

NATIONAL WORKSHOP ON

Renovation, Modernization, Uprating & Life Extension of Hydro Power Plants Diverse Issues & Handling Strategies

16.12.2016 at SCOPE COMPLEX, NEW DELHI

WORKSHOP REPORT



CENTRAL ELECTRICITY AUTHORITY
Hydro Engineering and Renovation & Modernisation Division
New Delhi

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Report on the Workshop on Renovation, Modernisation, Uprating & Life Extension (RMU&LE) of Hydro Power Plants-Diverse Issues & Handling Strategies held on 16.12.2016 at SCOPE Complex, New Delhi

Background

Renovation, Modernisation, Uprating & Life Extension of old hydro power plants has been accorded high priority by Govt. of India as it is considered a faster and cheaper option of capacity addition in comparison to installing new units and for improvement in its operational reliability & efficiency. Keeping the spirit, CEA endeavors to identify new schemes for RMU&LE in addition to constantly monitoring the progress of hydro R&M schemes for expeditious execution and keep interacting with utilities from time to time. During the course of interaction, we are apprised about the problems being faced by the utilities in addition to sharing of valuable experience, which needs to be disseminated to stakeholders.

In order to highlight the diverse issues connected with RMU&LE of hydro power plants, right from essentialities in DPR, RLA studies, technical, financing, commercial and regulatory issues, Central Electricity Authority organized a one-day Workshop on “Renovation, Modernization, Uprating & Life Extension of Hydro Power Plant- Diverse Issues & Handling Strategies” on 16thDecember, 2016 at SCOPE Complex, New Delhi. Participation in workshop was by invitation and there was no delegate fee and SJVN Ltd. provided all the logistics for the workshop. More than 175 senior level experts from more than 40 organisations involved in R&M works from Central & States, PSUs, CERC, SERCs, E&M equipment manufacturers participated in the Workshop. A publication on RMU&LE of hydro power plant containing 33 technical articles was also released in the Workshop. The publication is appended herewith this report.

Inaugural Session (0915 – 1030Hrs)

The schedule and proceedings of the Workshop is enclosed as Annex-1. The whole Workshop was anchored by Rakesh Kumar, Director(HE&RM), CEA.

The Inaugural Session was chaired by Shri. S.D. Dubey, Chairperson, CEA with other distinguished dignitaries present on the occasion including, Shri K.K. Arya, Member (Hydro), CEA, Shri K.M. Singh, CMD, NHPC, Shri R.N. Mishra, CMD, SJVN and Dr. Arun Kumar, Professor, IIT Roorkee and Sanjay Srivastava, Chief Engineer (HE&RM). The distinguished dignitaries inaugurated the Workshop by lighting the lamp.

Shri Sanjay Srivastava, Chief Engineer(HE&RM), Organizer of this Workshop delivered the Welcome Address by giving background of the Workshop and emphasized the importance of consultation process among stakeholders on diverse issues connected with the RMU&LE. He indicated the gaps in RLA studies and DPR preparation, which not only results in inaccuracies in

estimation of scope of works but also delays the regulatory concurrence process. He further added that every effort should be made to prepare high quality bankable DPR, which would serve as a benchmark reference till completion of RMU&LE works. He informed that almost all the stakeholders connected with R&M works from across the country are present here and this workshop would strive through the day to reach implementable outcomes, helping the hydro sector in short as well as long run. He also thanked SJVN Ltd. for providing the logistics for this workshop.

Prof. Arun Kumar, Professor, IIT Roorkee gave the key note address on the occasion. He indicated that the pace of R&M Works of hydro plants in the country is extremely slow and there is a need to incorporate technological advancements in the area. He also mentioned that R&M Works may not be necessarily taken up after finishing 35 years as is the trend but should be taken up as and when it is required. He further said that there is no need for complete R&M of power plant in one go but piecemeal approach may be adopted in accordance with the changing technological scenario so that plants are not degraded up to the dumping level when the whole machine needs to be changed. He further told about sequence of RLA study. Utilities provide no specific benchmarks for investments and that is why lot of time is taken in the clearance process by electricity regulatory commissions. The PPT of his address is enclosed as Annex-I.

Shri R.N. Mishra, CMD, SJVNL addressed the gathering and went through the state of affairs of hydro sector. He expressed concern towards declining capacity addition of Hydro power and mentioned that in view of apathy towards hydro projects, there is concern of migration of professionals to other fields and at the same time, competent new recruits do not prefer to join Hydro Sector, and all this would further hurt this sector in long run. He mentioned that in view of new hydropower projects getting costlier year-by-year, RMU of projects is more relevant and leads to better efficiency at a much lower cost. He also discussed about retrofitting of 400 KV GIS and HVOF coating of underwater parts of machines against silting in Nathpa Jhakri HEP. He emphasized the necessity of R&M to be reviewed for the plant every 5 to 10 years of its operational life rather than at the age of 35 years.

Shri K.K. Arya, Member (Hydro), CEA addressed the gathering by giving the background of Workshop. He indicated that the share of hydro had been continuously declining and presently, it was around 14% of total installed capacity of the country and PLF was about 32%. He mentioned that while R&M is a necessary remedy for the Upgrading and Life Extension of the plant, cost of R&M works should also be looked into and stress should be there to keep the cost optimum. He further mentioned that as the RLA agency is not allowed to participate in bidding process, so very few players remain who are willing to conduct these studies and as such, this aspect should be thoroughly discussed during the workshop. He emphasized on formulation of an Action Plan for accomplishment of R&M works in best possible manner.

Shri K.M. Singh, CMD, NHPC addressed the gathering and reiterated the importance of hydro not only as a means of power generation but also as water security to country. As NHPC is operating lot of power plants and some of them completing the designed life, they are best

aware of the importance of R&M. He pointed out that R&M Works are of utmost importance in fast changing technological scenario, however, there is no proper policy/ guidelines existing for R&M Works due to which utilities are not getting convinced to carry out these activities at times. As such, the discussions on diverse issues associated with the R&M is the need of hour and such discussions would surely give a boost to hydro power sector. He further pointed out that the silt is a major problem for machines in Himalayan region which in turn cause damage to underwater parts, thus reducing life and efficiency of plant and all these make R&M a necessity to any hydro power plant.

Chief Guest Shri S.D. Dubey, Chairperson, CEA welcomed the participants coming from various parts of the country for this workshop. In his address, he expressed his concern about continuously decreasing share of hydro in overall installed capacity. He mentioned that Hydro has slipped to third position in terms of sector-wise installed capacity i.e. after thermal & renewable. He emphasized on need of water management to prevent or moderate floods and augment the irrigation requirements. Also, hydropower saves a lot of coal and helps in reducing carbon emissions as compared the thermal power. Hydro Plant is a consistent power generator in comparison with solar and wind.

Release of Publication on R&M: HE&RM Division of CEA had compiled technical papers on R&M containing views of stakeholders across the country on diverse issues connected with the topic. The publication contains 33 technical papers and Appendix on status of R&M since VIII Plan onwards. The book was also released by Chief Guest Shri S.D. Dubey, Chairperson, CEA and he appreciated the efforts of HE&RM Division in bringing out the publication, which shall be very helpful to the power utilities planning for R&M works in their plants.

At the end, the vote of thanks was delivered by Shri Rakesh Kumar, Director(HE&RM), CEA and the session concluded for tea.

Rapporteurs for the Inaugural Session:

1. Sh. K.K. Neema, Deputy Director, CEA
2. Sh. Amit Roy Singal, Assistant Director, CEA

Technical Session-I (1045 – 1330 hrs)

Chairman: Shri K.K. Arya, Member (Hydro), CEA

Co-chairman: Shri R.K. Bansal, Director(Elect.), SJVN

Rapporteurs: 1. Sh. Sandeep Malik, Deputy Director, CEA

2. Sh. Deepak Choudhary, Assistant Director, CEA

1. Studies preceding R&M Works & Essentialities in Detailed Project Report: Key to successful Start of Works- Shri Sanjay Srivastava, Chief Engineer (HE&RM), Central Electricity Authority

The presentations mainly emphasized on the systematic studies to be made before start of RMU&LE works so that the work could proceed in planned and systematic manner. The studies would inflict confidence to regulatory and approving authorities on the soundness of proposal. The presenter indicated essentialities of DPR and its format. He discussed in detail about pre-requisites for clearance of R&M work proposals from CEA. He mentioned that generally, utilities do not give due importance to DPR, which not only results in complexities during bid stage but also results in delays. He explained that although the initial cost and gestation period of hydropower is large but the same gets compensated in view of its very long life. With proper R&M, plant's life can be repeatedly extended every 30-35 years, as the life of civil structure is at least 100 years. He also emphasized on water availability and power optimization study to be carried out.

Recommendation(s):

- Preparation of bankable DPR.
- Scope of Work to be clearly spelt in DPR.
- Transparency in bidding for competition.
- Timely tie-up with funding agencies.
- Good project management.

(Complete presentation is enclosed as Annex-II)

2. Best Practices in Bidding Process, Broad parameters to Aim and Performance Guarantees from Renovated Plants – Shri Ratish Kumar, Director (Projects), NHPC

The presentations emphasized the need based RLA study in place of complete RLA and it should be carried out depending on the extent of RMU and replacement. He stressed that RLA may not be required for parts needing uprating as these parts are required to be replaced and if TG is replaced, shaft should also be replaced. Also, RLA for small components like motors and pumps is not necessary. As per global experience, approx. 5 to 10 % capacity addition can be achieved by simply encroaching upon overload margins, safety factors, if the

same was not already used due to actual site & layout conditions. Capacity addition up to 10 to 20% is achievable by changing the F-class insulation of the stator and by changing the Hydraulic profile of the runner. Capacity addition up to 15 - 30% is achievable by changing the complete unit and retaining only embedded parts.

He also discussed about CERC Regulation 2014, which allows tariff revision on RMU&LE works. He emphasized on segregation of work with respect to layout, time schedule and penalization for not achieving guaranteed output and efficiency.

Recommendation(s):

- Specification aspects for Bidding need to be framed based upon detailed O&M feedback and details of RLA studies.
- Equipments identified for refurbishment should have clear limits in scope of work.
- Bid document shall clearly indicate the terms & condition in respect of following:
 - Shut down & handing over
 - Taking over
 - Payment and other terms
 - Performance guarantee test
 - Rectification period in the event of deficient performance
 - Liquidated damages and limitation of liabilities
 - Warranty obligation arising out of change of laws, regulation, etc.

(Complete presentation may be viewed at Annexure-III)

3. Policy and Regulatory Obligations in R&M proposals – An overview of Issues – Shri S.C. Srivastava, Chief(Engineering), Central Electricity Regulatory Commission (CERC)

The presentations emphasized on policy and regulatory obligation in R&M proposals. He talked about the timely recovery of cost of electricity in reasonable manner and balancing the interests of utility/ generating agency on one hand and beneficiaries on the other. Developer doing R&M works should keep in mind the interest of beneficiary from cost point of view as higher R&M cost may make difficult to sell power on account of higher tariff. He indicated that in surplus power scenario, the thermal plants are ready to provide power at very cheap rates at short notice and this aspect also needs to be taken care of. He indicated that regulatory view on R&M is supportive and explained the case study of Bairasiul Hydro Power Plant.

Recommendation(s):

- The DPR of R&M case must consider technical, financial and commercial aspects.
- Implementing agency should look into cost-benefit, consumer benefits and other intangible benefits while planning R&M of hydro plants.

(Complete presentation may be viewed at Annexure-IV)

4. Financing Options, Managing Cost and Tariff to make R&M Works Commercially Viable - Shri B.C.K. Mishra, Director(Operations), UJVNL

The presenter informed that UJVNL Ltd. realized that capacity and generation enhancement through RMU of old power stations is an effective, environment friendly and riskless proposition. Economy in cost and time in RMU shall essentially result from utilization of the existing infrastructure, selective replacement of critical components and RMU will lead to increase in efficiency, peak power and energy availability apart from giving a new lease of life to the power plant/ equipment. The reliability of a power plant shall improve by use of modern equipment. He told about various phases covering various projects viz. Pathri, Mohammadpur, etc. He also mentioned that UJVNL shall enhance generation by more than 800 MU which will be equivalent to installing a new plant of about 160 MW capacity. He said that not much of expertise is available in the Indian market for Scope determination of RMU Project and also discussed about usefulness of reverse engineering in R&M. He told about various financing options for RMU&LE like NABARD, PFC, REC, etc. and measures to control cost and making a viable tariff for renovated plant.

Recommendation(s):

- Any manufacturer who is engaged in RLA&LE studies should not be debarred from participation in Tender process for project execution since there is dearth of good agencies for conducting RLA studies.
- Way out for Cost as it is always an issue which is calculated in general based on thumb rule (1.5-2.5Crore/MW), without considering the scope and size of the units.
- Making available the whole plant for dismantling and scope assessment
- Resolution of Issues related to copy right of the original manufacturer;
- Since no major implementation risk is attached to the R&M project, financing is not a concern for the owner.

(Complete presentation may be viewed at Annexure - V)

5. Commercial Aspects in R&M - Shri S.K. Agarwal, Executive Director (Commercial), NHPC

The presenter discussed about Need for Renovation & Modernisation, Advantages of R&M of old Power Stations, Govt. policies on R&M, Regulatory Provisions & Commercial aspects, Overview of R&M of Bairasiul Power Station, Issues requiring clarification / amendments in tariff regulations, Clarity in Regulation 15(4), O&M Expenses during Post R&M period, Recovery of AFC during execution of R&M works and Treatment of residual value in R&M cost base. He also mentioned that RLA study should be carried out on regular basis in an interval of 10 years instead of 35 years to know that whether machines are healthy to serve for 35 years or not. He discussed about differences in view of issues raised by NHPC with CERC with respect to fixation of tariff in Bairasiul Power Station. Further, he added that Admitted Cost needs to be added to the cost of project while calculating its asset value. He emphasized that there must be a recovery mechanism of AFC during R&M works.

Recommendation(s):

- Necessary clarifications are required to be incorporated in the CERC regulations where ROE on residual value (10% equity of the owner) plus 30% of R&M cost may be allowed. Existing regulation is silent on treatment of residual value in total post R&M cost of the project.
- Methodology followed by CERC in case of old power stations i.e. fixation of O&M expenses on the basis of previous years' actual data with applicable annual escalation may be followed in the post R&M period also to cover up the actual O&M expenses.
- In case one or more units are run during period of R&M by doing some adjustments, power so produced from old units may be sold separately for which separate guidelines may be given by CERC.

(Complete presentation may be viewed at Annexure-VI)

6. Life Enhancement of E&M equipment through Improved O&M Techniques - An experience of SJVN - Shri S.P. Pathak, General Manager, SJVNL

The presentation was made in two parts i.e. in first part, experiences of SJVN with HVOF hard coatings of underwater turbine parts at NJPS and RHPS were discussed and in second part, discussion was made on SJVN experience on Life Extension measures for E&M equipment. Based on SJVN experience, life enhancement of E&M equipment through improvised Operation and Maintenance (O&M) techniques were suggested. He also presented a case study about retrofitting of 400 KV GIS and HVOF coatings of underwater turbine parts of machines against silting in Nathpa Jhakri HEP.

Recommendation(s):

- Need to develop most optimal suitable combination of HVOF and soft coating for enhancing the life of underwater components.
- Modernisation should be continuous process and can also be part of the Renovation programme.

(Complete presentation may be viewed at Annexure-VII)

Technical Session-II (1415 – 1615 hrs)

Chairman: *Shri D.V. Singh, CMD, THDC*

Co-chairman: *Shri K.P. Singh, Chairman, UERC*

Rapporteurs: *1. Sh. R. K. Jayaswal, Deputy Director, CEA*

2. Sh. Rakesh Kumar, Assistant Director, CEA

1. CFD analysis, Laboratory Test Rigs for Estimation of Erosion Wear and Performance Testing as Per IEC Before and After the RM&U - Especially Thermodynamic Method – Dr. B.K.Gandhi, IIT Roorkee

The presentation put some light on energy efficiency measurement methods such as current meter method and thermodynamic measurement method. He also discussed importance issues that needs to be addressed by engineering community such as pre and post efficiency methods, true evaluation of hydro power potential, CFD analysis for optimizing the design, etc.

Recommendation(s):

- Modernisation can be performed simultaneously with Renovation to improve the reliability of hydro power station.
- Uprating also possible where hydro power potential is not fully exploited. So focus should not be limited only to R&M of E&M works.

(Complete presentation may be viewed at Annexure-VIII)

2. Importance and Process of RLA Studies in Ascertaining need for R&M – A Case Study – Dr. M. Venkateswara Rao, Joint Director, CPRI

The presenter started with what is RLA and its importance, and process of RLA study in Civil structures, E&M and HM equipment, Instrumentation and Switchyard equipment. He stressed that RLA should necessarily be done for major components and studies may be completed in 30 days during the lean generation period. He presented 3 case studies i.e a RLA study of Gumti(3x5MW) HEP, 2nd case study on penstock of 8MW plant and also a case study on 126MW hydro generator shaft.

He concluded that no quantitative assessment of life in terms of years is possible with the data generated, however, it helps in assessing the present state and condition of the plant equipment which in turn enables the asset managers to identify the R&M needs and it also enables to forecast the budget in the DPR for R&M needs.

Recommendation(s):

- Diagnostic tests need to be conducted periodically (every 2/3/4 years) to monitor the trend in the parameters of HEP. Data logged over the years and the trend analysis provide useful information to initiate appropriate remedial measures to extend the life of equipment.
- Practices of regular visual inspection of penstocks, clearing of vegetation, painting whenever needed, etc. are to be continuously followed. The practice of coating of the riveted joints should be continued periodically.

(Complete presentation may be viewed at Annexure-IX)

3. Challenges Experienced & lessons learnt with RMU&LE Works – A Case Study by Shri M.Shivamallu, Chief Engineer (Elect. Design) and Shri N.V. Raghuram, S.E.(Elect.), KPCL

The presentation discussed R&M of KPCL and it was informed that in KPCL, there are 21 hydro projects with oldest plant being 116 years old. Case study of NHP was made in great detail. The presenter made following conclusions

- After opening of the unit, reverse engineering will take considerable time which will affect the schedule of erection and commissioning.
- OEM will have the advantage of having the initial designs and hence has the advantages with respect to manufacturing and delivery of new components.
- NON-OEM manufacture may have a different solution for solving the problems. It may be difficult to benchmark the prices especially with respect to refurbishment works and with two differing technologies. These aspects have to be factored while executing the works to adhere to planned schedule.
- We have taken up preparation of DPR for R&M works of turbine of Unit-1,2 & 3 in association with IIT Roorkee.
- DPR prepared and submitted to Hon'ble KERC.

(Complete presentation may be viewed at Annexure-X)

4. DVC Experience with RMU&LE Works – A Case Study by Md. Eyasin, Chief Engineer

The presentation discussed R&M of Maithon hydro project where uprating of generator was taken up by upgrading its insulation to class F. He also showed concerns for Panchet HEP where in spite of best efforts from CEA and DVC, M/s NHPC did not undertake part-II of consultancy work which hampered tendering work for R&M. He also mentioned that benefits available to wind and solar power should be replicated to hydro R&M and the cumbersome process of clearance of R&M should be simplified and there should be some tariff benefits from regulator side too.

Recommendation(s):

- Formation of standard norms and procedure for R&M which can be referred during implementation of R&M scheme.
- Lack of standardization in arbitration clauses and procedure.
- Guidelines on specific cost standard per MW for undertaking RMU.
- Benefits for solar such as Renewable Purchase Obligation (RPO), Sales Tax exemption, concessional custom duty exemption, 100 % excise duty exemption should be passed to hydro R&M expenditure too.
- Creation of Nation Hydro Fund (NHF) for R&M or special hydro power financing schemes through soft loan like Power Systems Development Fund (PSDF).

(Complete presentation may be viewed at Annexure-XI)

5. Challenges Experienced & lessons learnt with RMU&LE Works – A Case Study by Shri Janardan Choudhary, Executive Director(O&M), NHPC

The presentation discussed about NHPC experiences on R&M studies for Life Extension of Bairasiul hydro power plant. He touched all the technicalities of Electro-Mechanical equipment that are proposed to be replaced after the outcome of the studies. He also showed reservations with CEA for taking 13 months to approve the R&M of the project. However, it was clarified by CEA officers that many a times delay occur due to insufficient data in submitted DPR.

Recommendation(s):

- Swift approval of R&M proposal by CEA and CERC.

(Complete presentation may be viewed at Annexure-XII)

6. Challenges Experienced & lessons learnt (Regulatory/ Finance/ RLA/ DPR/ Scope/ Bidding/ Execution/ Performance/ Tariff) with RMU&LE Works – A Case Study by KSEB

The presentation indicated that KSEB has 12 stations having installed capacity more than 25 MW, 20 stations with capacity less than 25 MW, 2 Thermal stations and one wind farm with total installed capacity being 2211.735 MW. The backbone of the Kerala grid is the 780 MW Idukki HEP (Underground station 6x130MW). The major power stations in Kerala were commissioned during the period from 1940s to 1980s. Since most of the HEPs under KSEB are due to complete their normal useful life of 35 years, the RMU&LE of these plants is needed and justified as it is a faster and cost effective option to bridge the demand supply.

Recommendation(s):

- Better coordination among all the stakeholders like contractor, supervisory department staff, project engineering wing and local authorities is mandatory for the success of the project.

- Safety should be of the utmost priority.
- Project time schedule is critical and shall be adhered by implementing modern time management practices.
- The Tender conditions are to be carefully framed for ensuring the participation of reputed firms in Bidding. Tendering process should be transparent.

(Complete presentation may be viewed at Annexure-XIII)

Technical Session-III (1630 - 1800 Hrs)

Chairman: *Shri R.N. Mishra, CMD, SJVN*

Co-chairman: *Shri B.K. Agarwal, Ex Member (Hydro), CEA*

Rapporteurs: *1. Sh. V.S.R. Raju, Deputy Director, CEA*

2. Sh. P.K. Sangwan, Assistant Director, CEA

1. Challenges Experienced & lessons learnt with RMU&LE Works in BBMB – A Case Study by Ms. Abha Saini, Chief Engineer, BBMB

The presenter gave background of BBMB and informed that they have an installed capacity of 2918.73 MW as on 30.11.2016 from 28 Units. Hydroelectric project development can be broadly classified as: Green field Project- Setting up of new hydro project and Brown field Project- Reaping enhanced life and benefits from old projects. The broad strategies adopted by BBMB was **Step-1:** Initial Upgradation Plan: Optimization of design margins, **Step-2:** Upgradation of Generators by utilizing Turbine margins, **Step-3:** Upgradation of both Turbine, Generator and associated equipment. She presented case study of RMU&LE of Bhakra Left Bank Power Station and explained about the problems faced during R&M like metallurgical issue (silicon content), lower bracket and upper bracket, cavitation guarantee check, etc. She stressed on importance of contract management and complete RLA study preceding R&M works.

Recommendation(s):

- Equipment to be replaced should be designed suitable to present operating head regime to get the uprated output and better efficiency.
- RLA study is must for better planning and cost reduction before R&M is taken up.

(Complete presentation may be viewed at Annexure-XIV)

2. Experience of AHEC and RMU in Karnataka – Prof. S.K. Singal, IIT Roorkee

The presenter gave brief background of AHEC which was established in 1982 to impart education, training and carry out research in the area of power generation through the development of small hydro power. It is also working in the field of other renewable energy sources as well environmental management of water bodies and carried out RLA studies in Uttarakhand and Uttar Pradesh. AHEC carried out RMU study and prepared DPRs of more than 100 hydro projects of different capacities in Himachal Pradesh, Uttarakhand, Punjab, Jammu & Kashmir, Arunachal Pradesh, West Bengal, Bihar, Sikkim, Uttar Pradesh and Karnataka. AHEC also have testing and measurement facilities for carrying out RLA test and investigations. He explained various measurement devices and tests to be performed on Electro-Mechanical parts. He also emphasized upon importance of RLA study and DPR.

Recommendation(s):

- RLA study should not be skipped as it gives a clearer picture of the works to be undertaken.

(Complete presentation may be viewed at Annexure-XV)

3. R&M Works of Kopili HEP – A Case Study by NEEPCO- Shri M.S. Jyrwa, Executive Director (O&M), NEEPCO

He presented case study of R&M works carried out in Kopili HEP commissioned in 1984. Kopili faced a peculiar problem of acidic reservoir with a PH value of 2.82 to 3.5 due to which underwater parts were extensively damaged. As a solution to this, all underwater parts were replaced using stainless steel.

Recommendation(s):

- If somehow cost-effective technology on effective coating (s) can be developed indigenously by the domestic industry, then this can be beneficial to Hydro power sector.

(Complete presentation may be viewed at Annexure-XVI)

4. Fast tracking R&M Implementation: Manufacturer view on Technical Specifications, Bidding Process and Site Related Issues – Shri Saurabh Sharma, Deputy Manager, BHEL, Bhopal

He emphasized upon the usage of cutting edge technologies in R&M like CFD analysis and simulation, finite element analysis for erosion and cavitation studies. Scope of works need to be clearly defined and detailed history of unit along with petrographic and hydrological data and civil drawings should also be given.

Recommendation(s):

- Advanced numerical simulation techniques like CFD analysis offer potent solutions to the challenges associated with hydro power plant R&M. CFD has an added advantage in terms of cost as well as flexibility to simulate complex phenomenon.
- Number of years of operation should be clearly defined in the guidelines for hydro projects after which R&M to be made mandatory.
- To bring down the frequency of unplanned outages, replacement should be made mandatory for the machines that are above 35 years.

(Complete presentation may be viewed at Annexure-XVII)

Panel Discussion (1800 – 1915 Hrs)

Chairman: *Shri K.K. Arya, Member(Hydro), CEA*

Co-chairman: *Shri A.B. Pandya, Ex-Chairman, CWC*

Members:

1. *Shri Sanjay Srivastava, Chief Engineer(HE&RM), CEA*
2. *Shri P.C. Kureel, Chief Engineer(HE&TD), CEA*
3. *Dr. ArunKumar, Professor, AHEC, IIT Roorkee*
4. *Shri R.K. Bansal, Director (Electrical), SJVNL*
5. *Shri Narender Kumar, ED, BHEL*
6. *Shri Brijlal V, Chief Engineer (Generation), KSEB*
7. *Shri M. Shivamallu, Chief Engineer (Elect. Design), KPCL*

After the end of Technical Session-III, the panel discussion was held under the Chairmanship of Shri K.K. Arya, Member(Hydro), CEA. The panel discussions started with Shri K.K. Arya giving brief of day's proceeding and his views on the issues. Thereafter, Panel Members gave their views one-by-one and the floor was opened for discussions. The participants raised various questions to the panelists as well as other dignitaries sitting amongst participants. The outcomes of the panel discussions are summarized hereunder:

- i) There was a general consensus that RMU&LE of hydro plants is a thrust area and identification of plants requiring renovation need to be identified in advance as there are several essentialities to be fulfilled, which may take several years before actual execution of R&M Works.
- ii) RLA studies are largely being conducted in the process of identifying/ undertaking R&M works though there were divergent views on extent of RLA studies which depend on case-to-case basis. However, the panel was of view that RLA studies must be conducted as a mandatory technical requirement.
- iii) Among the utilities, there was a general view that there is a dearth of experienced contractors who could take up the job of RLA studies and bring out reliable scope for R&M works. Similarly, the need for experienced consultancy firms was also felt who could take up the work of DPR preparation, framing technical specifications and other related works till re-commissioning of plant.
- iv) The quality of equipment used and methodology adopted for RLA studies have a major role in data reliability. As such, the enabling sophisticated equipment needs to be employed by firms.
- v) In some of the presentations, delay on the part of regulators in approving the scheme was pointed out. On this, there was a view that often, the delay is on account of poor quality of DPR with inadequate data and justifications. As such, there was a consensus that utilities must ensure quality DPR, which not only helps in quicker approval but also helps in execution of works.

- vi) Modern technology in instrumentation & controls must be employed. Emphasis on online instrumentation was made for monitoring machine vibrations, silt in water and DGA of transformers. Numerical simulation techniques, which consist of High Performance Clusters (HPC) dedicated for CFD analysis and commercial CAD/ CFD/ CAE software, are effective tools for replacing traditional model test for hydro turbine R&M projects.
- vii) The power sector related rules, regulations and IS/IEC have undergone tremendous changes in last decade or so and the old hydro power plants in which now RMU&LE works are planned were constructed with old regulations existing then. Accordingly, the renovated plant must meet all the regulatory requirements, particularly with regard to FGMO/RGMO, synchronous condenser mode of operation and black-start facility. The technical specifications of the existing power plants undergoing RMU&LE need to be updated.
- viii) It was pointed out that RMU proposals are presently electrical and mechanical works centric and generally, ignore civil works and hydro mechanical works. However, Erosion and damages on the civil works specially the trash racks, diversion works, channels, tunnels, desilting chambers, surge shaft, penstock, TRT etc. also require a special attention in renovation proposals of the hydropower plants.
- ix) Barrage type run-of-river hydro projects should plan automatic trash cleaning machine for reducing the high head losses and power losses.
- x) It was suggested that civil structure quality should be reassessed as the generally considered life of 100 years of civil structures is not sacrosanct due to EPC nature of contract. Also, change in hydrology should be factored in during R&M. As such, hydropower potential should be reaffirmed before finalising the requirements and tender specifications.
- xi) Utilities may go for Performance Testing of the hydropower plants before and after the RMU&LE as per IEC-60041. Suitable methodology like thermodynamic method should be used for measuring the plant efficiency with minimum uncertainties. Third party testing should be encouraged.
- xii) Experts also pointed out that if substantial part of a system or assembly is changed then complete replacement should be considered to avoid possible accidents e.g. Sabarigiri incident where the shaft was not changed during R&M and later broke abruptly.
- xiii) KSEB suggested to provide incentives for taking up R&M works as there are lot of financial constraints faced by state power utilities.
- xiv) It was emphasized that in R&M schemes, Safety aspect should not be compromised and there is a need for disciplined and scientific approach to tackle the execution related safety aspects.
- xv) Research institutions may provide valuable inputs in order to measure the plant performance with minimum uncertainty, modification required in turbine design, protective coating materials study, and numerical study. The collaboration among power

utilities, research institutions and manufacturers must be encouraged to evolve innovative technologies in RMU&LE of hydro power plants.

- xvi) R&M specific skill development and technology driven regular training and brain-storming sessions should be regularly organized.
- xvii) The members mentioned that so far in various plan periods, R&M works have been done in large number of hydro projects also providing uprating benefits in addition to life extension. The problems encountered by the power utilities were of varying nature and the technical solution provided are of great learning for future. Further, as most of the old hydro projects are in state sector, various methodologies with respect to RLA studies, DPR preparation, bidding process, execution, etc. were tried and as observed in various presentations in the workshop, the utilities have rich experience in implementing RMU&LE works in a cost effective manner. As such, it was generally felt that the sharing of experience & learning on handling of challenges needs to be systematically documented. Some agency like CBIP may come forward to do further work and collect the case studies and correlate them to arrive at standardization and in turn prepare model documents.

RECOMMENDATIONS OF WORKSHOP

The workshop discussed broad range of issues relating to RMU&LE and number of case studies presented by the Utilities. Based on the proceedings of the Workshop, the following recommendations could be considered:

1. RMU&LE of hydro plants being a thrust area, the identification of plants requiring renovation need to be identified by power utilities on priority. To prioritize the work, an empowered committee for this specific purpose may also be constituted.
2. The power utilities need to engage reputed and experienced firms to undertake RLA studies as a part of commencement of R&M works. However, there is a shortage of experienced contractors who could take up the job of RLA studies and bring out reliable scope for R&M works. Similarly, experienced consultancy firms may also be encouraged to take up the work of RMU&LE and help utilities in DPR preparation, framing technical specifications and other related works till re-commissioning of plant.
3. The quality of equipment used and methodology adopted for RLA studies have a major role in data reliability. As such, the enabling sophisticated equipment needs to be employed by firms.
4. The manufacturers of E&M equipment need to assist power utilities in framing the scope and also should provide them with timely budgetary offers so as enable utilities to firm up the financial requirement in DPR.
5. The utilities should keep provision of installing modern online monitoring systems like machine vibrations, silt in water, DGA of transformers etc. for improving plant reliability.
6. The power sector related rules, regulations and IS/IEC have undergone tremendous changes and the old hydro power plants in which RMU&LE works are planned were constructed with old regulations existing then. As such, the RMU&LE specifications must comply CEA & other statutory regulations and other applicable standards.
7. RMU proposals must also give due attention to civil works in addition to E&M and hydro-mechanical works. Erosion and damages of the civil works specially the trash racks, diversion works, channels, tunnels, desilting chambers, surge shaft, penstock, TRT etc. also require special attention in renovation proposals of the hydropower plants.
8. Power utilities may go for Performance Testing of the hydropower plants before and after the RMU&LE as per IEC-60041.
9. In case substantial part of a system or assembly is changed then complete replacement should be considered.
10. The RMU&LE works need to be incentivized as lot of financial constraints are particularly being faced by state Power utilities.

11. In R&M schemes, proper Safety aspects need to be complied and there is a need for disciplined and scientific approach to tackle the execution and O&M related safety aspects.
12. Research institutions may provide valuable inputs in order to measure the plant performance with minimum uncertainty, modification required in turbine design, protective coating materials study, and numerical study. The collaboration among power utilities, research institutions and manufacturers must be encouraged to evolve innovative technologies in RMU&LE of hydro power plants.
13. R&M specific skill development and technology driven regular training must be arranged by power training institutes.
14. So far, R&M works have been done in large number of hydro power projects and the problems encountered by the utilities were of varying nature and the technical solutions provided are of great learning for future. As such, CBIP or any other appropriate institute may be asked to take up the work of compilation of the case studies and make a compendium for reference and record. Further, there is a need to co-relate the experiences and prepare model documents, which would immensely benefit the Power utilities.

National Workshop on

Renovation, Modernisation, Upgrading & Life Extension of Hydro Power Plants – Diverse Issues & Handling Strategies

16th December 2016, SCOPE Complex Auditorium, Lodhi Road, New Delhi—110 003

0830 – 0915 Hrs.	Registration will be free, based on Invitation from CEA	
0915 – 0920 Hrs.	Presentation of Bouquets and Lighting of Lamp	
0920 – 0925 Hrs.	Welcome Address	Shri Sanjay Srivastava, Chief Engineer (HE&RM), CEA
0925 – 0940 Hrs.	Key Note Address	Dr. Arun Kumar, Professor, AHEC, IIT Roorkee
0940 – 0950 Hrs.	Address	Shri R.N. Mishra, CMD, SJVN
0950 – 1000 Hrs	Address	Shri K.K. Arya, Member (Hydro), CEA
1000 – 1010 Hrs.	Address	Shri K.M. Singh, CMD, NHPC
1010 – 1025 Hrs.	Inaugural Address	Shri S.D. Dubey, Chairperson, CEA
1025 – 1027 Hrs.	Release of CEA Publication on R&M	
1027 – 1029 Hrs	Presentation of Memento	
1029 – 1030 Hrs.	Vote of Thanks	Shri Rakesh Kumar, Director(HE&RM), CEA
<p>Rapporteurs: 1. Sh. K.K. Neema, Deputy Director, CEA 2. Sh. Amit Roy Singal, Assistant Director, CEA</p>		

1030 – 1045 Hrs. High Tea

1045 – 1330 Hrs. **Technical Session - I**

Chairman: Shri K.K. Arya, Member (Hydro), CEA

Co-Chairman: Shri R.K. Bansal, Director (Elect.), SJVN

- Studies preceding R&M Works & Essentialities in Detailed Project Report: Key to successful Start of Works - **Shri Sanjay Srivastava, Chief Engineer(HE&RM), Central Electricity Authority**
- Best Practices in Bidding Process, Broad parameters to Aim and Performance Guarantees from Renovated Plants – **Shri Ratish Kumar, Director (Projects), NHPC**
- Policy and Regulatory Obligations in R&M proposals – An overview of Issues – **Shri S.C. Srivastava, Chief (Engineering), Central Electricity Regulatory Commission (CERC)**
- Financing Options, Managing Cost and Tariff to make R&M Works Commercially Viable - **Shri B.C.K. Mishra, Director(Operations), UJVNL**
- Commercial Aspects in R&M – **Shri S.K. Agrawal, Executive Director, NHPC**
- Life Enhancement of E&M equipment through Improvised O&M Techniques - **Shri S.P. Pathak, General Manager, SJVNL**

Rapporteurs: 1. Sh. Sandeep Malik, Deputy Director, CEA

2. Sh. Deepak Choudhary, Assistant Director, CEA

1330 – 1415 Hrs. Lunch

1415 – 1615 Hrs.

Technical Session – II

Chairman: *Shri D.V. Singh, CMD, THDC*

Co-Chairman: *Shri K.P. Singh, Chairman, UERC*

- CFD analysis, Laboratory test rigs for estimation of erosion wear and Performance testing as per IEC before and after the RM&U-Specially Thermodynamic Method – **Dr. B.K. Gandhi, IIT, Roorkee**
- Importance and Process of RLA Studies in Ascertaining need for R&M – A Case Study – **Dr. M. Venkateswara Rao, Joint Director, CPRI**
- Challenges Experienced & lessons learnt with RMU&LE Works – A Case Study by **Shri Chief Engineer (Elect.Design) and Sri. N.V. Raghuram, S.E(Elect.), KPCL**
- DVC Experience with RMU&LE Works – A Case Study by **Md. Eyasin, Chief Engineer**
- Challenges Experienced & lessons learnt with RMU&LE Works – A Case Study by **Shri Janardan Choudhary, Executive Director(O&M), NHPC**
- Challenges Experienced & lessons learnt (Regulatory/ Finance/ RLA/ DPR/ Scope/ Bidding/ Execution/ Performance/ Tariff) with RMU&LE Works – A Case Study by **Shri Brijlal V Chief Engineer(Generation) & Shri Suresh TR, Dy. Chief Engr., KSEB**

Rapporteurs: 1. *Sh. R.K. Jayaswal, Deputy Director, CEA*

2. *Sh. Rakesh Kumar, Assistant Director, CEA*

1615 – 1630 Hrs.

Tea

1630 – 1800 Hrs.

Technical Session - III

Chairman: *Shri R.N. Mishra, CMD, SJVN*

Co-Chairman: *Shri B.K. Agarwal, Ex Member (Hydro), CEA*

- Challenges Experienced & lessons learnt with RMU&LE Works in BBMB – A Case Study by **Ms. Abha Saini, Chief Engineer, BBMB**
- Experience of AHEC in carrying out RMU / RLA studies & RMU in Karnataka – **Prof. S.K. Singal, IIT, Roorkee**
- R&M Works in Kopili HEP – A Case Study by NEEPCO – **Shri M.S. Jyrwa, Executive Director (O&M), NEEPCO**
- Fast tracking R&M Implementation: Manufacturer view on Technical Specifications, Bidding Process and Site Related Issues – **Shri Saurabh Sharma, Dy. Manager, BHEL Bhopal**

1800 – 1915 Hrs.

Panel Discussion & Recommendations

Chairman: *Shri K.K. Arya, Member(Hydro), CEA*

Co-Chairman: *Shri A.B. Pandya, Ex-Chairman, CWC*

Panel Members: 1. *Shri Sanjay Srivastava, Chief Engineer(HE&RM), CEA*

2. *Shri P.C. Kureel, Chief Engineer(HE&TD), CEA*

3. *Dr. Arun Kumar, Professor, AHEC, IIT Roorkee*

4. *Shri R.K. Bansal, Director (Electrical), SJVNL*

5. *Shri Narender Kumar, ED, BHEL*

6. *Shri Brijlal, Chief Engineer (Generation), KSEB*

7. *Shri M. Shivamallu, Chief Engineer (Elect. Design), KPCL*

Rapporteurs: 1. *Sh. V.S.R. Raju, Deputy Director, CEA*

2. *Sh. P.K. Sangwan, Assistant Director, CEA*

ANNEXURES

(Please refer <http://cea.nic.in/herm.html>)