Before

UTTARAKHAND ELECTRICITY REGULATORY COMMISSION

Pet. No. 71 of 2025

In the Matter of:

Petition for seeking prior approval of Capital Investment for Rehabilitation works of Head Race Tunnel (HRT) of Maneri Bhali-II, HEP, Distt- Uttarkashi (Part-A) under Section 61 and 86 of the Electricity Act, 2003 read with the relevant regulations and guidelines of the Commission.

And

In the Matter of:

UJVN Limited,
"UJJWAL", Maharani Bagh, GMS Road,
Dehradun.

…Petitioner

Coram

Shri M. L. Prasad	**Chairman**
Shri Anurag Sharma	**Member (Law)**
Shri Prabhat Kishor Dimri	**Member (Technical)**

Date of Order: January 08, 2026

ORDER

This Order relates to the Petition filed by UJVN Ltd. (hereinafter referred as 'the Generator' or 'the Petitioner') seeking approval of the Commission under Section 61 and 86 of the Electricity Act, 2003 read with Regulation 22 (4) of Uttarakhand Electricity Regulatory Commission (Terms & Conditions for Determination of Multi Year Tariff) Regulations, 2024 (UERC Tariff Regulations, 2024) for seeking prior approval of Capital Investment on Rehabilitation works of Head Race Tunnel (HRT) of Maneri Bhali-II, HEP, Distt-Uttarkashi (Part-A).

Background

2. The Petitioner vide its letter No. 63/UJVNL/03/D(P)/D-5 dated 03.07.2025 submitted its Petition under Section 61 and 86 of the Electricity Act, 2003 read with Regulation 22 (4) of Uttarakhand Electricity Regulatory Commission (Terms &

Conditions for Determination of Multi Year Tariff) Regulations, 2024 (UERC Tariff Regulations, 2024) for seeking prior approval of Capital Investment on Rehabilitation works of Head Race Tunnel (HRT) of Maneri Bhali-II, HEP, Distt-Uttarkashi (Part-A).

3. The Petitioner under the 'Facts of the case' has submitted that:

"

…

3.4 The Maneri Bhali Hydro Project Stage-II, managed by UJVNL, represents a significant run-of-the-river initiative on the Bhagirathi River in Uttarkashi, Uttarakhand. Initiated in 1980-81 by the Irrigation Department, this project was designed with an installed capacity of 304 MW and features a barrage at Joshiyara and a powerhouse at Dharasu. Despite early financial and geological challenges that stalled progress post-1989, the project was revived in 2002, following the formation of Uttarakhand state, and was commissioned in March 2008.

3.5 The project diverts water through a 16 km long head race tunnel (HRT) to generate 1,566 MU of electricity annually. The water in the Maneri Bhali Stage-II is diverted through a diversion structure situated at Joshiyara near township of Uttarkashi at about 152 Km from Rishikesh the nearest rail head. The diversion structure is designed to divert 142 cumec of water into a head race tunnel of diameter 6.0 m and length 16 Km to generate 1566 MU of electricity annually.

3.6 The barrage site complex at Joshiyara (Uttarkashi) comprises a 81 m long barrage with five bays each of width 13 m. Each bay is equipped with 13 m x 15.55 m (W x H) radial gates. With crest at EL 1093 m, the barrage provides a live storage of 7.55 lacs cubic meter between EL 1108 m (maximum) to 1103 m (minimum). At intake to the head race tunnel, a fore bay and a sedimentation chamber consisting of 97 hoppers each of size 13 m x 13 m have overall dimension of 93 m x 182 m (W x L) is provided to provision silt free water to powerhouse. It settles particles of size larger than 0.15 mm which is getting flushes out to the downstream of the barrage through a flushing conduit. The forebay, downstream of the sedimentation chamber, consist of 10 bays equipped with fixed wheel type gates of size 7.7 m x 8.25 m (W x H). The overall length of the forebay is 93 m and is connected to the head race tunnel by a 43 m long cut and cover section.

3.7 The water conductor system comprises of a concrete lined head race tunnel, a surge tank and steel penstock. The 16 m long head race tunnel is of horseshoe shape having a diameter 6 m with designed discharge of 142 cumecs. The invert levels of HRT at the inlet and at the surge tank are EL 1094 m and EL 1000 m respectively. The

average gradient of HRT is 1 in 170. The restricted orifice type surge tank, height 172 m and diameter 13.7 m has been provided at the tail end of HRT to take care of the water hammer conditions. Provisions of stop log gate has made at the inlet of the surge tank. Four units of penstock emanate from surge tank, each of length about 800 m and diameter 3.0 m. Provision of butterfly type penstock protection valve, on each penstock has been made just after it emergence from the surge tank.

3.8 *The power house comprises of four hydro power generating units of 76 MW each. The generator is powered by Francis turbines of 78 MW rated capacity. The rated flow through each turbine is 35.5 m3/s and is discharged to a common tail race channel (TRC).*

3.9 ***Analysis of Problem:- The Gamri Gad area of the Head Race Tunnel (HRT) in the Maneri Bhali Stage-II Hydro Electric Project is in a very sensitive and risky zone. The ground above the tunnel is only 20 to 22 meters thick, and it is located just 250 meters away from the active Srinagar Thrust, a known geological fault line. Since February 2021, leakage in this area has increased steadily—from 229 liters per second to 1602 liters per second by 2024. This continuous leakage has weakened the tunnel and the surrounding soil and rocks. Also, because the project is in Seismic Zone IV, which is prone to earthquakes, there is a higher risk of damage, especially near the nearby shear zone.***

3.10 *A significant challenge at the Gamri Gad site above the HRT section from chainage 13.700 to 13.778 km was identified during site visits in early 2021. These issues not only threaten the operational efficiency of the hydro project but also pose risks to the structural integrity of the tunnel. This section of the HRT is strategically crucial as it significantly impacts the overall stability and efficiency of the Maneri Bhali Stage-II project. Ensuring the integrity of this segment is essential not only for the current operation but also for the long-term sustainability of the hydro project.*

3.11 *To address the issue multiple expert committees were formed and experts of CBIP & DSRP had also visited the site.*

3.12 ***The expert committees opined that permanent HRT leakage control solution could be achieved by repair of leakage source from inside to the HRT, which would require dewatering of HRT. Thus shutdown of Power House for about 04 to 06 months may be required. Alternate proposal to channelize the leakage water through MS pipes and strengthen the adjoining strata of low cover zone should be carried out. The results/ implications of this proposal will be observed and if leakage discharge is under control, then a limited leakage may be allowed to safely pass through the MS Pipe.***

3.13 *To address these risks, immediate action is required. Based on Expert committee observations and recommendations, it is proposed to undertake the following works as Part-A of the rehabilitation plan:*

A. *Internal inspection of the HRT using a Remotely Operated Vehicle (ROV), which will help in precisely identifying the leakage points, cracks, or damaged sections without the need for dewatering the tunnel. This inspection will guide all future remedial work and help assess the structural health of the HRT.*

B. *Ground strengthening and slope stabilization at the Gamri Gad site, involving triangulated grouting with cement and PU material, as well as controlled channelization of pressurized leakage water through MS pipes to minimize internal erosion and hill destabilization.*

These measures are essential for:

- *Preventing further weakening of the tunnel structure and overlying strata.*
- *Enhancing the effectiveness of grouting by reducing soil saturation.*
- *Stabilizing the critical overburden zone to resist seismic stress.*
- *Reducing ongoing leakage and avoiding further upward migration of seepage.*
- *Ensuring the long-term operational safety of MB-II and surrounding infrastructure.*

3.14 *In view of above, a DPR amounting to ₹ 12.27 Crore (including taxes) has been prepared in-house for carrying out the works related to Rehabilitation works of Head Race Tunnel (HRT) of Maneri Bhali-II, HEP, Distt-Uttarkashi (Part-A).*

3.15 *The proposed Part-A works under the rehabilitation plan include the following major key activities:*

- *Internal inspection of the Head Race Tunnel using a Remotely Operated Vehicle (ROV)*
- *Channelize the leakage water safely pass through MS pipe.*
- *Drilling and re-drilling operations*
- *Cement and PU grouting for strengthen the adjoining strata of low cover zone.*
- *Engagement of geologists for expert supervision*

- *Conducting geophysical investigations such as ERT, MASW, and Noise Fault tests.*
- *Miscellaneous civil works as required for site stability.*

3.16 In the first stage part-A works is being planned and part-B will be considered after ROV inspection report and detailed assessment.

3.17 In view of the ongoing safety risks and financial implications of shut down of the project, these works are both urgent and essential. The proposal directly supports the structural safety and operational continuity of the Maneri Bhali Stage-II Hydro Electric Project.

3.18 As per Regulation 22 (4) of UERC Tariff Regulations, 2024, a generating company is required to get prior approval for the additional capitalization works exceeding ₹ 5 Crore. The Regulation 22 (4) of UERC Tariff Regulations, 2024 states that: -

"Any addition/modification to the existing assets exceeding Rs. 2.50 Crore in case of distribution licensees, Rs. 5 Crore in case of generating companies/transmission licensees shall be taken up only after prior approval of the Commission. The application for approval of the Commission shall be accompanied with the approval of BoD in accordance with UERC (Conduct of Business), Regulations, 2014."

3.19 The estimated cost for carrying out the capital investment on Rehabilitation works of Head Race Tunnel (HRT) of Maneri Bhali-II, HEP, Distt-Uttarkashi (Part-A) is summarized as under-

S. No	*Name of work*	*Estimated Amount (Rs. In Lacs.)*	*Remark*
1.	*Inspection of the Head Race Tunnel of MB-II project by ROV (Remotely Operated Vehicle) in water filled condition at Chinyalisaur.*	*265.00*	*To optimize the planned closure period, elaborate planning, statuary approvals, exact location/causes of the leakage as well as engagement of a resourceful agency to undertake repair activities, inspection from inside of HRT is essential.* ***The work has been awarded to M/s IROV Tech. Kerela, India. Due to high turbidity in Bhagirathi river the work is scheduled to be executed in the lean season period Dec2025.***
2.	*Strengthening of strata and ground improvement works including channelization of*	*962.00*	*Leaking water from HRT contains fine soil particles, highlighting the presence of internal erosion and subsurface voids. This phenomenon poses a serious threat*

S. No	Name of work	Estimated Amount (Rs. In Lacs.)	Remark
	leakage water flowing out from HRT of MB-II HEP at Gamri Gad.		*to ground stability of low cover zone and could eventually lead to structural compromise or land settlement. Therefore, it is essential to carry out remedial measure works to fill these voids, arrest soil erosion, and prevent further destabilization.*
Total (In Lacs.) with GST		***1227.00***	

3.20 The aforesaid DPR for Rehabilitation works of Head Race Tunnel (HRT) of Maneri Bhali-II, HEP, Distt-Uttarkashi (Part-A) has been approved by the BoD, UJVN Ltd. in its meeting held on 11.06.2025 (Copy Minutes of Meeting of BoD dated 11.06.2025 …). The works proposed in the DPR will be carried out during the financial year 2025-26 & 2026-27 (Copy of the DPR …).

3.21 ***Financing Plan and Phasing of Expenditure:***

That the Petitioner shall arrange the expenditure from its internal resources and the total expenditure of Rs. 12.27 Crore inclusive of taxes will be incurred during the FY 2025-26 & FY 2026-27 as proposed in the DPR.

*..."[**Emphasis added**]*

4. Further, the Petitioner under the section 'Relief sought' has mentioned that:

"

In view of submissions contained in the Petition, it is respectfully prayed that the Hon'ble Commission may kindly:

…

ii. Approve the total capital investment of ₹ 12.27 Crore (including taxes) for carrying out the capital investment on "Rehabilitation works of Head Race Tunnel (HRT) of Maneri Bhali-II, HEP, Distt-Uttarkashi (Part-A)."

iii. The cost of proposed works has been developed on the basis of estimates as detailed in this filing. There may be difference between the present estimates and the cost of actual implementation. The Hon'ble Commission is therefore requested to kindly consider and approve the actual expenditure that may be claimed during the true-up of the expenditure.

..."

5. On preliminary examination of the Petition, the Commission vide its letter No. 1092 dated 13.10.2025 issued following deficiencies/infirmities to UJVN Ltd. and directed it to submit point-wise reply before the Commission latest by **06.11.2025**:

"

1. *UJVN Ltd. is required to confirm regarding the presence of any water source in the area in the close vicinity of the Gamri Gad area. UJVN Ltd. is required to furnish the details of historical significance w.r.t. 'Gamri Gad'.*

2. *UJVN Ltd. at para 3.9 of its Petition has mentioned that leakage at Gamri Gad area has steadily increased from 229 liters per second to 1602 liters per second by 2024. In this context, UJVN Ltd. is required to furnish details of historical monthly data w.r.t. leakage from Gamri Gad area in MS excel format for both measurement sites i.e. U/S site and D/S site. Further, UJVN Ltd. is required to furnish Hourly data of both measurement site i.e. U/S site and D/S site available from real time automatic discharge measurement system and corresponding values of reservoir level at Joshiyara Barrage, MW output of MB-II for last 01 month in MS excel.*

3. *UJVN Ltd. is required to furnish the estimated monthly generation loss in MUs and corresponding revenue loss (in Rs. Crore) due to leakage at Gamri Gad since the aforesaid leakage has been identified. Further, UJVN Ltd. is required to furnish the details of measures taken by it for restricting the leakage since 2007 till date, along with details of expenses incurred in a particular FY and details of its capitalization in its books. Moreover, substantiate the execution of the works taken-up and its impact on the leakage flow.*

4. *UJVN Ltd. has filed a Petition under Regulation 22 of UERC (Tariff) Regulations, 2024 for seeking prior approval of capital investment on Rehabilitation works of HRT of MB-I HEP. However, UJVN Ltd. submitted that work pertaining to inspection of HRT by ROV has been awarded to M/s IROV Tech, Kerela. In this regard, UJVN Ltd. is required to justify how the aforesaid works qualify for in-principle approval.*

5. *UJVN Ltd. is required to describe/furnish write-up regarding the 'triangulated grouting with cement and PU material, as well as controlled channelization of pressurized leakage water through MS pipes' and justify how the said methodology in conjunction with analysis from ROV would be effective in identification of leakage points in HRT and controlling the leakage. Moreover, furnish that what is the*

anticipated life of the proposed solution and details of annual O&M cost on the same, if any.

6. *UJVN Ltd. is required to furnish copy of tender w.r.t. underwater examination through Remotely Operated Vehicle (ROV). UJVN Ltd. is required to confirm whether ROV can execute under water welding operations or any other options are available.*

7. *UJVN Ltd. is required to clarify regarding the soil stabilization method adopted in the proposed works in continuous water flowing environment and efficacy of cement grouting/PU grouting in this respect.*

8. *UJVN Ltd. is required to clarify regarding the impact of Dam/gate/Generation output on the leakage water flow rate at Gamri Gad.*

9. *UJVN Ltd. is required to furnish legible copy of the following:-*

   - *Page 11 of Appendix-I 'Geological section along HRT alignment'*
   - *Page 12 of Appendix-I 'GSI geological section along HRT of MB-II'.*
   - *Page 16 of Appendix-I 'Longitudinal section of HRT showing Details of lining in different reaches of MB-II HEP'.*

10. *In context to Page 17 of Appendix-I, UJVN Ltd. is required to furnish cross- section diagram of chainage 13.7180-13.7530 [RCC lining 60 cm-circular shape (35 m) of 6 m dia], 13.7530-13.8130 [60 m Steel liner in circular shape of 6 m dia and 16 mm thick], 13.8130-13.9000 (87 m)[RCC lining 60 cm- circular shape of 6.0 m dia]. Moreover, furnish the details of the overlapping zone of the circular shape of RCC lining 60 cm on both ends of steel liner at Gamri-gad as mentioned above. Furthermore, confirm whether there exists any RCC/PCC lining on outside of the Steel Liner (60 m) long.*

11. *UJVN Ltd. is required to confirm regarding the type of bonding/welding done between various steel liner sections installed at 60 m length (13.7530-13.813 chainage) of HRT.*

12. *UJVN Ltd. is required to confirm that steel liner exists only at 60 meter length of HRT (13.753 – 13.813 Km.) in the whole 16 Km. HRT length, and if so, the reason*

for selecting the same over other existing lining technology in the 16 Km. HRT of MB-II HEP.

13. *UJVN Ltd. has shown steel liner at chainage 13.734 to 13.794 Km. at page 13 of 140 in Appendix 1, whereas steel line is shown at chainage 13.7530 to 13.8130 Km. at page 17 of 140. UJVN Ltd. is required to confirm regarding the same. Further, UJVN Ltd. is required to furnish the procedure of installation of steel liner sections viz. its standard length and methodology adopted for jointing different steel sections.*

14. *Furnish a write-up on significance and usage of following methods/technologies:-*

- *Radioactive tracer technique*
- *Electrical Resistivity tomography technique*
- *Multi Channel analysis of surface waves (MASW)*
- *Acoustic methods (Noise Fault technique)*

15. *At page 22 of Appendix-I, the Expert Committee had identified that initially the problem occurred in year 2007 i.e. before CoD of the Project and the same was controlled by grouting near point of tunnel alignment. UJVN Ltd. is required to furnish details of the aforesaid works done in 2007 with details of chainage where it was executed and cost incurred on the aforesaid works.*

16. *UJVN Ltd. is required to furnish the basis of quantity estimations for ROV (page 77 of appendix-1) and items at S.No. 1 to 10, 32 and 33 (page 78,79 & 82 of appendix-1).*

17. *UJVN Ltd. is required to furnish write up on how the findings of the RoV would be beneficial for pin-pointed identification of weak zones in HRT and execution of the stabilization works. Further, how its findings would impact the estimates as proposed in the instant Petition.*

18. *Justify regarding conducting geo-physical investigations such as ERT, MASW and Noise fault tests in addition to inspection from ROV. Further, confirm whether inspection through ROV is one time exercise or it works on iterative process of finding followed by confirmation.*

19. *UJVN Ltd. in Cost Benefit Analysis (CBA) chapter XII has taken average revenue loss for 06 months due to dewatering the tunnel required for carrying out the rehabilitation works at HRT while computing the benefit-cost ratio against the Part-*

A rehabilitation cost of Rs. 12.27 Crore. In this regard, UJVN Ltd. is required to clarify that how the aforesaid CBR calculation is true for the instant proposal of Rs. 12.27 Cr. by considering generation loss due to HRT closer (dewatering of the tunnel).

20. *At page 95, UJVN Ltd. has shown execution of works from November 2025 onwards whereas inspection of HRT is proposed in December 2025. UJVN Ltd. is required to confirm regarding the sequence. Moreover, UJVN Ltd. is required to furnish the L2 level bar-chart of all the activities along with its leakages with each other viz. Start-Start, Start-Finish, Finish-Start and Finish-Finish for the proposed works in the investment approval petition.*

21. *UJVN Ltd. is required to furnish the efforts made by it for getting funding/assistance from the State/Central govt. w.r.t. the proposed works."*

6. In response to the above observations/deficiencies, Petitioner vide its letter No. 128/UJVNL/03/D(P)/D-5 dated 07.11.2025 submitted its reply and furnished the following:

"

1…

Reply: *No other perennial or seasonal water source exists in the close vicinity of the Gamri Gad area apart from the Gamri Gad stream itself. The nearest habitations are Chamiyari village (approximately 1.5 km upstream) and Margaon village (It is situated on the right hill slope of the Gamri Gad stream, approximately 1.6 km downstream from the leakage point and about 0.4 km above the stream valley). "Gamri Gad" is a minor natural stream carrying hill slope runoff that joins the Bhagirathi River further downstream. It does not possess any cultural, archaeological, or historical significance as per available records or local inputs. Therefore, no water source or heritage site is affected by the proposed rehabilitation works.*

2…

Reply: *The desired leakage data at Gamri Gad from 229 LPS to 1602 LPS attached … Furthermore, hourly data of both measurement site i.e. U/S site (by manual) and D/S site from real time automatic discharge measurement system and corresponding values of reservoir level at Joshiyara Barrage, MW output of MB-II for last 01 month has been attached …*

3…

Reply: *The estimated generation loss due to this leakage is negligible, as the average leakage discharge is about 0.70% of design discharge when compared to the total design energy generation of the project. However, UJVN Ltd. continues to monitor the leakage conditions closely to ensure that any potential increase is identified and addressed promptly to ensure safety of tunnels/Water conductor system as well as safety to the existing cultivation fields, approach way, Canal and water pipeline. The detail of expenses incurred since 2007 to till date has been attached ... The treatment works including drilling/ grouting has been initiated from March 2021 and currently under progress. The major grouting work has been done from March 2024 to July 2024. Before the major work done as grouting treatment, the maximum leakage water discharge was recorded at 1,470 Ltr per second on 28 December 2023. After implementing the grouting operation, the discharge was significantly reduced to a minimum of 362 Ltr per second by 23 June 2024. That clearly indicates the positive impact of the grouting work, as the leakage has significantly reduced after its execution. But the treatment work is essential for the safety & integrity of water conductor system of the project.*

Here it is important to mention that, in view of the complexity of the problem, UJVNL constituted various expert committees between 2021 and the present (refer pages 22-46 of the DPR). UJVNL officials held frequent meetings with these expert committees. The treatment work proceeded via repeated meetings, site visits and observations, followed by recommendations from technical experts at each phase. The details of the 13 minutes of the expert committees are already attached in the DPR (pages 100-183).

4…

Reply: *The ROV-based inspection work was originally awarded as a standalone diagnostic activity valued below ₹5.00 crore, which falls under UJVN Ltd.'s delegation of financial powers and did not require prior approval of the Hon'ble Commission. Subsequently, during the preparation of the comprehensive DPR on Rehabilitation of Head Race Tunnel of MB-II Project, Chinyalisaur, Uttarkashi, it was technically established that the ROV inspection is also an essential preliminary activity for assessing the internal condition of the HRT and formulating the final rehabilitation methodology. Integration of ROV findings will ensure identification of accurate localization of grouting, optimized grout quantity and higher treatment success rate.*

Therefore, the ROV inspection forms an integral component of the overall rehabilitation work and has been included in the DPR. Furthermore, the expert committee, in its minutes dated 11 December 2024 and 30 April 2025 (see pages 177–183 of the DPR), recommended that HRT inspection via ROV be carried out by an experienced agency for a stretch of approximately 3 km upstream of the surge shaft, covering both the Gamrigad and Srinagar thrust zones. This inspection needs to be initiated without delay.

5…

Reply: *The proposed triangulated grouting with cement and PU material is a systematic technique adopted for stabilization and leakage control around the Head Race Tunnel (HRT). In this method, grout holes are drilled in a triangular pattern to achieve uniform coverage and deeper penetration into the fractured rock zones.*

In this connection, kind attention is invited to reply of point no. 03 in which details of high level expert committees have been shared. As this was very delicate and highly technical work, therefore such committee was constituted.

In this process in the first stage, MS pipes will be installed at the leakage zone to provide a controlled passage for pressurized water, allowing safe discharge and relieving internal pressure. This step facilitates drying of the immediate surroundings, enabling effective and durable grouting under stable conditions.

Subsequently, multiple grouting holes will be drilled in a triangulated pattern around the leakage zone, ensuring multidirectional grout penetration into the rock mass for effective strengthening and sealing of the leakage area.

Cement grout fills larger voids and open joints, providing structural rigidity, while PU grout seals fine cracks and micro-fissures, forming a watertight and flexible membrane against pressurized seepage.

Wherever minor residual leakage persists, controlled channelization through the installed MS pipes is maintained to regulate the flow and prevent internal erosion, as well as any potential damage to the surrounding rock mass, strata or tunnel lining. This all was frequently discussed in review meeting of expert committee & also during site visit.

The grouting plan will be precisely guided by ROV inspection data, which will identify leakage zone, liner cracks and weak spot. Integration of ROV findings

ensures accurate localization, optimized grout quantity and higher treatment success.

This method of triangle pattern of grouting for consolidation of sub-surface has been successfully applied in several major hydro tunnels (e.g., Teesta-V, Parbati-II and Nathpa-Jhakri HEP)*. This was also recommended by the expert committee. Keeping in view of the uncertainty of geological movements due to presence of Srinagar thrust in the vicinity of leakage area, it may be difficult to assess the anticipated design life of the proposed system. However the proposed rehabilitation work will help in avoiding sudden failure /damage of the tunnel and grouting will also stabilize and strengthen the strata/slope. This will also reduce the possibility of slope failure. The annual O&M cost of approximately 0.5% - 1.0% of rehabilitation cost for inspection and minor maintenance, but long term success of the treatment can't be exactly guaranteed. The methodology may or may not stop the leakage completely but soil stabilization via grouting will definitely improve the safety of water conductor system.*

6…

Reply: *The copy of tender document has been attached …* ***The work of underwater inspection of the Head Race Tunnel (HRT) using Remotely Operated Vehicle (ROV) has been awarded to M/s IROV Tech, Kerala for diagnostic inspection of approximately 3.0 km stretch of the HRT in water-filled condition. The ROV is equipped with HD camera, sonar imaging system and dye-injection modules to detect cracks, voids, liner distortion and seepage points****. The awarded scope is strictly limited to inspection and data collection.*

At present, the selected indigenous ROV does not include in-situ repair, welding or maintenance capability. However, it is acknowledged that advanced ROV systems with limited underwater maintenance features such as micro-welding, epoxy sealing or patch repairs are available internationally. The feasibility of utilizing such advanced ROVs can only be evaluated after observing the actual tunnel conditions during the upcoming inspection. Their success depends entirely on internal accessibility, turbidity and visibility parameters within the HRT. Moreover, these maintenance-capable ROVs are foreign based, high-cost, specialized systems, requiring customized design, mobilization/custom clearance and highly skilled operation. UJVNL has already explored possibilities in this direction. M/s Hibbard Inshore, a reputed American company established in 1984 and globally recognized

for its expertise in underwater, submerged, and pressurized environment surveys, had previously conducted similar ROV-based inspection works at major international hydro projects, including the Nathpa Jhakri Hydro Power Station in India.

The firm had submitted an indicative estimate exceeding ₹15.00 crore solely for inspection-related activities, with the repair cost to be determined post-inspection likely amounting to nearly twice the inspection cost. Considering the high expenditure involved, it was decided to explore indigenous ROV agencies capable of undertaking such works. Accordingly, at the current stage, the awarded work has been limited to inspection and diagnostic assessment only, which will serve as the technical basis for evaluating the need and feasibility of any future underwater maintenance activities.

7...

Reply: *The methodology includes controlled channelization of seepage water through pre-installed MS pipes, which safely diverts the leakage flow and creates semi-dry peripheral conditions suitable for effective grouting. Under these controlled conditions, triangulated cement and PU grouting will be carried out under the guidance of high level expert committee.*

The cement grouting will be carried out at controlled pressure (typically 3–5 bar) to fill macro-joints, cavities and loosened rock interfaces. ***The grout mix will use superplasticizers and anti-washout agents to maintain suspension in residual seepage. Subsequently, hydrophobic PU grout will be injected to seal micro-fissures and residual leakage paths. PU polymerizes rapidly (in few seconds) on contact with water, forming a dense, elastic and impermeable resin matrix that resists further water ingress.***

This dual-material system ensures both structural consolidation and hydraulic sealing even under partial water flow. The procedure has proven effective in similar hydro projects such as Parbati-II, Teesta-V and Koldam HEP, where grouting was executed under active seepage and also recommended by expert committee members in past & have been found successfully*.*

Hence, the adopted soil and rock stabilization approach using controlled flow diversion followed by cement -PU grouting is technically suitable for the Gamri Gad leakage zone.

8…

Reply: The leakage at Gamri Gad originates from the pressurized Head Race Tunnel (HRT) segment between chainage 13.750 km and 13.813 km, where the internal hydrostatic head is directly influenced by the reservoir level at Joshiyara Barrage and the generation discharge of MB-II units.

Hydraulic correlation studies and flow monitoring have shown that the leakage rate at Gamri Gad varies proportionally with tunnel internal pressure, which depends primarily on two operating parameters:

a.) Dam/Reservoir Level (Upstream Head): An increase in reservoir water level leads to a corresponding rise in the static head inside the HRT, which causes higher hydraulic gradients along existing micro-fractures, thereby increasing seepage discharge. Conversely, when the reservoir level is reduced during low inflow periods, the leakage flow reduces significantly, confirming a direct head–leakage dependency.

b.) Generation Output and Discharge Load: Field observations show that the leakage at Gamri Gad varies inversely with the generation load of MB-II. When the generation load is low, the water flow inside the Head Race Tunnel (HRT) becomes slow and the static pressure within the tunnel remains almost constant along its length. This sustained pressure condition increases the tendency of water to seep through weak joints and fractured rock zones, resulting in higher leakage discharge at Gamri Gad.

During high-generation periods, larger water discharge through turbines increases flow velocity and creates a small head loss along the tunnel. This reduces the static pressure near the leakage zone and as a result, the leakage flow decreases.

However, during sudden load changes or emergency shutdowns, temporary pressure surges (water hammer effect) may occur, which can momentarily increase the leakage before the pressure stabilizes. These sudden pressure rises have also contributed to erosion in the affected areas.

In summary, leakage flow at Gamri Gad increases during low-generation conditions and reduces under high-generation operation, confirming that the seepage is directly related to the internal hydraulic pressure in the HRT.

Therefore, the leakage at Gamri Gad is also dependent upto some extent on reservoir level varying due to operational requirement of the project and HRT pressure conditions and not on any independent surface or groundwater source.

9. *…*

Reply: *The desired legible copy has been annexed …*

10. ...*.*

Reply: *The desired drawings has been annexed … The RCC lining 60 cm-circular shape of 6.0 m dia (internal) lining has been done throughout the length of 182 mtr from ch. 13.718 to ch. 13.900 with a 16 mm thick steel liner in circular shape of 6.0 m dia installed between chainage 13.7530 km and 13.8130 km.*

11. ...

Reply: *The steel liner sections installed in the 60 m stretch (chainage 13.7530 m to 13.8130 km) of the Head Race Tunnel (HRT) were joined using full-penetration butt welding (Groove weld) carried out through manual metal arc welding (MMAW/SMAW) technique.*

12. ...

Reply: *It is respectfully submitted that, as per the approved DPR and actual site construction records, steel liners have been provided at six (06) distinct locations along the Head Race Tunnel (HRT) of Maneri Bhali Stage-II HEP, not only at the 60 m stretch (chainage 13.753 – 13.813 km).*

Tunnel lining type is selected based on local rock mass conditions, expected loads, seepage/erosion risk, low cover zone and constructability. For a single small but critical reach where standard lining would be ineffective or would require very large auxiliary works, a steel liner is an established remedial and protective solution.

Each of these locations corresponds to geologically weak and hydraulically sensitive zones, identified during both pre-construction investigations and during actual tunnelling. The decision for localized installation of steel liner was taken based on site-specific safety, structural integrity and hydraulic considerations.

13. ...

Reply: *The steel liner has shown at ch 13.753 to 13.813 km at page 17 of 140 appendix is correct. It is informed that the steel liner has been installed by Irrigation Department. As*

per available records the steel liner 16 mm thick and 6.0 mtr dia has been supplied in two adjoining pieces each of 2.5 mtr length. Each section of 2.5 mtr length of steel liner has been connected through butt welding joint.

14.

Reply:

1. Radioactive Tracer Technique: This method traces seepage movement by introducing safe radioactive isotopes into suspected leakage areas. The movement of tracers is monitored using detectors, which helps confirm seepage paths and flow direction. However, due to certain limitations, this technique has not yet been applied at the Gamri Gad site.

2. Electrical Resistivity Tomography (ERT): ERT is used to study subsurface conditions by measuring electrical resistivity variations. Using an array of electrodes, 2D resistivity imaging provides a depth-wise profile to identify water-saturated or fractured zones. The method helps locate seepage paths and assess the effectiveness of grouting.

3. Multi-Channel Analysis of Surface Waves (MASW): MASW is a seismic method used to evaluate ground stiffness and shear-wave velocity (Vs). It helps determine subsurface layering, compactness and soil/rock strength. In HRT investigations, MASW identified the shear strength and stiffness of strata affected by seepage.

4. Noise Fault (Acoustic) Technique: This technique uses geophones to detect abnormal vibrations or sounds generated by water leakage. The sensors record real-time acoustic signals, allowing precise localization of leakage points. Digital filtering helps distinguish true leakage noise from background vibrations.

Conclusion: An integrated approach using ERT, MASW and Noise Fault techniques effectively detected seepage zones and strata weakness along the HRT. The results correlated well, identifying low-resistivity and low-stiffness zones. Re-survey after rehabilitation is recommended to verify treatment efficacy.

15. ...

Reply: *Initially, the minor leakage was observed in the year 2007, prior to the commissioning of the project. During the construction phase, two exploratory drill holes of approximately 3-inch diameter were drilled at the Gamri Gad location to measure the rock/strata cover along the tunnel alignment.*

During the tunnel testing stage, at the time of commissioning of project, minor water leakage was noticed from these exploratory holes at Gamri Gad. Then as per record the leakage points were controlled by grouting with 120 bags of cement. The said grouting work was executed by M/s NPCC Ltd. (the executing agency at that time) through Irrigation department.

Detailed cost records of this localized grouting work were maintained under the construction phase accounts. However, the expenditure was of minor nature and was included under the overall tunnel grouting and finishing activities of 2007.

***16.** …*

***Reply:** The quantities for items listed at S. No. 1 to 10 have been derived based on the adopted triangular grouting pattern, ensuring effective coverage and grout penetration across the identified leakage zones. The detailed measurement calculations supporting these estimations are …*

Further, the quantities under items at S. No. 32 and 33 pertain to the verification and confirmation stage, which include conducting ERT and MASW tests after completion of rehabilitation works to assess improvement in strata conditions and to confirm the effectiveness of executed grouting.

17. ...

***Reply:** The ROV will perform underwater sonar mapping at every 1-meter interval, enabling a detailed 3D visualization of the tunnel profile and identifying any deformations, cracks, cavities, or lining defects. Along with sonar, high-resolution video recording will assist in visual inspection of vulnerable and fractured zones.*

In areas showing fine cracks or suspected seepage, a dye test will be conducted through the ROV to confirm leakage pathways and assess the severity. These combined findings will help in accurate localization of distress zones, minimizing uncertainty in sub-surface conditions.

The outcome of this survey will serve as a technical baseline for advance planning, enabling preparation of location-specific designs, material requirements and execution methodologies for internal works to be undertaken after dewatering of the tunnel, if required any time in future. This will help in:

- *Advance mobilization and procurement of materials and equipment*
- *Design optimization for anticipated problem zones*

- *Assessment of damage /works required, consequently planning of minimization of shutdown duration and project closure time, Enhancement of operational efficiency and safety during execution*
- *Reduction of uncertainty during internal strengthening works post-dewatering.*

Thus, the ROV survey will provide critical pre-dewatering insights that will enhance planning accuracy, execution readiness and safety, ensuring effective stabilization works and minimizing project shutdown time.

The ROV findings will also provide critical insight into the internal structural condition of the HRT, enabling a realistic assessment of how long the tunnel can be safely operated under the present conditions before major rehabilitation is required from inside the tunnel after dewatering.

The location/ chainage of leakage area in HRT as identified by ROV will be treated during execution of the proposed work. The findings of ROV will also be submitted to high level committee and the treatment work proposed in the petition will be executed as per their recommendations formulated on the basis of the findings of ROV.

18. ...

Reply: *As per the recommendations of the expert committee, the ROV survey is planned as a one-time exercise to obtain a detailed internal assessment of the HRT, including mapping of cracks, cavities, joints and leakage-prone zones prior to dewatering. It is not intended as an iterative process, though its findings will serve as a baseline for planning subsequent interventions and validating external grouting works.*

In addition to ROV inspection, geo-physical investigations such as Electrical Resistivity Tomography (ERT), Multi-Channel Analysis of Surface Waves (MASW) and Noise Fault tests are proposed to provide complementary information. While ROV gives a direct visual and positional understanding of internal tunnel conditions, these geo-physical techniques help in:

- ***Mapping subsurface resistivity variations, weak or fractured zones and water pathways (ERT),***
- ***Evaluating shear wave velocity and stiffness of surrounding rock mass (MASW),***

- ***Detecting hidden leakage or fault zones through acoustic signatures (Noise Fault tests)***.

Together, ROV and these geophysical investigations provide a comprehensive and reliable assessment of the HRT condition, enabling precise targeting of both internal and external stabilization works, optimizing design, materials and execution while ensuring safety and operational efficiency.

19. *…*

Reply: *The proposed intervention for strengthening the overburden strata and stabilizing the ground around the HRT is a critical step toward ensuring the structural integrity and operational safety of the Head Race Tunnel (HRT). By addressing active leakage zones and reinforcing geologically vulnerable areas, the treatment will substantially reduce the risk of progressive deterioration and catastrophic tunnel failure, thereby enhancing the overall resilience of the MB-II HEP infrastructure.*

The CBA was done considering the scenario that, if any eventuality happens and the rehabilitation is to be undertaken in emergency conditions from inside the tunnel after complete dewatering, a minimum period of six months would be required to complete the treatment work in that stretch. Moreover, once dewatered, the weak zones along the 16 km length of the HRT may undergo further deformation at any chainage, which could lead to an extension of the rehabilitation duration and associated risks. Although the likelihood of tunnel failure under current conditions is low, the consequences, if it occurs, would be extremely severe in both time and cost terms. ***If the overburden strata are not adequately strengthened or the weak zones are not properly supported, there remains a significant risk of localized instability that could lead to complete closure of the HRT. In such an event, the restoration and rehabilitation process may take more than one year to complete, resulting in prolonged shutdown of the generating units and substantial revenue loss****.*

Therefore, the consideration of an average generation loss equivalent to six months due to dewatering of the tunnel for rehabilitation works in the Cost Benefit Analysis (CBA) has been taken as a conservative yet realistic assumption. This estimation reasonably accounts for the potential downtime necessary to execute critical stabilization and structural reinforcement measures. Further, considering the present power demand scenario of the State, complete closure of the project for such an extended period may not be feasible, and it

is also unlikely to obtain the approval from concerned authority for dewatering and suspension of generation for such a long duration.

Though the CBA was done assuming the above mentioned scenario, however, the proposed work is essential for ensuring safety and maintaining integrity of water conductor system of the project and avoiding any sudden failure/ collapse or damages of the HRT.

Thus, the proposed treatment is both technically critical and economically justified, delivering a high return through improved safety, risk reduction, and sustained operational efficiency.

20….

Reply: *The ROV inspection has been deliberately scheduled for December 2025, corresponding to the lean-flow period when turbidity is minimum, ensuring clearer visibility and safer underwater operations. Post-inspection, data analysis and expert review will determine the detailed execution plan for strengthening and channelization works during the subsequent quarter. L2 bar chart has been reviewed and annexed …*

21….

Reply: *The proposed rehabilitation works are planned to be executed through UJVN Ltd.'s capital investment under the Capital Expenditure Plan for FY 2025–26 and FY 2026–27. No financial assistance or external funding has been sought or sanctioned from the State Government, Central Government, or any agency such as DRIP–III/world Bank for this scheme.*

However, UJVN Ltd. remains open to aligning this project with any future Central or State rehabilitation program for hydro infrastructure in case should such schemes become available. If any such funding will be available /allowed by GOU, the same shall be duly informed to the Hon'ble Commission." [***Emphasis added***]

7. The Commission vide its letter No. 1351 dated 03.12.2025 directed UJVN Ltd. to make a Power Point Presentation (PPT) covering the need and justification alongwith legal, technical and financial aspects of the Petition on 10.12.2025. On the said date i.e. on 10.12.2025, UJVN Ltd. along with its subject experts, made PPT before the Commission.

Commission's Observations, Views & Directions:-

8. Based on the examination and analysis of the proposal, subsequent written submissions and submissions made during Power Point Presentation dated 10.12.2025 before the Commission, the observations, views & directions of the Commission are as follows:-

(1) With regard to the proposed works, the Commission has observed that the Petitioner has sought in-principle approval for the works amounting to **Rs. 12.27 Crore** (including taxes) for which necessary approval was accorded by the BoD in its 126th BoD meeting held on 11.06.2025. The details of the DPR is mentioned below:-

S. No.	Name of work	Estimated Amount (Rs. In Lakh)	Remarks
1.	Inspection of the Head Race Tunnel of MB-II project by ROV (Remotely Operated Vehicle) in water filled condition at Chinyalisaur.	265.00	To optimize the planned closure period, elaborate planning, statuary approvals, exact location/causes of the leakage as well as engagement of a resourceful agency to undertake repair activities, inspection from inside of HRT is essential. **The work has been awarded to M/s IROV Tech. Kerela, India.** Due to high turbidity in Bhagirathi river the work is scheduled to be executed in the lean season period Dec2025.
2.	Strengthening of strata and ground improvement works including channelization of leakage water flowing out from HRT of MB-II HEP at Gamri Gad.	962.00	Leaking water from HRT contains fine soil particles, highlighting the presence of internal erosion and subsurface voids. This phenomenon poses a serious threat to ground stability of low cover zone and could eventually lead to structural compromise or land settlement. Therefore, it is essential to carry out remedial measure works to fill these voids, arrest soil erosion, and prevent further destabilization.
Total (In Lakh) with GST		**1227.00**	

(2) With regard to the relevance of the proposed works, the Petitioner in its Petition has submitted that the Gamri Gad area of HRT in MB-II project is in a very sensitive and risky zone, which has proximity with active Srinagar Thrust, a known geological fault line. Since February 2021, leakage in this area has increased steadily. This continuous leakage has weakened the

tunnel and surrounding soils and rocks. As per expert committee opinion the permanent HRT leakage control can be achieved by repairing leakage from inside of HRT, which would require dewatering, which is time taking and expensive proposition. Alternatively, for precise location of the leakage points, cracks or damaged sections without need for dewatering the tunnel, the Petitioner has proposed to inspect the HRT using Remotely Operated Vehicle (ROV). Further, the Petitioner in the instant Petition is proposing to channelize the leakage water through MS pipes and strengthen the adjoining strata for low cover zone by cement and PU grouting in the instant Petition.

Accordingly, the Petitioner has sought approval for aforesaid activities under the capital head in FY 2025-26 & FY 2026-27.

(3) On examination of the Petition and subsequent submissions, the Commission with regard to the leakage from Gamri Gad area has observed that:

(a) The Petitioner in its DPR has submitted that the leakage is being observed at Gamri Gad area, which is a low cover area and was identified at the time of project designing stage. Accordingly, a steel liner in circular shape of 06 mtr. dia and 16 mm thick was installed at chainage 13.7530 km. to 13.8130 km. in order to provide strength to the vulnerable section in the HRT, which shares a close proximity with active Srinagar thrust line and sensitive from the perspective of seismic activity in the region. It appears that leakage is coming out through steel liner which has been embedded in the aforesaid reach of HRT. The leakage may be either through the grout holes or through the joints of the liner. At the time of commissioning of MB-II project, minor water leakage was noticed, and the leakage points were controlled by grouting done by M/s NPCC Ltd. (the executing agency at that time) through Irrigation department. However, later in 2021, leakage in the said area was again observed and since then the leakage has steadily increased from 229 liters per second to 1602 liters per

second by 2024. This continuous leakage has weakened the tunnel and the surrounding soil and rocks.

In this context, it is observed that the leakage data furnished by the Petitioner depicts that there has been a significant increase in leakage from the said area.

(b) The leakage at Gamri Gad originates from the pressurized Head Race Tunnel (HRT) segment between chainage 13.750 km and 13.813 km, where the internal hydrostatic head is directly influenced by the reservoir level at Joshiyara Barrage and the generation discharge of MB-II units. The Hydraulic correlation studies and flow monitoring depicts that the leakage rate at Gamri Gad varies proportionally with tunnel internal pressure, which depends primarily on two operating parameters i.e. Dam/Reservoir Level (Upstream Head) and Generation Output and Discharge Load.

In this regard, from the submissions of the Petitioner, the Commission is of the view that the leakage discharge from the HRT at Gamri Gad area has a direct co-relation with the head at Joshiyara Barrage i.e. higher is the head higher is the hydraulic gradients along existing micro-fractures, thereby increasing seepage discharge and *vice-versa*. Whereas, there exists an inverse relationship between generation and discharge from the HRT at Gamri Gad i.e. higher is the generation, larger water discharge through turbines resulting in increasing flow velocity and creates a small head loss along the tunnel, which reduces the static pressure near the leakage zone and results in decrease in leakage flow and *vice-versa*. Moreover, during sudden load changes or emergency shutdowns, temporary pressure surges (water hammer effect) may occur, which momentarily increases the leakage before the pressure stabilizes, which also contributes to erosion in the affected areas.

(c) The Petitioner in its Petition has submitted that several attempts have been made by them in the past for arresting the leakage and during PPT dated 10.12.2025 presented before the Commission, the Petitioner

has furnished details of the 'Gamri Gad grouting status' as mentioned below:

"

Gamri-Gad Grouting Status			***HRT Crown Level***		***1019.00***
			HRT Invert Level		***1013.00***
			Gamri Gad Level		***1039.00***
Drill Hole No.	***Collar Elevation (m)***	***Drilling depth (drilling upto EL)***	***Period of Grouting***		
ODH-3	*1043.00*	*-*	*2022*		
ODH-4	*1043.00*	*-*	*2022*		
ODH-5	*1043.00*	*-*	*2022*		
CDH-1	*1043.00*	*-*	*2022*		
CDH-2	*1043.00*	*-*	*2022*		
EDH-1	*1053.18*	*-*	*23-03-2023*	*-*	*23-03-2023*
		-	*08-04-2023*	*-*	*08-04-2023*
EDH-2	*1054.00*	*-*	*15-05-2023*	*-*	*15-05-2023*
EDH-3	*1053.00*	*28m. (EL 1025.00m)*	*19-03-2024*	*-*	*06-04-2024*
		30m. (EL 1023.00m)	*07-05-2024*	*-*	*14-05-2024*
EDH-3A	*1053.00*	*29m. (EL 1024.00m)*	*14-05-2024*	*-*	*24-05-2024*
EDH-3B	*1053.00*	*29m. (EL 1024.00m)*	*23-05-2024*	*-*	*08-06-2024*
EDH-4	*1047.00*	*12m. (EL 1035.00m)*	*16-03-2024*	*-*	*16-03-2024*
		14m. (EL 1033.00m)	*26-03-2024*	*-*	*26-03-2024*
EDH-4B	*1047.00*	*10.5m. (EL 1036.50m)*	*04-04-2024*	*-*	*04-04-2024*
		15m. (EL 1032.00m)	*11-04-2024*	*-*	*11-04-2024*
EDH-5	*1050.00*	*20m. (EL 1030.00m)*	*19-03-2024*	*-*	*09-04-2024*
		26m. (EL 1024.00m)	*14-05-2024*	*-*	*24-05-2024*
		30m. (EL 1020.00m)	*14-05-2024*	*-*	*05 -06-2024*
2T	*1053.00*	*20m. (EL 1033.00m)*	*08-11-2024*	*-*	*08-11-2024*
		26m. (EL 1027.00m)	*14-11-2024*	*-*	*14-11-2024*
		32m. (EL 1021.00m)	*18-11-2024*	*-*	*18-11-2024*
7T	*1050.00*	*17m. (EL 1033.00m)*	*21-11-2024*	*-*	*21 -11-2024*
		23m. (EL 1027.00m)	*24-11-2024*	*-*	*24-11-2024*
		29m. (EL 1021.00m)	*27-11-2024*	*-*	*27-11-2024*
1S	*1053.00*	*21m. (EL 1032.00m)*	*07-10-2024*	*-*	*07-10-2024*
		26m. (EL 1027.00m)	*12-10-2024*	*-*	*12-10-2024*
		32m. (EL 1021.00m)	*20-10-2024*	*-*	*20-10-2024*
5S	*1053.00*	*18m. (EL 1032.00m)*	*23-10-2024*	*-*	*23-10-2024*
		24m. (EL 1026.00m)	*28-10-2024*	*-*	*28-10-2024*
		30m. (EL 1020.00m)	*04-11-2024*	*-*	*04-11-2024*
EDH 4T	*1053.00*	*16m. (EL 1037.00m)*	*31-12-2024*	*-*	*31-12-2024*
		20m. (EL 1033.00m)	*05-01-2025*	*-*	*06-01-2025*
		25m. (EL 1028.00m)	*12-01-2025*	*-*	*13-01-2025*
		30m. (EL 1023.00m)	*19-01-2025*	*-*	*19-01-2025*
EDH 6T	*1052.00*	*15m. (EL 1037.00m)*	*06-01-2025*	*-*	*06-01-2025*
		20m. (EL 1032.00m)	*13-01-2025*	*-*	*13-01-2025*
		25m. (EL 1027.00m)	*19-01-2025*	*-*	*20-01-2025*
		30m. (EL 1022.00m)	*28-01-2025*	*-*	*28-01-2025*
EDH 3S	*1053.00*	*15m. (EL 1038.00m)*	*28-01-2025*	*-*	*28-01-2025*
		20m. (EL 1033.00m)	*07-02-2025*	*-*	*07-02-2025*
		25m. (EL 1028.00m)	*13-02-2025*	*-*	*13-02-2025*
		30m. (EL 1023.00m)	*19-02-2025*	*-*	*19-02-2025*

"

(d) In view of the complexity of the problem, the Petitioner has constituted various expert committees between 2021 & till now and has held frequent meetings with the expert committees in this context.

(4) With regard to implementation schedule, the Petitioner has provided an implementation schedule in its DPR for the proposed works anticipating to initiate the work of 'Inspection of the Head Race Tunnel of MB-II project by ROV (Remotely Operated Vehicle) in water filled condition at Chinyalisaur' in the month of December, 2025 to February, 2026 and had proposed to initiate execution of the work of 'Strengthening of strata and ground improvement works including channelization of leakage water flowing out from HRT of MB-II HEP at Gamri Gad' from October, 2025 onwards. In this context, the Commission had enquired regarding the project execution schedule vide its letter dated 13.10.2025. In response to query at Sl. No. 20, the Petitioner submitted a Bar Chart depicting initiation of strengthening of strata and ground improvement works after Inspection of the Head Race Tunnel of MB-II project by ROV i.e. from January, 2026 onwards and proposed to complete the works by June, 2027.

(5) With regard to the usage of Remote Operated Vehicle (ROV) for identification of the leakage areas in the HRT, the Commission has observed that the work of underwater inspection of the Head Race Tunnel (HRT) has been awarded to M/s IROV Tech, Kerala for diagnostic inspection of approximately 3.0 km stretch of the HRT in water-filled condition. Further, it is observed that ROV is equipped with HD camera, sonar imaging system and dye-injection modules to detect cracks, voids, liner distortion and seepage points. In context to the usage of in-situ repair by the ROV, the Petitioner in its submission dated 07.11.2025 has submitted that: -

"*At present, the selected indigenous ROV does not include in-situ repair, welding or maintenance capability. However, it is acknowledged that advanced ROV systems with limited underwater maintenance features such as micro-welding, epoxy sealing or patch repairs are available internationally. The feasibility of utilizing such advanced ROVs can only be evaluated after observing the actual tunnel conditions during the upcoming inspection. Their success depends entirely on internal accessibility, turbidity and visibility parameters within the HRT. Moreover, these maintenance-capable ROVs are foreign based, high-cost, specialized systems,*

requiring customized design, mobilization/custom clearance and highly skilled operation.

…

Considering the high expenditure involved, it was decided to explore indigenous ROV agencies capable of undertaking such works. Accordingly, at the current stage, the awarded work has been limited to inspection and diagnostic assessment only, which will serve as the technical basis for evaluating the need and feasibility of any future underwater maintenance activities."

(6) Further, the Petitioner has submitted that the ROV inspection has been scheduled during the lean flow period when turbidity is minimum ensuring clearer visibility and safer underwater operations. The ROV would perform underwater sonar mapping at every 1-meter interval, enabling a detailed 3D visualization of the tunnel profile and identifying any deformations, cracks, cavities, or lining defects. Along with sonar, high-resolution video recording would assist in visual inspection of vulnerable and fractured zones.

For the areas showing fine cracks or suspected seepage, a dye test shall be conducted through the ROV to confirm leakage pathways and assess the severity. These combined findings would help in accurate localization of distress zones, minimizing uncertainty in sub-surface conditions.

The outcome of ROV survey would serve as a technical baseline for advance planning, enabling preparation of location-specific designs, material requirements and execution methodologies for internal works to be undertaken after dewatering of the tunnel, if required any time in future.

The ROV findings shall provide critical insight into the internal structural condition of the HRT, enabling a realistic assessment of how long the tunnel can be safely operated under the present conditions before major rehabilitation is required from inside the tunnel after dewatering.

Post inspection of the 03 km. stretch of HRT upstream of the surge shaft upto the Srinagar thrust line by the ROV, the chainage of location in the HRT as identified shall be treated as proposed in the instant Petition. Further, the findings of ROV shall be submitted to high level committee and the treatment work would be executed as per their recommendations.

(7) With regard to the strengthening of strata and ground improvement works including channelization of leakage water flowing out from HRT of MB-II HEP at Gamri Gad, the Commission has observed that:-

(a) The Petitioner has envisaged triangulated grouting with cement and PU material for stabilization and leakage control around the Head Race Tunnel (HRT). In this method, in step 1 'Channelization of Leakage Water', the Petitioner has envisaged channelization of leakage water by drilling 06 Nos. 5-6 inches dia mtr. holes and installing MS pipes near saturated location (near EDH-4) which would be approx. 3-7 mtrs. above the HRT crown. The aforesaid holes function as dedicated escape paths for pressurized water, thereby reducing internal water pressure and avoiding further erosion or displacement of fine soil particles. The channelization of leakage water would also reduce the tendency of leakage water to shift in upward direction of hill slope.

(b) In step 2 'Execution of Grouting', the execution of grouting shall be done in which total 16 Nos. cement grout holes and 06 Nos. Polyurethane (PU) grout holes with 1.25 mtr. spacing center to center shall be drilled and grouted in order to fill voids, seal cracks and consolidate the surroundings loose strata in the vicinity of the leakage zone. The aforesaid cement and PU grout holes would be done in a triangular pattern as per the advice of the experts. The cement-based grouting of each hole shall be executed in 22 stages from EL 1021 to 1043 mtr. with each stage having a depth of 01 mtr. in order to ensure adequate sealing and strengthening of the strata. The PU based grouting of each hole shall be executed in 10 stages from elevation 1021 to 1031 mtr. with 01 mtr. depth per stage in order to fill voids and cracks for ensuring watertight sealing and improving rock mass integrity. The grouting sequence shall be executed in primary-secondary-tertiary grouting sequence to ensure uniform distribution and effective sealing.

(c) In step 3 'Stabilization of over burden' over the period of the time the drying of the surrounding area due to water channelization shall enable more effective grouting and would aid in stabilization of the overburden layers improving long-term slope and tunnel safety. The Petitioner has constituted an expert committee for providing recommendations for leakage treatment works in the HRT.

(d) In step 4 'Testing and validation of grouting effectiveness' would be assessed by conducting a series of field tests namely water pressure testing (lugeon test), grout intake monitoring, drill logging and water observation and acoustic monitoring (optional) and resistivity testing (optional).

(8) The Commission has observed that in response to the specific query w.r.t. Cost Benefit Analysis, the Petitioner in its submission dated 07.11.2025 has submitted that "*… Although the likelihood of tunnel failure under current conditions is low, the consequences, if it occurs, would be extremely severe in both time and cost terms.* ***If the overburden strata are not adequately strengthened or the weak zones are not properly supported, there remains a significant risk of localized instability that could lead to complete closure of the HRT. In such an event, the restoration and rehabilitation process may take more than one year to complete, resulting in prolonged shutdown of the generating units and substantial revenue loss***.

Therefore, the consideration of an average generation loss equivalent to six months due to dewatering of the tunnel for rehabilitation works in the Cost Benefit Analysis (CBA) has been taken as a conservative yet realistic assumption. This estimation reasonably accounts for the potential downtime necessary to execute critical stabilization and structural reinforcement measures. Further, considering the present power demand scenario of the State, complete closure of the project for such an extended period may not be feasible, and it is also unlikely to obtain the approval from concerned authority for dewatering and suspension of generation for such a long duration.

Though the CBA was done assuming the above mentioned scenario, however, the proposed work is essential for ensuring safety and maintaining integrity of water conductor system of the project and avoiding any sudden failure/ collapse or damages

*of the HRT. Thus, the proposed treatment is both technically critical and economically justified, delivering a high return through improved safety, risk reduction, and sustained operational efficiency." [**Emphasis added**]*

(9) Further, with regard to cost benefit analysis, the Commission has observed that the Petitioner has computed the benefit to cost ratio as 4.08 for the proposed works in the instant Petition by considering a total potential revenue loss of Rs. 50.12 Crore by considering that if rehabilitation work of HRT are carried out by dewatering the tunnel in planned way during the lean season to ensure cost effectiveness, it would take 06 months (November to April) to complete the works. Thus, the average potential revenue loss for 06 months, based on the last 06 years average six months lean discharge period of corresponding 06 months, has been computed as Rs. 50.12 Crore. The Commission has observed that the Petitioner has computed the cost benefit analysis by considering that if in an eventuality the HRT collapses then the rehabilitation work for the HRT would take approximately 06 months, thus, no direct tangible profit & loss are envisaged from execution/non-execution of the proposed works. However, the nature of the works are critical to be addressed for ensuring the safety of the underground water conducting system i.e. Head Race Tunnel of MB-II HEP which if unattended, may result in catastrophic losses to the Petitioner as MB-II is the largest HEP with 304 MW installed capacity. The potential threat to the HRT of MB-II HEP due to leakage from Gamri Gad area where the topsoil cover is in the range of 20-22 meters and is also close to the active Srinagar thrust zone, which is vulnerable from the point of seismic activity in the region. Further, the Commission has observed that the Petitioner has anticipated an average leakage discharge of 0.7% of design discharge, which once translated in terms of revenue would result in a loss of approx. 1.9 Crore on an annual basis considering AFC of Rs. 272.34 Crore for FY 2025-26.

(10) From the submissions of the Petitioner, it is observed that post execution of the proposed works, the leakage from HRT in the Gamri Gad area may or may not stop completely but the proposed works would result in soil stabilization via grouting and improve safety of water conducting system.

Further, the Commission has observed that the leakage from the HRT if not attended can potentially result in increased average leakage discharge from the said area and would have long lasting financial implications for the Petitioner, besides threatening the safety of the Head Race Tunnel and may jeopardize the stable generation from MB-II HEP which is crucial for the State Generation Sector.

(11) With regard to the cement and PU grouting, the Petitioner in its submission dated 07.11.2025 has submitted that:-

"…the cement grouting will be carried out at controlled pressure (typically 3–5 bar) to fill macro-joints, cavities and loosened rock interfaces. The grout mix will use superplasticizers and anti-washout agents to maintain suspension in residual seepage. Subsequently, hydrophobic PU grout will be injected to seal micro-fissures and residual leakage paths. PU polymerizes rapidly (in few seconds) on contact with water, forming a dense, elastic and impermeable resin matrix that resists further water ingress.

This dual-material system ensures both structural consolidation and hydraulic sealing even under partial water flow. The procedure has proven effective in similar hydro projects such as Parbati-II, Teesta-V and Koldam HEP, where grouting was executed under active seepage…"

Further, it is observed that post execution of the aforesaid works, the Petitioner envisages to control the erosion & void expansion in the leakage area of Gamri Gad, improved grouting effectiveness leading to durable reinforcement of weak zone, stabilization of critical zone with the help of triangulated grouting pattern, mitigation of seismic risk due to strengthening of strata and reduction in leakage discharge.

In this regard, it has been observed that the methodology of triangulated pattern of cement & PU grouting proposed by the Petitioner in the instant Petition has also been implemented in similar hydro projects in India under similar conditions and therefore, the Commission is of the view that proposal of the Petitioner of conducting cement & PU grouting after channelizing the leakage water from the Gamri Gad area appears to be a prudent approach. The Commission expects that the proposed works if executed meticulously under guidance of the expert committee would not only help in

strengthening the weak strata in the seismically vulnerable zone and provide strength to the HRT but also may help in reducing the generation loss due to leakage at Gamri Gad area.

(12) The Commission finds it proper to consider the instant proposal as approved by the BoD amounting to Rs. 12.27 Crore for the proposed works.

9. Based on the above discussions and considering the safety aspects associated with the leakage of water at Gamri Gad from the pressurized HRT segment between chainage 13.750 km. and 13.813 km. of MB-II HEP, the Commission grants *post-facto* approval for the works proposed in the DPR amounting to **Rs. 2.65 Cr.** for '**Inspection of the Head Race Tunnel of MB-II project by ROV (Remotely Operated Vehicle)'** and in-principle approval for the works proposed in the DPR amounting to **Rs. 9.62 Cr.** for '**Strengthening of strata and ground improvement works including channelization of leakage water flowing out from HRT of MB-II HEP at Gamri Gad'** as approved by the BoD in its 126th BoD meeting dated **11.06.2025** subject to the following:-

(1) The Petitioner should ensure execution of the works at most economical prices from the bidders.

(2) The Petitioner shall ensure that all the works carried out by the contractors shall be duly executed as per the procedures laid down for ensuring the quality & quantity of the work and drawings approved by the competent authority.

(3) The Petitioner shall ensure that the work carried out by the contractors are executed as per the guidance & supervision of the expert consultants ensuring risk mitigation associated with safety of the head race tunnel of MB-II HEP. Further, the Petitioner shall ensure to include appropriate clauses in its contract to indemnify the petitioner against losses arising due to contractor's defaults, neglect or negligence in executing the work or not adhering to guidance or supervision.

(4) The Petitioner is directed to incorporate adequate defect liability provisions in its contract so that the concerned contractors may be bound to execute their works within time and with quality & efficiency.

(5) The Petitioner is directed to make all efforts for complying with the recommendations and suggestions provided in the reports of the expert Consultants committee and take regular feedback/views on the proposed works from the said committee. A provision to the effect be kept in the contract to be executed with contractor, so that contractor is equally bound to apply and comply with aforesaid recommendations and suggestions.

(6) The Commission may verify/check the proposed works to be executed by the Petitioner at any point in time during/post execution of the works from the perspective of Quality, Optimum utilization of resources, Benefits accrued from the proposed investments etc.

(7) The Petitioner shall ensure to maintain photographic/videographic evidence at each stage of the proposed works and submit the same to the Commission along with the Completion Report of the Project including the completed cost of each of the works with as-built drawings along with expenditure incurred and financing of the Project.

(8) The Petitioner must submit the detailed sanctioned letter from the Financial Institution, if any, to the Commission as soon as they get approval for the same. All the loan conditions that may be laid down by the funding agency, if any, in their detailed sanction letter should be strictly complied with. However, the Petitioner is directed to explore the possibility of swapping the loan with grant/cheaper debt option, if any, available from DRIP/MoP/GoU.

(9) The Petitioner shall, within one month of the Order, submit a 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 said works.

(10) The cost of the proposed work and servicing on the same shall be allowed in the Annual Fixed Cost of the Petitioner after the assets are capitalized and subject to prudence check of the cost incurred.

10. 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, 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.

(Prabhat Kishor Dimri)	**(Anurag Sharma)**	**(M. L. Prasad)**
Member (Technical)	**Member (Law)**	**Chairman**