

Before

UTTARAKHAND ELECTRICITY REGULATORY COMMISSION

Petition No. 17 of 2015

In the matter of:

Prior approval of "Capital Investment for Renovation & Modernization of 4 x 36 MW Chilla HEP" of UJVN Ltd..

And

In the matter of:

UJVN Ltd., "UJJWAL", Maharani Bagh, G.M.S. Road, Dehradun.Petitioner

Coram

Shri Subhash Kumar	Chairman
Shri K.P. Singh	Member

Date of Order: January 29, 2016

ORDER

This Order relates to the Petition filed by UJVN Ltd. (hereinafter referred to as "UJVN Ltd." or "the Petitioner") under Section 61 and 86 of the Electricity Act, 2003 read with the relevant Regulations i.e. Regulations 25 of UERC (Terms and Conditions for Determination of Tariff) Regulations, 2011 for seeking approval of Capital Investment for Renovation & Modernization of 4 x 36 MW Chilla.

2. UJVN Ltd. vide letter No. 95/UJVNL/03/D(P) dated 04.03.2015 had filed an Application under Regulation 25 of UERC (Terms and Conditions for Determination of Tariff) Regulation, 2011 for seeking prior approval in the matter of Capital Investment for Renovation & Modernization of 4 x 36 MW Chilla HEP.
3. The works proposed under R&M of Chilla HEP broadly categorized in Civil & Hydro-mechanical works, Power Plant and Accessories (E&M) alongwith other various heads viz. establishment, maintenance, T&P etc. The estimated cost submitted for the proposed works is as follows:-

Sl. No	Item	Estimated Cost (In Rs. Lakh)
A	Works	
1	Preliminary	76.80
2	Civil & Hydro Mechanical Works	1932.38
3	Maintenance @ 1% of Civil Works	19.32
4	Power Plant & Accessories (E&M)	31588.38
	Total A- Works	33616.88
B	Establishment @ 4% of Civil Works & E&M (being a RMU Project)	1340.83
C	Ordinary T&P @ 1% of A-Works	336.17
D	Losses on stocks @0.25% of Civil Works	4.83
E	Receipt & Recoveries	-
	Total Direct Changes	35298.71
F	Indirect Charges (Audit & Account @ 1% of A-Works)	336.17
	Grand Total	35634.88
5	IDC	10363.55
	Total Cost including IDC	45998.43

Thus, the Petitioner has submitted a proposal of Rs. 459 Crore (including IDC) for the R&M works of Chilla HEP.

4. The Petitioner has submitted that the project will be financed with debt-equity ratio of 70:30 and equity will be provided from budgetary support from GoU while debt would be arranged from Financial Institutions.
5. The Commission heard the matter for admissibility on 07.04.2015 and issued an Order dated 07.04.2015, with the direction that:

“

 1. *The discrepancies in the Petition as observed by the Commission pertaining to the Cost Estimate be reviewed and submitted to the Commission within 10 days of the Order.*
 2. *The staff of the Commission is directed to list out the discrepancies in the proposal and send the same to the Petitioner within 7 working days.*
 3. *The Petitioner to hold consultation in this regard with the beneficiary namely UPCL and submit the record of consultation to the Commission within 2 months of date of the Order.*
 4. *The next hearing for admissibility is posted for 21.04.2015.”*
6. In compliance to the direction issued at para 2 the staff of the Commission issued following preliminary discrepancies to UJVN Ltd. vide reference No. 97 dated 17.04.2015:

“

1. UJVN Ltd. in its application/petition has not specified the exact enhancement/uprating of installed capacity of the Plant as a whole. Though the increase in capacity of individual machine is reflected in the submission.

UJVN Ltd. is required to make specific submission in this regard.

2. UJVN Ltd. in its submission has opted for Propeller turbine with turbine efficiency of 92% and the relevant calculations have been done on the basis of this efficiency. On perusal of the report it has been observed that in figure 8.4 Turbine Efficiency Curve (at page No. 215) of the DPR annexed as Appendix-I, depicts that the maximum efficiency of the Propeller turbine at 155 m³/sec with net Head of 32.23 m is almost 90%.

UJVN Ltd. is required to clarify the basis for this hypothetical increase of 2% in turbine efficiency.

3. UJVN Ltd. in its submission has mentioned that the design discharge of the Power Channel is 620 m³/sec and authorized discharge is 565 m³/sec (which has been enhanced to 600 m³/sec).

UJVN Ltd. is required to submit the original documents alongwith the safety considerations with regard to the continuous flow of 620 m³/sec in existing Power Channel as the authorized discharge is 565 m³/sec.

4. UJVN Ltd. in its submission has submitted that the individual machine will be operating at its rated output with maximum unit flow/discharge of 155 m³/sec.

UJVN Ltd. is required to justify the flow of the above discharge with existing Penstocks.

5. UJVN Ltd. has included the complete replacement of the generator against refurbishment of the generator proposed by Canadian Commercial Corporation (CCC) in option 2-b, without giving proper justification, as the same will increase the cost of the Project.

CCC in its investigation has not reported any defects/shortcoming in rotor spider, top bracket, stator core, etc., though it has recommended some modifications in slip rings and break rings and did not recommend for replacement. UJVN Ltd. in its Revalidated DPR has proposed replacement of Stator frame, Stator core, rotor pole alongwith complete rotor winding, rotor spider, generator shaft, etc.

UJVN Ltd. is required to justify the replacement.

6. For Cost Estimation "Parametric Estimation" technique has been adopted on the basis of the rates received for RMU works of Mohammadpur, Pathri and Khatima HEPs of M/s ANDRITZ Hydro Power Pvt. Ltd.
UJVN Ltd. is required to explore the options of Budgetary offer for cost estimation.
 7. The cost estimates of the Civil works are not supported by the estimates and the rate schedules.
UJVN Ltd. is required to submit the supporting computation of the Civil estimates.
 8. UJVN Ltd. is required to submit the basis for taking the rate of interest as 12% for estimating of cost of loan.
 9. The energy generation has been calculated considering the availability of the plant as 95%. UJVN Ltd. is required to submit the details of the Plant availability during last five years.
 10. UJVN Ltd. is required to submit the document in support of equity funding from GoU for the Project."
7. Further as per direction of the Commission issued at point no.1 and 3 of the Order dated 07.04.2015 (mentioned at para 5 above), UJVN Ltd. submitted its reply on affidavit vide reference No. 163/UJVNL/03/D(P)/D-5 dated 17.04.2015 stating that:

"

1. ***The discrepancies in the Petition as observed by the Commission pertaining to the Cost Estimate be reviewed and submitted to the Commission within 10 days of the Order.***

...

It is to submit that the rates received from one of the bidders in open tenders of Mohammadpur, Pathri & Khatima HEPs invited by UJVN Ltd. were considered for estimation of the cost for RMU of Chilla HEP as only the said bidder was common in all the RMU Projects. The details of the cost estimate have been explained in the 'Report on Revalidation of DPR Data for RMU of Chilla HEP' at page 7 & 8 of 10.

The estimate for Switchyard components including LAs & CTs is based on the offer from above bidder received for Khatima Project. It is to inform that the equipment wise cost may not be precise as the tenders are being invited on a turnkey basis where only total cost is considered. The cost of individual equipment may not be compared with the rates received elsewhere for that particular equipment because we are considering the complete cost of RMU works on a turnkey basis.

The rates for 'Switchyard Components' and 'Control, Metering, Protection & SCADA' have been reviewed. Earlier the rates of the common bidder for Khatima HEP were considered in the cost estimate of Chilla. On going through both the offers it has been observed that one bidder is lower for 'Switchyard Components' and the other one for 'Control, Metering, Protection & SCADA'. The lowest values for these equipments are now being considered in the cost estimate as S. no. 4 & 5 (cost estimate of E&M works enclosed as Annexure-1) and are as follows:

<i>Particular</i>	<i>Rates on the basis of the common Bidder (Pathri, Mohammadpur & Khatima) considered earlier in the cost estimate</i>	<i>Rates on the basis of the L1 Bidder of Khatima</i>	<i>Rates being considered now in the cost estimate</i>
<i>Switchyard Components</i>	<i>6,21,58,121</i>	<i>2,90,47,315</i>	<i>2,90,47,315</i>
<i>Control, Metering, Protection & SCADA</i>	<i>3,12,76,331</i>	<i>5,96,81,614</i>	<i>3,12,76,331</i>
<i>Total</i>	<i>9,40,34,452</i>	<i>8,87,28,929</i>	<i>6,03,23,646</i>

Therefore, the E & M cost has now been worked out as Rs. 312.51 crore in place of the earlier value of Rs. 315.88 crore i.e. reduction of Rs. 3.37crore. Correspondingly the total cost of the project including IDC will be Rs. 455.23 crore...

The capacity of the individual machine is proposed to be uprated to 43.2 MW each. The combined output of the powerhouse when all 4 machines are running is likely to be 4x41.5 MW= 166 MW.

Therefore, the overall estimated cost of RMU including capacity enhancement seems to be reasonable.

3. ***The Petitioner to hold consultation in this regard with the beneficiary namely UPCL and submit the record of consultation to the Commission within 2 months of date of the Order.***

It is respectfully submitted that the matter is being referred with UPCL, the beneficiary and the record note of consultation shall be submitted to the Hon'ble Commission immediately on its receipt."

8. The scheduled hearing of 21.04.2015 in the matter of admissibility was postponed and the same was communicated to UJVN Ltd. vide letter No. 108 dated 20.04.2015.

9. The Commission also issued a letter vide reference No. 105 dated 20.04.2015 to UJVN Ltd. for making Power Point Presentation on the following points on 25.04.2015, which was pre-poned to 24.04.2015:

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1. *Justification for the need of RMU*
 2. *Approach for selecting R&M Activities*
 3. *Plant availability vis-à-vis Generation for past 5 years*
 4. *Cost estimate alongwith basis*
 5. *Benefit to Cost Ratio, IRR calculation*
 6. *Post RMU benefit w.r.t. enhancement in capacity, availability, generation, life extension etc.*
 7. *Comparison of parameters (pre & post RMU) viz. availability, generation O&M expenses etc.”*
10. On the scheduled date of presentation i.e. on 24.04.2015 the Power Point Presentation was made by UJVN Ltd. However, the reply of deficiencies issued vide letter dated 17.04.2015 was not submitted by the date.
11. UJVN Ltd. vide its letter No. 212/UJVNL/03/D(P)/D-5 dated 14.05.2015 requested the Commission for extension of time upto 25.05.2015 for submitting the reply of deficiencies issued by the Commission vide letter No. 97 dated 17.04.2015.
12. With regard to admittance of the Petition, the Commission issued a letter No. 651 dated 20.07.2015 to UJVN Ltd. directing it to make another Power Point Presentation on 30.07.2015.
13. On the schedule date i.e. 30.07.2015, the Power Point Presentation was made by UJVN Ltd. and during the Presentation discussions were held on various issues and accordingly, UJVN Ltd. was asked to clarify the same. To which, UJVN Ltd. vide its letter No. 4599/UJVNL/01/MD/U-6 dated 14.08.2015 submitted the information/clarification on affidavit. The submission made by UJVN Ltd. is being reproduced below:

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- (1) *The Detailed project report of RMU of Chilla HEP was prepared by M/s SNC Lavalin in June 2006 wherein they have recommended Option-2b (New Propeller turbine with refurbished generator & enhanced discharge).*

SNC Lavalin have technically considered option 2b, 3b & 3c as the viable solutions for the utilization of enhanced discharge of 620 m³/s and enhanced installed capacity. However, the results of the economic analysis for these options are as follows:

S. no.	Description	Option 2b	Option 3b	Option 3c
1.	IRR	16.6%	14.5%	14.6%
2.	BCR	1.88	1.75	1.73
3.	NPV (million USD)	57.40	62.47	66.07

Option 2b was considered over 3c due to shorter schedule, easier maintenance of turbine runner blades without dismantling, easier construction without any generator barrel and foundation modifications. As per above table, it is clear that option 2b & 3b have very encouraging economic parameters while option 2b has marginal advantage over option 3b.

The option 2b was approved by the Board of Directors in 31st meeting held on 23.06.2006. As the Tehri Project was commissioned in 2007, the DPR was validated based on authentic discharge data available. The revalidated DPR for RMU of Chilla HEP was approved by the Board of Directors in 69th meeting held on 26.11.2013 for option 2b but with new generator in place of replacement of generator.

The considerations for proposing complete replacement of generator instead of refurbished generator have been elaborated in 'Report on revalidation of DPR data for RMU of Chilla HEP' at pages 3,4 & 5 of 10. There is Upgradation of around 10% capacity of the plant. The refurbished generator shall devoid the bidder an opportunity to design for generator which will have better efficiency as compared to refurbished generator. The efficiency of the new generator shall be 98% at full load which is higher than that of the refurbished generator.

- (2) *Cavitation coefficient values have been calculated using cavitation equation and it is established that Kaplan turbine for the present setting and condition is not at all an acceptable condition for operation due to cavitation phenomenon., Hence, a Kaplan*

runner is not a feasible solution for the present turbine discharge setting and the DPR has opted for propeller type turbine over Kaplan type turbine.

It is also to inform that BHEL (OEM) has requested to consider Kaplan turbine in the present setting as Kaplan turbines by inherent nature are extremely suitable to cater to changed input conditions.

- (3) *The unit efficiency values as quoted in DPR have been taken by M/s SNC Lavalin as specified by the manufacturer (GE Canada). These efficiencies correspond to the efficiency of the closest runner available with the manufacturer at that time. The efficiency of a new propeller type turbine in a new power station would normally be above 92% but in case of Chilla, it is limited to 92% due to existing hydraulic profile of the water passages (Draft Tube & Spiral Casing). The weighted averages efficiency has been considered as 92% in revalidated DPR and same has been sought from the bidders.*

The turbine efficiency is likely to be optimized further through improved profile of the runner blades and the model test. The modern day design and CFD analysis have enabled to attain a better efficiency in the range of 92% for the propeller type turbine. Model Acceptance test is included in the tender document as per relevant IEC code which will firm up efficiency values.

- (4) *M/s SNC Lavalin has initially proposed capacity of the individual machine as 43.2 MW with the condition that it will be 41.5 MW when all the machines are running. Later, they have informed about the capacities as 42.5 MW & 40.7 MW respectively. However, the installed capacity of the plant is now proposed to be upgraded to 4x39 MW i.e. 156 MW with 10% overload from the present installed capacity of 144 MW (4x36 MW). Hence, it is proposed to carry out uprating of the plant by additional 12 MW.*

The design energy calculations have been revised in view of above. The energy potential for 90% dependable year has been calculated as 1006.21 MU. (Annexure-1). The annual generation shall increase to 1006.21 MU against 739.48 MU (generation of dependable year 2008-09) without any environmental and socio economic impact. This gain is equivalent to putting a new power house of about 60-65 MW which may cost around Rs. 500 crore.

- (5) *M/s SNC Lavalin have carried out hydrodynamic model studies of the power channel system computing the water levels along the channel for various discharges and levels at the power station forebay. They have also conducted load rejection tests and verification*

of minimum freeboard at the power channel under steady state as well as transient conditions for proposed operating flow of 620 m³/s. The minimum freeboard criteria is respected in all the cases except for the case when proposed operating flow of 620 m³/s passes through the bypass with power station shut down and one bypass gate out of operation. Modification of the existing stop log slots in the bypass control structure and addition of freeboard curb part is proposed to be carried out for safe flow of 620 m³/s under all the conditions.

It has been observed, in past a higher discharge has been passed through power channel to meet the higher discharge requirement of Chilla Power House machines. In view of above, it is expected that after required repairing of the power channel, it may be able to safely carry a discharge of 620 m³/s.

- (6) *Parametric Estimation technique has been adopted in estimating the cost for RMU of Chilla HEP. Parametric Estimation is a technique wherein a statistical relationship is developed between the historical data and variables to calculate an estimate for activity parameters.*

For estimation of the cost for RMU of Chilla HEP, the rates received from M/s Andritz Hydro Pvt. Ltd. in open tenders of Mohammadpur, Pathri & Khatima HEPs invited by UJVN Ltd. were considered for estimation of the cost for RMU of Chilla HEP as only the said bidder was common in all the RMU Projects. The same was used to estimate the cost of turbine & generator components. The details of the cost estimate have already been explained in the 'Report on Revalidation of DPR Data for RMU of Chilla HEP'. The rates of the common bidder were considered for 'Switchyard Components' and 'Control, Metering & SCADA' estimate as all these contracts were EPC in nature.

In accordance with the philosophy adopted for estimation of the project cost, it is not prudent to compare the price of few individual items in the estimation with the itemized prices of those items available in the market.

As far as budgetary offers are concerned, it is to humbly submit that manufactures are generally reluctant to submit the same due to lot of technical requirement and analysis thereby having cost implications.

The estimated costs for different alternatives in the DPR prepared by M/s SNC Lavalin are budgetary ones. The cost for option 2b was 119.32 million US Dollar including IDC at mid 2005 level (Rs. 715 crores considering 1 US Dollar = INR 60)

whereas the total cost of RMU was estimated at Rs. 359.69 crore without IDC & Rs. 490.56 crore with IDC as per approved Revalidated DPR.

Reworking of the cost for RMU of Chilla HEP was carried out in compliance to the directives of Board of Directors wherein lead time was reduced to 18 months. The estimated revised cost was Rs. 356.34 crore without IDC & Rs. 459.94.56 crore with IDC.

As per hearing on dated 7.04.2015 before the Hon'ble UERC, the Switchyard Components' and 'Control, Metering, Protection & SCADA' cost was reviewed. The E&M cost has now been worked out as Rs. 312.51 crore in place of the earlier value of Rs. 315.88 crore i.e. reduction of Rs. 3.37 crore. Correspondingly, the total cost of the project including IDC has become Rs. 455.23 crore.

The financial and economic analysis have been revised as per the prevalent parameters of "Terms and Conditions for Determination of Tariff" by Hon'ble UERC (Annexure-2). The main economic parameters are detailed below:

Levelized Tariff	IRR	BCR	NPV
Rs. 2.05 per unit	20.83	2.97	431.39 lakh

UJVN Ltd. intends to improve the generation, operation and safety of the Chilla HEP including an increase in plant capacity, efficiency and generation potential to the highest economic level with minimum downtime. The RMU of Chilla HEP is called for on account of following main factors:

- a) Due to increased clearances between runner chamber and runner, erosion of under-water parts, runner and its disturbed profile, the efficiency of machines has gone down, and they are not able to give rated output at rated discharge. The total output of plant has reduced to 130 MW only. As per the Field Efficiency Test of Unit #2 carried out in June 2005, present T/G units have suffered deterioration of their efficiency by then percent, with consequent inefficient utilization of the hydro potential.
- b) The turbines are subjected to heavy erosion of the under water parts, requiring lengthy shutdown of the units, with consequent loss of energy and increase in maintenance cost.
- c) The Availability of discharge has increased after commissioning of Tehri Dam.
- d) Old and obsolete Control & Protection equipments and other power house

auxiliaries.

- e) Inefficient/old design turbines and generators.*
- f) Non-availability of spare parts of outdated systems and equipments.*
- g) Erratic functioning of switchyard equipments.*
- h) Erratic functioning of Hydro Mechanical equipments.*
- i) Damages in the Barrage, Power Channel etc.*

In view of above, it is requested to kindly accord approval of Capital Investment for Renovation, Modernization & Upgradation of 4x36 MW Chilla HEP as per DPR so that RMU proceeds for an early implementation in order to harness the benefits of regulated flow in post Tehri scenario without any environmental and socio economic impact."

14. Further, to justify and emphasise the need of RMU of the said HEP, UJVN Ltd. referred a document of Central Electricity Authority (CEA) which specifies the best practices and benchmarking for Renovation and Modernization of Hydro Projects. In chapter 7 of the above referred document, following has been specified with regard to RMU:

"7.1 -Renovation & Modernisation (R&M) of old plants is considered to be the best option to bridge the wide gap between demand and supply of power as R&M programmes are cost effective having much lower gestation period compared to setting up of new plants."

- Renovation, modernization and uprating of hydro generating units (RM&U) which have outlived their normative operating life and the relatively new machines with generic problems are recognized to yield considerable additional benefits of energy at minimum cost. RM&U programmes can be expected to yield benefits in about 3 to 4 years as against installation period for new hydro generating capacity of 6 to 7 years.

- RM&U programmes may be taken up timely to prevent deterioration in operation of generating units which may lead to their premature retiring. By undertaking timely RM&U & Life extension programme, the generating plant can be made to operate for another extended period of 20 to 25 years with improved reliability and availability.

7.2 NEED FOR RENOVATION, MODERNISATION & UPRATING OF HYDRO POWER PLANTS

-The normative operative life of hydro electric power plant is 30 to 35 years after which it normally requires Life extension through renovation.

-By undertaking activities involving replacement of worn out or damaged components the availability of the generating unit and to some extent its life would be increased but no improvement in output or efficiency can be expected.

-The output and efficiency of generating units can be increased by replacing old or damaged components by redesigned components using State of the art materials. Especially in old equipment a significant increase in output and/or efficiency can be achieved by the use of new materials and advanced engineering methods. In addition, the overall life expectancy of the equipment will also be increased.

-By undertaking uprating programmes it is possible to uprate the generating capacity of existing units by 10 to 30% based on the water availability, operating margin and technological upgradation. This programme may be involving rewinding of stator from Class B to Class F, restoring stator core, improving air gap, replacing turbine runner with advanced blade profile and material while carrying out uprating of the plant, modernization by replacing conventional excitation system with static excitation system, replacing conventional governing system with micro processor based electro hydraulic governing system, retrofitting existing control and protection system to modern state of the art system etc. may also be undertaken for improvement of reliability in operation of the plant. However, uprating of generating capacity may be taken up after detailed investigations and studies.

7.3 APPROACH FOR SELECTING R&M ACTIVITIES

The performance of the generating units should be the guiding factor in selection of R&M activities rather than the period of their operation. The following aspects/requirements to be kept in view while selecting R&M activities:-

-Activities covering main equipment i.e. turbine, generator and C&I equipment and other plant equipment essential for efficient and sustained performance of the units as well as station be identified.

-Activities which have direct impact on improvement of generation, efficiency, machine availability etc. be assigned higher priority.

-Activities which yield uprating benefits because of rewinding with Class F insulation, runner with improved profile be given priority.

-For silt prone hydro power stations, R&D activities on advanced techniques like plasma coating on under water parts of turbine, and development of new materials may be given

priority. Adoption of closed circuit cooling system, Cu-Ni tubes for coolers etc. may also be considered.

-Activities which include state of the art equipment such as electronic governors, static excitation system, micro processor based controlled high speed static relays, on line monitoring devices and silt content in water.

-Activities like augmentation of water conductor system which may increase the discharge/head & hence the peaking capacity & additional generation of the generation station."

15. Furthermore, UJVN Ltd. vide its letter no. 565 dated 07.12.2015 submitted following additional information/clarification and requested the Commission to take cognizance of these submissions:

"...

1. Selection of Kaplan Turbine in place of Propeller Turbine

As per the additional information submitted vide letter 527/UJVNL/01/MD/ GM (RMU)/Chilla dated 13.10.2015, it was elucidated that Kaplan turbine is now being considered in place of Propeller turbine for RMU of Chilla HEP based on report submitted by M/s BHEL (OEM of Chilla HEP) on account of variable operational suitability of Kaplan turbine (40% to 100% load variation) over a fixed blade propeller (90% to 100%) turbine.

Accordingly, BOD of UJVN Limited was apprised regarding selection of Kaplan turbine in place of Propeller turbine in the 76th meeting held on 30.09.2015. "The Board consented on selection of Kaplan turbine in place of Propeller turbine for RMU of Chilla HEP based on the report of M/s BHEL (OEM of Chilla HEP)". (Minutes of the 76th Board meeting enclosed: **Annexure: 1**)

2. Up-gradation of plant:

The installed capacity of the plant is proposed to be upgraded to 156 MW from present installed capacity of 144 MW wherein individual machines will be upgraded from 36 MW to 39 MW with additional 10% continuous overload capacity (as per standard industry practices). Hence practically, capacity of individual machines shall be 42.9 MW each including overload capacity.

The annual generation shall increase to 1006.21 MU against present generation of 739.48 MU (gain of 266.73 MU) without any environmental and socio economic impact. This gain is equivalent to putting a new power house of about 60-65 MW.

3. Refurbishment v/s replacement:

The primary objective of RM&U is the life extension the hydro-generating unit beyond the useful designed life. The option of refurbishing instead of replacing certain vital components of the hydro-generating unit shall pose a potential gap or a weak link in the renovated hydro-generating unit post RMU work, thus there won't be a uniform life extension of the hydro-generating unit in totality in spite of carrying out major RMU work and the average life enhancement shall be reduced on account of the bottle necks imbibed

in the form of refurbished components. Further, the safe operating reliability of the renovated unit shall be governed by the life of the oldest refurbished component. This situation shall result in apprehension from the prospective bidders in offering guarantee on the unit post RMU due to the existence of refurbished components.

*Nowadays, the cost of refurbishment work is equal or almost comparable to the cost of replacement of the component with a new one and the same is being recommended by top OEMs such as BHEL. In case of RMU of Tiloth HEP, BHEL has informed that performance of stator frame & core, rotor, bearing brackets and foundation etc. for up-rated loads and capacity cannot be guaranteed and have recommended for complete replacement of generator (copy of the relevant page enclosed as **Annexure: 2**)*

Hence, it is quite evident that by choosing refurbishment of vital components of the hydro-generating over complete replacement with latest technology based new components we are just saving peanuts in terms of money while risking the benefits (viz. high operational reliability, low outages, lower generation & availability losses) of complete capital investment on the RMU work, which is definitely not a prudent choice.

Apart from above, experience gained while carrying out RM&U in the past clearly indicate there is a high probability that components which were earlier envisaged & proposed to be refurbished were found to be in a state beyond a possible repair/refurbish ultimately resulting in complete replacement of the said components during execution. However, such decisions during the course of the contract execution require amendment in orders which further require approvals from different levels resulting in unnecessary & prolonged shutdown of units, long delivery period etc and may ultimately result in loss in generation/ availability along with associated revenue.

Replacement of Generator:

The complete replacement of the generator has been proposed in place of refurbishment due to reasons which have been enumerated in 'Report on Revalidation of DPR Data for RMU of Chilla HEP' at pages 3, 4 & 5 of 10. Further, M/s SNC Lavalin has specified while considering the refurbishment of generator in its DPR that "the components which will be retained may not be guaranteed."

Since capacity up-gradation is proposed post RMU in Chilla HEP therefore, by replacing the old generator with a new one, risk of failure on account of old refurbished components shall be eliminated. Hence it will be pragmatic to replace these suggested items so as to have reliable operation of the units for years to come.

*The cause is further bolstered as the OEM i.e. BHEL in case of RMU of Tiloth HEP intimated that performance of stator frame & core, rotor, bearing brackets and foundation etc. for up-rated loads and capacity cannot be guaranteed and have recommended for complete replacement of generator (copy of the relevant page enclosed as **Annexure: 2**). Therefore, replacement of the complete generator is considered as justified and indispensable and for RMU of Chilla HEP.*

Replacement of Static Excitation System:

It is to reiterate that excitation current requirement as per upgraded option at full load is 1065 A DC which is higher than the capacity of the existing excitation system i.e. 1000 A DC. Therefore, the presently installed Static Excitation system cannot be used and is required to be replaced by a new compatible excitation system.

Also, the spare parts for the existing Static Excitation System are not available with M/s BHEL, the OEM. M/s BHEL has further confirmed UJVN Limited that spares like

CPUCA module & other critical cards cannot be supplied for the existing AVR system at Chilla as it has been declared obsolete. The copy of MoM between M/s BHEL-EDN, Bangalore & UJVNL, dated 2.04.2011 is enclosed in this regard. (**Annexure: 3**)

Replacement of Governors:

M/s Andritz Hydro Pvt. Ltd. (earlier VA Tech), OEM of Governor has informed vide letter dated 29.05.2013 (copy enclosed as **Annexure: 4**) that governors installed at Chilla HEP have already become obsolete and therefore the spares will not be available after July, 2013 onwards.

Further, keeping up with the latest industry practice, governors with high operating pressure of 80-120 kg/cm² are proposed instead of low pressure (40 kg/cm²) governors which will have smaller oil pipelines, servomotors, OPUs & accordingly smaller boring in the shaft. Therefore, it is required to replace the existing governor with latest technology & state of the art governors.

Replacement of Generator Transformer:

The capacity of individual hydro-generating unit is proposed to be up-graded from 36 MW to 39 MW with additional 10% continuous overload capacity which means that the upgraded unit may be operated at 42.9 MW. The capacity of existing generator transformer is 42.5 MVA while a generator transformer having capacity of 48 MVA or above shall have to be installed to cater to the up-rated operating requirement post up-gradation.

Further, the existing generating transformers (year of manufacturing 1975) have completed more than 35 years of service and end of life breakdown cannot be ruled out. Therefore, replacement of existing generator transformers with higher capacity new generator transformers is indispensable in order to further negate generation/ availability on account of the said breakdown.

Replacement of UATs & SATs:

The existing Unit auxiliary transformers (UAT) and Station auxiliary transformers (SAT) are quite old and oil filled. Dry type transformers upto 33 kV are being extensively used all over the country instead of Oil filled transformers because dry type transformers are maintenance free, less susceptible to fire hazards and is more environment friendly as the spillage of transformer oil is completely negated. Same has been recommended by Central Electricity Authority (Technical Standards for Construction of Electrical Plants and Electric Lines) Regulations, 2010 (copy of relevant pages enclosed as **Annexure: 5**).

The UATs and SATs at Chilla HEP are installed at the transformer decks which are proposed to be replaced with the dry type transformers in view of above reasons. The new transformers shall have a life of 30-35 years with almost zero maintenance and higher reliability.

Switchyard Work:

The switchyard equipment viz. ABCB type circuit breakers, isolators/ dis-connectors, CTs, PTs/ CVTs, LAs, PLCC equipment etc have become very old and susceptible to failures. The said equipment were also proposed to be replaced in the DPR prepared in 2006 by M/s SNC Lavalin. The OEM of the ABCB circuit breakers i.e. M/s ABB (erstwhile HBB) have confirmed vide letter dated 05.08.13 that ABCB type circuit breakers have phased out due to end of design life and new technology innovation, hence spares/ overhauling of the same has also been discontinued (Copy enclosed as **Annexure: 6**).

It is proposed to replace 132 kV switchyard equipments in line with above so as to have high reliability and imbibe latest state of the art technology such as optical type instrument transformers in the renovated powerhouse. This will also result in keeping up with higher accuracy and efficiency requirement of the futuristic SCADA system.

4. Cost Estimation

The rates received from M/s Andritz Hydro Pvt. Ltd. (AHPL) in open tenders of Mohammadpur, Pathri & Khatima HEPs invited by UJVN Ltd. were considered for estimation of the cost for RMU of Chilla HEP as only the said bidder was common in all the RMU Projects. The details of the cost estimate have been explained in the 'Report on Revalidation of DPR Data for RMU of Chilla HEP' at page 7 & 8 of 10.

A parametric estimating model is a mathematical representation of cost relationships that provide a logical and predictable correlation between the physical or functional characteristics of a project and its resultant cost. A parametric estimate comprises of cost estimating relationships and other parametric estimating functions that provide logical and repeatable relationship between independent variables (such as design parameters/characteristics) and the dependent variable (cost). It is a methodology associated with strategic approach in project management practices.

'Parametric Estimation' is best fitted in present scenario where all three projects are canal based with vertical Kaplan machines and have other proportional parameters. It has used the rates received through open tenders for three identical proportionate projects (Mohammadpur, Pathri & Khatima HEPs) which will give real time value for the estimation of RMU of Chilla HEP with accuracy better than any budgetary offer. Manufactures are generally reluctant to submit the same due to lot of technical requirement and analysis thereby having cost implications.

The estimated cost for different alternatives in the DPR prepared by M/s SNC Lavalin is based on budgetary offer. The cost for option 2b in the said DPR was 119.32 million US Dollar including IDC at mid 2005 level (Rs. 715 crores considering 1 US Dollar = INR 60) whereas the total cost of RMU was estimated at Rs. 359.69 Crore without IDC & Rs. 490.56 Crore with IDC as per approved Revalidated DPR.

Reworking of the cost for RMU of Chilla HEP was further carried out in compliance to the directives of Board of Directors wherein lead time was reduced to 18 months. The estimated revised cost was reduced to Rs. 356.34 Crore without IDC & Rs. 459.94.56 Crore with IDC.

Subsequently, the cost of the 'Switchyard Components' and 'Control, Metering, Protection & SCADA' was reviewed as per hearing dated 07.04.2015 before the Hon'ble UERC. Accordingly, the E&M cost of RMU has now been worked out as Rs. 312.51 Crore against earlier value of Rs. 315.88 Crore (i.e. reduction of Rs. 3.37 Crore). Correspondingly, the total cost of RMU of Chilla HEP including IDC has works out to be Rs. 455.23 Crore.

The financial and economic analysis was carried out as per "Terms and Conditions for Determination of Tariff" by Hon'ble UERC and submitted vide letter No.429/UJVNL/01/MD/GM(RMU) dated 14.05.2015. The key economic parameters are very encouraging and are as detailed below:

Levelized Tariff	IRR	BCR	NPV
Rs. 2.05 per unit	20.83%	2.97	431.39 Lakh

As detailed above, Kaplan turbine is now considered In place of Propeller turbine for RMU of Chilla HEP. The cost of Kaplan turbine and associated parts may be higher as compared to Propeller turbine. However, no revision in the cost estimate is being considered at present.

In view of above, It is requested to kindly accord approval of Capital Investment for Renovation, Modernization & Upgradation of 4 x 36 MW Chilla HEP so that UJVN Limited may proceeds with RMU work of Chilla HEP at the earliest in order to harness the benefits of regulated discharge available in post Tehri scenario without any environmental or socio economic impact and ensure dependable future generation along with enhancement of the station output to the highest economic level."

Commission’s observations, views and decision

16. On examination/scrutiny of the proposal, revalidated proposal and subsequent submissions made by UJVN Ltd., the Commission has observed that the original design energy of 4x36 MW Chilla HEP is 725 MU, which has gone to the level of 900 MU under the existing conditions due to availability of water subsequent to the commissioning of Tehri HEP in 2007-08. The energy generated post-commissioning of Tehri HEP is as follows:

Year	Generation (MU)	Year	Generation (MU)
2008-09	776.578	2012-13	858.925
2009-10	739.479	2013-14	784.609
2010-11	775.156	2014-15	800.310
2011-12	910.016	2015-16 *	748.633

**FY 2015-16 upto Sep 15 Actual, Oct 15 to March 16 estimated*

17. The Commission has observed that UJVN Ltd. has proposed an Uprating of 12 MW capacity in addition to the existing installed capacity of 144 MW, thus, as per proposal the plant capacity would be 156 MW in place of 144 MW which in turn would result in increase of annual generation to 1006 MU. Further, it has also been observed that the increase in annual generation with respect to the average of energy actually generated during past 7 years under present circumstances is 200 MU.
18. The proposal has further been analysed vis-à-vis guidelines issued by CEA (mentioned at para 14 above) with regard to the best practices and Benchmarking of Renovation & Modernization of HEPs and it has been observed that the Chilla HEP has lived its life more than the useful life specified for a Hydroelectric Plant i.e. 35 years.

19. Since, in the instant Petition, UJVN Ltd. has proposed post RMU design energy of Chilla HEP as 1006 MU with enhancement of 12 MW in installed capacity of the Plant. Therefore, the RMU proposal submitted by the Petitioner appears to be for the purpose of extension of life of the Plant as well as uprating in the installed capacity of the Plant.

20. In accordance with the guidelines specified in a document of CEA regarding the Uprating following has been stipulated:

"-By undertaking uprating programmes it is possible to uprate the generating capacity of existing units by 10 to 30% based on the water availability, operating margin and technological upgradation." ...

The Petitioner in its submission has submitted that the RMU of Chilla HEP has been proposed for optimum utilization of increased water availability post-commissioning of Tehri HEP and in the instant case, the proposed increase in generating capacity of each Unit is 8.33% (from 36 MW to 39 MW each) with additional 10% continuous overload capacity (As per standard Industry practices) meaning thereby, there would be practically an enhancement of total 18.33% (from 36 MW to 42.9 MW each) in capacity when only one Unit would be operated with required discharge and other Units remain either in maintenance or breakdown.

21. Further, with regard to the approach adopted by the Petitioner for selecting R&M activities, the original DPR was examined. It was observed that as per original DPR prepared by M/s SNC Lavlin in June, 2006, option 2(b) (new Propeller turbine with refurbished generator and enhanced discharge) was recommended among other viable solutions for utilization of enhanced discharge of 620 m³/s. M/s Lavlin had recommended option 2(b) assuming it the best of two options just because of easier maintenance of Turbine blades, easier construction without any generator barrel and foundation modification. M/s Lavlin also mentioned in the DPR that the existing generators of Chilla may be uprated to 48 MVA through rewinding to class F insulation to match the output of new Propeller Turbines, which was initially approved by BoD in 31st meeting held on 23.06.2006.

Thereafter, based on the actual data of discharge available post commissioning of Tehri HEP, a Revalidated DPR for RMU of Chilla HEP was submitted to the Commission, wherein the BoD in its 69th meeting held on 26.11.2013 had accorded

approval to option 2(b) of the original DPR with following changes:

- (i) Replacement of Generator in place of refurbishment.
- (ii) Replacement of line protection, UATs & SATs and DC Battery Bank. The cost of these modifications was projected around 42 Crore for all 4 Units.
- (iii) It was reported that Power Channel from Virbhadra Barrage is already catering the discharge of more than 620 m³/sec and option 2(b) can be very well implemented. The energy generation was calculated considering turbine efficiency 92%, generator efficiency 98% and availability 95%. Installed capacity 172.8 MW, Average capacity 117.76 MW and average energy generation 1029.87 MU.
- (iv) Parametric estimation were adopted by UJVN Ltd. in estimating the cost for RMU for Chilla HEP on the basis of rate received from M/s Andritz Hydro in open tenders of Mohammadpur, Pathri and Khatima HEPs and the estimated cost was calculated as Rs. 359.70 Crore without IDC and 490.57 Crore with IDC.

Furthermore, in 72nd BoD meeting on 26.09.2014, the BoD suggested that UJVN Ltd. should scale down the period of completion from 5 and half years alongwith lead time to maximum 18 months in order to reduce the cost of the project and passed the resolution with these modifications.

22. UJVN Ltd. in the original as well as in the revalidated DPR had proposed the Propeller turbine. However, on asking the Petitioner to confirm the type of turbine proposed considering the suitability for such HEPs, it was submitted that the option of considering Propeller/Kaplan turbine was discussed with the prospective bidders & specifically with M/s BHEL, OEM of Chilla HEP on dated 24.09.2015. M/s BHEL have also recommended the Kaplan turbine in place of Propeller turbine for all four units during RMU of Chilla HEP as a final option. The same has been confirmed by the Petitioner vide letter dated 07.12.2015. Therefore, now the proposal of the Petitioner to be considered for approval is Kaplan turbine in place of Propeller turbine for all four Units. Based on the justification brought before the Commission by the Petitioner in this regard, the Commission observed that the revised proposal of installation of Kaplan turbine in place of propeller turbine is justified.
23. With regard to the proposal of the Petitioner for complete replacement of Generator, the Commission observed that Chilla HEP has lived its normative useful life and has been in continuous operation for last more than 35 years. Since, design & capacity of Turbine is proposed to be changed to match the uprating capacity and design of

Generator is dependent on Turbine design parameters. Meaning thereby, turbine uprating parameters/design would be the key factor for assessing/finalising the Generator design. Hence, the Commission finds that the proposal for complete replacement of Generator to match the proposed uprating capacity is justified. Moreover, the above is also necessary keeping in view of the compatibility/coherence in Turbine and Generator.

24. With regard to the replacement of Excitation System, Turbine Governors, Control and Protection System, the Commission is of the view that the Petitioner should opt for micro-processor based digital system fulfilling the desired parameters essentially to have the operating system of Excitation, Governor and Control System on the same protocol.

For Switchyard and Unit protection, the Protection System with numerical relays compatible with SCADA should be opted and similarly Auxiliary System LT Switch Gear compatible with SCADA System should be opted for ease in operation and flexibility in Control and Monitoring System.

25. Inline with the CEA Regulations in the matter of Technical Standards for construction of Electrical Plants and Electric Lines, the proposal for replacement of UAT & SAT from oil filled to dry type, which have already served more than 35 years, is appropriate.
26. At present, each installed Generator Transformer is having a capacity of 42.5 MVA corresponding to existing 36 MW machine and with the uprating of the machine from 36 MW to 39 MW + 10% continuous overloading, the capacity of Generator Transformer would not be sufficient to cater the output/generation. Therefore, the Commission finds that the proposal of replacement of Generator Transformers is justified.
27. With regard to the works proposed under Civil and Hydro-mechanical, the Commission has taken note of the submission of UJVN Ltd. and is aware of the fact that over the period of time there could have been damages in the Civil & Mechanical structures and Hydro-mechanical structure/equipments and such damages in the structure/ equipment might be causing heavy leakages resulting in continuous loss of generation. Therefore, the Commission agrees that proposed refurbishment works of

Civil and Hydro-mechanical system would be required.

28. The Commission observed that UJVN Ltd. has made all its calculation based on discharge of 620 m³/s without any change in water conducting system except with regard to the capacity to bypass the discharge. The Commission conveyed its concern to the Petitioner that the impact of increase in discharge from 565 m³/s to 620 m³/s should be given due consideration viz. capacity of power channel, capacity of penstock, capacity of spiral casing, capacity of draft tube and capacity of the intake/bypass system and accordingly decision on the same should be taken. The subsequent submissions made by UJVN Ltd. in this regard, supports its original proposal stating that the present water conducting system is capable of handling the enhanced discharge and necessary studies have been made by it, which assures the same.
29. With regard to the approval of overall estimated cost of the Project under RMU, the cost estimate submitted by the UJVN Ltd. is based on the projection of the prices of the items of RMU quoted by a common bidder who participated in the tender proceedings of Mohammadpur, Pathri and Khatima HEP. It is known that the said HEPs are entirely different in their design, capacity, head etc., therefore, the Commission is of the view that taking the reference prices for cost estimation of Chilla HEP is not proper.

Further, the submission of UJVN Ltd. in its revalidated DPR in support of the parametric evaluation that getting offers from reputed manufacturers takes a long time as the manufacturers are reluctant to give the offer and taking the prices of awarded projects as base cost will be more firm than the budgetary offer, does not seem to be a reasonable approach for cost estimation of entirely different HEP as possibility of error/deviation in parametric evaluation is quite higher for two unlike/divergent Plants.

UJVN Ltd. has taken the total cost on straight line method for all equipments namely Generating equipments, Transformers, Power House Auxiliary equipments, etc. and has taken reference of Unit rate of items of Khatima HEP for the Switchyard equipments. While, prices of these three HEPs have been extrapolated for estimating the cost of equipments related to control, metering, protection and SCADA Systems. The cost estimate of the Project could be made more realistic by taking the offer for

equipment or based on prevalent Cost Schedules for these equipments in other power utilities except for main generating equipment as these are Plant specific.

As discussed above, taking reference of the Plants which is different in terms of technical parameters is not reasonable, therefore, the Commission feels that Budgetary offer, as basis for estimating cost of proposed RMU of Chilla HEP, should have been the best approach. However, since the present proposal brought before the Commission is full of deviations from the original proposal/DPR viz. in type of turbine, capacity of individual machines as well as of the Plant. Moreover, in the cost estimate of the Petitioner number of the anomalies were observed and the same had been pointed out and conveyed to the Petitioner. Also in a particular case the item rates were taken 10 times to the prevailing rates of that item. Therefore, the Commission is of the view that the parametric estimation is not appropriate methodology for framing the cost estimate. Hence, the total estimated cost is not being approved. As there are number of changes in the scope of work etc. a revised DPR needs to be submitted after completion of RMU works.

30. With regard to the submission of record of consultation with beneficiary namely UPCL in this case, it has been observed that the Commission issued an Order dated 07.04.2015 wherein at para 3 of the Order following has been stipulated:

"The Petitioner to hold consultation in this regard with the beneficiary namely UPCL and submit the record note of consultation to the Commission within two months of the date of the Order."

Accordingly, UJVN Ltd. informed UPCL vide its letter dated 02.05.2015 for submission of comments on the proposed RMU work of Chilla HEP as directed in the aforesaid Order. UPCL did not respond to the said letter sent to it by UJVN Ltd. Further, in absence of comments from UPCL, UJVN Ltd. again approached UPCL for ensuring the compliance of the above directions of the Commission by both the parties in the matter. Notwithstanding the clear cut directives of the Commission and repeated follow up by UJVN Ltd. for holding consultation including submission of comments by UPCL in the subject matter, the Commission is of the view that the Petition cannot be put on hold indiscriminately for want of UPCL's comments and therefore, decides to dispose off the instant Petition now.

31. Based on the above discussion, the Commission grants in-principle approval for the works discussed above.

32. The above in-principle approval is being granted subject to the following:

- (1) The Petitioner is directed to obtain the prices through competitive bidding for the works allowed by the Commission under the prevailing rules & regulations and prudence of the prices will be scrutinized at the time of fixation of tariff after completion of the R&M works.
- (2) 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 is directed to explore the possibility of swapping the loan with cheaper debt option available in the market.
- (3) The Petitioner shall, within one month of the Order, submit letter from the State Government or any such documentary evidence in support of its claim for equity funding agreed by the State Government or any other source in respect of the proposed R&M works.
- (4) After completion of the aforesaid R&M works, the Petitioner shall submit the completed cost and financing of the project.
- (5) 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.
- (6) The norms of performance of the Plant shall be appropriately re-fixed after completion of RMU.

Ordered Accordingly.

(K.P. Singh)
Member

(Subhash Kumar)
Chairman