

## **Chapter-IV**

# **Operation, repair and maintenance of Hydro Electric Projects**



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### POWER DEPARTMENT

#### Punjab State Power Corporation Limited

#### Operation, repair and maintenance of Hydro Electric Projects

There was shortfall in generation with respect to targets to the extent of 1,175.52 MUs equivalent to ₹ 764.09 crore at three hydroelectric plants. Transformation losses were above prescribed limit to the extent of 37.32 MUs. Delay in execution of various works resulted in avoidable generation loss of 64.69 MUs valuing ₹ 42.04 crore. Annual maintenance activities undertaken beyond lean period resulted into generation loss of 384.42 MUs equivalent to ₹ 249.88 crore.

#### 4.1 Introduction

In Punjab, the activity of generation and distribution of power has been entrusted to Punjab State Power Corporation Limited (Company). The total installed capacity (including share from all the sources viz. own Thermal & Hydro, Independent Power Producers (IPPs), share from Bhakhra Beas Management Board (BBMB), share from Central Sector, Punjab Energy Development Agency (PEDA) and new & renewable sources of energy (NRSE) Projects and other states), as on 31 March 2022 was 13,940.84 MW. Out of this, Company has its own available installed capacity of 2,775.25 MW (Thermal-1,760 MW and Hydro-1,015.25 MW<sup>1</sup>). The share of hydro power in total own installed capacity was 36.58 *per cent* and 7.28 *per cent* in overall installed capacity. As on 31 March 2022, the Company had five Hydro Electric Projects (HEPs) as detailed below:

1. Shanan Power House (SPH), Joginder Nagar (110 MW), commissioned in 1932 and uprated in 1982.
2. Ranjit Sagar Dam (RSD) Hydro Electric Project (600 MW<sup>2</sup>) commissioned in 2000.
3. Anandpur Sahib Hydel Project (ASHP) (134 MW) commissioned in 1985.
4. Mukerian Hydel Project (MHP), Stage-I (207 MW), commissioned during 1983 to 1989 and Stage-II (18 MW) commissioned during 2017 and 2018.

<sup>1</sup> 110 MW (SPH) + 452.4 (RSD) + 134 (ASHP) + 225 (MHP) + 91.35 (UBDC) +2.50 (Micro Hydel Projects)

<sup>2</sup> 20 *per cent* is shared with Jammu & Kashmir (to be supplied at generation cost) and 4.60 *per cent* with Himachal Pradesh (free of cost). Therefore, out of 600 MW, available capacity for PSPCL was 452.40 MW.

5. Upper Bari Doab Canal Power Houses (UBDC), Stage-I (45 MW) commissioned during 1971 to 1973 & Stage- II (46.35 MW) commissioned during 1989 to 1992.

#### **4.2 Organisation structure**

The operation & maintenance (O&M) of all the HEPs is being looked after by Chief Engineer/ hydel projects with Superintending Engineers (SEs)/ Executive Engineers (XEN) at Circle and plant level respectively.

#### **4.3 Audit objectives**

The objectives of audit were to assess whether:

- optimum generation as per targets fixed by CEA was being achieved;
- the guidelines issued by Central Electricity Authority (CEA) for operation and maintenance (O&M) of Hydro Electric Projects (HEPs) were being adhered to;
- the repair and maintenance of the hydro power houses were being planned and executed during lean period specific to the project so as to minimise generation loss as per CEA norms;
- trained manpower as per best practices/ guidance given by CEA in hydroelectric power generation was deployed in power houses.
- contracts relating to repair/maintenance/renovation and other works of projects were being executed efficiently and as per the terms of the contract; and
- envisaged benefits of the work for repair/overhauling/ renovation were achieved.

#### **4.4 Scope and methodology of audit**

The audit was conducted for the period 2019-22. To achieve the audit objectives, records relating to generation, annual scheduled maintenance, outages (planned and forced), purchase of equipments for power houses, execution of repair/capital works and deployment of manpower were examined.

#### **4.5 Audit Criteria**

The criteria adopted for achievement of audit objectives were derived from the following sources:

- Guidelines issued by CEA and norms fixed by Central Electricity Regulatory Commission (CERC);

- Generation targets fixed by CEA/ Company,
- Maintenance schedule framed by Company;
- Schedule completion period / contractual delivery period; and
- Best practices in operation & maintenance of Hydro Power Stations.

## 4.6 Audit Findings:

### 4.6.1 Generation

Central Electricity Authority (CEA) fixes the generation targets for HEPs having capacity of more than 25 MW. As such, generation targets did not include targets in respect of 91.35 MW UBDC (comprising of three powerhouses of 15 MW each and three powerhouses of 15.45 MW each) and 18 MW MHP-V. Accordingly, to match the targets, generation of 1,180.09 MU and 309.15 MU from UBDC and MHP-V respectively was excluded from the total generation. Against the targets set by CEA for HEPs having capacity of more than 25 MW, generation during the period 2019-22 was as below:

**Table 4.1: Targeted Generation *vis a vis* Actual Generation (in MU) in respect of HEPs having capacity of > 25 MW**

Name of HEP	2019-20			2020-21			2021-22		
	Target	Actual	Excess /Shortfall	Target	Actual	Excess /Shortfall	Target	Actual	Excess /Shortfall
SPH	485	564.99	79.99	485	503.07	18.07	502	521.91	19.91
RSD	1,560	2,099.18	539.18	1,560	1,518.94	(-)41.06	1,638	1,162.96	(-)475.04
ASHP	640	603.72	(-)36.28	640	565.99	(-)74.01	709	396.36	(-)312.64
MHP	1,080	1,098.37	18.37	1,120	1,282.31	162.31	1,120	883.51	(-)236.49
<b>Total</b>	<b>3,765</b>	<b>4,366.26</b>	<b>601.26</b>	<b>3,805</b>	<b>3,870.31</b>	<b>65.31</b>	<b>3,969</b>	<b>2,964.74</b>	<b>(-)1,004.26</b>

*Source: Information provided by the Company*

Against targets of 11,539 MU for HEPs (having capacity more than 25 MW), actual generation was 11,201.31 MU leaving a shortfall of 337.69 MU during 2019-22.

Total generation from all the five HEPs (including projects having capacity less than 25 MW) was 12,690.56 MU *i.e.* 4,939.14 MU, 4,389.60 MU and 3,361.82 MU during 2019-20, 2020-21 and 2021-22 respectively. There was decline in generation from 4,939.14 MU during 2019-20 to 3,361.82 MU during 2021-22 *i.e.* 1,577.32 MU (31.94 per cent).

Project-wise analysis showed that there was shortfall to the extent of 516.10 MU in case of RSD during 2020-22, 422.93 MU in case of ASHP during 2019-22 and 236.49 MU in case of MHP during 2021-22. In ASHP there was shortfall in generation during all the three years from 2019-20 to 2021-22. The overall shortfall in generation w.r.t. targets was to the extent of

1,175.52 MUs in respect of these three HEPs equivalent to loss of revenue of ₹ 764.09 crore<sup>3</sup>. The reasons for shortfall in generation were forced shutdown (reference Paragraph 4.6.4), delay in carrying out of major repair/capital maintenance works (reference Paragraphs 4.6.6.1 and 4.6.6.2), annual maintenance during peak period (reference Paragraph 4.6.7) and less availability of water.

The Government stated (May 2023) that targets could not be achieved as the same were fixed by CEA on assumption basis and they were not backed by scientific basis. The reply was not acceptable as the CEA fixes the targets after considering all the standards and parameters. The fact remains that the generation targets were not achieved.

#### **4.6.2 Transformation losses**

Central Electricity Regulatory Commission (CERC) prescribes the norm of transformation loss<sup>4</sup> which is a maximum of 0.50 *per cent* of energy generated. An analysis of project-wise transformation loss during 2019-22 showed transformation loss at SPH (110 MW) and MHP (225 MW) were in excess of the norms of 0.50 *per cent*. Transformation losses at SPH were ranging between 1.24 *per cent* and 1.58 *per cent* which aggregated to 14.68 MUs during 2019-22 while at MHP these were ranging between 1.01 *per cent* and 1.37 *per cent* aggregating to 22.64 MUs during 2019-22. The excess transformation losses of 37.32 MUs deprived the Company of potential revenue of ₹ 24.26 crore<sup>5</sup> during 2019-22. Higher transformation losses in SPH and MHP were due to installation of single phase instead of three phase generator transformers and old generator transformers which have outlived their life respectively.

The Government stated (May 2023) that remedial measures to minimise the transformation losses are being taken.

#### **4.6.3 Plant Availability Factor and Plant Load Factor**

To achieve optimum generation, availability of the power plant has to be ensured. A Lower Plant Availability Factor<sup>6</sup> (PAF) indicates that the power plant is available for generation for a shorter period and lower Plant Load Factor<sup>7</sup> (PLF) indicates that the plant is generating less power than its capacity. Plant-wise PAF and PLF during 2019-22 is as below:

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- <sup>3</sup> Loss of revenue is calculated at ₹ 6.50 per unit *i.e.* average revenue realisation rate for 2019-22.  
<sup>4</sup> Transformation losses refers to losses from generation voltage to transmission voltage.  
<sup>5</sup> Loss of potential revenue is calculated at ₹ 6.50 per unit, the average revenue realisation rate per unit for the period 2019-22.  
<sup>6</sup> Plant Availability Factor is the amount of time for which plant is able to produce electricity over a certain period, divided by amount of time in that period.  
<sup>7</sup> Plant Load Factor is a percentage of energy generated by the power plant corresponding to installed capacity/energy which it can produce in a particular period.

**Table 4.2: Plant Availability Factor and Plant Load Factor (in per cent)**

Name of HEP	Plant Availability Factor				Plant Load Factor			
	2019-20	2020-21	2021-22	Average	2019-20	2020-21	2021-22	Average
SPH	81.76	77.15	83.37	80.76	58.47	52.21	54.16	54.95
UBDC	92.39	87.37	81.43	87.06	58.81	49.25	39.25	49.10
RSD	89.46	76.01	89.59	85.02	39.83	28.90	22.13	30.31
ASHP	92.37	89.71	85.42	89.17	51.29	48.22	33.77	44.43
MHP	91.71	94.24	85.75	90.57	60.68	71.41	49.03	60.37

Source: Information provided by the Company

There are no specific norms regarding PAF and PLF, however, as per CEA, average operating availability *i.e.* PAF of hydro generating units on all India basis during 2019-20 to 2021-22 ranged between 92.68 *per cent* and 93.97 *per cent*. It was observed that average PAF of these five projects ranged between 80.76 *per cent* (SPH) and 90.57 *per cent* (MHP) during 2019-22. Further, the average PLF ranged between 30.31 *per cent* (RSD) and 60.37 *per cent* (MHP) during 2019-22. There was decline in PLF of each plant from 2019-20 to 2021-22 which corresponds to decline in generation during the above period.

The Government stated (May 2023) that the low PAF was due to increase in planned outages as well as more forced shut downs. Audit is of the opinion that the Company could have at least reduced the duration of forced shut downs by regular preventive maintenance.

#### 4.6.4 Loss of generation due to forced outages

Forced outage is an outage/non-availability of a generating unit due to fault or other reasons which has not been planned *e.g.* unexpected breakdown of the unit. To achieve optimum generation, it should be ensured that the plant remains available for generation. The operational reliability of the generating units shall be such that whenever the grid demands, it should be available for generation. Best practices in operation & maintenance of hydro power stations shall be such that by following such procedures, downtime of individual generating units & plant should be minimum *i.e.* forced outages should be minimised.

During 2019-22, out of total forced outages of 10,365 Machine hours<sup>8</sup>, major outage *i.e.* 7,812 Machine Hours (75.36 *per cent*) was in case of MHP and 1,782 Machine Hours (17.19 *per cent*) in case of ASHP, constituting 92.55 *per cent* of total forced outages. On account of these forced outages, the Company had to suffer generation loss of 124.93 MUs equivalent to ₹ 81.20 crore<sup>9</sup>. The main factors for the forced outages were breakdown of

<sup>8</sup> In respect of ASHP, MHP, SPH and UBDC only.

<sup>9</sup> Loss of revenue is calculated at ₹ 6.50 per unit, the average revenue realisation rate per unit during 2019-22.

machine/equipment, failure of 132 KV Transmission System and choking of inlet canal due to trash. To bring down the forced outages, the Company was required to improve its O&M practices and take up the matter with the Punjab State Transmission Corporation Limited (PSTCL) to reduce failure in the transmission system and recouping of generation loss due to faults in its transmission system. Audit also observed at Ranjit Sagar Dam (RSD), forced outages were being treated as planned outages and the works under forced outages were being carried out as planned works, which was not justified.

The Government accepted and stated (May 2023) that equipment requiring major overhauling etc. have been identified and the Company is working on its replacement. They added that the matter of failure of transmission network is being taken up with PSTCL.

#### **4.6.5 Under-utilisation of Upper Bari Doab Canal Project**

The Upper Bari Doab Canal (UBDC) HEP comprises of six machines having total capacity of 91.35 MW. The project has a 20 KM hydel channel with maximum discharge capacity of 7,200 cusecs. The continuous variation of volume of discharge had caused damage to the channel, which required protection and restoration. Accordingly, the water discharge in the hydel channel was restricted to 6,100 cusecs against the full capacity of 7,200 cusecs. The Company decided (April 2017) to execute channel repair works at an estimated cost of ₹ 1.69 crore in order to achieve the rated discharge capacity to 7,200 cusecs thereby increasing its generation capacity.

It was, however, observed that though the above civil works were got executed (up to March 2021) incurring a total cost of ₹ 1.51 crore, the capacity of the channel could still be utilised only up to 6,700 cusecs. The Company observed that increase in discharge in hydel channel beyond 6,700 cusecs leads to net head loss and consequent decrease in generation. The Company could not correctly assess the reasons causing underutilisation of the capacity of the channel and the power plant despite executing the above works.

The Government accepted the fact and stated (May 2023) that to utilise the hydel channel at full capacity, studies for renovation, modernisation & uprating and remaining life assessment is under process.

#### **4.6.6 Delay in execution of works:**

##### ***4.6.6.1 Loss of generation due to delay in implementation of Digital Governing System***

Governing system is the main controller of the hydraulic turbine. The governing system regulates the water flow through the turbine to control its speed or power output and system frequency.



The purchase order for supply and work order for erection and commissioning of Digital Governing System (DGS) to be installed at UBDC Hydel project was issued (July 2019) at ₹ 2.11 crore (₹ 2.02 crore for supply and ₹ 8.85 lakh for erection) in favour of M/s ABB India Limited (firm). As per the contractual delivery clause, material was to be supplied up to April 2020 and the work of commissioning of DGS was to be completed within 30 days from the start of work depending upon availability of machines. Against the above delivery schedule, supply was completed by July 2020 *i.e.* after a delay of three months. Two machines were handed over to the firm on 20 December 2020 and one on 15 February 2021. As such, the work was to be completed by 19 January/17 March 2021. However, the machines were commissioned on 7 June 2021 *i.e.* after a further delay of 138 days/81 days. The reasons for the delay were not on record. Due to delayed delivery and commissioning by the contractor, the Company suffered generation loss of 47.36 MUs equivalent to revenue of ₹ 30.78 crore<sup>10</sup>.

The Government, while accepting the facts stated (May 2023) that the matter to incorporate provision to safeguard the financial interest of the Company is under consideration.

#### **4.6.6.2 Delay in completion of work by M/s BHEL**

The capital overhauling of Machine No. 2 (15 MW) of Powerhouse No.1 at MHP, Talwara was required to increase life of generating assets, improve efficiency, increase availability, reduce O&M expenditure and generation loss etc. The Company planned (2016-17) capital overhauling of the machine during the ensuing lean season (March-June).

The work was allotted (August 2019) to M/s BHEL (firm), the original equipment manufacturer (under single tender enquiry), for ₹ 24.60 crore. The machine was handed over (March 2021) to the firm, who was to complete the work by 15 June 2021. However, due to spread of Covid 19 and additional work involved, the firm submitted (June 2021) the revised completion date as 1 September 2021. The machine was commissioned on 8 November 2021 *i.e.* after a delay of 67 days. The delay in completion of the work resulted in generation loss of 17.33 MUs equivalent to potential revenue of ₹ 11.26 crore<sup>11</sup>.

The Government stated (May 2023) that the work got delayed due to spread of Covid-19 and emergence of additional work. The reply was not tenable as the

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<sup>10</sup> Loss of revenue is calculated at ₹ 6.50 per unit *i.e.* average revenue realisation rate for 2019-22.

<sup>11</sup> Loss of revenue is calculated at ₹ 6.50 per unit *i.e.* average revenue realisation rate for 2019-22.

loss has been calculated after considering the revised completion date submitted by the firm.

#### **4.6.6.3 Delay in capital maintenance of Generator Transformers**

The Company decided (November 2019) to carry out capital maintenance/overhauling of three single phase 62.5 MVA, Generator Transformers (GTs) installed at RSD, departmentally from its Grid Construction Division, Amritsar (GCD) at a tentative expenditure of ₹ 1.41 crore. The GCD was requested (January 2020) to lift one GT, however, the same was lifted (January 2021) after a lapse of one year. Capital overhauling of this GT was completed in July 2021 and it was shifted at site in February 2022 *i.e.* after more than seven months from the date of completion of capital overhauling.

Finally, this GT was commissioned/ energised in March 2022. Audit observed that there was delay of one year in lifting the first GT from the project site to the crane bay and further delay of more than seven months in shifting it back to the project after capital maintenance. The main reason for delay in lifting up /shifting back was on account of non-availability of trailer of required capacity with the GCD. The work was awarded without considering the availability of trailer of required capacity for carrying out work inhouse, which shows improper planning. Audit further observed that capital maintenance of all the three GTs was required to be completed up to March 2021, however, capital maintenance of only one GT was completed/ commissioned by March 2022. Delay in execution of capital maintenance may result in breakdown of GTs and consequent generation loss.

The Government stated (May 2023) that project authorities made all efforts/ endeavours for timely execution of the work. The fact remains that capital maintenance of GTs at RSD has been overdue which may adversely affect the operations at any juncture.

#### **4.6.7 Annual Maintenance**

Regular/annual maintenance of powerhouse is necessary for its smooth and efficient running. Also, to minimise generation loss, annual maintenance should be scheduled and carried out during the lean period, which are different for different plants. Audit observed instances where annual maintenance/ capital maintenance was conducted beyond the lean period:

##### **A. Ranjit Sagar Dam Hydel Project**

600 MW RSD has four Units/Machines of 150 MW each. It was observed that annual maintenance schedule at RSD was not adhered to during 2019-22 as the same was not carried out as per plan. No annual maintenance in respect of

Unit-II and Unit-III was carried out during 2019-20 due to non-granting of permission by Power Controller of the Company. In 2020-21 and 2021-22, actual number of days taken for annual maintenance were more than that of planned (30 days) for each Unit. Besides this, maintenance was also done outside lean period which resulted in generation loss of 318.40 MUs and consequent loss of potential revenue of ₹ 206.96 crore<sup>12</sup>. The main reason for not adhering to annual maintenance plan was carrying out of major repair/replacement works along with annual maintenance work.

**B. Mukerian Hydel Project**

MHP has five powerhouses, of which powerhouses I to IV have three machines each and powerhouse-V has two machines. Annual maintenance of these machines was planned during the lean period that is generally observed during March to mid-June every year. Audit observed that during 2020-21, no annual maintenance was carried out except of powerhouse-V on account of Covid-19 pandemic. During 2021-22, actual number of days taken for annual maintenance of machines were more than that of planned days and the delay was ranging between 12 and 126 days, of which certain period was falling in the peak period that resulted in loss of generation of 32.95 MUs during 2021-22 equivalent to potential revenue of ₹ 21.42 crore. The main reasons for not adhering to annual maintenance plan was carrying out of major repair/replacement works along with annual maintenance work.

**C. Anandpur Sahib Hydel Project**

Work Order cum contract agreement for capital maintenance of Unit No. 2 was awarded (January 2022) to M/s Go Goal Hydro Private Limited due to its frequent breakdown on account of vibration. Lean period at ASHP is generally observed from November to March every year, however, capital maintenance of Unit No.2 was carried out from 5 January 2022 to 20 June 2022, taking a total of 167 days, which included 67 days (from 16 April to 20 June) in the peak season, which resulted in generation loss of 33.07 MUs and consequent loss of revenue of ₹ 21.50 crore. The main reason for not adhering to scheduled maintenance was delay in getting approvals.

The Government stated (May 2023) that planned maintenance scheduled could not be adhered to on account of execution of major works besides carrying out routine maintenance. The reply was not acceptable as the annual maintenance must be done during the lean period to minimise the generation loss.

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<sup>12</sup> Loss of revenue is calculated at ₹ 6.50 per unit *i.e.* average revenue realisation rate for 2019-22.

#### **4.6.8 Operation and Maintenance Expenses**

Operation and Maintenance (O&M) expenses include expenses incurred on repair and maintenance, establishment and administration expenses.

Among all the five projects, per unit O&M expenses in respect of 600 MW RSD were on the lower side (ranging between ₹ 0.06 and ₹ 0.10 per unit) and that of UBDC were on the higher side (ranging between ₹ 0.34 and ₹ 0.51 per unit).

##### ***4.6.8.1 Unjustified payment to Water Resources Department***

As per directions (October 2017) of the Government of Punjab, the Company has been paying ₹ 12 crore annually (with an increase of five *per cent* per annum over the previous year) to Water Resources Department (WRD) as lump-sum operation and maintenance (O&M) charges with a proviso that WRD shall give top priority to carry out works relating to safety of the dam.

Ranjit Sagar Dam (WRD) had a Derrick Crane for closing and opening of power tunnels. Due to problems in the operations of the crane, its manufacturer firm was approached for repair. After assessment, the firm gave a proposal to repair the crane at an estimated cost of ₹ 16.77 crore. It was mutually decided (February 2021) that the Company will pay ₹ five crore as grant to WRD instead of the earlier decision (May 2020) of payment of ₹ five crore as loan. In compliance to the above, the Company paid (October 2021) ₹ 1.38 crore to WRD.

Audit observed that since the Company has already been paying O&M expenditure to WRD, therefore, approval of additional amount of ₹ five crore as grant for repair of crane and payment of ₹ 1.38 crore thereagainst was not justified. Also, the Company had released ₹ 52 crore to WRD without ensuring actual expenditure incurred thereagainst and justification of the same.

The Government stated (May 2023) that the payment of ₹ 1.38 crore was released to WRD as decided by its Board of Directors. The reply was not tenable as besides payment of O&M charges, payment of additional amount is not justified.

#### **4.6.9 Other Issues**

##### ***4.6.9.1 Non-provisioning of adequate number of spare runners and deficiencies in Inventory Management***

For smooth operation of the powerhouse, adequate number of stores and spare items need to be maintained. Runner is one such vital component of a Hydro Electric Plant. It is the rotating part of the turbine that converts the energy of

falling water into mechanical energy. The turbine turns the generator rotor which then converts this mechanical energy into electricity. The Company has considered the useful life of runner as 25 years. Therefore, availability of healthy runners is the foremost requirement for efficient generation of power in a hydroelectric plant. As per CEA's Best Practices regarding operation and maintenance of hydro power plant, regular inspection of runners of turbines should be carried out and a record to that effect should be invariably maintained. It further provides that inspection and testing of the runners from experts needs to be done, to decide residual life to initiate action for procurement of runners. During scrutiny of records relating to runners at powerhouses, audit observed that against useful life of 25 years; the runners have outlived/completed 37 years at ASHP and 34-39 years at MHP. However, no spare runners were available at these projects.

Audit further observed that the Company had not evolved any mechanism of inventory management viz. fixing of inventory level of various spares according to their rate of consumption & criticality, ensuring timely availability of adequate number of critical spares/vital components like runners etc. Non-availability of such spares may hamper operations and thereby result in loss of generation.

The Government stated (May 2023) the spare runners would be procured during the Renovation, Modernisation and Upgrading works of the Power Houses.

#### **4.6.9.2 Mock Black Start Exercise as per Indian Electricity Grid Code**

Black start is the process of restoring an electric power station or a part of an electric grid to operation without relying on the external electric power transmission network to recover from a total or partial shutdown. As per Indian Electricity Grid Code clause 5.8(b) "Mock trial runs of the procedure for different sub-systems shall be carried out by the Users/ CTU/ STU at least once every six months under intimation to the Regional Load Dispatch Centre" (RLDC). Diesel generator sets for black start would be tested on weekly basis and test report shall be sent to RLDC on quarterly basis. In case mock black start exercise is not carried out periodically, capability of the generating station to recover from a partial or a total blackout may not be ensured and in case of emergency situation like total black out, generating station may fail to revive the system, when necessary.

Audit, however, observed that no such practices are being followed at the HEPs of the Company. The Government accepted (May 2023) the audit observation.

#### **4.6.9.3 Non deployment of technically qualified manpower in Power Houses**

Qualified and trained manpower is the foremost requirement in efficient and effective operations of any hydro electric project. Audit observed that most of the staff deployed in power houses was not technically qualified and percentage of technically unqualified staff was ranging between 56 *per cent* (UBDC) and 80 *per cent* (SPH) as they did not have any qualification (diploma/degree) in the concerned field. Since the jobs in the powerhouse are of technical nature, therefore, deployment of unqualified staff may impact the operational performance of the plant.

The Government stated (May 2023) that staff deployed in powerhouses were recruited as per pre-qualification criteria fixed by the Company and training was being provided to them. The Management, however, did not produce any records to show imparting of formal training to unqualified staff during the last three years.

#### **4.7 Conclusion**

Loss of generation occurred due to inefficient operations of powerhouse, delay in execution of repair & maintenance work, forced shutdowns and carrying out of annual maintenance and repair works beyond lean season. The Company had not evolved any mechanism of inventory management *viz.* fixing of inventory level of various spares according to their rate of consumption and criticality, ensuring timely availability of adequate number of critical spares/vital components like runners. There was shortage of technically qualified manpower in the powerhouse and no formal training programmes were arranged.

#### **4.8 Recommendations**

The Company may consider:

- *Renovation and modernisation of powerhouse for increasing efficiency of the powerhouses which were not operating efficiently;*
- *Ensuring proper contract management for timely repairs and maintenance to avoid lengthy shutdowns; and*
- *Posting of technically qualified and trained staff at the projects.*