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Report of the Comptroller and Auditor General of India on Capacity Utilisation, Electricity Generation, Sale and Collection of Revenue including Disaster Management by Hydro Power CPSEs (NHPC Limited, SJVN Limited, THDC India Limited and NHDC Limited)

भारतीय लेखा एवं लेखा परीक्षा विभाग ✦ INDIAN AUDIT AND ACCOUNTS DEPARTMENT

Union Government (Commercial)
Ministry of Power
No. 41 of 2015
(Performance Audit)

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Comptroller and Auditor General of India
on
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Preface

Hydro power is a renewable and environment friendly source of energy. As hydro power stations have the inherent ability for instantaneous operations, they are more responsive than most other energy sources, for meeting peak demand and improving reliability of the power system. As such it is important that existing hydro capacity is utilised optimally. Four CPSEs viz., NHPC Limited (NHPC), SJVN Limited (SJVN) THDC India Limited (THDC), and NHDC Limited (NHDC), with 23.72 per cent share in the hydro power generating capacity of the country, have a significant role to play in this regard.

In the above backdrop, performance audit was taken up to assess the effectiveness of activities from generation to collection of revenue by these four CPSEs between April 2009 and March 2014. In the wake of incident of flash floods on 16-17 June 2013 in Uttarakhand, specific aspect of disaster management in these CPSEs has also been covered.

The Audit Report has been prepared in accordance with Regulations on Audit and Accounts, 2007 and Performance Audit Guidelines, 2014 of the Comptroller and Auditor General of India.

Audit wishes to acknowledge the co-operation received from NHPC, SJVN, THDC, NHDC and Ministry of Power, Government of India at each stage of the audit process.

Executive Summary

Executive Summary

Introduction

Hydro power is a renewable and environment friendly source of energy. As hydro power stations have the inherent ability for instantaneous operations, they are more responsive than most other energy sources, for meeting peak demand and improving reliability of the power system. As such it is important that existing hydro capacity is utilised optimally. Four CPSEs *viz.*, NHPC Limited (NHPC), SJVN Limited (SJVN), THDC India Limited (THDC), and NHDC Limited (NHDC), with 23.72 *per cent* share in the hydro power generating capacity of the country, have a significant role to play in this regard.

(Para 1.1)

What does our audit cover?

This report covers activities from generation to collection of revenue by these four CPSEs between April 2009 and March 2014. In the wake of flash flood incident on 16-17 June 2013 at Uttarakhand, specific aspect of disaster management in these CPSEs has also been covered. Audit selected a representative sample of eight NHPC power stations as on 31 March 2014 using Interactive Data Extraction and Analysis (IDEA) software. In respect of remaining three CPSEs, which had one or two power stations, the only power station or the older one of each CPSE was selected.

(Para 2.1 and 2.5)

Our major audit findings

Performance audit brought out deficiencies in achievement of capacity utilisation, maintaining reservoir level, carrying out flushing operations for desilting, maintenance of generating units, revenue collection and disaster management. Significant audit findings are summarised below:

(i) **Under utilisation of capacity by power stations**

Average Capacity Utilisation Factor (CUF) of Bairasiul, Teesta-V, Chamera-III and Chutak power stations of NHPC during the period covered by performance audit were below their respective Design CUFs.

Tehri Hydro Power Station of THDC, was designed as a multipurpose project for Full Reservoir Level of 830m. Rehabilitation of families was done by State Government with funds amounting to ₹972.97 crore provided by THDC. However, THDC has not so far been permitted to fill the reservoir beyond EL 825m.

(Paras 3.1.1 and 3.1.2)

(ii) **Non-review of design energy**

During all the 20 years since commissioning in 1994-95, actual generation at Chamera-I power station exceeded the design energy by 13 to 60 *per cent*. However, its design energy had not been reviewed in terms of CEA guidelines. As design energy forms basis for recovery of fixed costs of power station, non-review of design energy to a realistic level resulted in additional earnings of ₹274.98 crore[1] to Chamera-I power station during 2009-2014 through sale of 3592 MUs secondary energy[2] with consequent additional burden on consumers.

(Para 3.1.3)

(iii) **Decrease in gross and live reservoir capacities due to inadequate flushing operations**

Silt deposition in reservoir can be minimised by (i) keeping water in reservoir up to specified level during monsoon and/or (ii) carrying out regular flushing operations for desilting as per specified norms. Non-adhering to above conditions not only reduces the useful life of reservoir and power station but also makes flood management more difficult. Due to inadequate flushing and non-maintenance of prescribed reservoir levels, gross and live reservoir capacities of three NHPC power stations reduced during five years ended 31 March 2014.

(Para 3.1.4 and 3.1.5)

(iv) **Generation loss due to forced outages during monsoon season**

As per Operational Norms for Hydro Power Stations fixed by CERC, all machines were required to be available 24 hours for all types of plants during the monsoon period. However, machines of CPSEs suffered forced outages aggregating 9871 hours during monsoon periods of 2009-14. Forced outages ranged from 293 hours in THPS to 2085 in Chutak power station.

(Paras 4.3.1)

(v) **Issues in billing and collection**

An examination of energy billing and collection by CPSEs disclosed that compliance to the compulsory conditions of opening LCs for requisite amount and maximum prescribed revolutions of LC per month were not ensured by NHPC. Accordingly, rebate of ₹60.48 crore was allowed by NHPC to beneficiaries who were not eligible for rebate as per the rebate policy.

(Para 5.1.2)

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[1] ***Worked out by multiplying secondary energy generated in the years 2009-10 to 2013-14, with energy charge rate of the respective financial years subject to ceiling of ₹ 0.80 per unit.***

[2] ***Energy generated beyond Design Energy***

Outstanding dues of ₹4112.49 crore remained unrecovered from five beneficiaries[3] by CPSEs as of 31 March 2015. CPSEs may have to seriously review various possibilities for recovery of dues from regularly defaulting beneficiaries.

(Para 5.2.1)

(vi) **Non-review and non inclusion of CWC guidelines in Disaster Management Plans**

Disaster Management Plans (DMP) of all power stations selected for performance audit except Indira Sagar power station of NHDC were not in accordance with CWC guidelines. These DMPs also did not incorporate Emergency Action Plan as a result of dam break analysis. Further, the DMPs were not reviewed annually as per requirement of Disaster Management Act, 2005. Lately, CPSEs have commenced the process of reviewing the DMPs.

(Para 6.3.1, 6.3.2 and 6.5)

(vii) **Ineffective flood management by Dhauliganga and Tanakpur power stations of NHPC**

Damages to Dhauliganga power station during floods of June 2013 were possible to have been mitigated by compliance to the provisions of Reservoir Operation Manual/ Disaster Management Plan regarding advance warning system, maintenance of reservoir levels, flushing of reservoir and lowering of Draft Tube gates in time. After the flood, power generation from Dhauliganga power station remained suspended up to May 2014. Similarly, timely rectification of defects pointed out by Dam Safety team before monsoon season and operation of barrage gates as per Barrage Regulation Rules could have mitigated the damages suffered by Tanakpur power stations (TPS) while managing flood of June 2013. Complete shutdown of TPS had to be taken from 11 January 2014 to 28 March 2014 to rectify the damages.

(Para 6.6.1 and 6.6.2)

What do we recommend?

Based on the audit findings, the following recommendations are made to facilitate improvement in operation and maintenance of hydro power stations:

Ministry of Power may

(i) Need to take steps for speedy resolution of the long standing issue of non-filling Tehri reservoir up to EL 830 m.

(ii) In line with the objective of National Electricity Policy of balancing the interests of consumers and reasonable recovery of cost by generator, coordinate with other agencies including the Regulator, if necessary, to ensure that design energy of power

[3] ***BSES Rajdhani Power Limited, BSES Yamuna Power Limited, Uttar Pradesh Power Company Limited, Power Distribution Department, J&K and Bihar State Electricity Board.***

stations consistently generating substantial secondary energy may be reviewed as per CEA guidelines.

CPSEs may

(iii) Ensure maintenance of reservoir level and carry out prescribed flushing operations as per provisions of Reservoir Operation Manuals to avoid sedimentation and consequent reduction in reservoir capacity as well as effective flood management.

(iv) Carry out annual planned maintenance of machines appropriately to minimize forced outages.

(v) Ensure the compliance with provisions of PPAs regarding opening/renewing LCs and allowance of rebate; and may explore various possibilities for recovery of dues from regularly defaulting beneficiaries including regulation of power as per CERC Regulations.

(vi) Establish an advance warning system upstream of the dam site, wherever feasible, so that preventive measures can be taken to ensure safety of dam, power house and population living downstream of the dam.

(vii) Ensure regular review and updation of DMPs and prescribe minimum number of mock drills on natural disasters to be conducted by power stations annually for effective preparedness to handle disasters.

(viii) Ensure that compliance to observations of all inspection teams, whether internal or external, relating to safety of structures, including functioning of instruments installed at dam site and power house are carried out promptly.

All the recommendations, except (ii), were generally accepted by Ministry/CPSEs. In respect of recommendation (ii), Ministry stated that this was a regulatory issue to be taken care of by CERC. However, Audit feels that in view of larger public interest as per the National Electricity Policy, Ministry may coordinate with the regulator to ensure the desired action.

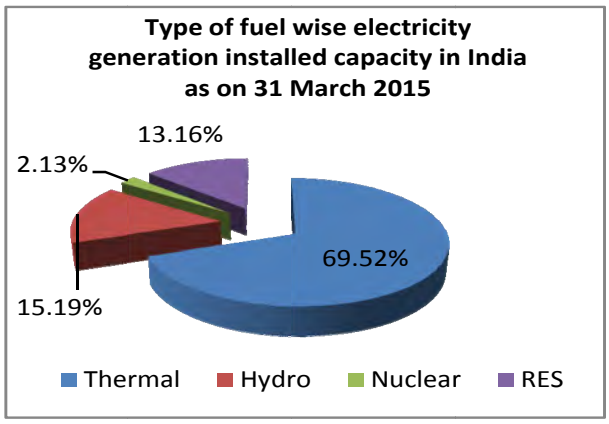
CHAPTER – I

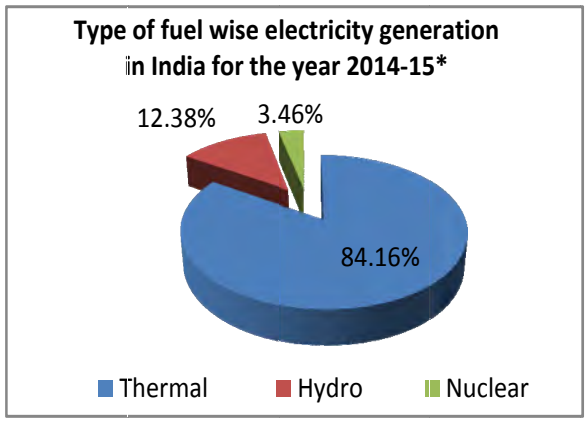
Introduction

1.1 Power sector Scenario in India and role of hydro power generators

Hydro power is a renewable and environment friendly source of energy. As hydro power stations have the inherent ability for instantaneous operations, they are more responsive than most other energy sources, for meeting peak demand and improving reliability of the power system.

Against the ideal energy mix[1] of 60 *per cent* thermal and 40 *per cent* hydro required for optimal utilisation of installed capacity, the share of hydro installed capacity and hydro generation *vis-à-vis* total installed capacity and total generation in the Country was 15.19 *per cent* and 12.38 *per cent* respectively, as on 31 March 2015. NHPC Limited (NHPC), SJVN Limited (SJVN), THDC India Limited (THDC) and NHDC Limited (NHDC[2]), are the major hydro electricity generators having 23.72 *per cent* (March 2015) of total hydro power installed capacity in the Country.





** Data of electricity generation from renewable sources is not available as the same is not maintained by CEA*

1.2 Profile of hydro power sector CPSEs

NHPC, SJVN, THDC and NHDC are important Central Public Sector Enterprises (CPSEs) in hydro power sector. Profile of these CPSEs as on 31 March 2015 is in Table 1.1.

[1] ***As per Annual Report of MoP for 2001-02.***
[2] ***NHDC Limited is a 51:49 Joint Venture company of NHPC Limited and Government of Madhya Pradesh.***

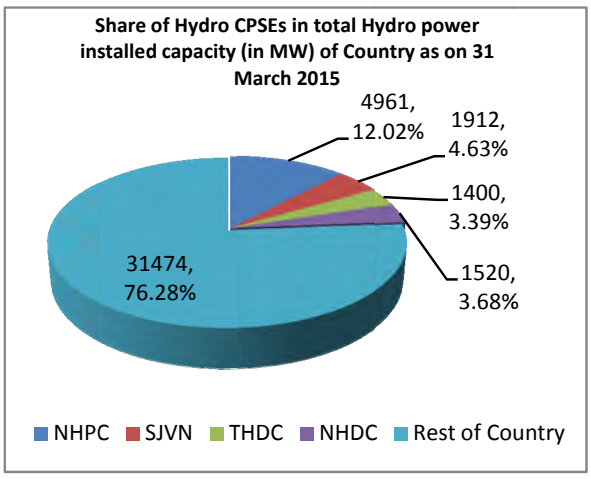
Table 1.1

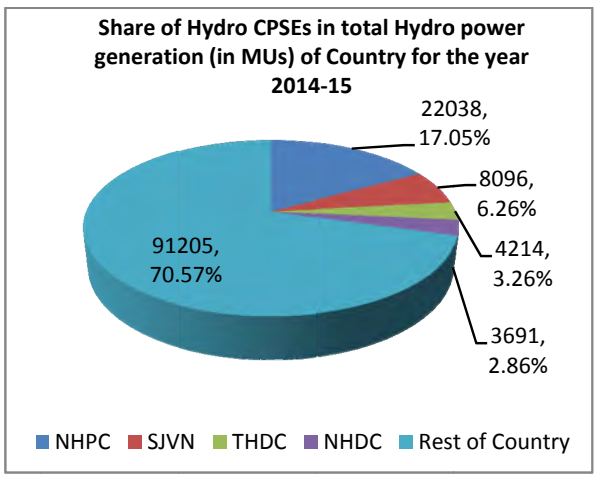
Profile of CPSEs selected for performance audit

Particulars/Name of the Company	NHPC	SJVN	THDC	NHDC
Month/Year of incorporation	November 1975	May 1988	July 1988	August 2000
Location of power stations	Himachal Pradesh, Jammu & Kashmir, Uttarakhand, West Bengal, Sikkim and Manipur	Himachal Pradesh	Uttarakhand	Madhya Pradesh
Installed power generating capacity as on 31 March 2015	4961.20 MW	1912 MW	1400 MW	1520 MW
No. of power generating plants	18	2[3]	2	2
Per cent of share of Central/ State Government to total equity as on 31 March 2015	Central: 85.96 (Balance public, FIs, etc.)	Central: 64.46 State: 25.51 (Balance public, FIs, etc.)	Central: 73.51 State: 26.49	NHPC: 51.08 State: 48.92

1.3 Contribution of hydro power CPSEs

As on 31 March 2015, share of NHPC, SJVN, THDC and NHDC in country's total installed hydro power generation capacity and total hydro power generation (central, state and private sector) for the year 2014-15 were as under:





Details of hydropower installed capacity and hydro power generation in the country as a whole and in each of the CPSEs selected for performance audit during six years ended 31 March 2015 are given in ***Annexure 1.1.***

[3] *Includes Rampur Power Station which was put under commercial operation between May and December 2014*

1.4 Financial position of CPSEs

Financial position and working results of the four CPSEs during six years ended 31 March 2015 are depicted in Table 1.2.

Table 1.2

Year-wise financial position and performance of CPSEs during 2009-2015

(₹in crore)

Particulars	Financial year					
	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
NHPC						
Paid up capital	12300.74	12300.74	12300.74	12300.74	11070.67	11070.67
Reserves and Surplus	10972.45	12279.94	14052.79	15539.76	14996.98	17215.72
Total revenue	4892.09	4932.11	6790.74	6539.43	6993.99	7663.58
Net Profit	2090.50	2166.67	2771.77	2348.22	978.79	2124.47
Return on Net worth[4] (%)	8.98	8.81	10.52	8.43	3.75	7.51
SJVN						
Paid up capital	4108.81	4136.63	4136.63	4136.63	4136.63	4136.63
Reserves and Surplus	2528.25	3068.89	3685.65	4273.38	4913.72	6066.41
Total revenue	1908.73	1955.82	2136.79	1916.62	2110.72	3261.10
Net Profit	972.74	912.13	1068.68	1052.34	1114.63	1676.75
Return on Net worth (%)	14.66	12.66	13.66	12.51	12.32	16.43
THDC						
Paid up capital	3297.58	3297.58	3297.58	3443.09	3473.09	3528.88
Reserves and Surplus	2152.98	2475.30	2864.56	3328.40	3858.15	4309.43
Total revenue	1423.91	1689.27	2055.08	2026.53	2182.38	2407.93
Net Profit	479.95	600.48	703.83	531.38	585.32	691.15
Return on Net worth (%)	8.81	10.40	11.42	7.85	7.98	8.82
NHDC						
Paid up capital	1962.58	1962.58	1962.58	1962.58	1962.58	1962.58
Reserves and Surplus	1231.98	1490.49	2068.96	2575.71	2699.95	3166.09
Total revenue	1005.93	1025.75	1450.51	1338.19	2115.43	1548.85
Net Profit	212.30	304.13	646.90	575.64	1063.63	766.46
Return on Net worth (%)	6.64	8.80	16.04	12.68	22.81	14.94

[4] ***Net Profit as a per cent of paid up capital plus Reserve & Surplus***

CHAPTER – II

Audit Approach

2.1 Scope of Audit

The performance audit covers activities from generation of electricity to collection of revenue between April 2009 and March 2014 by power stations of the four hydro power CPSEs. In the wake of the incident of flash flood that occurred on 16-17 June 2013 in Uttarakhand, adequacy of disaster management measures was also included in the scope of audit.

2.2 Audit Objectives

The objectives of performance audit were to assess whether:

(i) The hydro power stations were generating power economically and efficiently as per the envisaged goals;

(ii) Maintenance of power stations was as per prescribed norms with due regard to economy and efficiency;

(iii) Tariff notifications and processes prescribed for billing, allowance of rebate, imposition of surcharge and collection of debtors were complied with; and

(iv) Preparedness for disaster management in the power stations was adequate.

2.3 Audit Criteria

Audit criteria adopted for performance audit included:(i) original Detailed Project Report (DPR) of the power stations and completion/commissioning reports of power stations (ii) operation and maintenance manual of the power stations (iii) CEA's annual maintenance calendar (iv) Indian Electricity Grid Code (IEGC) Regulation 2010 (v) Minutes of the Standing Committees of the regions, Regional Power Committees, Technical Co-ordination Committees (vi) Normative Annual Plant Availability Factor (NAPAF)[5] for hydro generating stations as prescribed in Central Electricity Regulatory Commission (CERC) Regulations applicable for the period 2009-2014 (vii) CERC (terms and conditions of tariff) Regulations 2004 and 2009 (viii) tariff petitions, review petitions filed by CPSEs and tariff orders issued by CERC (ix) Power Purchase Agreements (PPA) entered into with beneficiaries; (x) Memorandum of Association and Article of Association of CPSEs (xi) Minutes of meetings of Board of Directors of the CPSEs, Committee of Directors, and other Board Level Committees (xii) best practices adopted by the industry (xiii) CEA norms for Disaster Management (xiv) Works and Procurement Policy and Procedure (WPPP) of CPSEs (xv) annual MOUs entered by CPSEs with the Ministry of Power (MoP) (xvi) Cost Audit Reports of power stations (xvii) Disaster Management Plans (DMPs) of selected power stations (xviii) Disaster Management Act, 2005

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5 Plant Availability Factor (PAF) fixed on normative basis by CERC in its Notification applicable to the tariff period 2009-2014 in respect of each of the hydro power stations considering plant type (i.e. Storage, Pondage or Run of the River), silt problem, other operating conditions and known plant limitations. Plants were entitled to incentive if actual PAF achieved was more than NAPAF or subject to disincentive if actual PAF achieved was less than NAPAF.

(xix) Central Water Commission (CWC) guidelines on Emergency Action Plan (EAP) for Dams, May 2006 (xx) State Disaster Management Plans (xxi) Environment Impact Assessment (EIA) notification, 1994.

2.4 Audit Methodology

Entry conference was held with the managements of NHPC, SJVN, THDC and NHDC on 06 August 2014 wherein the scope, objectives, audit criteria and audit sample were discussed. Relevant records at corporate offices and selected power stations of above four CPSEs were examined and discussions held with the senior management from time to time during August 2014 to December 2014 for firming up audit conclusions. The draft performance audit reports were issued to the managements of the above four CPSEs for their comments during January/ February 2015. These draft reports were updated/revised after considering the replies of the managements concerned and merged into a consolidated draft report. This report was again issued to the managements of these four CPSEs in May 2015 and exit conferences were held with them to discuss the audit findings in May 2015. Keeping in view the discussions held in the exit conferences, the audit findings/recommendations were modified, and the modified draft report was issued to MoP in June 2015. After receipt of MoP's reply dated 20 August 2015 to the draft report, an Exit Conference was held with MoP and managements of the four CPSEs on 25 August 2015. Representatives from CEA also attended the Exit Conference wherein audit findings and suggestions for improvement proposed in draft report were discussed. MoP's reply (August 2015), discussions at Exit Conference (August 2015) and additional replies received from Managements/MoP on observations and recommendations in August/September 2015 have been considered and duly incorporated in this report.

2.5 Audit Sample

Representative sample of eight NHPC power stations representing 44 *per cent* in terms of number and 49 *per cent* in terms of installed capacity as on 31 March 2014 was drawn using Interactive Data Extraction and Analysis (IDEA) software. In respect of other CPSEs which had one or two power stations, the only power station or the older one, was selected for the purpose of performance audit (details in ***Annexure 2.1***).

Table 2.1
CPSE-wise total number of power stations with installed capacity and number of power stations with installed capacity selected for performance audit

Name of CPSE	Population as on 31 March 2014		Sample selected	
	No. of power stations under operation	Installed capacity (MW)	No. of power stations	Installed capacity (MW)
NHPC	18	4831	8[6](44 *per cent*)	2359(49 *per cent*)
SJVN	1	1500	1(100 *per cent*) (Nathpa-Jhakri)	1500(100 *per cent*)
THDC	2	1400	1(50 *per cent*) (Tehri Hydro)	1000(71 *per cent*)
NHDC	2	1520	1 (50 *per cent*) (Indira Sagar)	1000 (66 *per cent*)
TOTAL	**23**	**9251**	**11 (48 per cent)**	**5859 (63 per cent)**

2.6 Audit Findings

Audit findings are discussed in subsequent chapters under the following headings:

Chapter III: Capacity Utilization and Electricity Generation

Chapter IV: Management of Planned and Forced Outages

Chapter V: Sale of Power and Revenue Collection

Chapter VI: Disaster Management

Chapter VII: Monitoring System

Chapter VIII: Conclusion and Recommendations

2.7 Acknowledgment

Audit appreciates and acknowledges the cooperation extended by MoP and Managements of NHPC, SJVN, THDC and NHDC in facilitating smooth conduct of audit.

[6] *(i) Bairasiul, (ii) Tanakpur, (iii) Chamera-I, (iv) Uri-I, (v) Dhauliganga, (vi) Teesta-V, (vii) Chamera-III and (viii) Chutak*

CHAPTER – III

Capacity Utilization and Electricity Generation

3.1 Capacity utilisation

3.1.1 Installed capacity of a power station is the maximum output of electricity which can be produced under specific conditions. The primary factors, in the case of hydro station, that determine capacity utilisation are 'water flow' and 'reservoir storage characteristics'. However, power stations are not operated at their full capacity at all times, and output varies according to the conditions at power stations and /or as per instructions given by the grid operator keeping in view the power supply and demand position. Capacity Utilisation Factor (CUF[7]) of power stations selected for performance audit for the five years ended 31 March 2014 can be seen in Table 3.1.

Table 3.1

Design, annual and average CUF of selected power stations during 2009-2014

(per cent)

Power Station	Design CUF[8]	Annual CUF					Average CUF from 2009-10 to 2013-14	Shortfall in average CUF w.r.t. design CUF in percentage points
		2009-10	2010-11	2011-12	2012-13	2013-14		
NHPC								
Bairasiul	49.40	39.51	45.09	46.36	45.79	40.46	**43.44**	5.96
Tanakpur	54.78	57.08	56.35	59.14	58.29	46.53	**55.48**	No shortfall
Chamera I	35.20	43.65	50.90	56.23	51.62	49.49	**50.38**	No shortfall
Uri I	61.52	64.28	72.30	64.31	70.56	59.96	**66.28**	No shortfall
Dhauliganga	46.27	46.23	46.23	47.17	46.31	54.50*	**48.09**	No shortfall
Teesta-V	57.59	58.15	58.73	57.48	50.77	51.48	**55.32**	2.27
Chamera III	53.67	-	-	-	47.19#	46.35	**46.77**	6.9
Chutak	55.26	-	-	-	12.39#	8.82	**10.61**	44.65
SJVN								
Nathpa-Jhakri	50.32	53.42	54.34	57.91	51.58	54.74	**54.40**	No shortfall
THDC								
Tehri Hydro	31.93	24.17	35.57	45.48	35.41	46.35	**37.40**	No shortfall
NHDC								
Indira Sagar	20.91[9]	24.18	25.09	37.52	33.06	46.56	33.28	No shortfall

**Worked out up to date of flooding of DGPS (i.e. 16 June 2013)*
 # Worked out from the commercial operation date (COD) i.e. June 2012 and July 2012 for Chamera III power station and November and February 2013 for Chutak power station.

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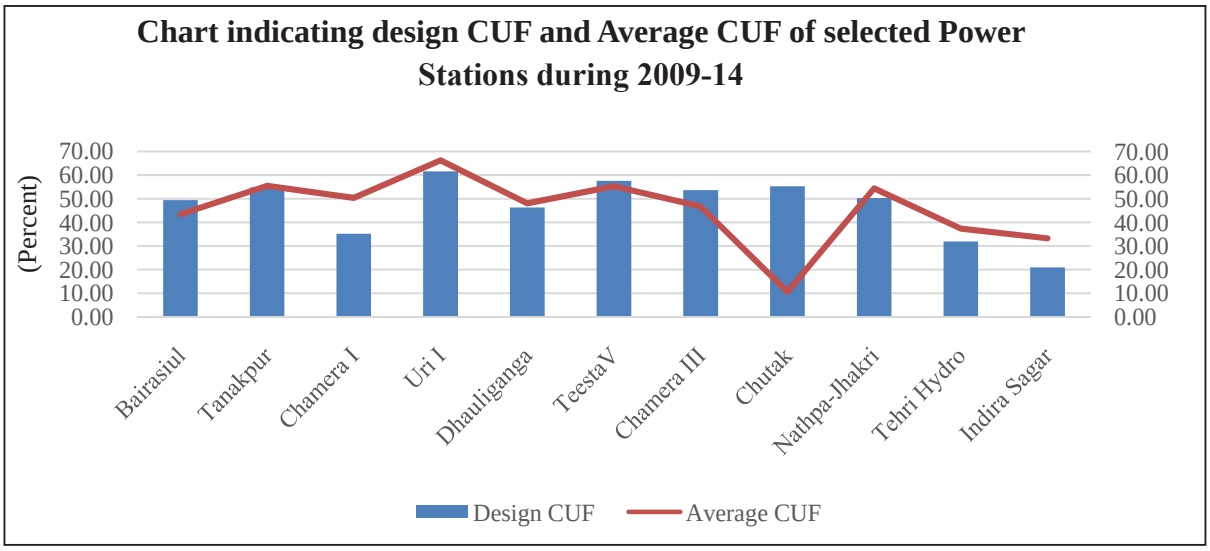
7 It is the ratio of actual energy generated by a power station to the equivalent energy output at the rated capacity over a period.

8 Design energy/ energy output at rated capacity x 100

9 Worked out on the basis of average of Design Energies for the years 2009-10 to 2013-14 (i.e. 1979 MU, 1901 MU, 1846 MU, 1715 MU and 1715 MU)

The chart below depicts the average CUF of power stations selected for performance audit during 2009-14:



It may be observed from the above table that average CUF of Bairasiul, Teesta-V, Chamera-III and Chutak power stations of NHPC were below their respective design CUFs by 2.27 to 44.65 percentage points.

While agreeing to the audit observation NHPC stated (February/August 2015) that all power stations have been advised to avoid any shortfall in average CUF with reference to design CUF. However, NHPC further explained that

(i) During 2009-14, Plant Availability Factors (PAF) of Bairasiul and Teesta power stations were 94.5 *per cent* and 87.8 *per cent* against the Normative Annual Plant Availability Factors (NAPAF) of 85 *per cent* fixed by CERC.

(ii) Less CUF in Chamera-III during 2013-14 was mainly due to shutdown of power station for rectification of water conductor system during its first year of operation and less water inflow.

(iii) Lower CUF in respect of Bairasiul was on account of less water inflow/poor hydrology.

(iv) At Chutak Power Station CUF was very low because it was not connected to the Grid. It runs on isolated load of Kargil area. Because of load constraints, its capacity utilization was low. Repeated breakdown of the units in Chutak power station were as a consequence of its prolonged part-load operation and associated high vibration, etc.

The reply is to be viewed against the facts that

(i) NAPAF is the plant availability factor fixed by CERC for tariff regulation, while capacity utilisation is being compared with the initial design CUF. NAPAF is based on location, type of plant (*i.e.* pondage, RoR and reservoir), silt condition and is

fixed generally below the PAF. Therefore, comparison of CUF with NAPAF is not appropriate.

(ii) In Chamera-III, during three months of 2013-14, water inflow was more than design inflow. In six months water inflow was less than design inflow, but reduction in actual generation w.r.t. design energy was in greater proportion. Only in three months reduction in generation was in the same proportion as reduction in water inflow. In fact there was 1387 hours of forced outages in 2013-14 itself which resulted in lesser capacity utilisation in Chamera-III.

(iii) Water inflow in Bairasiul was also more than design inflow during 37 out of 60 months.

(iv) Regarding Chutak it was enquired by Audit during the Exit Conference whether the demand factor and need for providing connectivity to National Grid was considered while preparing DPR. On this MoP asked NHPC to furnish a write up on this to Audit, which was awaited.

MoP stated (August 2015) that NHPC may instruct project teams to ensure avoidance of under utilisation of design capacity.

3.1.2 Utilisation of installed capacity in Tehri Hydro Power Station (THPS) of THDC

THPS, was designed as a multipurpose project[10] for Full Reservoir Level (FRL) of EL[11] 830m., with Maximum Reservoir Level (MRL) of EL 835m. As per the direction of Government of India (GOI), the State Government was responsible for entire rehabilitation task. The funds for rehabilitation were to be made available by THDC. Accordingly, rehabilitation of families upto MRL of EL 835 m level was done by State Government with funds provided by THDC. However, THDC has not so far been permitted to fill the reservoir beyond EL 825m. This was in spite of the fact that THDC had so far (January 2015) made payments of ₹972.97 crore required for rehabilitation of families upto EL 835 m (Maximum Reservoir Level).

MoP stated (August 2015) that State Govt. decision appears to be based on the socio-economic situation of the region and the issue was required to be taken up with Govt. of Uttarakhand through Ministry of Water Resources since the main loss was to irrigation in U.P. and cleaning of Ganga. Further, the MoP agreed (August 2015) in the Exit Conference that it would intervene in the matter on behalf of THDC.

3.1.3 Review of design energy

CERC orders dated 8 December 2000 *inter alia* provided that review of design energy of power stations might be undertaken by CEA as and when any specific information about change in consumptive use of water upstream or in runoff was brought to the notice of CEA.

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10 Apart from the power generation, its objective is to supply drinking water to Delhi as well as water for irrigation to Uttar Pradesh.

11 The elevation of a geographic location is its height above or below a fixed reference point.

Guidelines of CEA for submission of proposal for revision of design energy of hydro power stations also provided that review of design energy be undertaken after every five years as per CERC orders. Fixation of realistic design energy of a hydro power station is therefore, essential because it forms the basis for determination of tariff and recovery of costs by the hydro power station. As per CERC Regulations, total annual charges of a power station are recovered through tariff by generation of power up to the level of design energy. Any secondary energy[12] generated over and above design energy is an additional income to the power station. In case design energy is not reviewed and remains fixed at a level below the actual generating capacity of the power station, this would result in generation of more secondary energy. Consequently, the consumer is burdened as the secondary energy would be otherwise covered under annual charges if design energy is revised.

Audit examination revealed that during 20 years since commissioning in 1994-95, actual generation of Chamera-I had exceeded the design energy by 13 to 60 *per cent*. Despite significant and consistent variations in the actual generation *vis a vis* design energy consistently over the last 20 years, the design energy of Chamera –I power station was not got reviewed by NHPC in terms of above CERC orders and CEA guidelines. Therefore, Chamera-I power station earned ₹274.98 crore[13] during the period 2009-2014 through sale of 3592 MUs secondary energy. The end users were consequently burdened[14] to the extent of ₹274.98 crore, thereby defeating the purpose of National Electricity Policy of balancing the interest of consumers and reasonable recovery of cost by the generators and investors.

CEA stated (August 2015) that the guidelines had been formulated by them in order to give guidance for submission of proposal for design energy review. Any reduction/ increase in design energy would be known only after a review is carried out.

MoP stated (August 2015) that as informed by CPSEs, secondary energy was sold at a much lower rate of 90 paise/ unit which was actually only the reimbursement of cost of secondary energy. MoP also agreed in the Exit Conference (August 2015) that if CPSEs were earning more money they should pass on the same because they cannot be permitted to make undue profit. However, MoP felt that this was a regulatory issue and reference from the regulator could be made to CEA.

MoP's reply is to be viewed against the facts that

(i) all costs involved in generation of electricity were considered while calculating capacity charges and energy charges up to design energy. As such, any recovery by sale of secondary energy was in the form of undue profit, especially when in case

12 Energy generated beyond Design Energy.

13 Worked out by multiplying secondary energy generated in the years 2009-10 to 2013-14, multiplied by energy charge rate of the respective financial year subject to ceiling of ₹0.80 per unit.

14 Because in case of higher Design Energy, there would have been lesser or no secondary energy and energy charge rate would have been lesser. As per CERC notification applicable for the period 2009-14, Energy Charge Rate = Annual Fixed Charges x 0.5 x 10 / { Design Energy x (100 – Auxiliary consumption in per cent) x (100 – Free Energy to Home State in per cent)}

of deficiency of generation with reference to design energy in any year, the same was made good by beneficiaries in subsequent year.

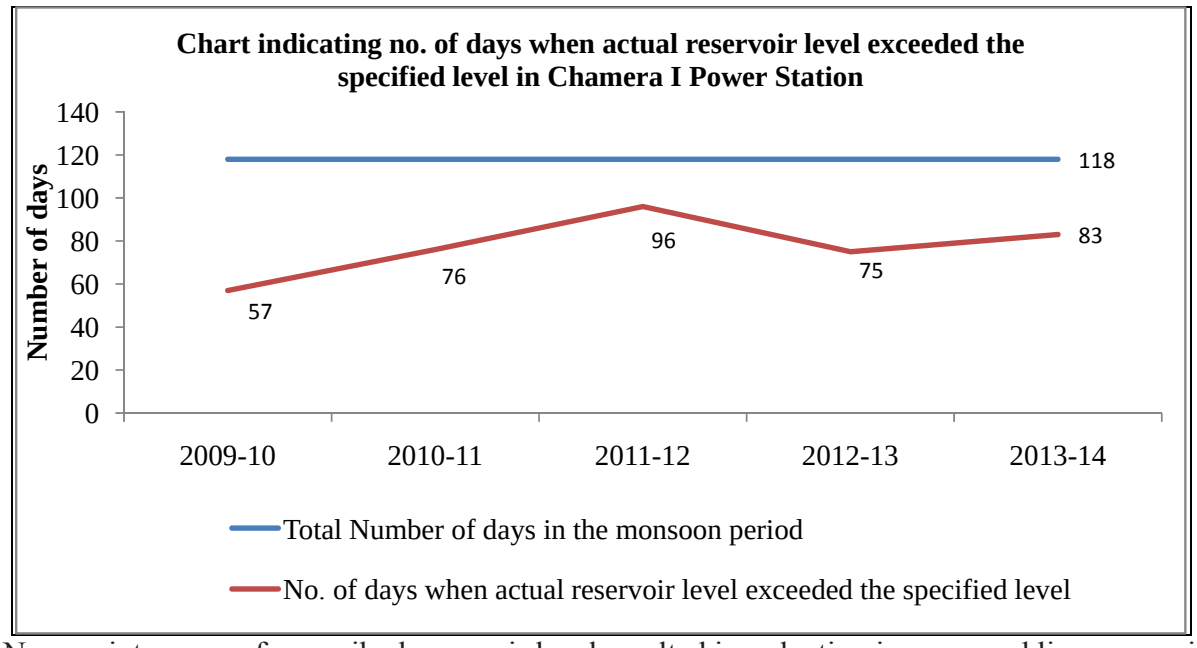
(ii) Further, National Electricity Policy provides for "balancing the interest of consumers and reasonable recovery of cost by the generators and investors". Therefore, in the larger public interest it was desirable for the MoP to coordinate with other agencies including the regulator to ensure desired action.

3.1.4 Inadequate reservoir flushing and resultant reduction in reservoir capacity

The best and most economical way to prevent silt from entering into the intake gates is to avoid silt deposition in reservoir. This can be achieved by (i) keeping water in reservoir at specified level during monsoon and/or (ii) carrying out regular flushing operations as per specified norms depending on type of reservoir. Non-adherence to the above conditions not only reduces the useful life of reservoir and power station but also makes flood management difficult.

Reservoir Operation Manuals (ROMs) of Chamera-I and Uri-I power stations of NHPC, and Tehri hydro power station of THDC provided for maintaining reservoir levels as a mechanism to avoid silt deposition. ROMs of other hydro power stations provided for specific requirements for flushing operations apart from maintaining reservoir levels during monsoon season to avoid silt deposition.

Audit noticed that Chamera-I power station did not maintain the specified reservoir level[15] during monsoon seasons 2009-14 as detailed in Chart below:



Non-maintenance of prescribed reservoir level resulted in reduction in gross and live reservoir

15 15 to 30 June -757 metres, 1 July to 15 September-750 metres, 16 to 30 September -755 metres and 1 to 10 October – 757 metres.

capacity of the Chamera-I by 15 *per cent* and 13 *per cent* respectively, during post monsoon 2008 to post monsoon 2013.

MoP/NHPC did not offer any comment on this.

Further, flushing operations were also not carried out as per specified norms. Table 3.2 indicates actual number of flushing operations performed by selected power stations of NHPC *vis a vis* those prescribed in their respective ROMs.

Table 3.2

Flushing operations prescribed in ROM and as actually undertaken by power stations of NHPC

Power Station	Number of flushing operations prescribed in ROM	Number of flushing operation actually undertaken				
		2009-10	2010-11	2011-12	2012-13	2013-14
Bairasiul	5	2	7	9	9	11
Tanakpur	4	4	2	3	4	4
Dhauliganga	8	6	6	6	3	0
Teesta-V	5	5	5	7	7	6
Chamera III	4	-	-	-	2	1
Chutak	5	-	-	-	0	0

3.1.5 Flushing operations in NHPC power stations

(i) In DGPS apart from inadequate flushing operations as indicated above, maximum water level in the reservoir during monsoon season (137 days each year) was kept between 1340 and 1345 meters as against prescribed level of 1340 metres on 4, 27, 22 and 49 days respectively during 2009-13 due to which gross and live storage capacity of reservoir declined by 5.9 and 3.9 per cent respectively during 2009-13.

(ii) In the first year (2012-13) of operation of Chamera-III power station, gross and live capacities of reservoir reduced by 18 *per cent* and 7 *per cent* with reference to gross and live capacities envisaged in its DPR.

(iii) Reservoir capacity of remaining power stations (Teesta V, Chutak and Tanakpur) was not assessed regularly during the period 2009-14. Accordingly, Audit was unable to assess the impact of flushing operations on the reservoir capacity of these power stations.

NHPC stated (February 2015) that flushing of Chamera III Power Station was done in tandem with Chamera-II power station for which permission was to be obtained by both power stations from Northern Region Load Dispatch Centre (NRLDC) and State authorities.

The reply is to be viewed against the fact that documents in support of disallowance of flushing operations by NRLDC in Chamera-III were not furnished despite specific request in this regard.

3.1.6 Flushing operations in Nathpa Jhakri Power station of SJVN

In Nathpa Jhakri Power station (NJHPS) of SJVN neither the frequency of flushing was prescribed in ROM nor was any system of assessment of post monsoon reservoir capacity put in place. In the absence of appropriate systems in place, Audit was unable to assess the adequacy of flushing operations carried out by NJHPS and consequent impact, if any, on the reservoir capacity.

SJVN stated (June 2015) that 100 *per cent* silt was flushed out during reservoir flushing.

However, no documentary evidence was provided in support of reply and sedimentation assessment study was not carried out after the monsoon without which it was not possible to assess the effectiveness of such operations.

CEA stated (August 2015) that concerned utilities need to follow specified norms to take care of this aspect.

MoP, stated (August 2015) that SJVN had been advised to streamline flushing of reservoir and incorporate in its ROM.

3.2 Auxiliary energy consumption in power stations

CERC order of December 2000 prescribed the norms of auxiliary energy consumption[16] and transformation losses in case of underground hydro power station with static excitation[17] and for surface power stations with static excitation as 1.2 *per cent* and 1.0 *per cent* of energy generation respectively. Out of the 11 hydro power stations selected for performance audit, eight power stations are underground and three power stations (*i.e.* Bairasiul, Tanakpur and Indira Sagar) are surface power stations.

In Bairasiul and Tanakpur power stations auxiliary energy consumption consistently exceeded the normative auxiliary energy consumption and actual auxiliary energy consumption exceeded norms by 23.43 Million Units (MUs) and 6.31 MUs respectively during last five years ended 31 March 2014.

NHPC stated (October 2014) that Tanakpur power station was commissioned in 1992, *i.e.* 22 years back. As such the efficiency of old electromechanical equipment like transformers, motors, pumps and other electrical equipment have its impact on auxiliary energy consumption. NHPC further stated (February 2015) that power stations with higher auxiliary energy

16 Auxiliary energy consumption means the quantum of energy consumed by auxiliary equipment of the generating station, such as the equipment being used for operating plant and machinery including switchyard of the generating station and transformation losses within the generating station.

17 The process of generating a magnetic field by means of an electric current is called excitation.

consumption are going to be addressed through Renovation & Modernization programme one by one, after the power station had run its initial useful life.

Reply is to be viewed against the fact that NHPC had not made any long term plan (February 2015) to take up Renovation & Modernisation of its power stations in phased manner.

CHAPTER – IV

Management of Planned and Forced Outages

One of the main objectives of Hydro CPSEs is to operate and maintain power station with maximum efficiency. This can be achieved through effective preventive maintenance and minimisation of downtime of generating units in the event of any outage.

4.1 Classification of outages in hydro power stations

Outages in a hydro power station take place due to three reasons: (i) Planned[18], (ii) Forced[19] and (iii) Miscellaneous[20]. Of these, miscellaneous outages do not affect availability of machines.

4.2 Planned outages

Planned outages of generating units are taken for annual/capital maintenance or monthly, weekly routine checks by hydro CPSEs. Audit observed following inadequacies in the annual planned/ capital maintenance carried out by power stations of NHPC:

(i) known defects in various systems of power stations continued to remain unsolved during regular annual planned maintenance of units resulting in subsequent forced outages and loss of power generation;

(ii) delayed receipt of new or repaired parts during scheduled annual maintenance period resulted in a subsequent additional outage for replacement of parts.

Power stations suffered loss of 35.97 million units of power generation during 2006 to 2014 due to subsequent avoidable forced outages on account of above reasons.

NHPC stated (August 2015) that all power stations had been advised to ensure availability of spares before annual maintenance and rectify the defects noticed during annual planned maintenance. Detailed audit observations along with management's reply and further remarks of audit thereon are indicated in ***Annexure 4.1***.

4.2.1 Contracts for maintenance works

Power station-wise observations on audit of contracts awarded for maintenance works are detailed below:

4.2.1.1 Dhauliganga Power Station of NHPC

A review of records relating to maintenance works in Dhauliganga Power Station (DGPS) revealed deficiencies in procurement planning leading to awards being made in 7 out of 26 selected cases (details in ***Annexure 4.2)*** either at the fag-end of the financial year or after close

18 For annual/capital maintenance or monthly, weekly routine checks as per O&M manual.
19 Due to sudden breakdown of machine on account of improper operation of equipment.
20 Outages due to other factors when the machine is otherwise operational but cannot be operated due to factors like low reservoir level/poor inflow, Transmission line faults/constraints, Excess weeding/silting, No/reduced system demand, Low head/too high tail water level, No irrigation demand, Grid disturbance/failure, Reserve shutdown/spinning reserve, etc.

of financial year in which equipment/spares were originally planned to be procured. In two out of seven cases (Items at sl. no. 2 and 3 of ***Annexure 4.2***) procurement was delayed by 10.5 months and five months respectively from the respective scheduled supply date, mainly due to absence of follow up with suppliers and delay in pre-dispatch inspection by Management thereby defeating the very purpose for which these insurance spares (critical spares) were being procured.

NHPC attributed (November 2014) delay in procurement to (i) late receipt of approval to Revised Budget Estimates (RBE) and (ii) poor response of supplier/manufacturers due to extreme remote location of DGPS for which tender had to be extended on many occasions.

Reply is to be viewed against the fact that delay due to late receipt of RBE approval was NHPC's internal matter, and was therefore, controllable. Further, out of seven cases pointed out in ***Annexure -4.2***, only in one case (at sl. no. 7 of ***Annexure 4.2***) tender submission had to be extended due to less response.

NHPC, however, assured (August 2015) that efforts shall be made to avoid procedural delays.

4.2.1.2 Tanakpur Power station of NHPC

Delays in procurement of materials by Tanakpur Power station (TPS) in 8 out of 29 selected cases (Details in ***Annexure 4.3)*** had arisen mainly due to delays in initiation of proposals (two cases viz. Sl No. 2 and 6 of ***Annexure 4.3***) and processing of award (six cases at Sl No 1 to 6 of ***Annexure 4.3***), which were possible to have been controlled by the Management. TPS took 12 to 30 months in processing of work award against four to seven months prescribed in NHPC Procurement Manual.

NHPC noted the audit observations and assured (August 2015) that efforts shall be made to avoid procedural delays.

4.3 Forced outages

4.3.1 As per principle laid down by CERC in December 2000 in the matter of 'Operational Norms for Hydro Power Stations',

(i) during the monsoon period all machines were required to be available 24 hours for all types of plants, and

(ii) during dry season, run of the river plant (without pondage) is required to the extent that no water is spilled. In plants with pondage facilities all machines are required to provide maximum capacity for at least three hours per day.

The above norms imply that there should be no outage during monsoon period and there should be no spillage of water due to forced outages.

Audit, however, observed that

(i) machines of power stations of CPSEs suffered forced outages aggregating 9871 hours during monsoon seasons of 2009-14 as detailed in the Table 4.1.

Table 4.1

Power station-wise forced outages during monsoon season

Power station	Forced outage (hours) during monsoon season of respective year					
	2009-10	2010-11	2011-12	2012-13	2013-14	Total
NHPC						
Bairasiul	523	372	274	353	0	**1522**
Tanakpur	279	93	213	19	461	**1065**
Chamera I	533	60	1	349	27	**970**
Uri I	0	41	9	79	989	**1118**
Dhauliganga	174	489	205	199	17	**1084**
Teesta V	49	117	34	226	23	**449**
Chamera III	-	-	-	356	108	**464**
Chutak	-	-	-	0	2085	**2085**
SJVN						
Nathpa-Jhakri	147	10	8	0	140	**305**
THDC						
Tehri Hydro	12	27	193	14	47	**293**
NHDC						
Indira Sagar	0	0	8	469	39	**516**
Total						**9871**

A review of machine outage data of power stations selected for performance audit revealed that forced outages during monsoon season in these power stations during last five years ended 31 March 2014 ranged between 293 hours (in Tehri hydro power station of THDC) to 2085 hours (in Chutak power station of NHPC). It was observed that due to forced outages in monsoon periods of 2009-14, power stations of CPSEs suffered generation loss of 341.99 MUs valuing ₹ 27.36 crore (calculated at the rate of ₹0.80 per unit).

(ii) during dry season also power stations suffered forced outages resulting in spillage of 6165.86 cumecs water and consequent generation loss of 160.22 MUs valuing ₹12.82 crore (calculated at the rate of ₹0.80 per unit) as detailed in Table 4.2.

Table 4.2

Power station-wise forced outages in lean season, quantity of water spilled due to such outages and estimated generation loss

Name of Power Station	Outage in hours	Generation loss(in MUs)	Amount (₹ in crore)	Water spilled due to forced outage in cumecs
Bairasiul	8:53	0.44	0.04	8.881
Tanakpur	256:48	2.02	0.16	505.804
Tessta V	1199:47	120.02	9.60	2753.285
Uri-I	93:05	5.56	0.45	228.742
Chutak	2929:11	20.89	1.67	1906.730
NJHPS	1167:32	11.30	0.90	762.413
Total	**5655:16**	**160.22**	**12.82**	**6165.86**

While NHPC did not offer any comment, THDC stated (December 2014) that it could only reduce the occurrence of outages and not eliminate them totally. Water was discharged in order to maintain the reservoir level permitted by the Government.

Reply of THDC is to be viewed against the fact that the cases pointed out above only relate to forced outages which coincided with water spillage. Though water had to be discharged to maintain the reservoir level permitted by Government the water spilled could also have been used for generation if there were no outages at that point of time.

SJVN stated (August 2015) that during the audit period of 60 months, out of total 262800 Machine Hours, forced outages in NJHPS were only 2736 machine hours, which worked out to 1.041 *per cent*.

While Audit appreciates the performance of SJVN in relation to forced outages, the fact remains that out of 1472.32 hours of forced outages, 305 hours was during the monsoon period. As per principle laid down by CERC, all machines were required to be available 24 hours for all types of plants during the monsoon period.

CEA stated (August 2015) that the utilities need to follow recommended Operation and Maintenance (O&M) practices and take preventive maintenance measures for better performance of the power stations in order to reduce forced outages as well as consequent loss of generation on this account, especially during monsoon season.

4.3.2 Audit further analysed the forced outages of more than six hours and observed that plant and machines of power stations selected for performance audit suffered outage due to long unresolved and recurrent faults which were possible to have been controlled through timely maintenance. Power stations suffered loss of generation of 438.66 MUs due to such avoidable forced outages during the period 2006 to 2014. Details of significant cases observed in Audit along with Management response are indicated in ***Annexure 4.4.***

CHAPTER - V

Sale of Power and Collection of Revenue

5.1 Sale of power

CPSEs enter into Power Purchase Agreement (PPA)/Bulk Power Supply Agreement (BPSA) with each beneficiary for supply of power. As per provisions of BPSA, the payment of bills for supply of power from power stations shall be made by the bulk power customers through a confirmed, revolving, irrevocable Letter of Credit (LC) to be established in favour of CPSEs for an amount equivalent to 105 *per cent* of their average monthly billing of preceding 12 months. The LC shall be kept valid at all the times during the validity of the agreement and the amount of LC shall be reviewed once in three/six months.

Audit reviewed the PPAs/BPSAs, LCs opened by beneficiaries and monthly energy sale bills raised and rebate allowed by CPSEs during the period 2009 to 2014 in respect of all 21 beneficiaries purchasing power from selected power stations and observed as under:

5.1.1 Non-signing/renewal of PPA/BPSA with beneficiaries

NHPC had signed PPAs/BPSAs with Delhi Vidyut Board (DVB) (up to 2002) for supply of power from its power stations. In 2002 DVB was split into two generating companies, a transmission company [Delhi Transco Limited (DTL)] and three distribution companies *viz*., North Delhi Power Limited (NDPL)-subsequently renamed as Tata Power Delhi Distribution Limited (TPDDL), BSES Yamuna Power Limited (BYPL) and BSES Rajdhani Power Limited (BRPL). Up to 31 March 2007, DTL had PPAs with NHPC and was doing bulk supply of power to distribution companies (Discoms). Therefore, up to 2007, there was no direct contractual relation between NHPC and Delhi Discoms. In April 2007, DERC allocated the capacities in NHPC generating stations directly to Delhi Discoms. As such, from 1 April 2007 Delhi Discoms came into direct contractual relation with NHPC. However, NHPC has not signed PPAs/BPSAs with Delhi Discoms so far (August 2015).

NHPC stated (February/August 2015) that PPA/BPSA with Delhi Discoms had expired in March 2007. Though BPSA signed with Delhi Discoms had expired, agreement had stipulated (clause 12) that *"the provisions of this agreement shall continue to operate till this agreement is formally renewed, extended or replaced."* As such, all the terms and conditions of expired BPSA were still in force till signing of new BPSA. NHPC further added that they were regularly pursuing with BYPL and TPDDL for early signing of BPSA.

The fact remains that PPAs/BPSAs had been signed with DTL and not directly with Delhi Discoms. Therefore, it would be in the interest of NHPC to sign PPAs/BPSAs with the Delhi Discoms. Verification of NHPC's reply in relation to SJVN and THDC revealed that THDC executed BPSAs with TPDDL and BRPL in March 2011 and March 2012, respectively.

However, BPSA with BYPL was yet to be executed by THDC. SJVN had not signed PPAs/ BPSAs with any of the three Delhi Discoms as yet (August 2015).

5.1.2 Implementation of rebate policy and payment security mechanism

As per rebate policy of NHPC, rebate was to be allowed to beneficiaries only if LC of the required amount (105 per cent of the monthly average bills of preceding 12 months) with a maximum of four revolutions per month was in place before the date of presentation of bill. NHPC, however, did not ensure compliance of above compulsory conditions while allowing rebate to the beneficiaries. Accordingly, rebate of ₹60.48 crore was allowed by NHPC to beneficiaries who were not eligible for rebate as per the rebate policy.

NHPC stated (February 2015) that (i) some of the beneficiaries while calculating the requisite value of LC did not include supplementary bills/arrear bills for the previous period as per their interpretation of relevant clause and (ii) some beneficiaries had opened revolving LC with five revolutions while they made the payment through Real Time Gross Settlement (RTGS). As such LC was not used as a means of payment and kept as a payment security mechanism only.

Reply is to be viewed against the fact that as per rebate policy of NHPC, LC was to be opened for an amount equal to 105 *per cent* of the monthly average bills raised by NHPC during preceding 12 months (whether normal, supplementary or arrear bills). Therefore, exclusion of supplementary and arrear bills from the amount of LC and opening LC with more than four revolutions made the beneficiaries ineligible for rebate as per policy.

Audit also observed that SJVN was not insisting on LC for timely payment of dues. As a result, obtaining LCs as a payment security mechanism was not enforced effectively. This was evident from the fact that LCs were not maintained by BRPL (2011-12), BYPL (2011-12 and 2013-14) and Power Distribution Department (PDD), Jammu and Kashmir (J&K) (2012-14) and dues aggregating ₹187.87 crore were outstanding from these beneficiaries as of March 2014.

SJVN confirmed (August 2015) non-opening of LCs.

MoP also stated (August 2015) that efforts should be made to maintain LC with all State Governments / Utilities.

5.2 Collection of revenue

5.2.1 Position of outstanding dues and regulation of power

The position of outstanding dues of beneficiaries which consistently failed to clear dues of NHPC, SJVN and THDC at the end of years 2009-10 to 2014-15 is indicated in the Table 5.1.

Table 5.1

Beneficiary-wise position of outstanding dues as at the end of years 2009-10 to 2014-15

(₹ in crore)

Year	Name of Beneficiaries	NHPC	SJVN	THDC	Total
2009-10	BRPL	44.42	9.71	18.66	**72.79**
	BYPL	38.37	6.07	7.94	**52.38**
	PDD J&K	87.99	14.50	25.83	**128.32**
	UPPCL	52.36	Nil	69.28	**121.64**
	BSEB	22.82	Nil	Nil	**22.82**
Total		**245.96**	**30.28**	**121.71**	**397.95**
2010-11	BRPL	14.39	13.72	20.53	**48.64**
	BYPL	8.99	8.55	12.83	**30.37**
	PDD J&K	15.00	22.39	11.42	**48.81**
	UPPCL	Nil	34.85	72.96	**107.81**
	BSEB	5.22	Nil	Nil	**5.22**
Total		**43.60**	**79.51**	**117.74**	**240.85**
2011-12	BRPL	281.02	69.62	68.34	**418.98**
	BYPL	187.01	39.45	15.75	**242.21**
	PDD J&K	46.51	27.00	30.07	**103.58**
	UPPCL	542.06	125.76	464.84	**1132.66**
	BSEB	147.96	Nil	Nil	**147.96**
Total		**1204.56**	**261.83**	**579.00**	**2045.39**
2012-13	BRPL	168.26	53.16	84.14	**305.56**
	BYPL	61.74	34.76	66.17	**162.67**
	PDD J&K	504.06	42.35	59.01	**605.42**
	UPPCL	452.52	139.84	759.09	**1351.45**
	BSEB	26.69	Nil	Nil	**26.69**
Total		**1213.27**	**270.11**	**968.41**	**2451.79**
2013-14	BRPL	34.26	57.81	88.37	**180.44**
	BYPL	44.78	67.34	116.56	**228.68**
	PDD J&K	1006.43	62.72	64.76	**1133.91**
	UPPCL	115.75	64.12	247.93	**427.80**
	BSEB	19.05	Nil	Nil	**19.05**
Total		**1220.27**	**251.99**	**517.62**	**1989.88**
2014 - 15	BRPL	111.64	116.80	196.68	425.12
	BYPL	152.35	90.32	192.04	434.71
	PDD J&K	1376.88	298.77	227.89	1903.54
	UPPCL	161.23	136.56	1032.24	1330.03
	BSEB	19.09	Nil	Nil	19.09
Total		**1821.19**	**642.45**	**1648.85**	**4112.49**

CERC (Regulation of Power Supply) Regulations, 2010 provided that in case of the outstanding dues beyond 60 days or in case the required LC or any other agreed payment security mechanism was not maintained as per the agreement, the generating company may serve a notice for regulation of power supply on the defaulting entity, for reducing the drawl schedule. PPAs signed between CPSEs and beneficiaries also included provision to the effect that if the bills were not paid by bulk power customer within 60 days from the date of billing, concerned CPSEs would have the option to regulate supply of energy to bulk power customer in accordance with the directives/ guidelines issued by CERC/GOI from time to time.

Audit examination of the implementation of above CERC regulations by CPSEs for defaulting beneficiaries disclosed that :

NHPC

(i) Though outstanding dues more than 60 days of BRPL BYPL and UPPCL started increasing since June 2011, NHPC resorted to power regulation for the first time only in February 2012.

(ii) Though the outstanding dues more than 60 days of PDD, J&K started piling up since June 2012, NHPC went for power regulation in February 2014 and that also lasted only for two days.

(iii) Regulation of power once started was stopped without complete adjustment of outstanding dues.

Consequently, outstanding dues of ₹1802.10 crore as of March 2015 remained to be realised by NHPC from the above beneficiaries even after regulation of power.

NHPC stated (August 2015) that vigorous follow up for timely realization of payments from beneficiaries was done. In a commercial environment, regulation of power was considered prudent only as a last resort when efforts of all level persuasions get exhausted.

MoP stated (September 2015) that outstanding payment to hydro CPSEs from various states was a matter of concern to this Ministry. Implementation of all provisions for payment security mechanism as laid down in CERC Regulations/PPAs was not always feasible due to opposition of the States and federal nature of our polity. Many a times, follow up and persuasion yielded better results. Nonetheless, CPSEs should always insist for implementation of prescribed safeguards.

The fact remains that due to continuously mounting outstanding dues from ₹43.60 crore as of March 2011 to ₹1821.19 crore in March 2015, NHPC with the assistance of MoP may have to seriously review various possibilities for recovery of dues from regularly defaulting beneficiaries.

SJVN

BRPL and BYPL had not maintained LC since April 2011 and their outstanding dues had been consistently increasing since May 2011. However, SJVN started regulation of power of BRPL and BYPL from November 2011 and December 2011, respectively when outstanding dues of BRPL and BYPL had increased to ₹35.73 crore and ₹30.70 crore, respectively. Even after regulation of power, the outstanding amount against BRPL and BYPL increased to ₹54.40 crore and ₹32.27 crore respectively in March 2012. SJVN withdrew regulation of power on 27 April 2012 after BSES on behalf of after BYPL and after BRPL submitted the firm liquidation plan vide letter dated 22 March 2012 confirming that 90 *per cent* dues of SJVN including surcharge would be liquidated in 11 instalments. As BYPL did not honour its commitment, SJVN again started regulation of power of BYPL from September 2013 which was in progress (December 2014). Further, in the case of UPPCL, though the outstanding dues were showing increasing trend since November 2011, SJVN started regulation of power only from April 2012 when the outstanding dues had increased to ₹101 crore.

SJVN stated (August 2015) that for realisation of outstanding dues regular follow up was done and regulation of power was undertaken as a last resort.

The fact remains that SJVN would need to work out a mechanism to liquidate the outstanding dues of ₹642.45 crore as of March 2015 from these parties.

MoP stated (August 2015) that besides efforts made for realization of outstanding dues, the CPSEs might consider issuing notices to the concerned State Governments/Utilities. MoP also stated in the Exit Conference that provisions regarding regulation of power were the important provisions because of which CPSEs were able to recover some outstanding amount.

5.3 Capacity declaration by NHPC power stations without availability of machines for full day

In 22nd meeting of Commercial Sub-Committee of Northern Regional Power Committee (NRPC) held on 13 October 2012, Northern Regional Load Despatch Centre (NRLDC) had clarified that as per Regulations 3(13) and 3(14) of CERC (Terms and Conditions of Tariff) Regulations, 2009, Declared capacity[21] (DC) should be for 00 to 24 hours. Machine declared under shut down should not be considered for availability as the same would not be able to generate power in case of any contingency in the Grid.

21 Regulation 3 (14) of the CERC (Terms and Conditions of Tariff) Regulations, 2009 defined declared capacity (DC) as the capability to deliver ex-bus electricity in MW declared by generating station in relation to any time block of the day or whole of the day, duly taking into account the availability of fuel or water and subject to further qualification in the relevant regulation. CERC vide Regulation 3 (13) further defined the term 'day' to mean 24 hour period starting from 0000 hour.

A review of capacity declaration by DGPS and TPS revealed that the power stations on various occasions had declared DC (in ex-bus MW) on the basis of availability of machines during peak hours, while the number of machines were not available for full day. Audit observed 53 instances where DC were declared despite the machines not being available for full 24 hours. In other three instances, one unit was under shutdown for the whole day in DGPS on 24 April 2009 and 19 December 2009 and another unit in TPS on 15 July 2011, but 100 *per cent* PAF was claimed by these power stations.

Thus by declaring DC on the machines not available for full day, though the power stations had given priority to their commercial interest, the safety of Grid in the event of any contingency was overlooked. NRLDC had also stressed that in case NHPC considered that regulations provided otherwise, it could take up the matter with CERC for clarification. Audit, however, observed that DGPS continued declaring DC even after reservation of NRLDC as per its own interpretation thereby ignoring the concern for Grid safety.

Further, NHPC had not taken up the matter regarding DC with CERC as suggested by NRLDC in 22nd meeting of Commercial Sub-Committee.

NHPC stated (February 2015 and August 2015) that the comment raised in Audit has been noted and in future, DC would be given only based on availability of machines.

CHAPTER – VI

Disaster Management

6.1 Importance of disaster management in hydro power CPSEs

Hydro power stations located in J&K, Uttarakhand, Himachal Pradesh and Sikkim fall in high seismic zone[22]. These power stations are located in the Himalayan region which is prone to heavy rainfall, especially during monsoon and the occurrence of flood and landslides at different locations is common. Further, since there is no other means of transport except roads in Himalayan States where power stations of CPSEs are located, poor accessibility to infrastructure increases the vulnerability of CPSEs during disasters. Thus, Disaster Management assumes great significance for Hydro power sector CPSEs.

6.2 Snapshot of disaster management regulations– Role of Government of India

CEA prepared (2002) a report on disaster management in power sector with intention to provide guidelines for safeguarding electrical installations against natural and man-made disasters.

Government of India (GoI) also enacted Disaster Management Act, 2005 (Act). Section 37 (1) of the Act, provided that every Ministry or Department of the GoI shall prepare a Disaster Management Plan (DMP) *inter alia* specifying the measures to be taken by it for prevention and mitigation of disasters in accordance with national plan. Section 37 further provided that every Ministry or Department shall review and update annually the DMP.

6.3 Observations on disaster management in hydro power CPSEs

In the light of CEA's guidelines and Disaster Management Act, 2005, the preparedness of selected power stations of CPSEs, to foresee and prevent disasters, was examined. Results of examination are discussed in succeeding paragraphs:

6.3.1 Existence and updation of DMPs

The following table indicates the position regarding preparation and updation of DMP by power stations selected for performance audit:

22 As per information available at Indian Meterological Department website, from the point of view of intensity of seismic activities the country has been divided into four zones. Zone –II to Zone-V. Zone-II (covering 43 per cent of total area) is the least seismic prone while Zone-V (Covering 12 per cent of the total area) is the most seismic prone.

Table 6.1

Details regarding preparation and updation of DMPs by selected power stations

Sl. No.	Name of Power Station	Year of start of commercial operation	Date of issue of DMP	Year of review and updation of DMP
	NHPC			
1	Bairasiul	1982	April 2005	Not reviewed and updated
2	Tanakpur	1993	April 2005	-do-
3	Chamera-I	1994	April 2005	October 2012
4	Uri-I	1997	April 2005	Not reviewed and updated
5	Dhauliganga	2005	November 2007	-do-
6	Teesta-V	2008	March 2012	-do-
7	Chamera-III	2012	October 2014	Not due for review and updation
8	Chutak	2013	January 2015	
	NHDC			
9	Indira Sagar	2005	October 2013	Not reviewed and updated
	SJVN			
10	Nathpa-Jhakri	2004	March 2007	Not reviewed and updated
	THDC			
11	Tehri Hydro	2007	May 2009	June 2015

As could be seen from above table, out of 11 power stations, which prepared DMPs, eight did not review the same annually as per requirement under clause 37(1) (b) of the Disaster Management Act, 2005. Of the remaining three power stations, only one power station reviewed its DMP and in other two, it was not due for review and updation.

NHPC stated (August 2015) that instructions for updation of DMP had been circulated to all HOPs and same shall be finalized shortly.

MoP agreed (August 2015) that NHPC needed to ensure updation of DMP annually in all its power stations. MoP also endorsed CEA's comments on suitable measures to be taken by utilities for disaster management in case of dam failure or sudden release of water. Disaster management in case of flash flood might also be factored in, especially in view of the Uttarakhand floods in 2013.

Regarding NJHPS, SJVN stated (August 2015) that the DMP prepared in 2007 was reviewed in June 2013.

However, the fact remains that the areas identified in the review like flooding of power house due to excessive inflow of water from Bayal nallah, requirement for coordination mechanism especially during monsoon season, coordination with District Administration, Army, Karcham Wangtu project, Rampur Hydro electric project and strengthening of early warning system stations in real time situation were yet to be addressed in DMP.

As regards THPS, THDC stated (August 2015) that DMP of THPS had now been revised and circulated to all concerned on 04 June 2015 and shall be reviewed on annual basis.

MoP stated (September 2015) that CPSEs were addressing the inadequacies in their DMPs. As there is no human control over natural disaster, the objective should be to ensure how disasters can be prevented and/or contained.

6.3.2 Use of dam break analysis inputs in preparation of DMPs

Dam break is partial or catastrophic failure of a dam (which may happen in unlikely event/s of defective construction, poor management, inadequate spillway capacity or natural calamity) leading to the uncontrolled release of water causing severe damage to the lives and properties situated downstream. The effect of such a flood disaster can be mitigated to a great extent, if the resultant magnitude of flood peak and its time of arrival at different locations downstream of the dam can be estimated, facilitating planning and emergency action measures. Therefore, it is the responsibility of the organizations involved with the safety of the dams to plan preventive measures so that in the eventuality of dam failure, the loss can be minimized to the extent possible.

The Environmental Impact Assessment (EIA) Notification 1994 insisted upon the need for preparation of EIA and Environment Management Plan (EMP) which included dam break analysis to provide essential inputs for preparation of inundation maps and DMP. Compliance of EIA notification 1994 by CPSEs is discussed in following paras:

NHPC

6.3.2.1 Audit observed that out of eight selected power stations of NHPC, dam break analysis was conducted only in respect of three projects *viz.* Chamera I and III and Chutak. No dam break analysis was carried out in remaining five power stations *viz.* Bairasiul, Dhauliganga, Tanakpur, Uri I and Teesta V.

NHPC stated (November 2014) that, EIA and EMP, which essentially included dam break analysis, were prepared only for those projects which were taken up after EIA Notification.

The reply is to be viewed against the fact that (i) dam break analysis even in respect of project Teesta V where DPR was prepared after issue of EIA notification, was not carried out. (ii) EIA Notification had been issued by Ministry of Environment and Forests way back in 1994. As more than 20 years have passed after the issue of notification, it was desirable for NHPC to conduct dam break analysis for older power stations as well to ensure the relevance of their DMPs to the current situation. However, dam break analysis in respect of only one of the older power stations *viz*. Chamera- I had been carried out and in remaining four older power stations dam break analysis was not carried out. Though Chamera-I got dam break modelling study conducted in March 2005, the DMP updated in October 2012 did not include Emergency Action Plan (EAP) to deal with dam break situation.

NHPC stated (August 2015) that Dam Break Analysis in respect of all power stations would be completed within one year and would be included in DMPs/EAPs.

THDC

6.3.2.2 The DMP of THPS as originally prepared in 2009 did not include flood plain maps.

THDC stated (August 2015) that flood plain maps had since been made part of revised DMP in June 2015 which has been sent to MOP also for consideration of National Disaster Management Authority (NDMA).

6.4 Gaps between DMP of power stations vis a vis *CEA guidelines and States' DMP*

Audit observed that following provisions, though required as per CEA guidelines or States' DMP, were not included in DMP of NHPC power stations selected for performance audit:

(i) Setting up of advance warning system as measure of preparedness to deal with floods.

(ii) Finalization of commitment contracts for fixed periods with various agencies for resource deployment at short notice, such as large capacity truck mounted DG sets, fleet owners of trucks/trailers and cranes, *etc*.

(iii) Assessment of hospitals to respond to a given emergency situation to work out Emergency Medical Plan for Company's Hospital in Power Station complex.

(iv) The DMPs of power stations had not prescribed Standard Operating Procedures (SOPs) which will be useful for activities like search and rescue, medical assistance, provision of food, drinking water, sanitation, clothing, management relief camps and casualty management evacuation.

(v) Power stations had not carried out capacity building programme in house or externally in the areas of flood management including hydrological data collection and its management, hydrological studies, flood forecasting and use of latest Geographical Information System (GIS) based technologies in decision making.

Accepting the audit observation, NHPC stated (August 2015) that (i)TPS has initiated proposal to establish one Gauge and Discharge (G&D) observation site at foothills of Purnagiri temple, which will also give an advance warning for preparedness to deal with floods. Points raised at sl. Nos. (ii), (iv) and (v) shall be further deliberated upon. As regards point no. (iii), emergency medical plan was being included in DMP.

Regarding observation on steps taken by power stations other than TPS to set up advance warning system, NHPC stated (August 2015) that the importance of advance warning system which was a characteristic of storage projects, remains an additional knowledge on which no further corrective action was possible to be taken by the power station. Further, some of NHPC's power stations were in cascade and there was a proper co-ordination between upstream

and downstream power stations with respect to inflow. Therefore, a proper warning in advance was provided to the downstream projects. Wherever feasible, upstream G&D sites shall be established.

The reply is, however, to be seen against the fact that flood forecasting and warning was important to minimize damage potential from floods. Accurate flood forecasting and advance warning are aimed for providing valuable time to the people and to civil authorities in taking preventive measures like evacuation, relief and rehabilitation measures, preparedness for flood fighting by engineering authorities and thus mitigating losses from floods.

MoP agreed (August 2015) that advance warning system as recommended by Audit should be installed in all hydro projects.

6.5 Non-compliance of guidelines of Central Water Commission

Dam Safety Organisation of Central Water Commission (CWC) issued guidelines for development and implementation of EAP for dams in May, 2006. These guidelines should be followed during development and implementation of EAP for dams. However, the following CWC guidelines were not followed/ complied by the power stations, (except Indira Sagar) selected for performance audit, while preparing EAP for dam.

(i) The EAP should include a section that is signed by all parties involved in the plan, where they indicate their approval of the plan and agree to their responsibility in its execution. Including the approval signatures is essential in an EAP, as it assures that all parties involved are aware of and understand the EAP and agree to do their assigned roles, as soon as an emergency takes place.

(ii) The plan should designate a spokesperson to disseminate information. The news media, including radio, television and newspapers should be utilized to the extent available and appropriate.

(iii) Prescribed formats for emergency event report, earthquake damage report, *etc.*, to be used for recording various emergency situations and unusual occurrences.

NHPC accepted the Audit observation and stated (February 2015) that Draft EAP as per the CWC format had since been circulated to all power stations. The same shall be finalised by respective power stations shortly taking care of all the necessary compliances. NHPC further stated (August 2015) that EAPs for dams/ barrages of six NHPC power stations namely Chamera-I, Chutak, Nimmo-Bazgo, Dulhasti, Uri-II and Tanakpur had already been completed. Draft EAPs of other power stations have also been completed and shall be finalised within six months. Input from dam break analysis shall be incorporated wherever available and shall be updated.

SJVN stated (August 2015) that new Emergency Preparedness Plans (EPP) for NJHPS covering these aspects had been prepared and submitted for the approval of Management on 31 May 2015.

The SJVN Management need to approve the new EPPs on priority in line with CWC guidelines.

6.6 Lapses noticed in dealing with flood of June 2013 in DGPS and TPS of NHPC

In the intervening night of 16 and 17 June 2013 a devastating flood occurred in Uttarakhand which created disastrous situation in all complexes of DGPS. TPS also suffered damages due to this flood.

Audit examined the operational conditions prevailing before the flood of 16-17 June 2013 with reference to codal provisions and observed that both the power stations overlooked various codal requirements, compliance of which could have mitigated the adverse impact of the disaster. Power station-wise observations are as under:

6.6.1 DGPS of NHPC

DGPS was constructed with design flood of 3210 cumecs. Dhauliganga Dam was built on Dhauliganga River (5 Km upstream of confluence of Dhaulganga and Kali rivers), while water from the turbines was discharged through Draft Tubes (DTs) into a common tail race tunnel which in turn discharges water into Elagad nallah immediately upstream of its confluence with river Kali.

During the flood of 16-17 June 2013, despite maximum discharge 2051.72 cumecs as against design flood of 3210 cumecs, substantial damages occurred to the power station components *viz;* power house was submerged up to half the level of office floor (EL 1045 m) and there was heavy accumulation of silt on all the floors[23] the outlet of Tail Race Tunnel (TRT) was choked, four pole structure near the sub-station was washed away; hence grid power supply to power house was not available.

Dhauliganga Reservoir

Flooding in Dhauliganga Power House

23 i.e. Spherical valve floor (EL 1025 m), turbine floor (EL 1029 m), Intermediate floor (EL 1033 m) and Generator floor (EL 1039 m) and office floor (EL 1045 m)

Flooding in Dhauliganga Power House

Besides, eight blocks of B-type quarters (48 quarters) were completely washed away, C and D type quarters, field hostel, co-operative store, nursery school, workshop, colony roads, Central Industrial Security Force (CISF) colony and central store at Dobat suffered severe damages. In this regard NHPC informed MoP immediately after the disaster on 17 June 2013 that due to cloudburst and heavy unprecedented rainfall in upstream reaches of Dharchula area of Pithoragarh District during last two days and subsequent flood in river Kali, water entered the TRT and all systems of powerhouse had submerged in the early hours of 17 June 2013. Besides, a team from NHPC Corporate Office, consisting of Executive Director (Projects), Executive Director (Commercial) and GM (Design and Engineering) who visited the power house site and colony areas of DGPS on 19 and 20 June 2013, submitted its report on 21 June 2013; wherein it mentioned the extent of damages and restoration works required to be carried out. In addition, DGPS prepared (21 June 2013) a report on sequence of events. The reports did not critically examine the sequence of events and adequacy of efforts to mitigate the impact of flood. Restoration activities started from July 2013 with dewatering of power house and three out of four generating units of DGPS were re-commissioned in May-June 2014. Unit no. 1 was put on generation on 22 May 2015.

Audit examined the actual reservoir operations conditions with reference to provisions prescribed in Reservoir Operation Manual (ROM) and sequence of events that had taken place in power house just before the flooding and observed the following lapses:

(i) Against the requirement of ROM, DGPS did not have any Gauge & Discharge (G&D) site located upstream to provide 2 hour advance information. The Feasibility Report (FR) of DGPS had also proposed[24] the need for installation of one or two automatic warning stations in the upstream reaches of Dhauliganga. Further, a gauge site was also required to be maintained at outfall of the TRT as per ROM and readings taken at half hourly intervals during monsoon season were required to be communicated to control room on the dam top. DGPS, however, stopped keeping G&D data in respect of site at outfall of TRT (Kali River) after June 2012 without recording any reason.

(ii) ROM prescribed maintenance of reservoir level at Minimum draw down Level (EL 1330 m) during monsoon period (from 1 June to 15 October) in order to minimize the sediment accumulation in live capacity zone of reservoir as well as for management of flash flood. Against this, the reservoir was maintained around Full Reservoir Level (*i.e.* 1345 m) right from start of monsoon period on 1 June till the date of flooding on 16 June 2013, except on 11 and 12 June 2013 when it was 1338.80 m and 1337.49 m, respectively.

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*24 **Based on study of stream flow records at both Chhirkala and Tawaghat, it was concluded that during high floods, the increase in discharge in Dhauliganga was very fast, which could be even faster during extreme floods. As per FR, the automatically recording station consisting of a pressure sensor at the bottom of the river in an upstream reach could be connected to a tele metering system that could transmit data on the river level continuously or only when the water level exceeds a critical height. Transmission of the signals from the field station to the receiving station could be arranged via satellite or via radio link.***

(iii) ROM provided that during monsoon period, the gauges should be observed at an interval of every half hour. Against this, the gauges were being observed at an interval of two hours. Silt level showed increasing trend between 2200 hr on 15 June 2013 (975 ppm) and 0200 hr on 16 June 2013 (1182 ppm); and at 0400 hrs (2450 ppm), it was recorded more than twice the level recorded at 0200 hrs, still the next measurement was taken after two hours**.**

Flood water discharge form Radial Gate

(iv) Flushing operations due in May and June 2013 as per provisions[25] of ROM were not carried out despite the fact that till the date of flood (16-17 June 2013) the condition laid down in ROM, for carrying out flushing in June month, of discharge exceeding 150 cumecs was existing from 09 June 2013 to 11 June 2013. ROM further provided that if a flood of magnitude of 500 cumecs occurs, the sediment flushing operation should be conducted. However, despite the fact that river inflow was more than 500 cumecs continuously since 0100 hours of 16 June 2013, DGPS started flushing from 0900 hrs of 16 June 2013 only.

Picture showing the intensity of Flood

Damage to Dhauliganga dam site due to flood

25 First silt flushing should be done between 1st May and 31st May when discharge exceeds 110 cumecs; and if discharge does not exceed 110 cumecs then flushing should be carried out on 31 May irrespective of discharge. Second flushing should be done between 1st June and 30 June when discharge exceeds 150 cumecs; and if discharge does not exceed 150 cumecs then flushing should be carried out on 30th June irrespective of discharge.

(v) DMP of DGPS provided that in the situation of flooding of power house, maintenance staff should be informed by operation in-charge for lowering of DT gate[26] and as soon as the gate is lowered, the DT drain valve should be opened. However, from the sequence of events recorded in power house just before the flood, it was noticed that at any stage maintenance staff was not asked by operation in-charge to lower the DT gates. Consequently, water entered the power house from TRT and damaged it.

NHPC stated (August 2015) that (i) The G&D site had been re-established, 5 km upstream of dam w.e.f. 01 June 2015 and the discharge readings recorded regularly. Regarding G&D site at outfall of TRT (Kali River), the same was discontinued as it was not much of relevance for Power Station; (ii) The reservoir level at DGPS was maintained keeping in view generation constraints and inflow of river. However the Power Station has been cautioned to maintain level as per ROM; (iii) A parallel silt measurement method in addition to filtration and drying method which was capable of indicating silt at half-hourly interval has been set up; (iv) After restoration of the plant, all the flushings have been done as per the ROM guidelines and the same shall be ensured for future also; and (v) In Power Station, DT gates were provided for maintenance purpose and not for preventing flooding of power house. Even if DT gates were lowered, there were other galleries / openings from which water would have entered in power house. There was no protocol to lower the DT gates. Nevertheless, instructions have been issued to lower DT gates in high flood conditions as a measure of abundant caution. Since the water level rose very abruptly, there was no reaction time left to lower the DT gates as the kind of flash situation was unprecedented. The attention of the operation personnel at that moment got engaged in de-energizing the line circuit and other electrical installation and to escape to safety from real life hazard. In the Exit Conference (August 2015), it was added that provisions of ROM had nothing to do with disaster as they related to Dhauliganga river while the TRT from where water entered into the Power House opened in Elagad nallah.

Reply is to be viewed against the facts that (i) maintaining gauge site and taking half hourly readings at outfall of TRT was a requirement of ROM and therefore cannot be treated as irrelevant. (ii) CEA in March 2007 had recommended closing of DT gates to avoid flooding of Hydroelectric stations which had been included in the DMP (November 2007) of DGPS. Therefore, DT gates were required to be lowered as per the protocol prescribed in the DMP of DGPS (iii) From the daily Dam log it was seen that the water inflow increased abruptly from 579.14 cumecs at 06:00 hours (generation was stopped at 06:20 hours) to 1008.2 cumecs at 20:00 hours on 16 June 2013, *i.e.* water inflow almost doubled in 14 hours and flooding of

26 Draft tube is located between lower ring of turbine and tail race. It conveys water after discharge from runner to tail race tunnel. Draft tube (DT) gates are provided for isolating the Power house and tail pool before taking maintenance of the turbine. The DT gates are provided with hoisting mechanism. Draft Tube gate is kept closed, when respective turbine is in maintenance. Four Draft Tube gates for opening size of 3.8 m x 3.0 m, were provided in DGPS for preventing backflow of water from tail race side. For operation of four DT gate, four electrically operated 10 Tonne capacity Rope Drum hoists was also provided. Total lift of gate is 21.0 meters, while Lifting & Lowering speed of these gates was 0.5 meter per minute. Thus, lifting and lowering time for DT gate worked out to 42 minutes.

powerhouse happened six hours later *i.e.* at 02:00 hour of 17 June 2013. Thus, there were ample indications and time available for the Management to lower the DT gates.

CEA recommended (August 2015) that utilities may undertake suitable measures to avert the flooding of powerhouse.

6.6.2 TPS of NHPC

TPS was designed for passing flood of 7.02 lakh cusecs[27] (or 19879 cumecs). However, while negotiating the flood of 5.34 lakh cusec (or 15121 cumecs) on 17 June 2013, the power station suffered major damages and its power channel was filled with silt. To rectify the damages and clean the power channel, complete shutdown of TPS had to be taken from 11 January 2014 to 28 March 2014. Audit observed following lapses on the part of TPS in dealing with flood of June 2013:

(i) **Non-availability of system for advance information**

Regulation Rules of Tanakpur Barrage as modified in August 1999 required that a forecasting station at Pancheswar be installed before monsoon-2000. Corporate office of NHPC again instructed (March 2007) TPS to install discharge measuring system in the catchment areas of the project to provide advance warning on the occurrence of flood in the river so that timely action for shut down of the power house could be taken. However, TPS had not installed any such system upstream of barrage.

NHPC stated (August 2015) that available gates were able to pass full flood water without any problem. Power Station was shutdown timely and no damage to generating equipment had occurred. NHPC, however added (August 2015) that the G&D site earlier proposed at Pancheshwar has been reviewed and same was now proposed at foot hills of Purna Giri Temple, which was about 20 km from Tanakpur Barrage along with telemetry system to get real time discharge data.

Reply is to be viewed against the fact that even though available gates were able to pass full flood water, the gate operation was not ensured strictly as per Tanakpur Barrage Regulations as discussed in the subsequent para due to which silt passed into power channel. For clearance of silt TPS had to incur an expenditure of ₹2.79 crore.

(ii) **Non-compliance to the observation of Dam Safety Team**

Dam Safety Teams carrying out inspections between May 2012 and April 2013 pointed out certain locations (as per details given in ***Annexure 6.1***) at left afflux bund[28], right afflux bund, and river bank to be more vulnerable to severe erosion related damages; and, therefore, advised repairs on those locations to be completed before onset of monsoon. TPS, however, did

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27 **1 cumec = 35.314 cusec**

28 Afflux bunds are provided on upstream and downstream to afford flood protection to low lying areas as a result of floods due to afflux (high rise in water) created by the construction ofbridge/structure.

not carry out repairs before onset of monsoon-2013. As a result TPS suffered major damages during flood of June 2013 on the following locations:

(i) The left afflux bund got extensively damaged between RD 200 m and RD 260 m. All the measures like cladding, toe wall, launching apron, *etc*. in this reach to soften the impact of the water current were washed out;

(ii) Change in course of river upstream of tail of the right afflux bund resulted in erosion of right bank as well as spilling of water through Sharda Ghat Bazar to the low lying areas.

(iii) Erosion on the right bank of river in the downstream of barrage along the alignment of power channel in the Military Engineering Service area. Five spurs[29] along with gabions / wire crates[30] between the spurs were completely washed away near RD 4650 m to 4880 m.

Thus, if the repairs suggested by Dam Safety Team had been carried out promptly, damages suffered by TPS while dealing with flood of June 2013 could have been mitigated.

NHPC stated (August 2015) that the right afflux bund and left afflux bund of the Tanakpur Barrage are made up of earthen material. Under such high flood condition, erosion of these bunds cannot be prevented. Repair of these bunds were undertaken during lean inflow period. To repair, the barrage had to be kept empty and thus shutdown of the power station was taken during that period. In lean inflow period, generation loss was minimum.

Reply is to be viewed against the facts that (i) TPS was designed for passing flood of 7.02 lakh cusecs, the flood of 2013 was only 5.34 lakh cusecs. (ii) Failure of Management to rectify defects pointed out by Dam Safety Team before onset of monsoon defeated the very purpose of the Dam Safety Inspection. Defects pointed out by Dam safety team in May 2012 remained unrectified for more than one year including the lean season of 2012-13. Repairs were undertaken subsequently in the lean season of 2013-14. Considering the criticality of work, it was desirable to expedite the works before the onset of monsoon 2013 to minimise the potential damages due to floods.

(iii) Non-operation of gates as per prescribed guidelines

Tanakpur Barrage Regulation Rules laid down following criteria for operation of barrage gates:

- Up to 1800 cumecs under sluice (1 to 5 and 19 to 22) bays to be operated
- Between 1800 cumecs and 5660 cumecs, inflow regulated through Barrage gates (6 to 18 gates)
- Beyond 5660 cumecs, all gates fully operated.

29 Spurs are constructed for protecting the river banks by keeping the flow away from it.

30 Walls constructed by filling large galvanized mesh wire with rocks. Flexibility of a Gabion structure allows it to withstand pressure without deforming cracking or braking as in case of concrete or other material

Audit, however, observed that during flood of 17 June 2013, the gate operation was not done as per above guidelines. Though river inflow increased to 5788 cumecs at 0700 hrs on 17 June 2013 and reached up to 15140 cumecs at 0000 hrs on 18 June 2015 all gates were not operated as per rules. Gate nos. 3 and 22 were not opened and remained closed throughout 17 and 18 June 2013. Opening of gate nos. 1 and 2 was important for clearing silt deposited in front of Head Regulator (intake structure). However, gate nos. 1 and 2 were not operated fully. Consequently, silt deposited in front of Head Regulator passed into power channel when generation was restored on 19 June 2013 after passing of flood. TPS had to take complete shutdown of power station from 11 January 2014 to 28 March 2014 to clear 1.32 lakh cum of silt deposited in the power channel at a cost of ₹2.79 crore.

TPS stated (December 2014) that (i) gate no. 3 was closed as the same was under maintenance, gate no. 22 could not be operated due to technical snag, opening of gate no.1 was done in restricted way due to ongoing civil work to treat cavity at the downstream side of control room and gate no. 2 was opened beyond 1 meter up to 6 meter as per requirement. NHPC added (August 2015) that gate opening was sufficient to pass the actual flood as there was no over topping of the gates as such the damages were not due to non operation of gates.

The reply is to be viewed against the facts that (i) TPS did not ensure that before onset of monsoon all barrage gates were in working condition and all works in barrage area, which could have restricted gate operation, were completed before start of monsoon season. (ii) Though there was no overtopping of gates, the power station suffered damage due to non-operation of gates in accordance with the provisions of Tanakpur Barrage Regulation Rules resulting in deposition of silt at head regulator and subsequent passage into the power channel.

6.7 Not conducting mock drills for various emergency situations

As per DMPs of power stations, mock drills to deal with various emergency situations were to be conducted at regular intervals. Details of possible disastrous situations on which various power houses did not conduct any mock drill during last five years ended 31 March 2014 are given below:

Table 6.2

Emergency situations on which power stations did not conduct mock drills

Sl. No.	Name of Power station and CPSE	Emergency situation on which no mock drill was conducted during five years ended 31 March 2014
1	Bairasiul (NHPC)	Bomb threat, attack of terrorists, flooding of power house and earthquake
2	Tanakpur(NHPC)	Bomb threat, attack of terrorists, flooding of power house and earthquake
3	Chamera-I(NHPC)	Flooding of power house and earthquake

Sl. No.	Name of Power station and CPSE	Emergency situation on which no mock drill was conducted during five years ended 31 March 2014
4	Uri-I(NHPC)	Fire threat, flooding of power house and earthquake
5	Dhauliganga(NHPC)	Flooding of power house and earthquake
6	Teesta V(NHPC)	Bomb threat, attack of terrorists, flooding of power house and earthquake
7	Chamera-III(NHPC)	Bomb attack, fire threat, attack of terrorists, flooding of power house and earthquake
8	Chutak(NHPC)	Bomb attack, fire threat, attack of terrorists, flooding of power house and earthquake
9	NJHPS(SJVN)	Flooding of power house and earthquake
10	THPS(THDC)	Flooding of power house and earthquake
11	ISP(NHDC)	Earthquake

NHPC stated (February 2015) that in the ensuing financial year *i.e.* 2015-16 all relevant mock drills would be organized as per set out norms and guidelines.

SJVN stated (August 2015) that mock drill on flood was conducted on 15 January 2015 and on 07 July 2015 in association with Army and District Administration.

The corrective action taken by SJVN in the year 2015 is appreciated and its continuance would be verified in future audits.

THDC stated (March/August 2015) that specific mock drills to deal with situations like flooding in powerhouse, landslides and earthquakes were in planning process. However, regular mock drill to deal with security breach and fire hazards were being organised from time to time.

NHDC noted the Audit observation for future compliance.

MoP also agreed (August 2015) that mock drills for all possible disasters should be conducted at regular intervals by all the CPSEs. Besides, every project may have a team in place trained in disaster management.

6.8 Lack of training programmes on disaster management

For effective implementation of any DMP, it is important that various stake holders are consistently sensitized through periodic training programmes, workshops, seminars, *etc.* Audit, reviewed the provisions of DMPs of power stations selected for performance audit as regards training on Disaster Management and observed that Nil to five number training programmes on disaster management and Nil to 45 number training programmes on fires safety, first aid, *etc*. were organised by various power stations during 2009-14 as per details given below:

Table 6.3

Training programmes conducted by power stations

Name of Power Station	Provision in DMP regarding training programmes on Disaster Management	Number of training programmes conducted during 2009-2014		Remarks
		On Disaster Management	On Fire safety, first aid etc.	
Bairasiul	Training and awareness of Fire and Safety equipments will be given to the maximum number of employees of power house and dam through any specialised agency twice in a year	Nil	Nil	
Tanakpur		4	10	There was no provision in DMPs regarding training on management of disaster caused by natural calamities
Chamera-I		2	1	
Dhauliganga		3	3	
Teesta-V		3	Nil	
Chamera-III		Nil	Nil	
Chutak		Nil	Nil	
Nathpa Jhakri	DMP did not contain provision regarding regular training of employees on disaster management	Nil	16	No training programme was conducted to deal with disaster caused by natural calamities.
Tehri Hydro	Every year once before onset of monsoon	5	45	
Indira Sagar	There was no provision in DMP regarding frequency and number of training programmes to be conducted on disaster management.	4	Nil	Only 7 employees were given training in four training programmes got conducted through outside agencies.

NHPC stated (February 2015) that in the ensuing financial year 2015-16, all the relevant training programmes would be organised as per set norms and guidelines in TPS and in other power stations.

SJVN stated (August 2015) that training program on Safety in plant and disaster management was organized on 06 and 07 August 2015 through National Safety Council.

NHDC stated (August 2015) that the overall updation of the DMP has already been initiated. The provision for frequency and number of training programme would be suitably included in the updated plan.

CHAPTER - VII

Monitoring System

7.1 Monitoring of generation in power stations of CPSEs is done through Daily Generation Report (DGR) which indicates machine-wise hours of operation, electricity generated, machine outage hours with reasons. For monitoring health of structures and systems dam safety inspection/technical inspections are conducted twice a year, once before monsoon (in April-May) and once after monsoon (in October-November).

DGR of each power station is circulated to higher officers at power station with copies to respective corporate offices and NRLDC. Dam safety inspection is conducted by internal teams consisting of members from the Corporate office and power station or through Dam Safety Organisation (DSO), while technical inspection was carried out by the team of the Corporate office.

7.2 Non-operational instruments

Audit noticed that large number of instruments installed at dam and other structures for monitoring their health were not in working condition. CPSE-wise observations in this regard were as under:

Name of CPSE	Audit observation
NHPC	95.65 *per cent* and 44.26 *per cent* of the instruments installed at Tanakpur and Dhauliganga respectively were not in working condition in May 2014.
SJVN	Since 2009 out of three Strong Motion Accelerographs, only one was in working condition. Five Micro-Seismic Recorders and four Inclinometers which Dam Safety Team recommended during its inspection in 2009 have not been installed so far (May 2015).
THDC	During 2009-2014, the proportion of working instruments in Tehri dam, Chute and Shaft and Power Station decreased from 37.33 *per cent*, 61.51 *per cent* and 27.5 *per cent*, respectively to 17.56 *per cent*, 60.97 *per cent* and 19.93 *per cent*, respectively. In view of large number of unresponsive instruments, CWC recommended (December 2009) that analysis may be carried out to assess sufficiency and redundancy of reliable instruments and a project specific instrumentation manual may be developed describing type, location and scope of all reliable instruments. However, no such manual had been developed (September 2015).

NHPC stated (August 2015) that action has been taken for prompt repair of non functional instruments at all power stations. Monitoring system of power stations has now been made effective and same was being done at the highest level. The observations of Dam Safety and Technical Inspection team are being attended in a time bound manner. During Exit Conference, NHPC stated (August 2015) that it has already committed to prepare an Instrumentation Manual within three months time duly demarcating the instruments important for short, medium and long terms.

Regarding NJHPS, SJVN stated (August 2015) that Strong Motion Accelerographs (SMAs) and Micro Seismic Recorders (MSRs) had gone out of order and no service was available on those modules due to obsolescence of technology. Cases were being initiated to procure and install new SMAs and MSRs. Four Inclinometers were installed at Nathpa Dam slope, but their holes had been choked with rock fragments/soil. Efforts were being made to make these instruments functional.

The reply of SJVN is to be viewed against the fact that observations of Dam Safety Team which had bearing on important aspect of monitoring impact of earthquakes on the behaviour of dam, were not attended to since 2009.

As regards THPS, THDC stated (August 2015) that (i) most of the instruments were installed in foundation/rock or concealed in the structural concrete and therefore, were unapproachable to undertake any repair/replacement at this stage; (ii) Additional instruments like standpipe piezometers[31], tri-axial joint meter[32], tape extension meter[33] have been installed; and (iii) Tehri Dam has three inspection galleries which facilitate physical inspection of clay core zone and continuous monitoring regarding settlement and other parameters to ensure health of Dam.

The fact, however, remains that in spite of pointing out by CWC in December 2009, THDC has not so far assessed sufficiency and redundancy of reliable instruments and formulated project specific Instrumentation Manual describing type, location and scope of all reliable instruments.

7.3 Shortcomings noticed in compliance of pre and post monsoon inspections of dam

NHPC

7.3.1 Comprehensive compliance by TPS of the suggestions of Dam Safety Inspections carried out in May 2012 and April 2013 would have made the flood management in 2013 more effective. [Detailed observation of Dam safety team and their non-compliance by TPS has been discussed under para (6.6.2 (ii))]

NHPC noted the audit observation for future compliance and stated (August 2015) that now the observations of Dam Safety Team were being monitored till the issue is resolved or sorted out.

SJVN

7.3.2 Post monsoon inspection reports of Dam Safety Organisation (DSO), Nasik for the years 2009 and 2013 revealed that observations raised in 2009 related to non-installation of meteorological instruments at dam had not been complied till December 2014. Similarly,

31 To measure pore water pressure.
32 To monitor movement of structural joint.
33 To monitor movement of rock mass/ structure.

observations of 2012 regarding preparation of EAP according to CWC guidelines, training of staff to monitor and operate the entire instrumentation of dam to ascertain the actual behaviour of dam under various operational conditions, etc. (Details in ***Annexure 7.1*)** were not attended by NJHPS so far (December 2014), thereby defeating the purpose of such inspection. It is also pertinent to mention that SJVN had not submitted compliance reports for any of the previous inspections conducted by the DSO till the last inspection (December 2013).

SJVN stated (August 2015) that (i) Purchase of Meteorological instrument was in final stage of tendering and these instruments will be installed in 2015-16, (ii) New Emergency Preparedness Plans for NJHPS has been prepared and submitted for the approval of management on 31 May 2015; and (iii) Training to monitor the entire instrumentation will be done before December 2015.

7.4 Non-compliance with recommendations of CWC for satellite based real time inflow forecasting for Tehri Dam - THDC

CWC, being the design consultant for THDC prepared (August 2005) a report for satellite based real time inflow forecasting for Tehri Dam reservoir. This would help in safety of dam by giving advance information regarding inflow into the reservoir and in turn help in reservoir operation thereby safeguarding the dam. For this CWC also proposed to set up five G&D stations at Dabrani, Uttarkashi, Dharasu on river Bhagirathi and at Gangi and Ghansali on river Bhilangana, 11 meteorological stations and one digital direct read out ground station at Tehri/ Rishikesh.

Audit, however, observed that even after eight years of operation, THPS has not yet (November 2014) completed real time inflow forecasting system as suggested by CWC and was operating with three G&D stations only.

THDC stated (November 2014) that as the work of establishment of real time inflow forecasting system was getting delayed, three numbers of G&D stations were established, out of which two were manual stations at Dharasu on river Bhagirathi and at Ghansali on river Bhilangana and one was automatic G&D station near zero bridge at Tehri. After commissioning of Koteswar HEP, G&D observations were taken at three locations, Dharasu, Ghansali and downstream of Koteshwar.

THDC added (August 2015) that installation of real time forecasting system was in progress and would be installed by January 2016.

CHAPTER – VIII

Conclusion and Recommendations

8.1 Conclusion

8.1.1 Hydro power is a renewable and environment friendly source of energy. As hydro power stations have the inherent ability for instantaneous operations, they are more responsive than most other energy sources, for meeting peak demand and improving reliability of the power system. Performance of operating power stations are gauged through various parameters such as capacity utilisation, annual generation, sale and revenue realisation specified by regulatory bodies like CEA and CERC.

8.1.2 Optimum utilisation of the installed capacity of a power station is important to ensure that the power station is being operated effectively and efficiently. THPS, was designed as a multipurpose project for Full Reservoir Level of 830m. Rehabilitation of families was done by State Government with funds amounting to ₹972.97 crore provided by THDC. However, THDC has not so far been permitted to fill the reservoir beyond EL 825m. Audit observed that due to inadequate flushing and non-maintenance of prescribed reservoir levels, gross and live reservoir capacities of three NHPC power stations reduced by 5.9 to 18 *per cent* and 3.9 to 13 *per cent* respectively during five years ended 31 March 2014. Design energy of power stations forms the basis for recovery of tariff and is required to be reviewed periodically so that end users were not burdened. Design energy of Chamera-I power station of NHPC was however, not reviewed despite the fact that this power station was consistently generating significant secondary energy over and above its design energy since its commissioning in 1994-95. As a result, the consumers were burdened to the extent of ₹274.98 crore during 2009-14.

8.1.3 One of the objectives of CPSEs was to operate and maintain power stations with maximum efficiency. This could be achieved only through effective preventive maintenance to minimise forced outages. It was observed that known defects in various systems of power stations remained unresolved during regular annual planned maintenance of units resulting in subsequent forced outages. As per Operational Norms for Hydro Power Stations fixed by CERC, all machines were required to be available 24 hours for all types of plants during the monsoon period. However, machines of CPSEs suffered forced outages aggregating 9871 hours during monsoon periods of 2009-14. Forced outages ranged from 293 hours in THPS to 2085 in Chutak power station.

8.1.4 CPSEs relaxed the implementation of provisions of payment security mechanism as LCs were either not obtained for required amount or were not used as a means of payment and power of defaulting beneficiaries was not regulated timely. NHPC also allowed rebate of ₹60.48 crore to ineligible beneficiaries due to inadequate amount of LC.

8.1.5 Hydro power stations located in J&K, Uttarakhand, Himachal Pradesh and Sikkim fall in high seismic zone. These power stations are located in the Himalayan region which is prone to heavy rainfall, especially during monsoon and the occurrence of flood and landslides is common. Moreover, absence of any other means of transport, except roads, in Himalayan States, increases the vulnerability of hydro power stations during disasters. Considering the importance of organised efforts to deal with a potential disaster situation, Government of India enacted the Disaster Management Act, 2005. The Act required that every Ministry or Department of the Government of India shall prepare a Disaster Management Plan (DMP) specifying measures to be taken for prevention and mitigation of disasters in accordance with national plan. The Act further required that such DMP should be reviewed and revised annually. Power stations, however, did not review and revise their DMPs as prescribed. Further, DMPs prepared by power stations did not include Emergency Action Plan in case of failure/breakage of Dam (Dam Break Analysis) and did not incorporate provisions of CEA guidelines on disaster management and States' Disaster Management Plans, like setting up of advance warning system, finalisation of commitment contracts for fixed periods. Lately, CPSEs had commenced the process of reviewing the DMPs.

8.1.6 Advance warning centers upstream of dam sites were not established as a measure of preparedness to deal with floods effectively. While dealing with flood of June 2013, DGPS overlooked the requirements of its Reservoir Operation manual as it (i) kept water level up to Full Reservoir Level instead of up to Minimum Draw Down Level (ii) did not carry out required flushing operations due in May and June 2013 (iii) measured silt content at intervals of two hours instead of at prescribed interval of 30 minutes and (iv) failed to close draft tube gates to prevent flooding of power house from tail race tunnel end. This resulted in flooding of the power house. Subsequently, due to restoration of the power station, generation from DGPS remained suspended from June 2013 to May 2014. TPS also overlooked the provisions of Tanakpur Barrage Regulation Rules during management of flood of June 2013 and had to be completely shut down from 11 January 2014 to 28 March 2014 for repairs. Yet till December 2014, the power stations failed to conduct mock drills to deal with natural calamities like earthquake and flooding of power house.

8.1.7 Effective monitoring of operation and maintenance of hydro power stations is essential for safe and efficient operation of the power station. Audit, however, observed that a large number of instruments installed at dams and other structures of CPSEs for monitoring their health were found non-functional during inspections by dam safety teams. NHPC and SJVN had committed to repairing/replacement of such instruments. In case of THDC, most of such instruments were stated to be unapproachable for repair/replacement. However, THDC was yet to take any action to address the issue by preparation of an

Instrumentation Manual describing the type, location, and scope of all reliable instruments as recommended by CWC.

8.2 Recommendations

Based on the audit findings discussed in foregoing chapters, the following recommendations are made to facilitate improvement in operation and maintenance of hydro power stations:

8.2.1 Ministry of Power may

(i) need to take steps for speedy resolution of the long standing issue of non-filling Tehri reservoir up to EL 830 m.

(ii) In line with the objective of National Electricity Policy of balancing the interests of consumers and reasonable recovery of cost by generator, coordinate with other agencies including the Regulator, if necessary, to ensure that design energy of power stations consistently generating substantial secondary energy may be reviewed as per CEA guidelines.

8.2.2 CPSEs may

(i) Ensure maintenance of reservoir level and carry out prescribed flushing operations as per provisions of Reservoir Operation Manuals to avoid sedimentation and consequent reduction in reservoir capacity as well as effective flood management.

(ii) Carry out annual planned maintenance of machines appropriately to minimize forced outages.

(iii) Ensure the compliance with provisions of PPAs regarding opening/renewing LCs and allowance of rebate; and may explore various possibilities for recovery of dues from regularly defaulting beneficiaries including regulation of power as per CERC Regulations.

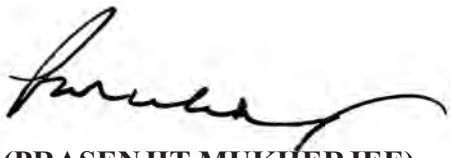
(iv) Establish an advance warning system upstream of the dam site, wherever feasible, so that preventive measures can be taken to ensure safety of dam, power house and population living downstream of the dam.

(v) Ensure regular review and updation of DMPs and prescribe minimum number of mock drills on natural disasters to be conducted by power stations annually for effective preparedness to handle disasters.

(vi) Ensure that compliance to observations of all inspection teams, whether internal or external, relating to safety of structures, including functioning of instruments installed at dam site and power house are carried out promptly.

All the recommendations, except 8.2.1(ii), were generally accepted by MoP/CPSEs. In respect of recommendation 8.2.1 (ii), MoP stated that this was a regulatory issue to be taken

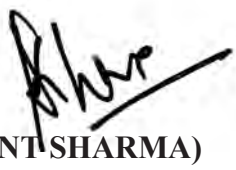
care of by CERC. However, Audit feels that in view of larger public interest as per the National Electricity Policy, MoP may coordinate with the regulator to ensure the desired action.



New Delhi
Dated : 13 November 2015

(PRASENJIT MUKHERJEE)
Deputy Comptroller and Auditor General
and Chairman, Audit Board

Countersigned



New Delhi
Dated : 13 November 2015

(SHASHI KANT SHARMA)
Comptroller and Auditor General of India

Annexures

Annexure-1.1

(As referred to in para 1.3)

Statement showing share of NHPC, SJVN, THDC and NHDC in country's total installed hydro power generation capacity as on 31 March and total hydro power generation for the years 2009-10 to 2014-15

Particulars	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
Total installed hydro generation capacity in the country (MW)	**36863**	**37567**	**38990**	**39491**	**40531**	**41267**
Installed capacity of NHPC (MW)	3629 (9.84%)	3749 (9.98%)	3749 (9.62%)	4024 (10.19%)	4831 (11.92%)	4961 (12.02%)
Installed capacity of SJVN (MW)	1500 (4.07%)	1500 (3.99%)	1500 (3.85%)	1500 (3.80%)	1500 (3.70%)	1912 (4.63%)
Installed capacity of THDC (MW)	1000 (2.71%)	1000 (2.66%)	1000 (2.56%)	1400 (3.55%)	1400 (3.45%)	1400 (3.39%)
Installed capacity of NHDC (MW)	1520 (4.12%)	1520 (4.05%)	1520 (3.90%)	1520 (3.85%)	1520 (3.75%)	1520 (3.68%)
Total installed capacity of above four CPSEs (MW)	**7649 (20.74%)**	**7769 (20.68%)**	**7769 (19.93%)**	**8444 (21.38%)**	**9251 (22.82%)**	**9793 (23.72%)**
Total hydro power generation of country (MUs)	**103916**	**114257**	**130510**	**113720**	**134848**	**129244**
Power generation by NHPC (MUs)	16960 (16.32%)	18606 (16.28%)	18683 (14.32%)	18923 (16.64%)	18386 (13.63%)	22038 (17.05%)
Power generation by SJVN (MUs)	7019 (6.75%)	7140 (6.25%)	7610 (5.83%)	6778 (5.96%)	7193 (5.33%)	8096 (6.26%)
Power generation by THDC (MUs)	2117 (2.04%)	3116 (2.73%)	4591 (3.52%)	4266 (3.75%)	5582 (4.13%)	4214 (3.26%)
Power generation by NHDC (MUs)	3071 (2.96%)	3197 (2.80%)	4664 (3.57%)	4161 (3.66%)	5712 (4.24%)	3691 (2.86%)
Total hydro power generation of above four CPSEs (MUs)	**29167 (28.07%)**	**32059 (28.06%)**	**35548 (27.24%)**	**34128 (30.01%)**	**36873 (27.34%)**	**38039 (29.43%)**

Annexure-2.1

(As referred to in para 2.5)

Details of Power Stations selected for Performance Audit

S. N.	Name of Power Station	Date of commercial operation	Location	River	No. and size of unit in MW	Installed Capacity (MW)	Type of Power Station
1	Bairasiul	April 1982	Chamba (HP)	Baira, Siul and Bhaled	3 x 60	180	RoR with pondage
2	Tanakpur	April 1993	Champawat (Uttrakhand)	Sharda	3 x 31.4	94.2	RoR
3	Chamera-I	May 1994	Chamba (HP)	Ravi	3 x 180	540	RoR with pondage
4	Uri-I	June 1997	Baramulla (J&K)	Jhelum	4 x 120	480	RoR
5	Dhauliganga	Oct.-Nov. 2005	Pithoragarh (Uttrakhand)	Dhauliganga	4 x 70	280	RoR with pondage
6	Teesta-V	Mar.-Apr. 2008	East Sikkim (Sikkim)	Teesta	3 x 170	510	RoR with pondage
7	Chamera-III	Jun.-Jul. 2012	Chamba (HP)	Ravi	3 x 77	231	RoR with pondage
8	Chutak	Nov. 2012 to Feb. 2013	Kargil (J&K)	Suru	4 x 11	44	RoR
9	Nathpa-Jhakri	Oct. 2003 to May 2004	Kinnaur and Shimla (HP)	Satluj	6 x 250	1500	RoR with pondage
10	Tehri Hydro	Sept. 2006 to July 2007	Tehri (Uttrakhand)	Bhagirathi and Bhilangana	4 x 250	1000	Multi-purpose power project with storage
11	Indira Sagar	Jan 2004 to March 2005	Khandwa (MP)	Narmada	8X 125	1000	Multi-purpose power project with storage

Annexure 4.1

(As referred to in para 4.2)

Inadequacies in Planned/Capital maintenance carried out by power stations

Audit observation	Ministry/Management reply	Further remarks of Audit
Delay in treatment of excessive leakages from Pressure Shaft of Dhauliganga Power station of NHPC During initial charging of Pressure Shaft[1]-I of Dhauliganga power station (DGPS) in August 2005, heavy water leakage was observed. Though the defect liability period was still on, DGPS, instead of asking contractor to rectify the defect, awarded (March 2006) the work of treatment of Pressure Shaft to another contractor, who after observing heavy water leakages, abandoned the work (April 2006). This was followed by three inspections viz. (i) By Design Division of NHPC (February 2007), who observed structural disturbances in shaft (ii) By Committee of Corporate office who observed (May 2008) excessive seepage and change in colour of water in Adit[2] to Pressure Shaft Top which was a warning sign calling for early remedial measures (iii) by another committee constituted (July 2011) to suggest suitable remedial measures for this problem. However, remedial action was not taken by the Management despite examination and recommendations of above three inspections. The work was only carried out during restoration of DGPS after floods of June 2013 at a cost of ₹18.30 lakh. Thus, a problem which cropped up immediately after commissioning of power station in August 2005 and had a direct bearing on the safety of important structures was not solved for eight years though planned maintenance was carried out by the unit every year. The leakage also resulted in generation loss (during lean seasons alone) to the extent of 11.85 MUs[3] valuing to ₹94.80 lakh from 2006-07 to 2012-13.	NHPC stated (February 2015) that repeated attempts were made by the power station for repair without resorting to dewatering of water conductor system / complete shutdown of Power Station. It was also stated (August 2015) that it was not commercially prudent to take complete shutdown of power station.	Reply is not acceptable because: (i) It took eight years due to management's indecisiveness. (ii) NHPC did not offer any comment on not getting the leakage rectified from the contractor during defect liability period. (iii) Dhauliganga power station was commissioned without completing painting job of inner surface of pressure shaft steel liner 1 and 2 and leakages from pressure shaft were noticed during initial charging itself.
Delayed/non-receipt of spares in Dhauliganga power station of NHPC The runners of unit nos. 3, 4 and 1 were planned to be replaced during annual maintenance 2009-10, 2010-11 and 2011-12, respectively. However, due to non-receipt of new/repaired runner before annual maintenance of above units, these units were put into operation without replacement of runner. After receipt of runner, these units had to be taken out of generation again for three days to five days, resulting in loss on account of lower PAF amounting to ₹1.32 crore. Due to non-synchronization of receipt of spares and maintenance schedule, Dhauliganga power station suffered loss of ₹1.32 crore on account of lower PAF.	NHPC stated (February/ August 2015) that schedule of unit's shutdown and availability of spares shall be matched and optimized to avoid any generation loss. It shall also be monitored by O&M Division, corporate office.	Audit appreciates the assurance given which would be watched in future.

[1] A vertical or inclined shaft designed to take up high pressure. Pressure shafts are the closed conduits entirely confined between surge shaft and main inlet valve (MIV) and guides the movement of water under pressure. Surge shaft is located at the end of head race tunnel. It is a well type structure of suitable height and diameter to absorb the upcoming and lowering surges in case of tripping and starting of the machine in the power house.

[2] Audit is a type of entrance to underground tunnels which may be horizontal or nearly horizontal.

[3] [{(70/26.8) x 0.15} x 24 hours x 30 days x 6] x 7

Non-maintenance of Main Inlet Valve (MIV) seal in Dhauliganga power station of NHPC During annual maintenance of 2011-12, maintenance team of DGPS found that leakage through MIV seals of unit no 3 and 4 of DGPS was at an alarming stage, but repair of the same was not undertaken because this required repair of Pressure Shaft-II also. Due to not carrying out repair of MIV during planned maintenance period, DGPS had to face forced outages of 164:48 hours in respect of unit no. 3 during 28 August 2012 to 04 September 2012, translating into generation loss of 11.54 MUs equivalent to ₹92.32 lakh (11.54 MUs x ₹0.80 per unit). Audit also observed that during this period due to non-availability of machine, power station was unable to schedule the desired level of power and also lost on account of lower PAF which worked out to ₹55.61 lakh[4].	NHPC stated (August 2015) that in spite of leakage in MIV, maintenance of same was not included during annual maintenance in 2011-12, as it could only be undertaken by emptying the pressure shaft for longer period. However, outages as reported cannot be attributed to leakage of MIV seal.	The reply is to be viewed against the fact that Daily Generation Report indicated that the reason for forced outage of DGPS were attributable to non-opening of MIV. Further, as the Management was aware of the leakage in MIV at the time of annual maintenance in 2011-12, it would have been appropriate to rectify the problem of MIV during the annual maintenance, which was undertaken during lean period. This could have avoided forced outage during peak period and consequent financial loss.
Improper annual maintenance in Tanakpur power station (TPS) of NHPC During the inspection of runner by Management in annual maintenance of 2013-14, crack on runner blade of Unit 3 was observed. The runner was sent to Bhopal unit of BHEL and the unit was put back into operation on 02 June 2014 by fitting an old repaired runner of this unit. However, immediately after synchronization, unit 3 developed problem of excessive shaft vibrations. After examination, TPS concluded that increased vibrations could be due to misalignment/unbalance. Since correction of misalignment/unbalance was a time taking activity, TPS decided to run the machine between 20-25 MW output (against 31.4 MW) so as to keep vibration within safe limit and carry out detailed analysis and corrective action during off peak season. However, the machine was repaired on 26 August 2014. Due to operating machine at reduced capacity, TPS lost on account of lower machine output of unit no. 3 to the extent of 12.58 MUs during peak period of 02 June-25 August 2014 valuing ₹1.01 crore (@ ₹0.80 per unit, the rate for secondary energy).	TPS stated (December 2014/June 2015) that had the machine been taken for repair, it would have taken 15-20 days approximately for repair. Accordingly, the machine was continued to run at 20-25 MW to avoid generation loss in peak period. The gap setting of Turbine Guide Bearing (TGB) was checked and got adjusted on 26 August 2014 after taking outage for 9:19 hours. Thereafter, vibration level was reduced and machine operated on full capacity. Complete realignment of the machine was planned during next annual maintenance for a period of 15- 20 days. NHPC stated (August 2015) that the Power Station has been cautioned to undertake such type of corrective measure without any delay in future. Ministry has not furnished any comment (August 2015).	As rectification of vibration level was a matter of around 9 hours, it was not clear as to why the same was not carried out on 02 June 2014 itself when excessive shaft vibrations were noticed. Between 02 June 2014 and 25 August 2014 (i.e. up to the date of repair) 12.58 MUs were lost due to running unit no. 3 at reduced load.

[4] [{₹27064.43 lakh(AFC)/2}/365]/4 x 6 (29 August 2012 to 03 September 2012)

Annexure 4.2

(As referred to in para 4.2.1.1)

Statement showing delay in procurement due to delay in initiation of proposal and processing award of Dhauliganga Power Station of NHPC

Sl No	Name of Contract	Budget Provi-sion (1)	Date of proposal (2)	Date of award/ (3)	Period in months from date of PR to award) (4=3–2)	Value of award (₹ in lakh) (5)	Sched-ule date of Supply (6)	Actual date of Supply (7)	Delay in Supply (8 = 7– 6)
1	Runner Cone	2009-10	19.3.10	17.12.11	21	20.93	16.11.12	20.12.12	1
2	Complete set of upper & lower bush housing assembly (20 nos. each)	2010-11	29.10.10	25.3.11	5	12.04	20.9.11	9.8.12	10.5
3	Top cover and bottom ring comprising of wearing plates	2010-11	28.6.10	10.2.11	7.5	21.97	9.8.11	2.1.12	5
4	Fix and moving Labyrinth	2011-12	11.8.11	27.1.12	5.5	70.98	24.7.12	21.8.12	1
5	Top cover and bottom ring comprising of wearing plates	2011-12	9.8.11	21.01.12	5.5	33.75	20.7.12	16.03.12 and 21.08.12	-
6	GIS CB active part & its spares	2011-12	19.5.11	12.07.12	14	37.82	24.5.13	30.5.13	-
7	Guide Vanes for Power House	2012-13	14.09.11	29.04.13	19.5	56.94	28.02.14	06.10.13	-

Annexure 4.3

(As referred to in para 4.2.1.2)

Statement showing delay in procurement due to delay in initiation of proposal and processing award of Tanakpur Power Station of NHPC

Sl No	Name of Contract	Budget Provision	Date of proposal	Date of award	Period from date of Proposal to date of award (In months)	Value of award (₹ in lakh)
1	Aircell Type Conservator for 49.5 MVA Generator Transformer for Tanakpur Power Station	2012-13	13.1.12	10.1.13	12	12.65
2	Supply, Installation, Testing & Commissioning of 02 nos. 625 KVA Silent DG Set with AMF Panel and Accessories Conforming to CPCB Norms	2011-12	22.12.09/ 10.2.12	16.6.12	30/4	99.08
3	Digital Automatic Voltage Regulator	2008-09	14.11.07	25.5.10	30	60.03
4	Digital Governor, MAX DNA Version	2011-12	3.6.11	27.7.12	13.5	157.65
5	01 NO. 55 Ton Capacity (Rough terrain) Mobile Crane.	2012-13	27.6.12	29.1.14	19	237.00
6	Supply, Installation, Testing & Commissioning of 625 KVA Silent DG Set with AMF Panel and Accessories Conforming to CPCB Norms	2012-13	27.10.12	31.3.14	17	54.39
7	Stator Air Coolers & Bearing Oil Coolers for 31.4 MW Generator	2011-12	20.6.11	13.1.12	6.5	49.77
8	Purchase of Runner blades template for measuring Runner blades.	2012-13	02.02.12	07.08.12	6	8.48

Annexure 4.4

(As referred to in para 4.3.2)

Cases of recurring forced outages and delayed resolution of faults

Audit observation	Management reply	Further remarks of Audit
Outages due to fault in Gas Insulated Switchgear Circuit Breakers On 21 June 2006 the Gas Insulated Switch gear (GIS) Circuit Breaker (CB) of Unit no. 4 of Dhauliganga Power station failed to interrupt the flow of current. As no spare CB was available, the faulty CB was replaced with healthy CB pole of bus coupler[5] and generation from Unit no. 4 was restored on 06 July 2006. Faulty CB pole was sent to M/s Alstom (the manufacturer), who intimated (October 2006) that in the absence of a clearly identified cause for damage, other investigations were required. After this, six more faults occurred in CBs of Unit nos. 1, 2 and 3 up to December 2012 (*i.e.*, on 20 March 2008, 07 March 2011, 15 February 2012, 30 October 2012, 07 December 2012 and 10 December 2012) due to which DGPS faced forced outages of 2527 machine hours. Finally, after a follow up in October 2012 a meeting was held (April 2013) between NHPC and M/s Alstom to discuss the reasons and preventive action required to be taken to avoid the recurrence. In the meeting M/s Alstom intimated that as a result of detailed study, some modifications had been done in the assembly of CBs for trouble free operation. Accepting the problem in design, M/s Alstom replaced complete active part inside the CBs of all the four generating units, bus coupler and both the transmission lines (total 21 no. poles) in January-February 2014. Audit observed that in spite of the fact that CBs were so maintenance free and highly reliable equipment that maintenance manual of OEM recommended only minor inspection, that too after every four years to six years, DGPS did not follow up failure of CBs with M/s Alstom, after October 2006 till October 2012 due to which DGPS lost 2527:43 machine hours translating into generation loss of 105.91 MUs[6].	NHPC stated (November 2014, February 2015 and August 2015) that (i) since there was no recurrence of fault after 2006 in the following year it was not expected in future also. Further, change in design was not solely based on occurrence of single fault. The firm felt the need for change in design after observation of four similar faults in 2012 and on persuasion of the management they admitted the design mistake, (ii) minor/ major inspection of CBs was not solely based on periodicity of operation of equipment but also on its number of operations performed in a day or number of tripping that occur due to outages of machine or feeders which cause detrimental effect on moving and fixed contact in active part.	Considering the reliability and maintenance free nature of equipment and first fault occurring within one year of commencement of commercial operations followed by another fault in 2008, it was desirable for DGPS to expeditiously follow up the results of further investigation on faulty CB sent to M/s Alstom's workshop. Further, the reply regarding admittance of design mistake by M/s Alstom confirms the fact that occurrence of fault in maintenance free and reliable part at early stages of operation was unusual. (ii) DGPS did not furnish actual number of operations performed on CBs in support of its reply.

[5] Bus coupler is a device which is used to switch from one bus to the other without any interruption in power supply and without creating hazardous arcs. It is achieved with the help of circuit breaker and isolators.

[6] 95.76 MUs in respect of first two outages occurring during peak season + 10.15 MUs in respect of other five outages occurring in lean period.

Outages due to non-opening of Guide Vanes (wicket gates) at DGPS DGPS started experiencing problem in automatic opening of wicket gates[7] after completion of first monsoon since its COD in October 2005. As the problem persisted for three years, General Manager/DGPS suggested (October 2009) replacement of existing servomotor with higher capacity servomotor in one of the units on experimental basis. However, no further action was taken in this regard. In the meantime an expert of M/s Alstom was called in October 2009, who suggested conditioning the greasing system of wicket gates. Despite conditioning, the problem of non-opening of wicket gates persisted during 2010. General Manager/DGPS reiterated (August 2011) his concern to O&M Division of the corporate office and requested for approval of proposal to increase the capacity of servomotors. As no decision was taken by O&M Division of NHPC on the proposal of GM/DGPS, DGPS continued to experience problem of non-opening of wicket gates during monsoon season of year 2011 also. O&M Division, Corporate office suggested (October 2011) coating of underwater parts to prevent damages due to siltation and cinematic test (dry test) of wicket gates to verify the wicket gate angle (degree) movement with reference to servo motor stroke (mm). Action on these measures was not taken by DGPS and in the meantime, due to major flood occurring in the midnight of 16-17 June 2013, generation at power house was stopped. During restoration of power station, based on recommendation of M/s Alstom, NHPC procured (November 2013) and installed four sets of wicket gate servomotors at a cost of ₹52.92 lakh. Outage reports after restoration (i.e. from May 2014 to August 2014) did not indicate problem of non-opening of wicket gates. Audit observed that delayed decision on replacement of servomotors, in spite of protracted pursuance by DGPS resulted in frequent outage aggregating to 208:02 machine hours with a loss of 14.56 MUs (equivalent to ₹1.16 crore) due to non opening of wicket gates during five years ended 31 March 2013. Besides, due to not generating as per agreed generation schedule on those dates, DGPS had to bear penalty of ₹1.78 crore in the form Unscheduled Interchange[8] Charges.	NHPC stated (November 2014 and August 2015) that initially M/s Alstom informed that servomotors were not under- designed and the guide vanes were not opening due to damages of underwater parts by silt. During annual maintenance of 2012-13, M/s Alstom studied the problem and concluded that there was no other option, but to replace the servomotor. Implementation/ replacement of servomotor were not desirable without detailed study. The servomotor was replaced in 2014 and now the Guide Operation was trouble free.	In view of satisfactory operation of all other parameters of wicket gates, DGPS had concluded in October 2009 itself of the need for replacement of servo motors. Corrective action was, however, not taken timely. Final solution of problem by replacement of servo motor also substantiates the fact that problem was with the servo motor itself.

[7] In Dhauliganga Power Station (DGPS) there are 20 Nos. of wicket gates in a unit to regulate the flow of water as per load variation. The Wicket gates are operated by two servomotors.

[8] Unscheduled Interchange in a time block for a generating station means its total actual generation minus its total scheduled generation. Charge for Unscheduled Interchange for all time blocks shall be payable for under-injection by the generating station, worked out on the basis of rates prescribed by CERC for average frequency of time block.

Outages due to Rotor Earth Fault at Tanakpur Power station Between August 2009 and September 2014, TPS suffered forced outages of 537: 38 hours due to frequent Rotor Earth faults in Unit no. 1. In spite of problem of Rotor Earth fault persisting since August 2009, TPS took up with BHEL (*i.e.* OEM) for the first time in January 2014 and asked it to carry out detailed examination/inspection and testing of complete rotor to find out the exact reason of such frequent failures. BHEL in September 2014 recommended re-insulation of wound poles, replacement of coil leads and insulated clamp, *etc.* for joint supports. The work was yet to be done (February 2015). Thus, permanent solution to the frequent problem in unit no. 1 due to Rotor Earth fault could not be found though five annual maintenances were carried out during 2009 to 2014. As a result of this TPS suffered generation loss of 16.87 MUs valuing ₹1.35 crore.	NHPC stated (February 2015 and August 2015) that first time rotor earth fault was developed on 21 August 2009 after capital maintenance of Generating Unit no.1. Thereafter rotor earth faults developed during 2010-11 and 2011-12. The problem has already been telephonically discussed with OEM and their recommendation of September 2014 will be implemented in phased manner in TPS and duly monitored by O&M Division.	Reply indicates that NHPC failed to provide permanent solution to the recurring problem of rotor earth fault during last five years.
Generation loss due to delay in repairing of radial gates in Teesta-V power station of NHPC Leakage of water from the radial gates of the dam of Teesta-V power station was noticed in March 2009 leading to loss of generation of power. Temporary repair work to arrest the water leakage was carried out during annual maintenance of 2010, but the problem could not be fully rectified. Management initiated action for major repair of radial gates in October 2012 on urgent basis. However, approval for major repair job of radial gates was accorded after eight months in June 2013. The work was awarded (December 2013) to M/s Mungipa Trade Links Private Limited at a value of ₹8.04 crore and was completed in March 2014. Audit observed that due to delay of eight months (October 2012 to June 2013) in administrative approval of the urgent repairing job, the work which was possible to be completed in July 2013, was actually completed in March 2014 resulting in generation loss of 301.32 MUs valuing ₹40.59 crore during the lean period from September 2013 to February 2014.	NHPC stated (April 2015 and August 2015) that the repair/replacement work of Stop log sill beams was only possible with complete shutdown of machine. Further, repair and maintenance of Stop Log Sill Beams were in progress in phased manner.	Reply is silent on the reasons for avoidable delay in administrative approval which resulted in generation loss.

Annexure 6.1

{As referred to in para 6.6.2(ii)}

Statement showing observations of Dam Safety Team which were not complied by Tanakpur Power Station within time limit recommended by the Team

Inspection period	Observation	Action taken by TPS	Audit observation
7 & 8 May 2012	**Left Afflux Bund** During previous inspection concrete lining between RD 280 – 400 m was found to be settled associated with cracks over concrete lining and cavities below. The further subsidence associated with cracks were observed during present inspection also in a stretch of about 50 m upstream side. Temporary protection works are being carried out by placing Tetrapods and the cavities are left. It is suggested that, after placing the Tetrapods, the cavities should also be filled with boulders/available granite blocks RBM or sand bags to suit site condition so as to avoid sudden collapse of the embankment during monsoon floods. As this stretch is more vulnerable to severe erosion related damages, the work be taken up on priority and completed before onset of monsoon -2012. **Inspection carried out on 15 & 16 October 2012** Damages observed in concrete lining during previous inspection has been treated temporarily between 240 to 340 m to prevent further extension during the monsoon and the balance portion between RD 186 m to 240 m is to be taken up shortly as per the suggestion given in previous inspection. **Inspection carried out on 01 & 02 April 2013** Same status was reported as during inspection of 15 & 16.10.2012.	Permanent restoration works of damaged portion between RD 280 m to 400 m were carried out during closure period of power station between 11.01.2014 to 26.03.2014.	The stretch which were adjudged (May 2012) by Dam Safety Team to be more vulnerable to severe erosion related damages and, therefore advised to be taken up on priority and completed before onset of monsoon -2012, were not taken up even before onset of monsoon-2013.
15 & 16 October 2012	**Right Afflux Bund** It was observed that a branch of main river was taking turn towards right bank near Sharda Ghat; as such it was advised that the damaged nose of spur constructed to divert water from Sharda Ghat be restored. **Inspection carried out on 01 & 02 April 2013** It was reported that power station had informed that restoration of the nose of the low level spur near Sharda Ghat would be taken up shortly.	The nose of the low level spur near Sharda Ghat Bazar was restored by awarding work to M/s Hillman Enterprises, Meena Bazar vide Letter of award dated 31 March 2014.	Restoration work suggested in October 2012 was not completed before onset of monsoon-2013.

Inspection period	Observation	Action taken by TPS	Audit observation
01 & 02 April 2013	**River bank protection works** Damages to nose and other portion of spurs at nine locations (parallel to Power Channel) at RD 2150, 2400, 2575, 2650, 4250, 4350, 4550, 4650 and 4880 reported during previous visit (October 2012) be taken on priority before onset of monsoon especially in MES area.	In compliance to above, the work has been executed before onsets of monsoon vide LOA no. 3115 dated 20.1.2014.	Works which were recommended by Dam Safety Team to be carried out before onset of monsoon 2013 were carried out before onset of monsoon 2014.

Annexure 7.1

(As referred to in para 7.3.2)

Statement showing external inspection's observations and status thereof in respect of NJHPS of SJVN

S. No.	DSO Nasik post monsoon inspection 2009 observations	DSO Nasik post monsoon inspection 2012 observations	DSO Nasik post monsoon inspection 2013 observations
1	–	National Committee on Dam Safety documents (as per Point no. 4.3, mentioned in Form of periodical inspection of Large Dam) should be prepared according to the guidelines of CWC and approved copy of the same should be sent to this organisation for record. Preparation of Emergency Action Plan (EAP) should be attended on priority. The EAP should be strictly prepared according to CWC guidelines.	Same observation as noticed during inspection of 2012
2	–	Data logger was observed out of order due to humid conditions in the gallery as the uplift measurement is important factor so the data logger should be repaired earlier.	Data logger was sent for repair. Hence reading could not be taken due to non-availability of portable data logger. (Final compliance report was awaited)
3	–	The water level measuring gauge was seen in illegible conditions. Separate readable and water proof gauge should be provided and the water level reading should be cross checked with the reading of automatic water stage recorder.	Same observation as noticed during inspection of 2012.
4	–	Three strong motion accelerographs are observed in foundation gallery, inspection gallery & top of dam. However, the storage and acquisition module (SAM) are out of order hence the accelerographs are also not in working condition. As the dam site is in Earthquake zone no. IV it is very essential to keep watch on the seismic activity.	Same observation as noticed during inspection of 2012.
5	No meteorological instruments (such as rain gauge, wind velocity recorder etc.) are installed on dam site.	Same observation as noticed during inspection of 2009.	Same observation as noticed during inspection of 2009.

6	–	The staff should be properly trained to monitor & operate the entire instrumentation of dam to ascertain the actual behaviour of dam under various operational conditions. Hence, it is recommended that visit to Koyna hydroelectric project, Maharashtra, may be sought for the official concerned where the instrumentation scheme was monitored & operated very well by trained authorities.	Same observation as noticed during inspection of 2012.
7	–	Data Acquisition System (DAS) is installed on top of the dam for vibrating type instrument readings. It is not connected to computer for real-time monitoring. It is suggested to connect the same with computer for continuous monitoring.	Same observation as noticed during inspection of 2012.
8	–	Model study of EDA needs to be carried out for the present condition. Further result of actual performance of EDA should be compared with designed results.	Same observation as noticed during inspection of 2012.

Glossary of Technical Terms

Sl. No.	Technical term	Meaning
1	Adit	It is an underground opening from hill face either for facilitating underground construction (construction adit) or for exploration/ instrumentation (exploratory adit).
2	Afflux bund	An embankment or dyke designed to ensure that the structure is not outflanked during flood flows. In some cases, it also acts as an embankment to fervent flooding to the country side due to an afflux.
3	Bus coupler	A device which is used to switch from one bus to the other without any interruption in power supply and without creating hazardous arcs. It is achieved with the help of circuit breaker and isolators.
4	Capacity Utilisation Factor (CUF)	It is the ratio of actual energy generated by a power station to the equivalent energy output at the rated capacity over a period.
5	Circuit Breaker (CB)	Circuit Breaker is high speed isolating device even in fault condition.
6	Dam/Barrage	A barrier constructed across a river or natural watercourse for the purpose of: (a) impounding water or creating reservoir; (b) diverting water there from into a conduit or channel for power generation and or irrigation purpose; (c) creating a head which can be used for generation of power; (d) improving river navigability; (e) retention of debris; (f) flood control, etc.
7	Design capacity	Capacity at which a Hydro power plant is designed to generate electricity.
8	Design Energy	The quantum of energy which can be generated in a 90 *per cent* dependable year with 95 *per cent* installed capacity of the hydro generating station.
9	Design Inflow	Water inflow envisaged for generating designed energy.
10	Draft Tube (DT)	Draft tube is located between lower ring of turbine and tail race. It conveys water after discharge from runner to tail race tunnel.
11	Draft Tube (DT) gates	DT gates are provided for isolating the power house and tail pool before taking maintenance of the turbine. The DT gates are provided with hoisting mechanism.
12	Elevation (EL)	The elevation of a geographic location is its height above or below a fixed reference point.
13	Excitation	The process of generating a magnetic field by means of a DC electric current is called excitation.
14	Flood plain map	A flood plain map delineates the area that can be expected for different return period floods.
15	Gabion	Walls constructed by filling large galvanized mesh wire with rocks. Flexibility of a Gabion structure allows it to withstand pressure without deforming cracking or braking as in case of concrete or other material.
16	Gas Insulated Switchgear (GIS)	Gas-insulated switchgear is the insulating medium gas - SF6 – (Sulphur Hexafluoride).

17	Gross storage capacity	Gross storage capacity is capacity below full reservoir level. It would correspond to the sum of Dead storage capacity and Live Capacity.
18	Guide Vanes/Wicket gates	These are meant to regulate the flow of water as per load variation.
19	Inclinometer	Inclinometer is an instrument used to measure lateral movement and deformation of earthworks or structures. It provides magnitude of inclination or tilt and variation with time.
20	Inundation maps	A map delineating the area that would be flooded by a particular flood event. It includes the ground surfaces downstream of a dam showing the probable encroachment by water released because of failure of a dam or from abnormal flood flows released through a dam's spillway and/or other appurtenant works.
21	Launching Apron	A launching apron is a flexible stone cover placed on the bed of the river which settles into the scouring area as scouring takes place and covers the base and side of the scour hole, preventing it from developing further.
22	Live storage capacity	Live Storage Capacity between the lowest outlet level of reservoir or minimum drawdown level (MDDL) to the highest controlled water level or full reservoir level (FRL).
23	Main Inlet Valve	Main Inlet Valve is a hydraulically operated mechanical device to isolate turbine from HRT.
24	Normative Annual Plant Availability Factor (NAPAF)	Plant Availability Factor (PAF) fixed on normative basis by CERC in its Notification applicable to the tariff period 2009-2014 in respect of each of the hydro power stations considering plant type, silt problem, other operating conditions and known plant limitations.
25	Penstock	A closed conduit for supplying water under pressure to a water turbine.
26	Plant Availability Factor (PAF)	Plant availability factor or (PAF) in relation to a generating station for any period means the average of the daily declared capabilities (DCs) for all the days during the period expressed as a percentage of the installed capacity in MW less the normative auxiliary energy consumption.
27	Pressure Shaft (PS)	A vertical or inclined shaft designed to take up high pressures. Pressure shafts are the closed conduits entirely confined between Surge Shaft and main inlet valve (MIV) and guides the movement of water under pressure.
28	Radial gates	A gate with a curved upstream plate and radial arms hinged to piers and other supporting structure used in Dams to control water flow.
29	Referral Distance (RD)	Referral Distance from a specific point.
30	Rotor	The part of electric generator which rotates. The rotor stays inside the stator and is covered with copper wire. The rotor has a powerful magnet in it. Electricity is created when the rotor moves around the stator, and the magnetic field from the rotor creates an electrical charge inside the copper wire. This charge is collected and sent out as electricity.
31	Runner	Water strikes the edge of the runner pushes the blades and then flows toward the axis of the turbine. It escapes through the draft tube located under the turbine.
32	Secondary Energy	Energy generated beyond Design Energy.

33	Spur	A wall, crib, row of piles, stone jetty or other barrier projecting outward from the bank into a stream, for the purpose of protecting the bank from erosion or for arresting sand movement along the bank, concentrating the flow of a stream into a smaller channel, etc. is called Spur.
34	Standpipe Piezometer	A device used or monitoring pore-water pressure to determine the stability of slopes, embankment and landfill dykes, monitoring the effectiveness of dewatering scheme, monitoring seepage and ground water movements in embankments and dams.
35	Static excitation	The term "static excitation" refers to the stationary nature of the excitation system. The process of generating a magnetic field by means of an electric current is called excitation. The static exciter converts AC into DC for application to the machine field.
36	Surge Shaft (SS)	Surge shaft is located at the end of Head Race tunnel. It is a well type structure of suitable height and diameter to absorb the upcoming and lowering surges in case of tripping and starting of the machine in the power house.
37	Tail Race Tunnel (TRT)	A Tunnel carrying water downstream of the power house to the connecting stream.
38	Toe Wall	It is a shallow wall constructed at the junction of the toe of embankment or guide bund and the bed or floor to provide a footing for pitching.
39	Trunion	A pin or pivot on which something can be rotated or tilted.

List of Abbreviations

Abbreviation	Full form
AFC	Annual Fixed Charges
ATR	Action Taken Report
BPSA	Bulk Power Supply Agreement
BRPL	BSES Rajdhani Private Limited
BYPL	BSES Yamuna Private Limited
CB	Circuit Breaker
CEA	Central Electricity Authority
CERC	Central Electricity Regulatory Commission
COD	Commercial Operation Date
CPSEs	Central Public Sector Enterprises
CUF	Capacity Utilisation Factor
CWC	Central Water Commission
DC	Declared Capacity
DGPS	Dhauliganga Power Station
DGR	Daily Generation Report
DISCOM	Distribution Companies
DMMC	Disaster Management and Mitigation Centre
DMP	Disaster Management Plan
DPR	Detailed Project Report
DSO	Dam Safety Organisation
DT	Draft Tube
DVB	Delhi Vidyut Board
E&M	Electro mechanical
EAP	Emergency Action Plan
ECR	Energy Charge Rate
EIA	Environment Impact Analysis
EL	Elevation
EMP	Environment Management Plan
ERP	Enterprise Resource Planning
FERV	Foreign Exchange Rate Variation

FR	Feasibility Report
FRL	Full Reservoir Level
G&D	Gauge & Discharge
GIS	Gas Insulated Switchgear
GoI	Government of India
GoUK	Government of Uttrakhand
HoP	Heads of Power stations
IDEA	Interactive Data Extraction and Analysis
IEGC	Indian Electricity Grid Code
ISP	Indira Sagar Power station
KV	Kilo Volts
LC	Letter of Credit
LOA	Letter of Award
MDDL	Minimum Draw Down Level
MIV	Main Inlet Valve
MoP	Ministry of Power
MRL	Maximum Reservoir Level
MSR	Micro Seismic Recorder
MU	Million Unit
MW	Mega Watt
MWh	Mega Watt hour
NHDC	NHDC Limited
NHPC	NHPC Limited
NJHPS	Nathpa-Jhakri Hydro Power Station
NAPAF	Normative Annual Plant Availability Factor
NRLDC	Northern Regional Load Despatch Centre
NRPC	Northern Regional Power Committee
O&M	Operation & Maintenance
OEM	Original Equipment Manufacturer
ORM	Operation Review Meeting
PAF	Plant Availability Factor
PDD, J&K	Power Development Department, Jammu and Kashmir
PPA	Power Purchase Agreement
R&D	Research and Development

R&M	Renovation and Modernisation
RBM	River Bed Material
RCC	Reinforcement Cement Concrete
RCE	Revised Cost Estimate
RD	Referral Distance
RHEP	Rampur Hydro Electric Project
RLDC	Regional Load Dispatch Centres
ROM	Reservoir Operation Manual
RoR	Run of River
RPC	Regional Power Committee
RTGS	Real Time Gross Settlement
SCADA	Supervisory Control and Data Acquisition
SJVN	SJVN Limited
SLDC	State Load Dispatch Centre
SOP	Standard Operating Procedure
TGB	Turbine Guide Bearing
THDC	THDC India Limited
THPS	Tehri Hydro Power Station
TPS	Tanakpur Power Station
TRC	Tail Race Channel
TT	Telegraphic Transfer
UP	Uttar Pradesh
UPPCL	Uttar Pradesh Power Company Limited
WPPP	Works and Procurement Policy and Procedure