81 Cr, IDC cost is Rs. 3.99 Cr.) for which investment approval is being sought. It will be met through loan (70%) from Financial Institutions and 30% Equity/ Internal Resources of UPCL. The project is proposed to be implemented on turnkey basis. The duration of the project is 01 years. The details of substations and lines are as follows:

With objective to avoid low voltage and power factor issues, this project aims at:

• Installation of Automatic Reactive Power Solution (Capacitor Bank).

•	No. of 33/11 kV substations identified	:	61
•	No. of 33/11 kV Power Transformers	:	101
•	APFC panels to be installed	:	101 No. (387 MVAR)

- (ii) The detailed project report showing examination of an economic technical system together with the outline of the work to be undertaken, the salient features and particulars demonstrating the need for investment alongwith relevant cost benefit analysis is enclosed herewith at Annexure-A. The work to be undertaken does not have any adverse environmental effect. The estimated cost of the project is Rs. 88.29 Cr. (Capital Cost of Installation is Rs. 64.81 cr, IDC cost is Rs. 3.99 Cr. and AMC cost for 5 years is Rs. 19.48 Cr.). The estimated cost of the project will be met through loan (70%) from Financial Institutions and 30% Equity/ Internal Resources of UPCL. Further, a request letter to M/S REC for sanction of the loan has been sent and is enclosed herewith as Annexure-B. The approval from BOD is enclosed herewith at Annexure-C for your kind perusal."
- The Petitioner alongwith its Petition has enclosed certified true copy of 118th Board of Directors meeting dated 18.06.2024. The resolution passed by BOD states that:-

"RESOLVED THAT in view of deliberations in the meeting, approval of the Board of Directors be and is hereby accorded for Installation of Reactive Power Solution on 33/11 kV Substations in the State of Uttarakhand with AMC for 5 years with an estimated cost of Rs. 84.30 Cr. as per DPR, terms & conditions, timelines and all other details circulated in the Agenda Notes and Annexures thereto and as presented in the agenda."

- 5. The Petitioner under 'Relief Sought' has submitted that:
 - "…

11

- (iii) Grant approval for process the tender of Installation of Reactive Power Solution for real time power factor improvement, better voltage profile at identified 61 Nos. 33/11kV Substations thereby reducing reactive power losses to the minimum, this will also avoid line losses arising out of extra reactive power flow in the transmission network and provide more stability/ strength to the grid. However, the work will be awarded after getting the investment approval from Hon'ble Commission."
- 6. The Petitioner under objective of the Project has submitted that installation of the proposed reactive power solution would result in real time power factor improvement, better voltage profile, less technical losses and low transformer loading. The State network would be able to cater more consumers on existing infrastructure as well as it would improve the grid stability at higher voltages.
- 7. The Petitioner in its Petition has submitted that the problem/constraint would be addressed through the project/scheme/activity as follows:
 - *a) Introduction of Automatic Switched Capacitor Banks.*
 - *b) Precise and real time compensation of reactive power.*
 - *c) Establishment of reliable Reactive Power System*
 - *d) Improvement in line losses*
 - *e)* Existing infrastructure can accommodate more consumers
 - *f) Less loading of transformers*
 - g) Better utilization of Capacitors."
- 8. The Petitioner further submitted that for achieving Volt/volt ampere reactive optimization and Energy conservation through voltage improvement and loss reduction, UPCL is proposing 61 sub stations (101 Power Transformers) for Automatic Reactive Power Management system as per list detailed below. The said 61 Nos. 33/11 KV Substations were identified by analyzing minimum voltage and minimum power factor of all the 33/11 KV Substations of UPCL in the time-span of January 2021 to December 2021.

Sl. No.	Name of 33/11 kV Substation	Rating of Transformer in MVA	Load (MVA)	MVAR Required	Proposed MVAR
1	33/11 S/S Jakhnidhar	8	6.47	2.95	3
2	33/11 S/S Jakhnidhar	5	4.37	2.15	3
3	33/11 S/S Nainbagh	5	4.24	2.23	3
4	33/11 S/S Nainbagh	5	4.24	2.23	3
5	33/11 S/S Ghansali	5	4.34	2.42	3
6	33/11 S/S Ghansali	5	3.80	2.68	3
7	33/11 S/S Rajakhet	8	6.46	3.96	4.8
8	33/11 S/S Chiniyalisaur	5	4.24	2.23	3
9	33/11 s/s Sumari	5	4.24	2.23	3
10	33/11 S/s Latherdeva Sekh	8	7.11	4.17	4.8
11	33/11 S/s Latherdeva Sekh	8	5.93	3.48	4.8
12	33/11 S/s Bhadaipura	10	8.78	5.03	4.8
10	33/11 S/s Circle	10	0 E7	165	10
13	Rudrapur	10	8.57	4.65	4.8
14	33/11 S/s Lalpur	12.5	10.57	5.21	4.8
15	33/11 S/s Lalpur	10	8.47	4.46	4.8
16	33/11 S/s Lalpur	12.5	10.46	5.16	4.8
17	33/11 S/s Pantnagar	10	8.47	4.46	4.8
18	33/11 S/s Pantnagar	10	8.47	4.46	4.8
19	Majhrasheela Gadarpur	8	6.78	3.57	3.6
20	Majhrasheela Gadarpur	8	6.62	3.26	3.6
21	Majhrasheela Gadarpur	10	8.5	4.52	4.8
22	Majhrasheela 2 Gadarpur	10	8.47	4.46	4.8
23	Majhrasheela 2 Gadarpur	10	8.28	4.08	4.8
24	Chorgalia, Sitarganj	5	4.34	2.42	4.8
25	SIDCUL, Phase-II	0	()(0.70	4.0
25	Sitarganj	8	6.86	3.72	4.8
26	SIDCUL, Phase-II Sitarganj	8	6.94	3.87	4.8
27	SIDCUL, Phase-III Sitarganj	8	6.62	3.26	3.6
28	SIDCUL, Phase-III Sitarganj	5	4.09	1.94	3
29	Jhankat	5	4.29	2.33	3
30	33/11 S/S, Raiagar (Berinag)	5	4.24	2.23	3
31	33/11 S/S, Raiagar (Berinag)	5	4.24	2.23	3
32	33/11 S/S, Kunalta (Ganai)	5	3.50	2.10	3
33	33/11 S/S, Thal	5	4.09	1.94	3
34	33/11 S/S, Gangolihat	5	4.24	2.23	3
35	33/11 S/S, Gangolihat	5	4.24	2.23	3
36	33/11 S/S Khetikhan	5	4.29	2.33	3
37	33/11 S/S, Tanakpur	5	4.24	2.23	3
38	33/11 S/S, Banbasa	5	4.19	2.14	3
39	33/11 S/S, Banbasa	5	4.19	2.14	3
40	33/11 Champawat	8	6.38	3.83	4.8
41	33/11 Champawat	8	6.25	3.75	4.8
42	33/11 S/S, Kanlichhina	5	3.73	2.08	3
43	33/11 S/S, Bin	8	6.63	3.98	4.8

S1. No.	Name of 33/11 kV Substation	Rating of Transformer in MVA	Load (MVA)	MVAR Required	Proposed MVAR
44	33/11 S/S, Madmaneley	5	4.05	2.48	3
45	33/11 S/S, Madmaneley	5	3.92	2.41	3
46	33/11 Substation Barheni Bazpur	5	4.31	2.99	3
47	33/11 Substation Barheni Bazpur	5	4.29	2.73	3
48	33/11 Substation Ittawa, Bazpur	8	6.41	2.66	3.6
49	33/11 Substation Ittawa, Bazpur	8	6.55	3.11	3.6
50	33/11 Sub Station Jaspur Town	12.5	10.25	6.29	4.8
51	33/11 Sub Station Jaspur Town	12.5	10.13	6.21	4.8
52	33/11 Sub Station Amritpur Patti	8	6.78	3.57	4.8
53	33/11 Sub Station Amritpur Patti	8	6.86	3.72	4.8
54	33/11 S/S Maldhan Chaur	5	4.19	2.14	3
55	Gaindi Khata	5	3.81	2.07	3
56	Gaindi Khata	5	3.81	2.07	3
57	Sec-12	12.5	11.25	6.75	4.8
58	Sec-12	12.5	11.25	6.75	4.8
59	Lakha Mandal Vikasnagar	5	4.14	2.04	3
60	Lakha Mandal Vikasnagar	5	4.09	1.94	3
61	Shaiya Vikasnagar	5	4.56	2.79	3
62	Chakrata , Vikasnagar	5	4.62	2.89	3
63	Chakrata , Vikasnagar	5	4.62	2.89	3
64	Tuni Vikasnagar	5	4.68	2.98	3
65	Tuni Vikasnagar	5	4.68	2.98	3
66	33/11 S/s Gangapur	5	4.24	2.23	3
67	33/11 S/s Gangapur	5	4.24	2.23	3
68	33/11 S/s Kichha	12.5	10.59	5.58	4.8
69 70	33/11 S/s Kichha	12.5	10.59	5.58	4.8
70	33/11 S/S Kichna	8 F	6.78	3.57	3.6
71	$\frac{33}{11}$ $\frac{5}{5}$ Fulbhatta	10 5	4.24	2.23 E E 8	3
72	33/11 5/5 Sector-2	12.3	6 78	3.58	4.0
73	33/11 S/s Sector 3	12.5	10.59	5.57	4.0
74	33/11 S/s Sector-4	12.5	10.59	5.58	4.0
75	$\frac{33}{11} \frac{5}{5}$	12.5	10.59	5.58	4.0
70	33/11 S/s Sector-9	8	6 78	3.57	4.0
78	33/11 S/s Sector 12	5	4.24	2.37	3.0
79	Bhikiyasain	5	4 74	2.23	3
80	Mohanari Bhikiyasen	5	4 09	1 94	3
81	Dangoli Bageshwar	5	4.14	2.04	3
82	Banlekh Bageshwar	5	4.09	1.94	3
83	Sec-7	12.5	10.00	4.36	4.8
84	Sec-7	10	8.00	3.49	3.6
85	Sec-7	10	8.00	3.49	3.6
86	Sec-5	12.5	10.00	4.36	4.8
87	Sec-5	12.5	10.00	4.36	4.8

Sl. No.	Name of 33/11 kV Substation	Rating of Transformer in MVA	Load (MVA)	MVAR Required	Proposed MVAR
88	Begampur IP-4	10	8.00	3.49	3.6
89	Begampur IP-4	10	8.00	3.49	3.6
90	Kalagarh Kotdwar	5	4.39	2.51	3
91	Kot Pauri	5	4.19	2.14	3
92	33/KV TP Nagar	10	8.18	3.89	4.8
93	33/KV TP Nagar	12.5	10.23	4.86	4.8
94	33/11 S/S Laljiwala	12.5	10.98	6.28	4.8
95	33/11 S/S Laljiwala	12.5	10.37	5.93	4.8
96	33/11 S/S Pratappur	10	6.25	3.75	4.8
97	33/11 S/S Pratappur	10	6.25	3.75	4.8
98	33/11 KV s/s Doraha	8	7.29	3.84	4.8
99	33/11 KV s/s Doraha	8	6.94	3.66	4.8
100	33/11 s/s Betalghat	5	3.92	2.41	3
101	33/11 s/s Betalghat	5	3.92	2.41	3

9. The Petitioner in its Petition has submitted timeline for implementation of Project/Scheme/Activity as follows:

Time line of the Project/Scheme/Activity				
Likely Duration of Project (in months)	12(Twelve) months			
Likely Start Date	On accord of Administrative & Financial Approval			
Likely Completion Date	March 2025			

- 10. The Petitioner for computation of reactive power compensation solutions at various Substations/transformer locations has relied on the methodology adopted in the sample ERDA Study Report.
- 11. On examination of the submissions made in the Petition & DPRs certain deficiencies/infirmities were identified and accordingly, the Commission vide its letter No. 570 dated 22.07.2024 directed the Petitioner to furnish its reply on the following latest by 05.08.2024: -
 - "
 - 1. UPCL is required to furnish the 33/11 kV substation-wise capacitor banks installed in the UPCL's network in following format: -

Name of 33/11 kV S/s	Rating of installed transformer (in MVA)	Rating of capacitor bank (in MVAr)	Year of installation	Type of Capacitor bank (Fixed/Switched/ manual/automatic)	Details of Harmonic filters	Present condition

2. Regulations 3.1.2 'Reactive compensation and Harmonics' of UERC (Distribution Code) Regulations, 2018 provides that:

"...the size and location of the capacitor installations shall be determined using appropriate computer software, with reliable field data. Suitable precautionary measures, such as automatic switching etc., shall be adopted to avoid over voltages during light load periods."

In this regard, UPCL is required to confirm the adequacy of existing installed shunt capacitors with respect to the reactive power compensation and also confirm regarding the need for installation of harmonic filters at existing installed shunt capacitors in its network.

- 3. UPCL is required to furnish data sheet of each rating of capacitor bank installed in its network viz. 1800 kVAr, 3000 kVAr etc. alongwith details of cable size used for different rating of capacitor banks.
- 4. UPCL at point no. 4(ii) has submitted that the estimated cost of the project is Rs. 88.29 Cr. (Capital Cost of installation is Rs. 64.81 Cr., IDC cost is Rs. 3.99 Cr. & AMC cost for 5 years is Rs. 19.48 Cr.). However, at page no. 69 of the Petition, UPCL has enclosed 'certified true copy of Resolution passed by BoD in 108th BoD held on 18.06.2024', wherein, the project cost with AMC of 5 years is mentioned as Rs. 84.30 Cr. UPCL is required to clarify in this regard and submit documentary evidence that BoD has approved the project with estimated cost of Rs. 88.29 Cr.
- 5. UPCL has considered AMC cost for 5 years as Rs. 19.48 Cr. UPCL is required to furnish the basis of cost estimate for AMC.
- 6. UPCL at page no. 8 to 13 of its DPR has provided a list of 101 transformers (61 nos. 33/11 kV substations) where the proposed capacitor banks would be installed. The base data is of time-span January 2021 to December 2021. In this regard, UPCL is required to furnish the updated data of each transformer capacity as on 30.06.2024 including details of onload/offload tap changer at 33/11 kV transformer, current tap position and total no. of taps for each transformer where capacitor bank has been proposed.

Further, load (MW), load (MVA), power factor & voltage level data are to be furnished w.r.t. time-span July 2023 to June 2024 for the said 33/11 kV substations.

The augmentation in rating of transformer vis-a-vis data provided in DPR should be clearly highlighted in the aforesaid data.

- 7. UPCL at page no. 15 & 16 of the DPR has enclosed the single line diagram of proposed capacitor banks. In this regard, UPCL is required to confirm regarding the presence of harmonic filters installation along with the proposed capacitor banks for mitigating the ill-effects of harmonic current and voltages. Further, UPCL is required to furnish following:
 - *(i) A write-up on RVT including its need and significance in capacitor banks.*
 - (ii) Details of in-built protection available for protecting against over current, short circuit and over/under voltage scenarios in the proposed capacitor banks. Further, UPCL is required to confirm the over & under voltage setting limits for the proposed capacitor banks.
 - (iii) General arrangement drawing of capacitor banks (4800 kVAr, 3600 kVAr
 & 3000 kVAr) indicating its dimensions and clearances from the substation structures and equipment.
 - *(iv) Detailed write-up on control philosophy for the proposed capacitor banks.*
 - (v) Details of inbuilt alarms in APFC panel.
 - (vi) Type of Capacitor bank with weatherproof enclosure or without weatherproof enclosure.
- 8. UPCL at page no. 20 at S. No. 4.2 has included heat shrinkable jointing kit for 33 kV. UPCL is required to confirm regarding the same.
- 9. UPCL at page no. 20 at S. No. 3.8 has considered 3Cx185 sqmm armored 11 kV XLPE cable. In this regard, UPCL is required to furnish cable sizing calculation for 4800 kVAr, 3600 kVAr & 3000 kVAr capacitor banks duly considering the aspects of harmonic/ inrush current tolerance of 20%, voltage variation 10%, capacitor tolerance 15% and cable derations due to temperature and type of laying.
- 10. UPCL at page no. 23 of its DPR has enclosed BoQ for capacitor bank system. In this regard, UPCL is required to cross check and confirm the requirement of different ratings of capacitor banks which would be required for the instant project based on the rating of transformers as on June 2024 and updated data as per S. No. 3 and 8 above.

- 11. UPCL at page no. 33 to 38 of DPR has submitted the data pertaining to before and after capacitor banks installation scenarios. In this regard, UPCL is required to clarify why at S. No. 24 despite proposing capacitor bank of 4.8 MVAr against the required MVAr capacity of 2.42, the power factor improvement after capacitor banks installation remains 0.83. UPCL is required to clarify in this regard. Further, UPCL is required to cross check and correct any of such infirmities in computation of required MVAr capacity.
- 12. With regard to the data submitted at page no. 33 to 38 of DPR, it is observed that at several locations despite the reactive power compensation the voltage after the installation of capacitor banks is in the range of 10.03 kV. UPCL is required to confirm how in a real time scenario such issues of under voltage would be addressed despite having full reactive power compensation from the installed capacitor banks.
- 13. UPCL at page no. 50 has enclosed a report of ERDA, wherein, the instantaneous values of average and maximum are indicated which appear to be incorrect. Further, the graphs shown at page no. 50, 51, 52 do not correlate with the data as indicated in Table 'case 2: when APFC panel is in off condition'. UPCL is required to submit clarification this regard.
- 14. UPCL at page no. 55 to 58 has shown certain calculations pertaining to payback period. In this regard, it is observed that the data w.r.t. T&D losses has not been indicated correctly. Further, the 'kWh saved per day' is also not indicating the correct information at several places. Moreover, due to the incorrect consideration of T&D losses, the computation of payback period appears to be incorrect. UPCL is required to cross check and submit the corrected computations for the same.
- 15. UPCL at page 62 has shown computation of return on investment, wherein, the total units saved in a year against total no. of capacitors has been shown as '53454250'. UPCL is required to furnish the backup calculation for the same.
- 16. UPCL is required to furnish the SoR/supporting document considered for preparing the cost estimate for each line item indicated at page no. 19 to 21 of its DPR.

UPCL is required to furnish revised computations of BoQ, estimates and payback period computations based on the above-mentioned observations in hard and soft copy. "

 In compliance to the above observations of the Commission, UPCL vide its letter No. 1554/UPCL/D(O)/C-4 dated 25.07.2024 submitted its reply as mentioned below: -

"

Point-1: Details of previously installed capacitor banks on 33/11kV Substations in the UPCL's network are as follows:

Year of Installation:	2014-15 and 2015-16
Type of Capacitor Bank:	APFC

Sr No.	Sub station	Capacitor rating (KVAr)	Power Transformer rating (MVA)	Present condition
1	Sector-8 sidcul	3000 KVAr	12.5	Presently the installed Capacitor
2	Sector-8 sidcul	3000 KVAr	12.5	Banks are working satisfactorily as
		·	·	per performance reports (enclosed)
324	Pithoragarh	1800 KVAr	8	Furthermore There is a ongoing five
325	Tanakpur	1800 KVAr	5	(05) year contract for Comprehensive Maintenance (AMC) of all the installed 325 nos. Capacitor Banks. The contract was awarded in 2021-2022 and shall be valid for 5 years.

- **Point-2:** The documents in support of adequacy of existing installed shunt capacitors are attached as Annexure-1.
- **Point-3:** The technical details and specifications are attached as Annexure-2.
- **Point-4:** The duly signed agenda by the COD, UPCL submitted to the BOD is attached as Annexure-3 which clearly mentions the Project cost as Rs. 88.29 Cr. The Board was apprised with the agenda (annexure 3A) which included detailed project report (DPR), cost benefit analysis (CBA) of the project, PQR and other terms and conditions of the proposed tender for the project. The cost benefit analysis (annexure – 3B) took into consideration the IDC of Rs. 3.99 Cr for which the Board agreed to the proposal and approved the cost of DPR, timelines and all other details circulated in the agenda including CBA and all annexure thereto (annexure – 3C).
- **Point-5:** Total AMC cost for 5 years has been considered 30% of the capital cost which is @6% per year of the capital cost. Previously the project for repair and Comprehensive Maintenance Contract (AMC) was awarded by UPCL in 2021-22 in which the AMC charges were estimated @10% per year of the capital cost

(Annexure-4). The L-1 rate received in that project for 5 year AMC were approximately 43% (i.e. 8.6% per year) of the total project cost (Annexure-5). Thus in present project, the AMC cost has been considered @6% per year for 5 years, which is on lower side than the previous rates.

Point-6: The present capacity of each substation where capacitor bank has been proposed is as follows:

Sl. No.	Name of 33/11 kV Substation	Circle	Division	Rating of Transformer in MVA (As per DPR)	Current Status (in MVA)
1	33/11 S/S Jakhnidhar	TEHRI	TEHRI	8	8
2	33/11 S/S Jakhnidhar	TEHRI	TEHRI	5	5
3	33/11 S/S Nainbagh	TEHRI	TEHRI	5	5
4	33/11 S/S Nainbagh	TEHRI	TEHRI	5	5
5	33/11 S/S Ghansali	TEHRI	TEHRI	5	5
6	33/11 S/S Ghansali	TEHRI	TEHRI	5	5
7	33/11 S/S Rajakhet	TEHRI	TEHRI	8	8
8	33/11 S/S Chiniyalisaur	TEHRI	UTTARKASHI	5	12.5MVA Proposed
9	33/11 s/s Sumari	SRINAGAR	RUDRAPRAYAG	5	5
10	33/11 S/s LatherdevaSekh	ROORKEE	RAMNAGAR	8	8
11	33/11 S/s LatherdevaSekh	ROORKEE	RAMNAGAR	8	8
12	33/11 S/s Bhadaipura	RUDRAPUR	RUDRAPUR-I	10	12.5MVA Proposed
13	33/11 S/s Circle Rudrapur	RUDRAPUR	RUDRAPUR-I	10	10
14	33/11 S/s Lalpur	RUDRAPUR	RUDRAPUR-I	12.5	12.5
15	33/11 S/s Lalpur	RUDRAPUR	RUDRAPUR-I	10	10
16	33/11 S/s Lalpur	RUDRAPUR	RUDRAPUR-I	12.5	12.5
17	33/11 S/s Pantnagar	RUDRAPUR	RUDRAPUR-I	10	10
18	33/11 S/s Pantnagar	RUDRAPUR	RUDRAPUR-I	10	10
19	MajhrasheelaGadarpur	RUDRAPUR	RUDRAPUR-II	8	8
20	MajhrasheelaGadarpur	RUDRAPUR	RUDRAPUR-II	8	8
21	MajhrasheelaGadarpur	RUDRAPUR	RUDRAPUR-II	10	10
22	Majhrasheela 2 Gadarpur	RUDRAPUR	RUDRAPUR-II	10	10
23	Majhrasheela 2 Gadarpur	RUDRAPUR	KUDKAPUK-II	10	10
24	Chorgalia, Sitarganj	KUDKAPUK	SITAKGANJ	5	5
25	SIDCUL, Phase-II Sitarganj	RUDRAPUR	SITARGANJ	8	8
26	SIDCUL, Phase-II Sitarganj	RUDRAPUR	SITARGANJ	8	8
27	SIDCUL, Phase-III Sitarganj	RUDRAPUR	SITARGANJ	8	8
28	SIDCUL, Phase-III Sitarganj	RUDRAPUR	SITARGANJ	5	5
29	Jhankat .	RUDRAPUR	KHATIMA	5	5
30	33/11 S/S, Raiagar (Berinag)	PITHORAGARH	PITHORAGARH	5	5
31	33/11 S/S, Raiagar (Berinag)	PITHORAGARH	PITHORAGARH	5	5
32	33/11 S/S, Kunalta (Ganai)	PITHORAGARH	PITHORAGARH	5	5
33	33/11 S/S, Thal	PITHORAGARH	DHARCHULA	5	5
34	33/11 S/S, Gangolihat	PITHORAGARH	PITHORAGARH	5	5
35	33/11 S/S, Gangolihat	PITHORAGARH	PITHORAGARH	5	5
36	33/11 S/S KHETIKHAN	PITHORAGARH	CHAMPAWAT	5	5
37	33/11 S/S , TANAKPUR	PITHORAGARH	CHAMPAWAT	5	12.5MVA Proposed
38	33/11 S/S, BANBASA	PITHORAGARH	CHAMPAWAT	5	5
39	33/11 S/S, BANBASA	PITHORAGARH	CHAMPAWAT	5	5
40	33/11 CHAMPAWAT	PITHORAGARH	CHAMPAWAT	8	8
41	33/11 CHAMPAWAT	PITHORAGARH	CHAMPAWAT	8	8
42	33/11 S/S, Kanlichhina	PITHORAGARH	PITHORAGARH	5	5
43	33/11 S/S, Bin	PITHORAGARH	PITHORAGARH	8	8
44	33/11 S/S, Madmaneley	PITHORAGARH	PITHORAGARH	5	5

Sl. No.	Name of 33/11 kV Substation	Circle	Division	Rating of Transformer in MVA (As per DPR)	Current Status (in MVA)
45	33/11 S/S, Madmaneley	PITHORAGARH	PITHORAGARH	5	5
46	33/11 Substation BarheniBazpur	KASHIPUR	BAZPUR	5	5
47	33/11 Substation BarheniBazpur	KASHIPUR	BAZPUR	5	5
48	33/11 Substation Ittawa, Bazpur	KASHIPUR	BAZPUR	8	12.5MVA Proposed
49	33/11 Substation Ittawa, Bazpur	KASHIPUR	BAZPUR	8	12.5MVA Proposed
50	33/11 SUB STATION JASPUR TOWN	KASHIPUR	JASPUR	12.5	12.5
51	33/11 SUB STATION JASPUR TOWN	KASHIPUR	JASPUR	12.5	12.5
52	33/11 SUB STATION Amritpur Patti	KASHIPUR	JASPUR	8	12.5MVA Proposed
53	33/11 SUB STATION Amritpur Patti	KASHIPUR	JASPUR	8	12.5MVA Proposed
54	33/11 S/S MaldhanChaur	HALDWANI	RAMPUR	5	5
55	GaindiKhata	HARIDWAR	HARIDWAR_URBAN	5	5
56	GaindiKhata	HARIDWAR	HARIDWAR_URBAN	5	5
57	Sec-12	HARIDWAR	SIDCUL_RURAL	12.5	12.5
58	Sec-12	HARIDWAR	SIDCUL_RURAL	12.5	12.5
59	Lakha Mandal Vikasnagar	DEHRADUN_R URAL	VIKASNAGAR	5	5
60	Lakha Mandal Vikasnagar	DEHRADUN_R URAL	VIKASNAGAR	5	5
61	ShaiyaVikasnagar	DEHRADUN_R URAL	VIKASNAGAR	5	5
62	Chakrata , Vikasnagar	DEHRADUN_R URAL	VIKASNAGAR	5	5
63	Chakrata , Vikasnagar	DEHRADUN_R URAL	VIKASNAGAR	5	5
64	TuniVikasnagar	DEHRADUN_R URAL	VIKASNAGAR	5	5
65	TuniVikasnagar	DEHRADUN_R URAL	VIKASNAGAR	5	5
66	33/11 S/s Gangapur	RUDRAPUR	RUDRAPUR-I	5	5
67	33/11 S/s Gangapur	RUDRAPUR	RUDRAPUR-I	5	5
68	33/11 S/s Kichha	RUDRAPUR	RUDRAPUR-I	12.5	12.5
69	33/11 S/s Kichha	RUDRAPUR	RUDRAPUR-I	12.5	12.5
70	33/11 S/s Kichha	RUDRAPUR	RUDRAPUR-I	8	8
71	33/11 S/s Pulbhatta	RUDRAPUR	RUDRAPUR-I	5	5
72	33/11 S/s Sector-2	RUDRAPUR	RUDRAPUR-I	12.5	12.5
73	33/11 S/s Sector-3	RUDRAPUR	RUDRAPUR-I	8	8
74	33/11 S/s Sector-3	RUDRAPUR	RUDRAPUR-I	12.5	12.5
75	33/11 S/s Sector-4	RUDRAPUR	RUDRAPUR-I	12.5	12.5
76	33/11 S/s Sector-9	RUDRAPUR	RUDRAPUR-I	12.5	12.5
77	33/11 S/s Sector-9	RUDRAPUR	RUDRAPUR-I	8	8
78	33/11 S/s Sector-12	RUDRAPUR	RUDRAPUR-I	5	5
/9	Bhikiyasain	RANIKHET	BHIKIYASAIN	5	5
80	MohanariBhikiyasen	RANIKHET	BHIKIYASAIN	5	5
81	DangoliBageshwar	RANIKHET	BAGESHVVAR	5	5
82	BanlekhBageshwar	KANIKHEI	BAGESHVVAR	5	5
83	Sec-/	HARIDVVAR	SIDCUL_KUKAL	12.5	12.5
84	Sec-/	HARIDVVAR	SIDCUL_KUKAL	10	10
85	Sec-/	HARIDVVAR	SIDCUL_KUKAL	10	10
86	500-5 Sec 5	HAKIDWAK	SIDCUL_KUKAL	12.5	12.5
ð/ 00	JEC-J Ragammur ID 4			12.3	12.0
00	Begammur ID 4			10	10
09	begumpur 11°-4 KalagarhKotdwar	SRINACAD		5	5
01	KotDauri	SRINAGAK	DAIIDI	5	5
02	33/KV TD Nacar		ΠΛ/ΔΙΛΠΙΦ	10	10
92 03	33/KV TP Nagar	HARIDIAAD	ΓΛΙΔΙΔΠΙΡ	10	10
95 QA	33/11 S/S I AT ITATATA	HARIDIAAR	HARIDWAR HIRRAN	12.5	12.5
94	33/11 S/S I AI IIIA/AI A	HARIDIMAR	HARIDMAR HERAN	12.5	12.5
96	33/11 S/S Pratamin	KASHIDI IR	KACHIDI IR	12.5	12.5
97	33/11 S/S Protomur	KASHIDI IR	KASHIDI IR	10	10
31	sofii ofs riumpfur	MAJHFUK	MAJHFUK	10	10

Sl. No.	Name of 33/11 kV Substation	Circle	Division	Rating of Transformer in MVA (As per DPR)	Current Status (in MVA)
98	33/11 KV s/s Doraha	KASHIPUR	BAZPUR	8	12.5MVA Proposed
99	33/11 KV s/s Doraha	KASHIPUR	BAZPUR	8	12.5MVA Proposed
100	33/11 s/s Betalghat	HALDWANI	NAINITAL	5	5
101	33/11 s/s Betalghat	HALDWANI	NAINITAL	5	5

Proposal letter enclosed as annexure-6.

Further, the Minimum Power Factor and Minimum Phase to Phase Voltage Report received through RT-DAS System from Jun-2023 to Jun-2024 has been enclosed as annexure - 7.

Point-7: *The desired information is as follows:*

- (i) The Residual Voltage Transformer (RVT) plays a crucial role in 11 kV capacitor banks with open star connections of capacitors by providing accurate voltage measurements. In open star connections, capacitors are connected phase-toneutral, and the voltage across each capacitor is phase voltage (Vph). The RVT measures the residual voltage (V0) or the line-to-line voltage (VL) depending on the configuration. This measurement is crucial for accurately monitoring the voltage levels across the capacitors. These measurements are essential for monitoring, controlling, and protecting the capacitor bank, thereby optimizing its performance and ensuring the reliability of the electrical distribution system.
- (ii) OCR and Earth fault Relay is provided.
 U/O/V Relay is provided.
 For over voltage Limit is 10% of rated system voltage.
 Under Voltage Limit is -10% of rated system voltage.
- *(iii)* General arrangement drawing of capacitor banks indicating its dimensions and clearances from the substation structures and equipment are enclosed as annexure-8.
- *(iv) PF Correction Technique:*

1.5 multiplying factor for smallest Capacitor Bank is a Factory Default value. There are two PF set points to be set in APFC RELAY. The UPPER limit and the LOWER limit. APFC RELAY ensures that PF-UPPER is never exceeded. Additionally, "No change band" to minimum kVAr band size equal to smallest bank kVAr x 1.5 (factory default) ensures no hunting during the low kW loading. Smallest kVAr factor defines the no action zone prohibiting the capacitor bank On/Off operation to avoid hunting. The factory default value is 1.5 to keep compatibility with earlier APFC Units. Compensation Band Offset band is normally 50%-50% distributed around the calculated Target PF. This band size normally takes care of all the variations in supply voltage, frequency and harmonics changes, against the hunting of the Capacitor Banks. The band can be set from 0% to 100% above, below & distributed around the calculated Target PF Line. The factory default value is 50%, to keep compatibility with earlier APFC Units. APFC RELAY is normally set for PF settings as per first two diagrams shown where PF-LOWER is inductive. This philosophy helps to optimize the system maximum kVAr to be used as well as reduces the number of switching operations during higher loading conditions. This ensures better *life expectancies of the switched capacitors as well as the switching devices such* as Internal Relays or External Contactors. This methodology of kVAr compensation reduces the complex settings that are used by conventional PF Relays. The settings like C/K ratio and kVAr offsets / shifts are eliminated which makes APFC RELAY user friendly, and thus easy to commission.

(v) Details of inbuilt alarms in APFC panel. Protections provided: Over / Under Voltage Over-Supply-Current / Under kW Load. Over/Under AC Line Mains Frequency Supply Current Unbalance Phase Voltage Unbalance Phase Voltage Unbalance Total Capacitor Current Unbalance Capacitor Over-Current Panel Over-Temperature & APFC Internal Over-Temperature. Out-of-Steps (Insufficient Total Capacitive kVAr, indication. Non-Volatile RAM Fault, RTCC Battery-down Fault Control Voltage Supply Voltage to Contactor Coil, Nom. 240 V Fault.

(vi) Type of Capacitor bank is with weather proof enclosure with IP-54 protection.

- **Point-8:** This was a typographical error and has been corrected in the proposed tender. Corrected BOQ enclosed as annexure-9.
- **Point-9:** The calculation for adopting the given cable size are enclosed as annexure-10.
- **Point-10:** The requirement of different rating of capacitor banks has been deliberately finalized as per the voltage and power factor profile of the substation and DPR has been prepared after taking cognizance of the latest ratings of transformers installed (before and after calculation sheets enclosed as annexure-11).
- **Point-11:** The actual rating of the proposed capacitor bank was 3 MVAr. Corrected calculation sheet of before and after power factor and voltage profile are resubmitted (annexure-11) and taken into consideration. As per scope of work in the tender, the given list of capacitor banks is tentative which shall be finalized at the time of execution of the project.
- **Point-12:** The voltage range as has been calculated and is expected after installation of the capacitor bank is in the range of standard limit of <u>+</u>10% of 11KV (0.9 p.u to 1.1 p.u) and therefore has been accepted as technically feasible. As per point no. 7(v) over / under voltage protection are provided in the APFC panel.
- **Point-13:** The average & maximum values in the given table of ERDA seems to be interchanged. However the submitted calculation sheets have been reviewed and corrected calculations of savings and payback period are hereby re-submitted as annexure-12.
- **Point-14:** The values are due to typographical error only. However, the formulae are correct and the resultant values of each calculation are correct. The correctly typed sheets are again submitted as annexure- 12.
- **Point-15:** The savings have been derived based on the average savings achieved after installation of capacitor banks. The average savings per day have been considered for whole year while deriving the total annual saving and no reduction factor has been considered because, as per performance data sheet of the substations the loading of power transformers at the time of collecting the data was less than 50% and therefore the saving with such data may be considered as minimum saving per day and therefore the calculation for whole year have been done with this minimum saving only(annexure-12).

Point-16: Copies of SOR and previous tender rates of UPCL and market rates as considered while framing the estimate and methodology to frame the estimate are annexed as annexure-13.

- 13. On examination of UPCL's reply dated 25.07.2024, the Commission observed certain observations/requirement of additional information in its submission and the Commission vide its letter No. 697 dated 13.08.2024 directed the Petitioner to furnish its compliance on the below mentioned points: -
 - "
 - 1. UPCL is required to submit criteria for selecting the proposed 101 nos. transformers (in 61 substations) for installing the capacitor banks alongwith list of industrial feeders catered through these substations. Report/relevant documents are required to be submitted in support of the same.
 - 2. With regard to point no. 1 of the Commission's letter dated 22.07.2024, UPCL was required to provide certain information including details of harmonic filters and performance data for last two financial years pertaining to the installed capacitor banks in 33/11 kV S/s. However, UPCL in its submission dated 25.07.2024 has not furnished the information pertaining to year of installation, details of harmonic filters and performance data for last two financial years. In this regard, UPCL is required to submit the desired information strictly in the prescribed format along with the following information in separate column:-
 - (a) Loading on transformer (average & peak in MW) and average power factor after commissioning of respective capacitor bank vis-a-vis average & peak load and average power factor as on 30.06.2024. Any augmentation in capacitor rating from original is to be highlighted separately.
 - (b) Details of scheme under which the respective capacitor bank was installed.
 - 3. UPCL is required to submit the copy of the comprehensive AMC agreement for all the installed 325 nos. of capacitor banks clearly indicating the scope of work, terms & conditions. Further, UPCL is required to submit the details of the instances of individual capacitor bank failures in last three financial years i.e. during the said CAMC period.

- 4. The Regulation 3.1.2 'Reactive compensation and Harmonics' of UERC (Distribution Code) Regulations, 2018 mandates the determination of the size and location of the capacitor installations using appropriate computer software, with reliable field data. In this regard, UPCL is required to submit the latest reliable field data that has been considered for preparation of the instant proposal.
- 5. UPCL at point no. 2 of the Commission's letter dated 22.07.2024 was required to confirm regarding the need of installation of harmonic filters at existing installed shunt capacitors in its network, however, UPCL has not submitted the same. In this regard, UPCL is required to submit the aforesaid desired information.

Further, UPCL at point no. 7 of its submission dated 25.07.2024 has not submitted the information with regard to presence of harmonic filters installation along with the proposed capacitor bank for mitigating the ill-effects of harmonic current & voltage. In this regard, UPCL is required to confirm regarding the same.

- 6. UPCL at point no. 3 of its submission dated 22.07.2024 has submitted only the desired data sheet of installed capacitor bank, and BoQ of previous installation which provides for installation of 240 sqmm cable for 3 MVAr capacitors. Whereas, for 3 MVAr, 3.6 MVAr & 4.8 MVAr capacitors in the instant Petition, cable used is 3cx185 sqmm. UPCL is required to clarify regarding estimation of under sized cables for its proposed capacitors.
- 7. With regard to point no. 4, UPCL has submitted that the total project cost of Rs. 88.29 Cr. was included in the agenda and placed before the BoD which includes the capital cost of installation Rs. 64.82 Cr., IDC Rs. 3.91 Cr. & AMC cost of five years Rs. 19.48 Cr. The BoD accordingly at item no. 118.09 of its BoD dated 18.06.2024 has approved the cost of Rs. 84.30 Cr. that includes the project cost and AMC for five years. In this regard, UPCL is required to clarify the authenticity of its submitted agenda item no.in the submitted document which substantiate that it was placed before the BoD. Further, it has been observed that the BoD has approved the total project cost of Rs. 84.30 Cr. that includes the cost of Rs. 64.82 Cr. and AMC cost for five years Rs. 19.48 Cr. However, it does not include the proposed IDC cost of Rs. 3.99 Cr. in the agenda put-up before the BoD. Hence, it appears that UPCL has received an approval of Rs. 84.30 Cr. only from its BoD with

no variations in amount in the instant Petition. Whereas, the Petition put forward before the Commission is of Rs. 88.29 Cr. This prima-facie shows that IDC has not been approved by BoD. UPCL is given last opportunity to substantiate its claim that BoD has approved the amount for the instant Petition as Rs. 88.29 Cr.

- 8. UPCL has proposed the AMC cost for five years for the instant project as Rs. 19.48 Cr. In this regard, UPCL is required to submit the scope of work alongwith the terms & conditions considered for the proposed AMC.
- 9. With regard to point no. 6, it has been observed that UPCL was categorically directed to furnish the load (MW & MVA), power factor and voltage level data for time span July, 2023 to June, 2024 for the transformers at proposed capacitor banks locations. However, UPCL has failed to furnish the same. In absence of the relevant data which is important from the perspective of deciding the capacitor bank rating, it is futile to furnish load (MW & MVA), power factor and voltage level data for time span July, 2023 to June, 2024 for the transformers at proposed capacitor bank rating, it is futile to allow capacitor banks ratings based on previous years data. UPCL is required to furnish load (MW & MVA), power factor and voltage level data for time span July, 2023 to June, 2024 for the transformers at proposed capacitor banks locations for precisely determining the capacitor bank rating on the basis of reliable field data in accordance with the provisions of Regulation 3.1.2 of UERC (Distribution Code) Regulations, 2018. Accordingly, UPCL is required to revise its submissions including estimates and payback calculations.
- 10. UPCL at point no. 9 of its submission dated 25.07.2024 has submitted the calculation for considering 3cx185 sqmm 11 kV XLPE cable. However, UPCL has not considered the aspect of harmonic/inrush current tolerance of 20%, voltage variation 10%, capacitor tolerance 15% & cable derations due to temperatures and type of laying in its calculation. In this regard, UPCL is required to furnish cable sizing calculation for 4800 kVAr, 3600 kVAr & 3000 kVAr capacitor banks duly considering the aforesaid aspects. Further, it is observed that for calculating the cable size, UPCL has considered voltage as 12.65 kV while for 11 kV system generally in such condition there is no requirement of installation of capacitor bank. Further, it is unclear that why UPCL has considered 12.65 kV (higher voltage) for sizing the cable requirement whereas, the same should be determined for the lower voltage i.e. 9.56 kV.
- 11. UPCL at point no. 11 of its submission dated 25.07.2024 has submitted that the proposed capacity of capacitor bank is tentative and the same shall be finalized at the

time of execution of the project. In this regard, it is observed that in such condition it would result in substantial variation in the estimates whereas no variation has been allowed in BoD approval. UPCL is required to clarify in this regard.

- 12. As per the calculation submitted by UPCL at page no. 36 at S. No. 51 of the DPR, the required capacitor bank capacity is 6.2 MVAr, however, UPCL has proposed the installation of lower capacity capacitor bank i.e. 4.8 MVAr that would result in the improvement in voltage to only 10.03 kV. In this regard, UPCL is required to substantiate the reason for proposing the lower capacity capacitor bank at some substations.
- 13. UPCL is required to submit the recommendation/approval accorded by Northern Region Power Committee (NRPC) for the installation of the capacitor banks as proposed in the instant Petition, if any.
- 14. UPCL is required to submit reasons for not considering the diversity factor in computation of cost benefit analysis. UPCL is required to furnish the cost benefit analysis considering the suitable diversity factor."
- In compliance to the Commission's letter dated 13.08.2024, UPCL vide its letter No. 3434/Dir.(Operations)/UPCL/UERC dated 22.08.2024 submitted its reply as mentioned below: -
 - "
 - 1.

It is to apprise Hon'ble Commission that due to low voltage and low power factor in several parts of state there was huge unrest in consumers (news paper cuttings enclosed as Annexure-1). Hence, it was directed by State Government to resolve the issue as it was badly affecting the power supply across the State including drinking water schemes and agriculture works. To mitigate low voltage and power factor, proposal for installation of reactive power solution at the substations has been prepared. The size and locations of capacitor banks for preparation of DPR were identified based on field data (monthly lowest voltage and power factor for one year) obtained through MODEM installed in 33/11 kV Substations and also it was ensured the availability of land for installation of capacitor banks (space availability certificates from field units enclosed as Annexure-2). The calculations were carried out based on such data and the size of capacitor banks were finalized accordingly. The list of industrial feeders catered through these substations is enclosed as Annexure-3).

2.

The detailed information in desired format is enclosed as follows:

- (a) Latest data of previously installed capacitor banks regarding loading of transformer and average power factor etc after commissioning of respective capacitor bank is enclosed as Annexure-4 with performance certificates as Annexure-5. No augmentation in capacitor rating from original was done.
- *(b) Previously, the capacitor banks were installed under Internal Resource scheme.*
- 3.

Copy of agreement for comprehensive AMC is enclosed as Annexure-6. As per contract, initially the repair work was to be carried out and thereafter AMC was to be started. The repairing work completed by Jan, 2024 and the AMC period started w.e.f. Feb, 2024. The details of the instances of individual capacitor bank complaints and resolution status during the AMC period is enclosed as Annexure-7.

4.

The size and locations of capacitor banks for preparation of DPR were identified based on field data obtained through MODEM and availability of land for installation of capacitor banks (space availability certificates from field units enclosed as Annexure-2). The calculations were carried out based on such data and the size of capacitor banks were finalized accordingly. The latest reliable field data of 12 substations (18 transformers) as sample is enclosed as Annexure-8. The basis of data for making the DPR, IPDS data and RFMS (Rural Feeder Monitoring System) data was utilized for determining minimum voltage and minimum power factor month wise for one year. The RFMS portal was maintained by REC, New Delhi and its agreement/work got completed in Jan, 2024 and online availability of RFMS data stopped. Correspondence was also made with REC to continue the RFMS till Dec, 2024 (Ref. letter enclosed as Annexure-9). However, in place of RFMS, MoP GOI is presently developing NFMS (National feeder monitoring system) under RDSS using Smart meters. Since the RFMS data is not available at present, RTDAS data (which is maintained by UPCL) has been collected for the period of Jun, 2023 to Jun, 2024 but out of total 61 substations the RTDAS data is available only for 12 substations (18 transformers) which is being submitted on sample basis with analysis which confirms that the problem of low voltage and low power factor is still present in the system and needs to be rectified to improve power factor and voltage profile and safety of grid.

5.

Harmonic filters were not installed and therefore data regarding harmonic filters is not available.

6.

. . .

As per data sheet of M/s Polycab, M/s KEI and approved GTP of UPCL, the current capacity of 3x185 sqmm 11 kV cable is approximately 275 Amps (in ground) and 335 Amps (in air) whereas the calculated maximum current required for highest size capacitor rating i.e. 4.8 MVAr at 11 kV is 252 Amps. In previous contract of 2022 also which was executed for repair and AMC of capacitor banks, the size of 11 kV cable was kept as size of 3x185 sqmm for capacitor banks upto 3600 kVAr size. Therefore, for this project also, the 11 kV cable of 3x185 sqmm size was chosen while preparing the DPR (data sheet, GTP and calculation sheet enclosed as Annexure-10).

7.

. . .

The duly signed agenda as submitted to BoD, UPCL and MOM of the Board are enclosed as Annexure-11 & 12. As per item no. 118.09 of the MOM, "The agenda included detailed project report (DPR), cost benefit analysis (CBA) of the project, PQR and other terms & conditions...thereafter the Board agreed to the proposal". Further as per resolution, Board approved AMC, DPR, terms & conditions and all other details circulated in the agenda note (which included IDC) and annexure (including CBA which took IDC into consideration) thereto and as presented in the agenda. CBA is enclosed as Annexure-13.

8.

. . .

The scope of work alongwith terms & conditions considered for the proposed AMC are enclosed as Annexure-14.

9. ...

The basis of data for making the DPR, IPDS data and RFMS (Rural Feeder Monitoring System) data was utilized for determining minimum voltage and minimum power factor month wise for one year. The RFMS portal was maintained by REC, New Delhi and its agreement/work got completed in Jan, 2024 and online availability of RFMS data stopped. Correspondence was also made with REC to continue the RFMS till Dec, 2024 (Ref. letter enclosed as Annexure-9). However, in place of RFMS, MoP GOI is presently developing NFMS (National feeder monitoring system) under RDSS using Smart meters. Since the RFMS data is not available at present, RTDAS data (which is maintained by UPCL) has been collected for the period of Jun, 2023 to Jun, 2024 but out of total 61 substations the RTDAS data is available only for 12 substations (18 transformers) which is being submitted on sample basis with analysis which confirms that the problem of low voltage and low power factor is still present in the system and needs to be rectified to improve power factor and voltage profile and safety of grid.

10.

. . .

As per data sheet of M/s Polycab, M/s KEI and approved GTP of UPCL, the current capacity of 3x185 sqmm 11 kV cable is approximately 275 Amps (in ground) and 335 Amps (in air) whereas the calculated maximum current required for highest size capacitor rating i.e. 4.8 MVAr at 11 kV is 252 Amps. In previous contract of 2022 for repair and AMC of capacitor banks, the size of 11 kV cable was kept as size of 3x185 sqmm. Therefore, 11 kV cable of 3x185 sqmm size was chosen while preparing the DPR (data sheet, GTP and calculation sheet enclosed as Annexure-15). While calculating with 10% capacitor tolerance, 10% voltage tolerance and 5% harmonic tolerance, the ampacity required comes out to be 264 amps for 3600 kVAr and 352 amps for 4800 kVAr. Thus in such case, if required, the 11 kV cable of suitable size for 4800 kVAr may be provided by UPCL. Approximate difference in cost for providing such cable will be Rs. 6 Lac.

11. ...

As it takes time from preparation of DPR to execution of the project, the proposed capacity of capacitor banks has been kept tentative and shall be finalized at the time of execution of the project. In this regard, necessary provision has been made in the tender whereas variation shall be allowed subject to approval of competent authority of UPCL (Copy of tender clause is enclosed as Annexure-16).

12.

. . .

To maintain uniformity during execution, only 3 types of ratings have been proposed under the project viz 3 MVAr, 3.6 MVAr & 4.8 MVAr. Since, installation of capacitor banks is one of the several methods for improvement of power conditions, certain other methods such as construction of new substations, lines etc are also regularly being taken up to improve the network parameters as a whole. Therefore, proposed capacities of capacitor banks are expected to give the desired results.

13.

. . .

The copy of recommendation/approval accorded by NRPC for the installation of the capacitor banks as proposed in the petition is enclosed as Annexure-17. The DPR of the project was previously sent to PSDF (Power System Development Fund) for approval and financing. The project was approved/sanctioned by NRPC. But later on, the DPR was deemed returned by PSDF due to lack of funds (Annexure-18). The project was then sent for financing to SASCI scheme on 01.05.2024 (Annexure-19) but funding has not been provided under this scheme also.

14. ...

As mentioned earlier also, the loading of transformers at the time of collecting the data for preparation of DPR was approximately 40 to 50% and therefore, the savings have been calculated based on the uniform average savings for whole year without diversity factor. The cost benefit analysis and payback period have been calculated with these calculations. Hence the given calculations may be considered appropriate. The T&D losses have been assumed @25% as the project area covers mainly the non-high value consumers."

Commission's Observations, Views & Directions: -

- 15. Based on the examination and analysis of the Petition & subsequent submissions made by the Petitioner before the Commission, the observations, views & directions of the Commission are as follows:
 - (1) The Petitioner in its instant proposal has proposed for the installation of capacitor banks with ratings as 3 MVAr, 3.6 MVAr & 4.8 MVAr at 101 No.

transformer locations spread across 61 nos. 33/11 kV Substation in the State for improvement of voltage profile & power factor. Further, with the installation of the proposed capacitor banks precise & real time compensation of reactive power, establishment of reliable Reactive Power System, reduction in line losses, accommodation of more consumers in existing infrastructure and reduction in transformer loadings is anticipated.

(2) Regulation 3.1.2 'Reactive compensation and Harmonics' of UERC (Distribution Code) Regulations, 2018 mandates the determination of the size and location of the capacitor installations using appropriate computer software, with reliable field data. Understanding the relevance and need of assessment of capacitor bank sizing on the basis of **latest reliable field data**. However, the proposal of the Petitioner was prepared on the basis of site data viz. transformer capacity, transformer loading, power factor and voltage level for the period from January 2021 to December 2021. On observing this, the Commission suggested the Petitioner that the assessment of capacitor bank sizing should be in accordance with the aforesaid provision of the Regulation and thus, asked the Petitioner to submit the field data for time span from July, 2023 to June 2024.

In response to this, the Petitioner in its submission dated 22.08.2024 has furnished the data available from RT-DAS for only 12 Substations (18 No. transformers). On further examination of the said data *prima-facie* it is observed that in several cases out of said 18 transformers, required capacitor banks ratings proposed in the instant Petition have significantly changed.

Regarding non production of the field data for remaining Substations proposed in the Petition, the Petitioner stated that the Rural Feeder Monitoring System (RFMS) data is not available at present as the same was to be obtained from the portal developed by REC, which is not operating currently.

It has also been observed that at 09 locations out of 101 transformers, the power transformers have been augmented. This depicts that capacitor bank

sizing at these locations should be reviewed once again based on the latest data considering the dynamics of distribution system.

In this regard, the Commission took cognizance of the above facts and therefore, is of strong view that for proper & effective implementation of the project, the Petitioner should have conducted with due diligence study & estimation of adequately sized capacitor banks at each proposed location so that suitable capacitor banks are installed for catering the requirement of targeted power factor and future load requirements.

- (3) The Petitioner has computed the capacity of capacitor bank targeting to unity power factor, however, in some cases the capacitor bank of the proposed capacity are not capable to achieve the targeted value, which restrict the Petitioner's overall objective of achieving unity power factor and improvement in voltage profile. To this, the Commission asked the Petitioner to explain the rationale for proposing lesser rating of capacitor bank w.r.t. the required capacity as per its computation at certain cases. In response to this, Petitioner submitted that it has considered the same in its proposal in order to keep uniformity during execution. The Commission observed that such issues have arisen in cases where required capacity of capacitor bank is more than 4.8 MVAr i.e. the maximum capacity of capacitor bank proposed by the Petitioner.
- (4) With regard to requirement of underground 11 kV XLPE cable in the proposal, the Petitioner has proposed 3Cx185 sqmm for all 3 MVAr, 3.6 MVAr & 4.8 MVAr size capacitor bank. In this regard, the Commission suggested the Petitioner for considering harmonic/inrush current tolerance of 20%, voltage variation 10%, capacitor tolerance 15% & cable derations due to temperatures and type of laying in its calculation of cable sizing. In response to which, the Petitioner submitted that it has considered 10% capacitor tolerance, 10% voltage tolerance and 5% harmonic tolerance while considering the size of cable. The Petitioner has further submitted that the ampacity required would be 264 amps for 3600 kVAr and 352 amps for 4800 kVAr and in such cases, if required, the 11 kV cable of suitable size for 4800 kVAr would be provided by it as the cost implication is not substantial.

In this regard, the Commission opines that consideration of adequate design aspects while planning & estimation of equipment is vital and thus calls for consideration of adequate margins w.r.t. harmonic/inrush current tolerance, voltage variation, capacitor tolerance, cable derations due to temperatures and type of laying (air/ground/duct) while cable sizing. Whereas, in the instant case, it has been observed that weak/inadequate links are being proposed in the system which may result in either failure of the asset when it is utilized to its full capacity, or it would deteriorate soon. Thus, the Commission is of the view that for proper & effective implementation of the proposed works adequate safety & design margins should have been kept while designing & estimating the distribution assets. Hence, in the instant case the Petitioner is required to methodically assess the requirement of assets/equipment prior to execution of the project and install appropriate size of 11 kV 3C XLPE cable for 3 MVAr, 3.6 MVAr & 4.8 MVAr respectively duly considering aforesaid factors.

(5) During the examination of Cost Benefit Analysis (CBA), payback sheets & calculations, it was not clear whether the Petitioner has considered 15% T&D losses or 25% in its payback calculation. Further, the Petitioner did not consider diversity factor on its payback period calculations. Therefore, the Commission asked Petitioner to submit the revised payback calculation sheets. In response to the same, the Petitioner submitted that it has considered 25% T&D losses i.e. by excluding the T&D losses of high value consumers. With regard to diversity factor, the Petitioner submitted that the loading of transformer as considered by the Petitioner while preparing the DPR was 40 to 50%, therefore, it has calculated uniform average savings for whole year without considering diversity factor.

In this regard, the Commission understands that losses of technical nature can be reduced/minimized with installation of capacitor bank, however, from the submission of the Petitioner, it appears that Petitioner is anticipating 25% loss reduction in each case of installation of capacitor bank and projecting a payback period of approximately 5 years. This is certainly depiction of over optimistic picture before the Commission. The Commission believes that estimates should be pragmatic and not overoptimistic which gives false signals about an investment by depicting a rosy picture for substantiating an investment. The Commission is of the view that the Petitioner instead of considering optimistic scenario should be ready for the realistic situation. Right now, the T&D losses in the State is around 14 %, however, the Petitioner in order to project attractive payback period has considered 25 % T&D losses stating and has tried to justify it by that project areas cover non-high value consumers, where the losses are higher than average losses of the State. On further examination of the Petitioner's submission, it has been observed that the Petitioner has proposed installation of Capacitor banks at transformers which are catering to industrial loads also. Hence, Petitioner's submission that the project areas cover non-high value consumers is factually incorrect.

Therefore, in this scenario, it becomes all the more important that the Petitioner should pay more attention on maintenance and careful operation of the proposed capacitor bank so that it completes its useful life, because earlier retirement of the asset without reaping the benefits of the investment on the same would result in substantial financial losses to the Petitioner.

(6) Also, it has been observed that the total cost of the project is Rs. 88.29 Cr. that includes cost of installation Rs. 64.82 Cr., IDC Rs. 3.91 Cr. & AMC cost of five years Rs. 19.48 Cr. However, the BoD of the Petitioner dated 18.06.2024 has approved the cost of Rs. 84.30 Cr. that includes the project cost and AMC for five years. Therefore, the Commission asked the Petitioner to substantiate its claim of Rs. 88.29 Cr. made in the instant Petition as prima-facie it shows that IDC has not been approved by its BoD. In response to the aforesaid observation, the Petitioner produced before the

In response to the aforesaid observation, the Petitioner produced before the Commission duly signed agenda and MoM of the BoD dated 18.06.2024 The Petitioner emphasized that the agenda with item no. 118.09 was consisting of the DPR, Cost Benefit Analysis (CBA) of the project and other terms & conditions which was agreed by the BoD. The Petitioner further submitted that the IDC was included in the CBA. In this regard, considering the achievable benefits of the project, the Commission as of now is taking lenient view with an advice to the Petitioner to restrict the project cost within the total cost (including IDC) approved by the BoD and incase after bidding/execution it goes beyond the approved amount, the Petitioner should take necessary approval from BoD.

- (7) Prior to submission of the instant proposal before the Commission the same was also submitted for the purpose of funding to PSDF (Power System Development Fund) and also later to the State Government (GoU) under SASCI scheme. The Petitioner also submitted that Northern Regional Power Committee (NRPC) in its MoM dated 29.01.2024 has accorded approval for the same. However, the proposal could not be funded through PSDF or SASCI due to Fund constraint.
- (8) On the submission of the Petitioner with regard to the maintenance of these Capacitor Banks, the Commission is of the view that maintenance of capacitor banks is an important exercise as the maximum uptime of an asset is vital from its investment recovery perspective. Therefore, the Petitioner is suggested to frame its CAMC contract for ensuring highest degree of Service Level Agreement (SLA) with appropriate liquidated damages clause for compensating it against default in agreed SLA.
- (9) With regard to the harmonic filters, the Petitioner has submitted that no harmonic filters have been installed at any of the existing capacitor bank locations and infact no assessment w.r.t. harmonic voltage/currents is being done. In this regard, the Commission is of view that in current power sector scenario, 3 'A' i.e. 'Availability, Affordability & Accessibility of power and Quality & Reliability of power are important KPIs. The Commission understands that the proposed investment of the Petitioner is one step towards addressing the issue of Quality of power supply.

In this regard, Central Electricity Authority (Technical Standards for Connectivity to the Grid) (Amendment) Regulations, 2019 provides that:-

"Part IV

(3) Voltage and Current Harmonics

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- (i) The limits of voltage harmonics by the distribution licensee in its electricity system, the limits of injection of current harmonics by bulk consumers, point of harmonic measurement, i.e., point of common coupling, method of harmonic measurement and other related matters, shall be in accordance with the IEEE 519-2014 standards, as amended from time to time;
- •••
- (vi) The distribution licensee shall install power quality meters in a phased manner within three years from the date of commencement of the Central Electricity Authority (Technical Standards for Connectivity to the Grid) (Amendment) Regulations, 2018 covering at least 33% of the 33 kV substations each year."

It is a known fact that presence of harmonics in the electrical network may be the cause of malfunctioning of the equipment, such as in the case of overloading of the equipment. In particular, harmonics are the phenomenon which most heavily affects power factor correction capacitors. In fact, if supplied by a distorted voltage, the capacitors can draw a current of such intensity that it could seriously damage them. Thus, assessment of harmonics is not only crucial from the perspective of increased losses in the distribution network and its ill effects on equipment overloading but also the same is important from the perspective of safety of capacitors. Capacitors act as sink for the harmonic currents and may lead to capacitor failure or fire.

The Commission has observed that 26 transformers feeding industrial feeders are proposed for capacitor bank installation in the instant Petition. Industrial feeders are usually rich in terms of harmonics due to presence of various equipment viz. recti-formers, rectifiers, non-linear loads etc. Thus, the Commission deems it appropriate to direct the Petitioner to incorporate appropriate clauses for providing the solutions to mitigate harmonic current & voltage assessment in the AMC contract of the instant project/proposal, inline with the aforesaid provisions of CEA Regulations.

- (10) Further, the Commission opines that besides installation of capacitor banks several other interventions would be required such as better monitoring & assessment, prompt maintenance, construction of new Substations, lines, utilization of OFTC/OLTC of power transformers etc. for improving the distribution system parameters. Thus, installing capacitor banks at Substations/transformer locations is not one-stop solution for all the distribution sector problems such as low power factor, voltage profile, high technical losses, deferring investments for system augmentation etc. rather it is one of the ways which can provide helping hand towards resolving the aforesaid issues.
- 16. Based on the above and keeping in view of the need of the works proposed under the Project, the Commission hereby grants in-principle approval for the works proposed in the Petition, subject to the fulfilment of terms and conditions mentioned below:
 - (i) The Petitioner is directed to go for the competitive bidding for obtaining most economical prices from the bidders under the prevailing Rules & Regulations.
 - (ii) The Petitioner to restrict the cost of project execution within the total cost approved by the BoD i.e. Rs. 84.30 Cr., however, in case after bidding/post execution, the cost goes beyond the approved amount, the Petitioner shall take necessary approval from BoD.
 - (iii) The Petitioner is directed to methodically assess the requirement of assets/equipment prior to execution of the project and install appropriate size of 11 kV 3C XLPE cable for 3 MVAr, 3.6 MVAr & 4.8 MVAr respectively duly considering aforesaid factors. The Petitioner should ensure to keep the records of assessment mentioned above.
 - (iv) All the loan conditions as may be laid down by the funding agency in their detailed sanction letter are strictly complied with. However, the Petitioner should explore the possibility of swapping this loan with cheaper debt option available in the market.

- (v) Prior to implementation of the project, the Petitioner is directed to conduct with due diligence, study & estimation of capacitor banks at each proposed location so that suitable capacitor banks are installed for catering to the requirement of targeted power factor and future load requirements and achieve the desired results/benefits as has been projected by the Petitioner. The Petitioner should ensure to keep the records of study & estimation mentioned above.
- (vi) Petitioner to submit the scheduled program in the form of Bar Chart within 15 days of the Order. Further, Petitioner to submit monthly report on the progress of installation of Capacitor Banks vis-à-vis the scheduled program of the Project by 15th day of the next month on regular basis.
- (vii) CAMC contract be framed in order to ensure highest degree of Service Level Agreement (SLA) with appropriate Liquidated Damages (LD) clause for compensating the Petitioner against default in agreed SLA.
- (viii) Petitioner to incorporate appropriate clauses so as to mitigate the harmonic current & voltage assessment in the AMC contract of the instant project/proposal inline with the relevant provisions of CEA Regulations and solutions for mitigating the same.
- (ix) Petitioner shall submit half yearly report of the CAMC contract of all the 101 nos. capacitors banks before the Commission.
- (x) The Commission may verify/check the proposed works to be executed by the Petitioner at any point of time during/post execution of the works from the perspective of not only substantiating that assertions & commitments made by the Petitioner have been fully complied, but also to assess loading on transformer, power factor & voltage level alongwith rating & quality of equipment, optimum utilization of resources etc. as has been projected by the Petitioner.
- (xi) Post execution of the project, the Petitioner shall submit the Project Completion Report to the Commission alongwith details of Capacitor bank installed in each transformer, power factor & voltage profile before & after installation of capacitor bank, substantiated by extracts of MRI, photographs

of the installation with date, expenditure incurred/completed cost, financing of the Project and detailed analysis & calculations of the benefits accrued from the proposed investments etc. on the basis of such parameters

- (xii) The cost of servicing the project cost shall be allowed in the Annual Revenue Requirement of the Petitioner after the assets are capitalized and subject to prudence check of cost incurred. One of the basis for the approval of the investment is the Cost Benefit Analysis. The parameters stated in the Cost Benefit Analysis are required to be achieved to justify the investment and the same would be criteria to be considered in ARR Petition.
- 17. The approval is given subject to the above conditions and on the basis of submissions and statement of facts made by the Petitioner in the Petition under affidavit. In case of violations of any of the condition mentioned above or in case any information provided, if at any time, later on, found to be incorrect, incomplete or in case relevant information was not disclosed, that materially affects the basis for granting the approvals, in such cases, the Commission may cancel the approval or refuse to allow all or part of the expenses incurred in the ARR/True-up apart from initiating plenary action.

Ordered accordingly.

(Anurag Sharma) Member (Law) (M.L. Prasad) Member (Technical)/Chairman(I/c)