

**Challenges/Experienced & Lessons Learnt**  
***(Regulatory/Finance/RLA/ DPR/Scope/  
Bidding/Execution/Performance/Tariff)***  
**with RMU & LE Works – A Case**  
**Study**

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# Introduction

- Renovation & Modernization, Uprating and Life Extension (RMU&LE) of hydro plants is a cost effective way to extend the generation from the plant to the extended period of 20-25 years with improved reliability and availability.
- R&M programme can be expected to yield benefits in about 3-4 years as against construction of a new hydro plant of 7-8 years.
- Estimated cost per MW against R&M for Life Extension is much less than the new hydro projects of similar capacity.



# Experiences of NHPC – *A Case Study*

## R&M for Life Extension

| S. No. | Power Station             | Date of Commercial Operation | Completion of Useful Life | R&M proposed to be carried out during |
|--------|---------------------------|------------------------------|---------------------------|---------------------------------------|
| 1.     | BAIRA SIUL<br>(3 x 60 MW) | April,<br>1982               | March,<br>2017            | 2017-2021                             |
| 2.     | LOKTAK<br>(3 x 35 MW)     | June,<br>1983                | May,<br>2018              | 2018-2022                             |



# Baira Siul : Under Execution

- Major generating plant equipment incl. Generator, Turbine and Generator Transformers were manufactured / supplied during the year 1975-76
- Units were commissioned during 1980-81.
- Design Energy: 779 MU. *(In last 34 years of commercial operation, the power station has not achieved design energy in 25 years. Average generation during the last 10 years is 695 MU).*
- 30 years data of observed discharge in river at dam site (From 1984-85 to 2013-14) has been used for carrying out power potential and optimization studies. ***Considering the load factor, incremental kWh/ kW and utilization of water for purely energy generation purposes, the optimum installed capacity of the power station has been retained as 180 MW*** for which the project was originally designed mainly due to comparative reduction in inflows as well as negligible incremental benefits even beyond 150 MW.

# Studies Undertaken

- **Power potential and optimization studies:** 30 years data of observed discharge in river at dam site (From 1984-85 to 2013-14). **Revised DE: 708.59 MU**
- **Head loss in water conductor system:** Central Water and Power Research Station (CWPRS) in 2014 conducted measurements. **The actual head loss measured was 41.11 m** against original 32.57 m. The present **rated head is calculated as 238.1 m** against original rated head of 259 m.
- **Non-destructive Tests (NDT)** comprising of **rebound hammer test, ultra sonic pulse velocity test & cover meter tests and semi destructive tests** comprising of coring at pre-defined locations on certain concrete structures of the power station. The tests were conducted by Deptt. Of Civil Engineering, IIT Roorkee during Aug-2014 and were found to be satisfactory in respect of the civil structures of the power station.

# Scope: Major works proposed

## Bhaledh Complex:

- **Existing:** Maximum discharge from Bhaledh system reaches up to approx. 16 cumecs only as against the **design discharge of 19.82 cumecs.**
- **Proposal:** To trap available discharge in nallah, one additional Trench Weir is being proposed for providing total 24 cumec discharges in BFT.
- For augmenting the Bhaledh Feeder Tunnel capacity, it has been worked out that by lowering the finished invert level in tunnel by 0.85 m, the discharge carrying capacity of BFT can be **enhanced up to 24 cumecs.**

# Bhaledh Complex:



BHALEDH WEIR  
INTAKE



BHALEDH FEEDER TUNNEL OUTLET AT DAM



## Baira Dam Complex:

- **Existing:** Diversion Tunnel Service Gate got jammed very frequently due to silt. (Jammed gate has been raised with difficulty with the use pulling by ropes with the help of dozers etc. in addition to the available hoist capacity).
- **Proposal:** the gate is proposed to be equipped with a rope drum hoist of 160T capacity along with suitable hoist supporting structure instead of presently provided 65T capacity rope drum hoist. Related civil structure to be checked / strengthened for the revised hoist loads and weights





# Baira Dam Complex:



**RADIAL GATES**

**INTAKE**



## Power House Complex:

All Electro-mechanical equipment of power station are proposed to be replaced (except some components like MIV/BFV, Spiral casing, etc which are to be refurbished) :

| S. No.                                      | Existing  | Proposed under R&M   |
|---|---|--|
| <b>1. GENERATOR &amp; EXCITATION SYSTEM</b> |   |  |
| 1.1   | Generator 11 KV , 66.7 MVA, 97.6 efficiency <b>Class B insulation</b> | <b>Replacement</b> with Generator 11 KV , <b>74 MVA, Efficiency &gt; 98%, Class F insulation</b> , better CRGO and addition of brake dust collection, On line PD & Air Gap measurement |
| 1.2   | Static Excitation System  | <b>Retained</b> but compatibility of existing system with SCADA to be done in RMU  |

| S. No.   | Existing   | Proposed under R&M  |
|--|--|---|
| <b>2. TURBINE &amp; ACCESSORIES</b>                  |  |   |
| 2.1  | Turbine with wt. average <b>efficiency 91.3 %</b> with HVOF. | <b>Replacement</b> with Turbine with weighted average <b>efficiency &gt;93 %</b> with HVOF coating  |
| 2.2  | Draft Tube Liner, Stay Ring, Spiral Casing                   | <b>Refurbishment</b> only (as embedded parts)   |
| 2.3  | Lower Ring, Top Cover, Guide Apparatus, etc.                 | <b>Replacement</b>  |
| <b>3. MIV &amp; Butter Fly Valve and accessories</b> |  |   |
| 3.1  | MIV and BFV  | <b>Refurbishment</b> only   |
| 3.2  | Operating Mechanism & accessories                            | <b>Replacement</b> with new system like <b>N2 accumulator system, self lubrication bearings</b> , Main distributing valve, Sensor and instrument compatible to SCADA. |

| S. No.  | Existing   | Proposed under R&M   |
|---|--|--|
| <b>4. GSU TRANSFORMERS</b>                    |  |  |
| 4.1   | 25 MVA , 11/220 KV,<br>Single phase Generator<br>Step up Transformer   | <b>Replacement</b> due to ageing, increased losses                                     |
| <b>5. CONTROL MONITORING &amp; PROTECTION</b> |  |  |
| 5.1   | Control and Monitoring system:- <b>Manual</b>                          | <b>New Addition of SCADA.</b>  |
| 5.2   | CT & PT with accuracy <b>class 1</b>                                   | <b>Replacement with accuracy class 0.2 s.</b>  |
| 5.3   | Protection System :- <b>mix of electro magnetic and Static relays.</b> | <b>Replacement with numerical relays</b> that includes Protection of auxiliary system. |
| <b>6. Power Cables</b>                        |  |  |
| 6.1   | 11 KV, 415 V Paper insulated Cable                                     | <b>Replacement with XLPE cable.</b>  |

| S. No.             | Existing   | Proposed under R&M  |
|--------------------|--|---|
| <b>7. GOVERNOR</b> |  |   |
| 7.1                | Electronic Hydraulic Governor (Old & obsolete)                         | <b>Replacement</b> with <b>Digital Governor compatible with SCADA.</b>                              |
| <b>8. OTHERS</b>   |  |   |
| 8.1                | <b>Cooling Water system</b> Open loop type                             | <b>Replacement</b> with new Pumps including motor and addition of <b>closed loop cooling system</b> |
| 8.2                | <b>HVAC system</b> (out of order).                                     | <b>Replacement</b>  |
| 8.3                | Protection System :- <b>mix of electro magnetic and Static relays.</b> | <b>Replacement</b> with <b>numerical relays</b> that includes Protection of auxiliary system.       |
| 8.4                | Two nos. <b>415 V, 500 KVA DG sets</b>                                 | <b>Replacement</b> with <b>two nos. 11 KV, 1000 KVA DG sets</b>                                     |



POWER HOUSE

TURBINE FLOOR



# Cost Benefit Analysis

- Estimated cost **Rs. 341.41 Crore** at October 2014 PL including Rs. 68.35 Crores on Interest During Construction (IDC).
- Major benefit of the R&M is the life extension of the project.
- **The cost / MW for the proposed R&M works is about Rs. 2.0 Crs.** as against cost / MW of about Rs.10.0 Crs. for new hydroelectric power plant of similar size.
- Post R&M, **the levelised tariff is likely to be Rs. 4.09 / KWH.** Levelised tariff for new project of similar size, considering present day cost of the project @ 10 Crs. per MW, works out to Rs. 6.37 / KWH

# Regulatory Approval

- As per Regulatory provisions, R&M Proposal for Life Extension of Baira Siul Power Station was submitted to CERC for approval.
- CERC asked CEA for vetting of the Proposal. Civil /HM works was vetted by CWC.
- Since CEA considered the R&M proposal as full fledged DPR, its vetting involved detailed deliberations, justifications and extensive correspondence.
- It took nearly **13 months** for vetting of proposal by CEA. However, the process now established shall help in reduction in vetting time for subsequent proposals.



# Regulatory Approval

**CERC (vide its order dated 03.06.2016) accorded in-principle approval to the R&M proposal for **life extension of the Baira Siul PS by 25 years w.e.f 01.04.2021.****

Some major points highlighted by the CERC are as under:

- **One Independent Agency shall have to be engaged by NHPC during execution of the R&M which shall be vetting completion capital expenditure on R&M of the project..**

# Regulatory Approval.....contd.

- **During the period of unit shut down/station shut down for the purpose of carrying out R&M activities, following two separate records shall be maintained and submit the same to the Commission along with the tariff petition for approval of capital cost after R&M of the generating station.**
  - IEDC including man power cost, construction power cost, water charges etc. **booked to R&M activities;**
  - **Normal O&M expenses** of the generating station (not booked to R&M expenditure) which are not avoidable even when the unit/s/station is under shut down.
- **Part recovery of AFC i.e. O&M expenses and interest on loan shall be applicable during the period of unit/station shut down shall be governed as per the provision under Regulation 30 (2) of the 2014 Tariff Regulations.**

# Regulatory Approval.....contd.

## Capital Cost Post R&M:

- R&M expenditure plus original project cost reduced by accumulated depreciation recovered by the plant, shall form the basis of capital cost for the purpose of tariff post R&M.

Explanation: accumulated depreciation by the end of useful life may be almost 90% of the original capital cost. However, the same may not be 90% of the admitted capital cost (which also includes ACE post cut-off date) as the assets capitalized during the end of the useful life of generating station cannot be depreciated fully (90%) as per 2014 Tariff Regulations during the remaining period of useful life of the generating station

# Schedule of Completion/Execution

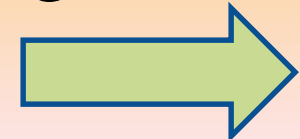
- Considering the Engineering & manufacturing cycle, the erection work at site is proposed to commence in 2018-19 coinciding with lean discharge season, and likely to be completed during the Year 2020-21.
- The unit wise dismantling / installation has been proposed keeping other two units remaining in operation, except for **six months** for which **complete shutdown** of the power house is required for undertaking the work of common auxiliary systems of power house as well as other works related to water conductor system and HM works.
- The above schedule warrants Meticulous planning and extensive scheduling to achieve running of other two units during R&M activities of one Unit.

# R&M of Loktak: Under Proposal

- Major generating plant equipment incl. Generator, Turbine and Generator Transformers were manufactured / supplied during the year 1974-77
- Units were commissioned during Apr-May 1983.
- Design Energy: 448 MU
- Power Station shall be **completing its useful life in June 2018**
- *Based on hydrological data (1991-92 to 2013-14) and restriction in discharge of HRT, **up-rating of capacity of power plant is not envisaged.***

# Cost Benefit Analysis

- Estimated cost **Rs. 260.47 Crore** at June 2015 PL including Rs. 42.26 Crores on Interest During Construction (IDC).
- Major benefit of the R&M is the life extension of the project.
- Annual energy of **562.73 MU** against the approved existing design energy of 448 MU.
- **The cost / MW for the proposed R&M works is about Rs. 2.0 Crs.** as against cost / MW of about Rs.10.0 Crs. for new hydroelectric power plant of similar size.
- Post R&M, **the levelised tariff is likely to be Rs. 4.59 / KWH.** Levelised tariff for new project of similar size, considering present day cost of the project @ 10 Crs. per MW, works out to Rs. 6.37 / KWH





**THANK YOU**