patikari power

AQUAGREEN

Engineering Management (P) Ltd.

2 X 8 MW Patikari Hydro Power Project
Annual Plant Performance Report
For the year 2017-2018

Contents

1. About the Project:

16 MW Patikari Project, implemented by Patikari Power Private Limited, is a run of the river hydro power project developed on Bakhli Khad, a tributary of Beas River and is located in Mandi district of Himachal Pradesh, India. Two (2) generating Units driven by horizontal shaft Pelton Turbines, each having a rated output of 8.0 MW (having 15% Continuous Machine Rating), are installed in the Power Station. The Design Energy of the Power Plant is 78.81 million KWh of electrical energy based on the 90% Dependable Discharge and rated output of 16 MW.

Besides appropriate Unit and Station Auxiliaries, state of the art Control and Monitoring System (SCADA) has been installed in the Power Station to ensure optimum generation there from. Power so generated is then being stepped up to 33kV through two (2) 11MVA Step-up Transformers and evacuated through one (1) double circuit 11km long 33kV Transmission Line terminating at the other end in 33kV Substation of HPSEB at Pandoh which is part of the HPSEB network. Patikari Power Private Limited have entered into a long term Power Purchase Agreement dated 5th July 2004 with HPSEB envisaging delivery of power from the Project at 33kV Substation of the Board at Pandoh in Mandi district of Himachal Pradesh.

Tariff for the electricity to be supplied by the Project to the Board at this Delivery Point is Rs. 2.25 per kWH (fixed). Both Units were commissioned in February 2008 and generated 641.75 Million Units till 31st March 2018.

Aquagreen Engineering Management Pvt. Ltd (AEMPL) has been appointed as the consultant for Patikari Power Project from December 2017.

2. Plant Performance

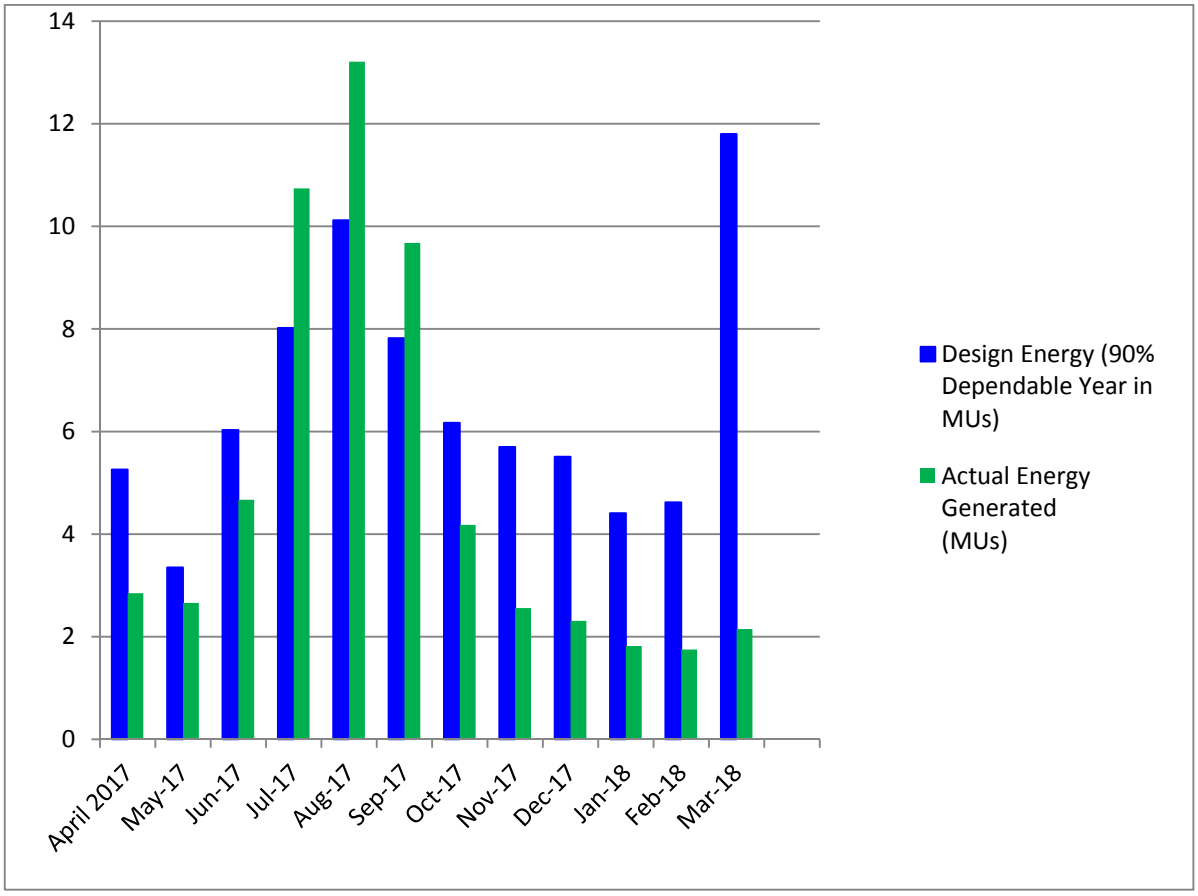
2.1 Data for monthly generation report, graph analysis, monthly tripping report and of 2017- 2018 are mentioned below:

Monthly Generation Data for the year 2017-2018

Month	Design Energy (90% Dependable Year in MUs)	Actual Energy Generated (MUs)	Actual Vs Design Energy %	Remarks
April 2017	5.26	2.85	54.14	Low discharge leading to less energy generation of 69.5% of design energy.
May 2017	3.35	2.66	79.34	
Jun 2017	6.03	4.67	77.48	
July 2017	8.02	10.74	133.93	Good discharge that leads to energy generation of 129.54% of design energy.
August 2017	10.12	13.21	130.51	
September 2017	7.82	9.68	123.74	
October 2017	6.17	4.18	67.70	Low discharge leading to energy generated 50.8% of design energy.
November 2017	5.7	2.56	44.92	
December 2017	5.51	2.31	41.9	
January 2018	4.41	1.82	41.2	Lean season leads to energy generated 26.3 % of design energy.
February 2018	4.62	1.75	37.8	
March 2018	11.8	2.15	18.2	
Total	78.81	58.58	74.33	

Graph Analysis of month wise generation for 2017-2018

The graph between the design energy Vs. actual energy generated of the Patikari Power Plant for the 2 X 8 MW for the year **2017-2018** is plotted below:



- The maximum generation was observed in August 2017, with total generation of 13.21 MU.

Tripping data from April 2017 to March 2018 of duration more than 20 minutes (As per ERA norms) is mentioned as:

Month wise Grid Failures of more than 20 minutes					
Sl. No.	**Date**	**Start**	**End**	**Total Duration**	**Remarks**
1	22-Apr-17	3:19	4:03	44 min	Grid failure from Bijani S/s.
2	22-Apr-17	4:05	4:30	25 min	Grid failure from Bijani S/s.
3	25-Apr-17	16:13	16:59	46 min	Grid failure from Bijani S/s.
4	25-Apr-17	18:03	18:26	23 min	Grid failure from Bijani S/s.
5	31-May-17	1:44	2:23	39 min	Grid failure from Bijani S/S.
6	6-Jun-17	23:40	0:22	42 min	Grid failure from Bijani S/S.
7	10-Jun-17	18:40	19:35	55 min	Grid failure from Bijani S/S, 132 kv supply fail.
8	10-Jun-17	19:37	20:26	49 min	Grid failure from Bijani S/S, 132 kv supply fail.
9	18-Aug-17	17:45	18:31	46 min	Grid failure from Bijani s/s due to 132KV supply fail from Kangoo S/S.

10	24-Aug-17	4:13	4:58	45 min	Grid failure from Bijani s/s due to 132KV supply fail from Kangoo S/S.
11	6-Sep-17	18:17	18:52	35 min	Grid failure from Bijani S/s.
12	11-Dec-17	10:02	10:30	28 min	Grid failure from Bijani S/S.
13	13-Dec-17	13:14	14:41	87 min	Grid failure from Bijani S/S.
14	Total	414 min			

Only the trips which are more than 20 minutes have been listed above and on 30th march and 31st march, Shutdown took place for External Fault rectification and Replacement of transmission line conductor between poles No. 66 & 67.

2.2 Month wise Generation since Commissioning

Month	Design Energy	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Apr	5.26	3.08	2.28	1.29	5.86	4.32	7.18	8.21	9.64	2.78	2.85
May	3.35	2.36	1.68	1.51	3.20	2.56	2.78	5.21	4.14	3.26	2.66
Jun	6.03	7.20	1.50	3.72	5.27	1.52	6.50	2.85	3.48	3.48	4.67
Jul	8.02	12.02	2.22	8.42	6.51	5.68	11.48	8.84	10.84	4.79	10.74
Aug	10.12	13.21	5.49	13.05	6.37	12.30	12.91	10.60	12.36	12.89	13.21
Sep	7.82	11.61	8.99	12.82	10.91	12.39	9.35	7.91	6.88	7.25	9.68
Oct	6.17	8.60	3.47	7.90	5.17	5.60	4.80	3.70	4.01	3.21	4.18
Nov	5.7	4.34	2.34	3.83	3.08	3.10	2.88	2.46	2.92	1.97	2.56
Dec	5.51	3.22	1.84	3.07	2.53	2.52	2.40	2.69	2.73	1.61	2.31
Jan	4.41	2.62	1.65	3.03	2.94	2.40	2.48	3.03	2.18	2.78	1.82
Feb	4.62	2.16	2.46	4.47	3.43	6.66	3.84	5.65	2.25	3.26	1.75
Mar	11.8	2.18	2.59	8.26	4.96	11.29	9.03	12.07	4.49	3.48	2.15
Total	78.81	72.6	36.51	71.37	60.23	70.34	75.63	73.22	65.92	50.76	58.58

Generation during the month of August 2017 was the highest recorded and generation during February 2018 was the lowest over 2017-2018.

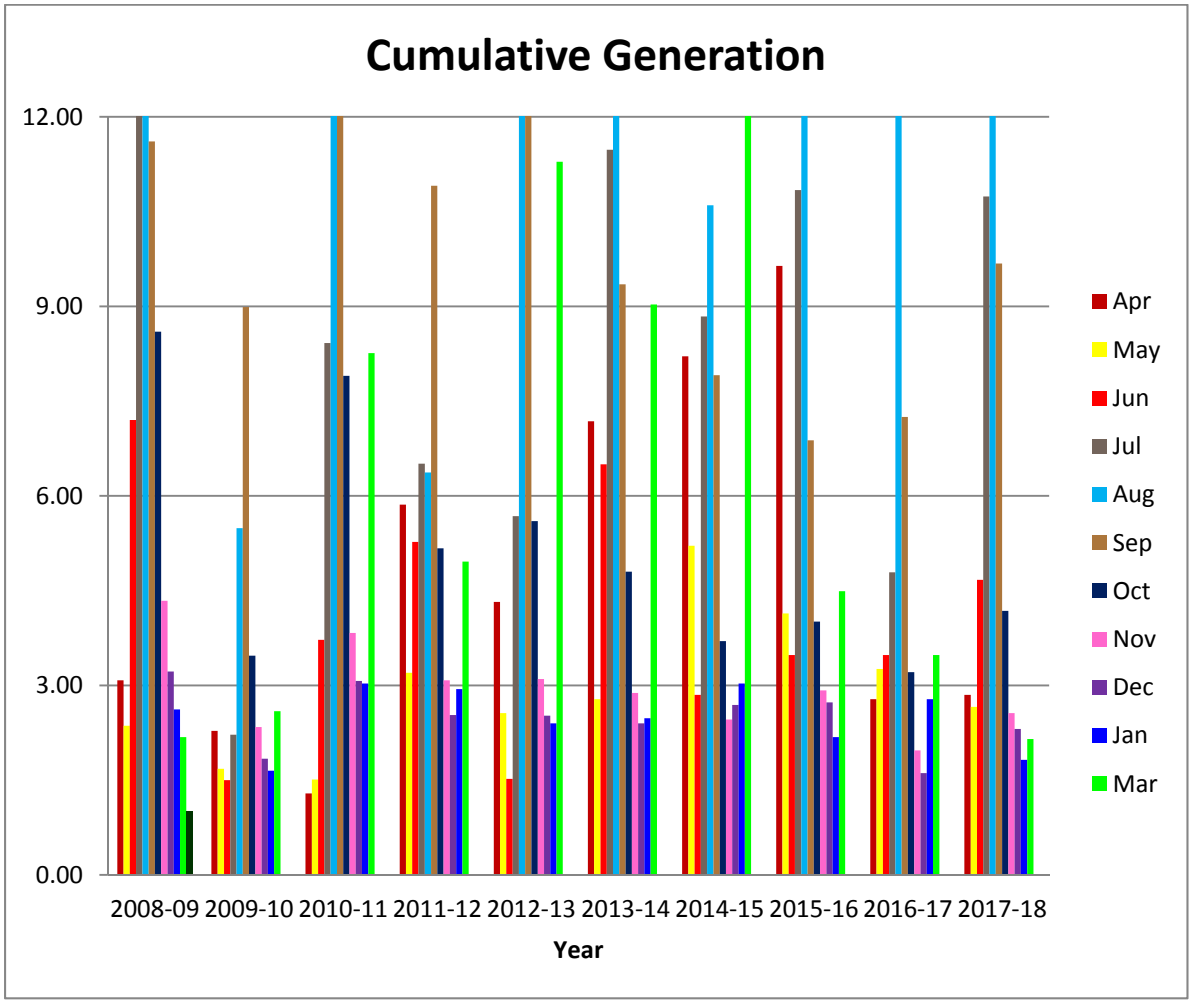
2.3 Quarterly Analysis for the Year 2017-2018:

Quarter Wise Performance of the Plant	Design Energy (MUs)	Actual Energy Generated (MUs)	Actual / Design Energy %
Quarter 1	14.64	10.18	69.5
Quarter 2	25.96	33.63	129.54
Quarter 3	17.38	9.05	50.8
Quarter 4	20.83	5.72	26.3
Total for the year 2017-2018	78.81	58.58	74.33

It can be observed from the table that generation during the 2nd Quarter was above the Design Energy and in the rest of the three quarters; it was less due to poor river discharges during their corresponding months.

2.4 Cumulative Generation at a Glance

The Year Wise Generation analysis of actual energy generated since commissioning is mentioned below:



2.5 Revenue Generation / Realization

The Patikari Project delivered **49.368** Units to electricity to HPSEB for the year ending March 2018 after accounting for 12% Free Power to the Home State. Against the energy supplied and billed till March 2018 amounting to MINR 112.89. HPSEB released payments amounting to MINR 105.32 for April 2017- January 2018.

Details about the monthly billings & receipts are tabulated here under:

Financial Year 2017-18				
Sl. No.	**Period**	**Total Saleable Energy (MWh)**	**Bill Raised (MINR)**	**Amount Received in MINR**
1	April 17	2.44	5.48	5.48
2	May 17	2.37	5.34	5.33
3	June 17	4.008	9.02	9.01
4	July 17	9.24	20.79	20.79
5	Aug 17	11.23	25.28	25.28
6	Sept 17	8.18	18.42	18.42
7	Oct 17	3.57	8.03	8.03
8	Nov 17	2.20	4.96	4.96
9	Dec 17	1.19	4.49	4.49
10	Jan 18	1.57	3.53	3.53
11	Feb 18	1.52	3.41	Pending
12	Mar 18	1.85	4.16	Pending
Total		49.368	112.89	105.32

3. Site Visit:

Site Visit by AEMPL Experts:

An inter-disciplinary team of experts from AEMPL visited the Patikari Power Project from 15th to 17th January 2018 and inspected the various components of the project along with the project officials. The list of experts from AEMPL and officials from PPPL is as under.

I. Patikari Power Private Limited (PPPL)

1. Shri. Shyamlal
2. Shri. Samanth Rai

II. Aquagreen Engineering Management Private Limited (AEMPL)

1. Shri. Naresh Kumar, Civil Design Expert
2. Shri. Yogendra Kumar, Electro-Mechanical Expert
3. Shri. Rajeev Thakur, Electro-Mechanical Expert

The team had close interaction with the project officials during the course of inspection.

Purpose of the Site Visit:

The purpose of the site visit by AEMPL experts, after the award of the O & M Consultancy assignment, was to inspect the various civil/Electro-Mechanical works of the project and to suggest measures, if any, for smooth operation of the project. Some of the civil/Electro-Mechanical works for which specific inspection/recommendations was requested from the project authorities comprised of the following.

Civil Works:

a. Inspection of the Headworks Complex comprising
   - The diversion structure,
   - Power Intake,
   - Desilting Chambers,

b. Augmentation of non-monsoon discharges by tapping of Aliu Nala and Bakora Nala into the water Conductor System – Inspection of the proposed sites,

c. Inspection of the Power House Complex.

Electro-Mechanical Works:

a. Inspection of Runner condition,
b. Inspection of Penstock Paint condition in the Power House u/s of the MIV,
c. To identify the reasons behind limitations in transmission line power carrying capacity and suggest a solution,
d. To verify the spare breaker requirement,
e. To check the adequacy of spare availability at site,
f. To review other O&M related issues.

Review of Civil Works:

a. Head Works:

The diversion structure built across Bakhli Khad comprises of a 28.32m long and about 5m height solid gravity ungated weir with crest level at EL.1402m. One gated under-sluice of size 1.8x1.2m with sill level at EL.1399.024m has been provided, in continuation of the ungated weir, towards the right bank to flush out the sediment load downstream into the river.

The head regulator/the power intake has been provided close to the under-sluice on the right bank of the khad to divert the design discharge into the water conductor system. The silt level of the trash rack structure has been provided at EL.1400.22m whereas the invert of the water conductor system at the head regulator/power intake has been provided at EL.1400.92.

To prevent entry of bed load materials into the water conductor system through the trash rack particularly during the monsoon seasons, option of providing wooden planks in the bottom portion of the trash rack needs to be studied. This will block the entry of bottom heavy sediment-laiden layer of water entering into the water conductor and only the top layers of water with comparatively less sediment concentration will enter the water conductor system.

b. Desilting Chambers:

Two surface desilting chambers have been provided on right bank of the river just downstream of the head regulator to remove 0.2mm and above

size of particles from the water entering the head race tunnel. The suspended silt load deposited at the bottom of the de-silting chambers is trapped and flushed out at 3 locations along the length of the chambers. During the site visit, only one chamber was under operation while the other chamber was closed. A lot of silt was seen to have deposited in the chamber which was not in operation.

During the inspection itself, flushing was carried out and it was ensured that all the three silt flushing pipes are clear and serviceable condition. Frequent flushing of these pipes is required to be done.

Steel Plates of Desilting Chamber

Approach Condition at the Inlet of Desilting Chamber

To prevent choking of the silt flushing system, the project authorities were advised to resort to drawdown flushing of the deposited materials in the chamber. This drawdown flushing by lowering the water level in the de-silting chamber should be carried out in one chamber at a time. For carrying out the flushing operation, the d/s gate of the chamber and silt flushing conduit/pipe gates should be closed and about 0.3 cumec discharge shall be released from the inlet gate.

After the water level in the chamber rises slightly above the deposited sediments/silt, one silt flushing conduit gate should be opened and flushing of sediments continued for some time. This process should be repeated by opening the other silt flushing gates also (but only one gate at a time).

After completing one cycle for each of the silt flushing gates, the exercise should be repeated 3 to 4 times. The project authorities were advised to first clean the 1st silt flushing pipe, which as reported by them has been choked, by a jet of water.

Silt Deposition in Desilting Chamber

During visit to the site, one such drawdown flushing operation was actually carried out in one chamber and it was seen that the deposited materials could be easily flushed out.

c. Tapping of Allu Nala and Bakora Nala for augmentation of power discharge:

As reported Moreover, at the proposed diversion site of both the nalas, water mills have already been constructed by the locals and it may be difficult to now tap this low lean period discharges from the proposed sites. In addition, construction/laying of surface steel pipe from the diversion works up to the Patikari water conductor system particularly at

Bakora Nala will be very difficult. The left bank hill slopes of the Bakora Nala along which the formation cut of earlier proposed road had already been cut is covered with loose muck/debris.

Any rolling boulders from above will damage the pipe laid on the left bank from the Bakora Nala weir site up to the water conductor system of the project. In view of above, it may not be advisable from techno-economic considerations to tap these nallas at the proposed locations for augmentation of project discharge during lean months. by the project authorities, the lean period discharge in the river is observed to be less than the corresponding 90% dependable year figures.

Accordingly, they plan to supplement the generation especially during lean discharge months by tapping other Nalas which join Bakhli Khad downstream of the weir site. Two such Nalas namely Aliu Nala and Bakora Nala have been identified by the project authorities for such tapping to augment the design discharge of the project during lean months.

Both the above sites were inspected by the AEMPL team during the visit. The lean period discharge in both the nalas was seen to be substantially low.

WATER MILL

Water Mill in the proposed Tapping Site

Left Bank Hill Slope at Bakora Nala

d. Power House Complex:

The Power House civil structures seem to be generally in order. To prevent rolling boulders from the upstream hill side hitting and damaging the power house upstream wall, steel chains have been provided just upstream of the power house. During inspection, it was seen that these steel chains are simply hanging from the top cable and are free at the bottom. The project authorities were advised to provide a cable through a bottom of these chains so that they prevent the falling boulders hitting the upstream wall of power house.

Steel Chains provided u/s of Power House

Review of Electro-Mechanical Works:

e. Unit#2 Runner Condition:

The runner chamber for unit#2 was opened and runner was inspected for any deterioration in surface thickness or hard coating erosion. However, after thorough inspection, the runner was found to be in order. Small patches of hard coating erosion at some locations were found; however, they were not significant.

Further, since the available spare runner, was repaired to rectify the crack at the root of the bucket, it was recommended to replace the Unit #2 runner with the spare (repaired) runner prior to high flow season and monitor the repaired crack during operation.

As a follow up measure, the Unit#2 runner was replaced with spare runner on 17th January 2018. DPT Tests were performed on February 2018 to check development of cracks on the joints. However, found in appropriate condition.

Runner Replacement

Dye Penetration Test

The Dye Penetration Test for the runner was performed on 15th February 2018 and checked that the buckets were in the appropriate condition. AEMPL team confirms that there is no need for further hard coating of any of the three runners for 2018-19.

f. Penstock Paint Condition:

The penstock was inspected for any erosion in surface painting. It was found that the external penstock (outside the power house building) painting was intact. However, inside the Power House, the painting has started to peel off and rusting has begun at some places. A suitable Anti Rust painting was recommended to be applied over penstock inside powerhouse which has been procured and applied over the penstock.

Rusting on Penstock/MIV during Site Visit

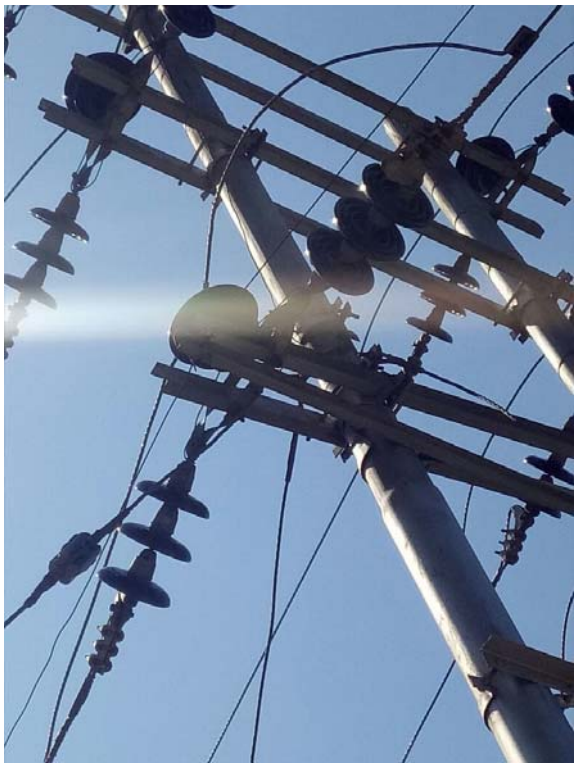
Penstock after Application Anti Rust Paint

g. 3kV Transmission Line Power Carry Capacity Issue:

The 33kV transmission line b/w. Patikari SHP and Pandoh sub-station of HPSEB is being maintained by Patikari SHP. However, there were incidences of line tripping (due to Phase to Earth fault) once the single circuit line carrying capacity increased beyond 12 MW. The issue was discussed at site and it was observed that the Earth wire conductor has been installed below the current carrying AAAC conductor.

In case of single circuit carrying more than 12 MW power, the sag in the main AAAC conduct, in the longer spans, increases which reduces Phase to earth clearance between AAAC conductor and the Earth wire, resulting in Phase to Earth Fault.

It was decided to increase the separation between Phase and Earth wire conductors in longer spans. The same was performed on 31th March 2018. The line is working in order since then. . We will review the situation during high flow period and conclude the suitability of this provision.



h. Spare Breaker Requirement:

Patikari Power has raised an issue about procurement of new 11kV and 33kV VCB to be retrofitted into the existing breaker panel. The issue has been reviewed and it was found that only breaker poles need replacement.

AEMPL has arranged offers for the Vacuum Interrupters for the 11kV and 33kV circuit breakers from the Originals Equipment suppliers as well other traders. Spare poles were procured and replaced by PPPL.

Bharat Electronics VCB

Crompton Greaves VCB

i. Checking the adequacy of Spare Availability at Site:

The availability of spares has been verified at site. Following spares need to be purchased and to be kept in store for O&M purpose;

- At least 4-no. Oil sampling Bottles to be purchased for sending transformer oil samples for DGA testing.
- 2-no. stainless Steel disc of Brake Jet valve need to be kept as spare.

j. SCADA Software Up gradation:

The version of SCADA software installed in the project has become obsolete. The OEM has not been able to provide support services for the same. Since the plant is not connected with the internet, there is no urgent requirement to upgrade the software. However, we'll need to replace/upgrade the software in near future. Offers have been received for software up gradation & matter is pending with board for approval.

k. Other O&M Issues:

- It was found that the 110V Lead Acid Batteries have started producing deposits in the bottom of the cell. It was recommended that a Residual Life Assessment (RLA) of the batteries to be performed.
- DGA of Generator Transformers needs to be carried out annually. DGA is planned during Annual Maintenance in May.
- Partial Discharge Monitoring of the Synchronous Generator should also be taken up during the proposed Annual Maintenance schedule. Offers for Partial Discharge monitoring are being obtained from the vendor.
- Some of the Outdoor LED flood lights are not working properly. LED procurement is being organized by PPPL.
- The cable grounding the Surge Arrestors were found be overheating. The same need to be replaced with 25 mm^2Aluminum cable.
- The 11kV cable connecting the Generator Transformer to the 11kV breaker overheats. A separate study needs to be carried for installation of Sheath Voltage Limiters at Transformer end.

4. Maintenance & Overhauling Works from September 2017 to March 2018:

- Replaced the Nozzle flushing Valve of Nozzle - 2 of Unit # 1 & Unit # 2 to prevent water leakage during September 2017.
- Replaced the deflector-2 sensor with new sensor during October 2017.
- Runner Bucket templates were prepared and bucket thickness measured for all 3-runners during December 2017.
- The Unit #2 runner was replaced with the repaired runner on 17th January 2018 and is in operation.
- The break jet pipe was repaired with the help of welding to correct the water leakage problem on 1st February 2018.
- Service of DG set was done on 2nd February 2018 as a regular maintenance activity.
- Inspection of Runner of Unit#2 was done on 15th February 2018 and performed the Dye Penetrate Test (DPT) on Runner Buckets and found that all buckets in appropriate condition.
- Water leakage from pipe of firefighting system for Transformer-2 and replaced the damaged pipe with new pipe of firefighting system for transformer-2 in switchyard. On 28th February 2018.
- The nozzle-2 seals were inspected and found damaged. So, they were replaced with new one at the same place on 23rd March 2018.

5. Preventive Maintenance

- **General:**
- To minimise the plant outages and consequent avoidable generation loss of the project, periodic preventive maintenance schedules for all equipment have been prepared & are being compiled with. These periodic maintenance schedules are listed below.
  - Daily Maintenance Schedule
  - Weekly Maintenance Schedule
  - Monthly maintenance schedule
  - Quarterly maintenance schedule
  - Half-yearly maintenance schedule
  - Yearly maintenance schedule
  - Apart from the above schedules, cleaning of the runner and its DPT was done.

6. Inventory Management

A sufficient stock of spares is being maintained in the Plant store in order to cater any preventive as well as other maintenance requirements in the Power Station. The consumption of Electrical, Mechanical & General material is being recorded and monitored on routine basis.

7. Safety Measures

Safety Manual has been issued to the Plant members & the Safety measures were compiled as per the manual. The safety charts had been displayed in the power house area. Mock drills related to Fire Protection / Flood Protection / any other natural calamity Protection are arranged on an annual basis in & around power house area to ensure preparedness for such exigencies.