ANNEXURE –1

CENTRAL ELECTRICITY REGULATORY COMMISSION

Core-3, 5th Floor. SCOPE Complex, Lodi Road, New Delhi-110 003
Tel : 4361051 Fax : 4360010

No : 20/6(1)/99-CERC

20th June 2000

To

Shri R.N. Ray,
Chief Engineer (Power)
Water and Power Consultancy Services (India) Ltd.,
213, Ansal Chambers-II,
6, Bhikaji Cama Place,
New Delhi – 1100 066
(Fax : 011-6194393/6197032)

Sub : Consultancy for formulating operational cost norms including O&M and escalation for Hydro Power for the Central Electricity Regulatory Commission.

Ref: i) Your offer letter WAP/P/BD/CER/2K dt. 23.3.2000
ii) Your letter WA/P/BD/CER/2K dt. 28.4.2000
iii) Your letter WAP/P/CERC/2K dt. 13.6.2000

Dear Sir,

I am directed to convey the acceptance of your above referred offer for Consultancy for formulating operational cost norms including O&M and escalation for Hydro Power for the Central Electricity Regulatory Commission on behalf of the Commission at the tendered amount of Rs. **9,40,000=00 (Rupees Nine lakhs forty thousand only)** on the following terms and conditions:

1. The assignment as per TOR as contained in Annexure-I shall be completed within a period of 60 days commencing from 21.6.2000. The schedule for submission of out-put would be as follows:-

Our-put 1	30 days from the date of award of contract
Out-put 2	30 days from the date of award of contract
Out-put 3	30 days from the date of award of contract

The time schedule shall be strictly adhered to.

The detailed methodology adopted shall be as discussed and approved by the Commission.

3. The schedule of payment shall be as follows:

On submission of Output 1	Rs. 2,82,000=00
On submission of Output 2	Rs. 2,82,000=00
On submission of Output 3	Rs. 2,82,000=00
On completion of assignment including assistance during hearings	Rs. 94,000=00
Total	Rs. 9,40,000=00

The payment to be released on raising of bill subject to acceptance of respective out put.

4. All the payments shall be subject to tax deduction at source in accordance with laws in force for the time being. The service tax @5% shall be extra.

5. The reimbursement of the expenses for the assistance during hearings shall be based on manday rates and DA rates of Rs. 3,000/- per manday and Rs. 2,000/- per day as per CERC's Appointment of Consultants Regulation, 1999.

6. The reimbursement of travel cost shall be at actuals subject to the restriction by Airfare by Economy class.

7. The payment for the assistance during hearings can be made on fortnightly basis subject to raising of bills and producing proof of travel expenses.

8. You shall not disclose to any unauthorised person any information and data that may be supplied to you by the Commission or by any other organisation, under the directions of the Commission. All such documents or any information that may have come to your knowledge directly or indirectly by virtue of the assignment shall be the property of the Commission.

9. You shall give an undertaking that the assignment shall not be in conflict with your prior or current obligation to other clients nor shall it place you in a position of not being able to carry out the assignments objectively and impartially.

10. In case of any default on your part in completion of the work within the time schedule agreed to herein above, the Commission shall be at liberty to get the work completed from any other agency at your risk and your cost.

11. Unless otherwise specifically provided, in case of any differences or disputes between the parties arising out of this assignment, these shall be referred for arbitration of a person nominated by the Commission. The proceedings shall be subject to the Arbitration and Conciliation Act 1996, as amended from time to time.

12. The Commission reserves its right to foreclose, terminate or cancel your engagement without assigning any reasons. In such cases you shall be paid remuneration after taking into consideration the part of the work completed prior to such foreclosure, termination or cancellation of the engagement as may be decided by the Commission, and the decision of the Commission shall be conclusive and binding. The remuneration so fixed and paid shall be deemed to be the final payment in such cases.

13. In respect of any matter for which no provision has been made in this agreement, the provisions contained in the general instructions of the Government on the subject of engagement of consultants shall apply.

You are requested to communicate your acceptance of the aforesaid terms and conditions.

Yours faithfully,

(R.S. BISHT)
Assistant Secretary

Encl : As above.

Copy to:

1. AC (Pay &Accounts)
2. Concerned Chief

ANNEXURE-1

Terms of Reference:

1. Review operational costs including O&M costs for Hydro Power internationally as well as within India with a view to develop industry best practice bench marks.
2. Review the existing norms for Hydro Power operational costs and O&M costs in India and advise on their efficacy from the view point of economy and efficiency.
3. Develop operational cost norms and O&M cost norms for Hydro Power stations and assist the Commission in the subsequent proceedings for notifying these norms.

The assistance to the Commission in the proceedings for notifying the above norms would be as follows:

(a) Assist the Commission in the proceedings

- Compilation of notes of hearings.
- Objective analysis of the statements made by the respondents and the petitioners before the Commission in writing as well oral submissions during the hearings.

- Suggest the acceptability of the arguments based on such analysis/studies based on International/domestic data along with implications of changes suggested on the utilities as well as the beneficiaries through note/report or presentation.

(b) Assist in drafting of Commission's orders on Operational Norms.

Consultancy outputs

1. Review paper on bench marking industry best practice for operational costs including O&M costs of Hydro Power, using international and domestic data.
2. Paper reviewing the analysis of the existing operational cost norms including O&M costs for Hydro Power in India.
3. Proposal for operating cost norms including O&M cost norms for Hydro Power stations.

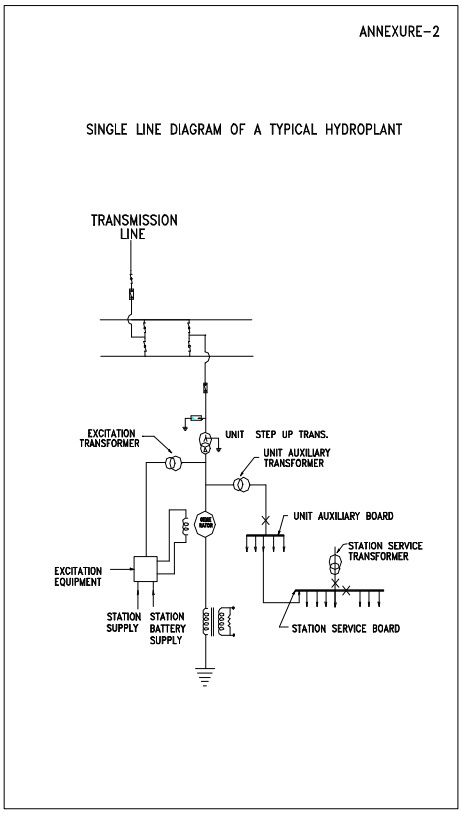
Time line

The consultant must adhere to the following time line:

Work item	Time line
Output 1	30 days from the date of award of contract
Output 2	30 days from the date of award of contract
Output 3	30 days from the date of award of contract

ANNEXURE -2

SINGLE LINE DIAGRAM OF A TYPICAL HYDRO PLANT



ANNEXURE – 3

AUXILIARY CONSUMPTION AND TRANSFORMATION LOSSES IN SOME HYDRO ELECTRIC PLANTS (SURFACE AND SEMI UNDERGROUND POWER HOUSES)

Sl. No	Name of the HE Plant	Installation (MW)	1996-97	1997-98	1998-99	1999-2000
1.	BHIVPURI H.E. GENERATING STATION (ANDHRAVALLEY P.S. CO. LTD.)	MAIN P.H. 6X12 TAIL RACE P.H. 2X1.5				
	Energy Generation (MU)		229.8	311.2	217.8	185.7
	Auxiliary consumption (MU)		3.0 (1.3%)	3.1 (10%)	2.9 (1.33%)	3.0 (1.61%)
	Transformation losses (MU)		2.9 (1.26%)	3.4 (1.1%)	2.8 (1.28%)	2.2. (1.18%)
2.	KHOPOLI GENERATING STATION (TATA H.E. P.S. CO. LTD.)	72				
	Energy Generation (MU)		194.73	164.37	167	178.92
	Auxiliary consumption (MU)		1.366 (0.7%)	1.35 (0.82%	1.43 (0.85%)	1.09 (0.61%)
	Transformation losses (MU)		4.584 (2.35%)	4.37 (2.66%)	4.42 (2.6%)	3.52 (1.97%)
3.	SRISAILAM (A.P. GEN. CORP. LTD.)	7X110				
	Energy Generation (MU)		2921	2955	2617	2371.7
	Auxiliary consumption (MU)		8.8 (0.30%)	6.58 (0.22%)	6.21 (0.2371%)	6.20 (0.26%)
	Transformation losses (MU)					
4.	NAGARJUNA SAGAR (A.P. GEN. CORP. LTD.)	1X110+ 7X100.8				
	Energy Generation (MU)		2161.4	2277.6	2383.1	1999
	Auxiliary consumption(MU)		37.4 (1.73%)	27.3 (1.20%)	13.7 (0.57%)	25.9 (1.30%)

	Transformation losses (MU)					
5.	NAGARJUNA SAGAR RIGHT CANAL P.H. (A.P. GEN. CORP LTD.)	3X30				
	Energy Generation (MU)		227.3	197.17	254	186.2
	Auxiliary consumption (MU)		4.1 (1.81%)	4.26 (2.15%)	5.8 (2.28%)	4.8 (2.57%)
	Transformation losses (MU)					
6.	NAGARJUNA SAGAR LEFT CANAL P.H. (A.P. GEN. CORP.LTD.)	2X30				
	Energy Generation (MU)		119.6	90.3	105.7	84.1
	Auxiliary consumption (MU)		1.37 (1.15%)	1.07 (1.19%)	1.07 (1.01%)	1.07 (1.27%
	Transformer losses (MU)		4.589 (2.35%)	4.37 (2.66%)	4.42 (2.6%)	3.52 (1.97%)
7.	UPPER SILERU (A.P. GEN. CORP.LTD.)	4X60				
	Energy Generation (MU)		447.4	354.1	322	275.1
	Auxiliary consumption (MU)		6.447 (0.1%)	0.586 (0.165%)	0.537 (0.166%)	0.27 (0.1%)
	Transformation losses (MU)					
8.	LOWER SILERU (A.P.GEN. CORP.LTD.)	4X115				
	Energy Generation (MU)		1068.5	764.6	872	1052.3
	Auxiliary consumption (MU)		3.4 (0.32%)	2.5 (0.33%)	2.53 (0.29%)	2.45 (0.23%)
	Transformer losses (MU)					
9.	MACHKUND (A.P. GEN. CORP.LTD.)	3X17 + 3X23				
	Energy Generation (MU)		504.1	299.5	249.3	
	Auxiliary consumption (MU)		2.4 (0.48%)	2.2 (0.74%)	1.93 (0.77%)	
	Transformation losses (MU)					
10	MAHATMA GANDHI H.E. STATION (VVNL)					(April 99 to Dec., 99)

	Energy Generation (MU)		132.53	143.33	158.86	70.3
	Auxiliary consumption (MU)		1.524 (1.15%)	1.42 (0.99%)	1.11 (0.7%)	0.533 (0.76%)
	Transformation losses (MU)		1.965 (1.48%)	2.13 (1.48%)	2.36 (1.48%)	1.04 (1.48%)
11.	JAWAHAR SAGAR (RSEB)	3X33				
	Energy Generation (MU)		477.1	382.3	392.8	244.76
	Auxiliary consumption (MU)		0.9 (0.118%)	0.52 (0.136%0	0.50 (0.127%)	0.45 (0.184%)
	Transformation losses (MU)					
12.	MAHI PH-I (RSEB)	2X25				
	Energy Generation (MU)		193.77	210.82	177	72.83
	Auxiliary consumption (MU)		0.49 (0.25%)	0.41 (0.196%)	0.44 (0.248%)	0.325 (0.446%)
	Transformation losses (MU)		1.35 (0.7%)	1.46 (0.7%)	1.25 (0.7%)	0.59 (0.8%)
13.	MAHIPH-II (RSEB)	2X45				
	Energy Generation (MU)		168.8	185	149.2	55.9
	Auxiliary consumption (MU)		0.32 (0.19%)	0.32 (0.176%)	0.32 (0.218%)	0.243 (0.434%)
	Transformation losses (MU)		1.63 (0.96%)	1.65 (0.89%)	1.32 (0.88%)	0.51 (0.9%)
14.	RANA PRATAP SAGAR (RSEB)					
	Energy Generation (MU)		692.7	549.3	554.3	313.54
	Auxiliary consumption (MU)		0.75 (0.11%)	0.87 (0.142%)	0.78 (0.141%)	0.56 (0.148%)
	Transformation losses (MU)		26.6 (3.8%)	14.12 (2.56%)	1.52 (2.79%)	9.16 (2.92%)
15.	BASSI POWER HOUSE (HPSEB)	4X15				
	Energy Generation (MU)		272.1	314.2	332.7	236
	Auxiliary consumption (MU)		0.546 (0.20%)	0.543 (0.17%)	0.60 (0.18%)	0.28 (0.118%)
	Transformation losses (MU)					

16.	GIRI POWER HOUSE (HPSEB)	2X30	(SEMIUNDER GROUND)			(UPTO DEC., 99)
	Energy Generation (MU)		238.3	245.8	280.5	168.9
	Auxiliary consumption (MU)		1.13 (0.473%)	1.186 (0.4820%)	1.162 (0.414%)	0.685 (0.405%)
	Transformation losses (MU)					
17.	KHEP (NEEPCO)	2X25 + 4X50				
	Energy Generation (MU)		872	816	995	719
	Auxiliary consumption (MU)		1.75 (0.2%)	2.38 (0.29%)	2.42 (0.24%)	1.5 (0.21%)
	Transformation losses (MU)					
18.	KANHER (MSEB)	1X15				
	Energy Generation (MU)		-	9.823	25.3	6.7
	Auxiliary consumption (MU)		-	0.091 (0.93%)	0.12 (0.479%)	0.09 (1.34%)
	Transformation losses (MU)		-			
19.	KOYNA DAM P.H. (MSEB)	2X18				
	Energy Generation (MU)		-	152.2	127.8	119.5
	Auxiliary consumption (MU)		-	0.247 (0.16%)	0.26 (0.2%)	0.18 (0.15%)
	Transformation losses (MU)		-			
20.	VAITARNA (MSEB)	1X60				
	Energy Generation (MU)		-	124.6	80.7	86.86
	Auxiliary consumption (MU)		-	0.67 (0.536%)	0.897 (1.11%)	0.724 (0.833%)
	Transformation losses (MU)		-			
21.	BHIRA TAIL RACE (MSEB)	2X40				
	Energy Generation (MU)		-	78.6	18.35	63.9
	Auxiliary consumption (MU)		-	0.43 (0.543%)	0.077 (0.42%)	0.041 (0.064%)
	Transformation losses (MU)		-			
22.	YELDARI (MSEB)	3X7.5				
	Energy Generation (MU)		-	14.93	4.85	19.7
	Auxiliary consumption (MU)		-	0.126 (0.845%)	0.137 (2.82%)	0.107 (0.593%)

	Transformation losses (MU)		-			
23.	TILLARI (MSEB)	1X60				
	Energy Generation (MU)		-	135.9	71	90.6
	Auxiliary consumption (MU)		-	0.81 (0.596%)	0.499 (0.7%)	0.497 (0.548%)
	Transformation losses (MU)		-			
24.	UJJANI (MSEB)	1X12				
	Energy Generation (MU)		-	24.5	5.43	31.84
	Auxiliary consumption (MU)		-	0.2111 (0.86%)	0.27 (4.97%)	0.246 (0.772%)
	Transformation losses (MU)					
25.	RADHANAGARI (MSEB)					
	Energy Generation (MU)		-	10.84	72.75	13.32
	Auxiliary consumption (MU)		-	0.010 (0.92%)	0.001 (0.001%)	0.000 (0%)
	Transformation losses (MU)					
26.	MUKERIAN H.E PROJECT (PSEB)	45+45+ 58.5+58.5				
	Energy Generation (MU)		1274.84-	1332.46	1528.4	1243.2
	Auxiliary consumption (MU)		2.47 (0.194%)	2.63 (0.197%)	3.156 (0.206%)	2.38 (0.192%)
	Transformation losses (MU)					
27.	ANANDPUR SAHIB HYDEL PROJECT(PSEB)					
	Energy Generation (MU)		960	579	1071.7	705.9
	Auxiliary consumption (MU)		1.24 (0.13%)	1.16 (0.2%)	1.53 (0.143%)	0.817 (0.116%)
	Transformation losses (MU)		4.99 (0.52%)	3 (0.52%)	5.57 (0.52%)	3.67 (0.52%)
28.	SHANAN P.H. (PSEB)	110				
	Energy Generation (MU)		507.4	600	637.2	-
	Auxiliary consumption (MU)		0.56 (0.11%)	0.537 (0.089%)	0.4 (0.063%)	-
	Transformation losses (MU)					

29	JALDHAKA HYDEL POWER STATION (WBSEB)	3X9+ 2X4				
	Energy Generation (MU)		88.48	111.8	123.12	83.46
	Auxiliary consumption (MU)		0.86 (0.98%)	0.83 (0.745%)	0.862 (0.70%)	0.57 (0.68%)
	Transformation losses (MU)		1.6 (1.8%)	1.99 (1.78%)	1.99 (1.6%)	1.03 (1.2%)
30	RAMAM HYDEL PROJECT STAGE-II (WBSEB)	4X12.75				
	Energy Generation (MU)		185.2	178.6	225.3	181.8
	Auxiliary consumption (MU)		0.76 (0.412%)	0.72 (0.4%)	0.668 (0.296%)	0.84 (0.464%)
	Transformation losses (MU)		1.18 (0.64%)	1.21 (0.67%)	1.43 (0.63%)	1.24 (0.68%)
31.	DEHAR P.H. BBMB (PW) SALPPUR	6X165				
	Energy Generation (MU)		3256	3490	3761	2733
	Auxiliary consumption (MU)		15.5 (0.475%)	16.8 (0.48%)	18.15 (0.48%)	13 (0.477%)
	Transformation losses (MU)		35 (1.1%)	67.6 (1.99%)	102 (2.7%)	67.4 (2.46%)
32.	GANGUWAL P.H. (BBMB)	77.65	(SURFACE CUM UNDERGROUND)			
	Energy Generation (MU)		570.6	486	615.8	463.5
	Auxiliary consumption (MU)		1.1 (0.19%)	1.145 (0.235%)	1.1 (0.178%)	0.86 (0.186%)
	Transformation losses (MU)					
33.	KOTLA P.H. (BBMB)	77.65				
	Energy Generation (MU)		603.3	572.4	530.66	470.33
	Auxiliary consumption (MU)		0.908 (0.15%)	0.926 (0.16%)	0.913 (0.17%)	0.675 (0.14%)
	Transformation losses (MU)					
34.	BHAKRA RIGHT BANK (P.H.)	685				

	BBMB BHAKRA					
	Energy Generation (MU)		3458	2520	3934	2480
	Auxiliary consumption (MU)		4.85 (0.14%)	4.64 (0.18%)	6.79 (0.17%)	3.67 (0.148%)
	Transformation losses (MU)		56.7 (1.64%)	26.5 (1.05%)	21.8 (0.55%)	20.2 (0.81%)
35.	BHAKRA POWER PLANT-I (OP.SECTION) (BBMB)	108X5				
	Energy Generation (MU)		2645	1865	2929	2130
	Auxiliary consumption (MU)		5 (0.19%)	5.4 (0.29%)	6.6 (0.22%)	5.33 (0.25%)
	Transformation losses (MU)		29.7 (1.12%)	20.5 (1.1%)	42.3 (1.44%)	25.17 (1.18%)
36.	GANDHI SAGAR (MPEB)	5X23				
	Energy Generation (MU)		564.4	430.7	539.4	114.7
	Auxiliary consumption (MU)		0.94 (.166%)	0.93 (0.216%)	0.85 (0.157%)	0.4695 (0.41%)
	Transformation losses (MU)		5.64 (1%)	4.30 (1%)	5.39 (1%)	1.14 (1%)
37.	PENCH (MPEB)	2X80				
	Energy Generation (MU)		292.4	475	561.2	305.1
	Auxiliary consumption (MU)		0.97 (0.33%)	1.03 (0.22%)	1.11 (0.197%)	0.685 (0.22%)
	Transformation losses (MU)		2.92 (1%)	4.75 (1%)	5.61 (1%)	3.05 (1%)
38.	BARGI (MPEB)	2X45				
	Energy Generation (MU)		487-	567.6	651.7	258.9
	Auxiliary consumption (MU)		0.11 (0.022%)	0.11 (0.019%)	0.11 (0.017%)	0.339 (0.131%)
	Transformation losses (MU)		4.87 (1%)	5.67 (1%)	6.51 (1%)	2.58 (1%)
39.	TONS (MPEB)	3X105				
	Energy Generation (MU)		323	502.5	430	533
	Auxiliary consumption (MU)		1.356	2.38	1.38	1.49

			(0.42%)	(0.47%)	(0.32%)	(0.28%)
	Transformation losses (MU)		3.23 (1%)	5.02 (1%)	4.29 (1%)	5.33 (1%)
40.	HASDEOBANGO (MPEB)	3X40				
	Energy Generation (MU)		359	189	611	221
	Auxiliary consumption (MU)		2.08 (0.58%)	0.27 (0.146%)	0.36 (0.06%)	0.236 (0.106%)
	Transformation losses (MU)		3.59 (1%)	1.89(1%)	6.11 (1%)	2.21 (1%)
41.	BIRSINGHPUR (MPEB)	1X20				
	Energy Generation (MU)		38	68	40.4	45.1
	Auxiliary consumption (MU)		0.38 (1%)	0.62 (0.92%)	0.47 (1.17%)	0.247 (0.547%)
	Transformation losses (MU)		0.38 (1%)	0.68 (1%)	0.40 (1%)	0.45 (1%)
42.	SHARAVATHI GENERATING STATION (KPCL)	10X103.5				(UPTO DEC., 99)
	Energy Generation (MU)		-	5304	5215.6	4401.7
	Auxiliary consumption (MU)			8.86 (0.167%)	9.64 (0.18%)	7.85 (0.178%)
	Transformation losses (MU)			54.57 (1.02%)	45.6 (0.87%)	34.5 (0.78%)
43.	LINGANAMAKKI DAM POWER HOUSE (KPCL)	2X27.5				
	Energy Generation (MU)		-	291.8	264.8	224.4
	Auxiliary consumption (MU)		-	0.41 (0.14%)	0.74 (0.28%)	0.326 (0.145%)
	Transformation losses (MU)		-	3.14 (1.07%)	1.26 (0.476%)	1.01 (0.452%)
44.	BHADRA HEP (KPCL)	39.2				
	Energy Generation (MU)		-	46.73	82.9	77.82
	Auxiliary consumption (MU)			0.394 (0.84%)	1.13 (1.36%)	0.38 (0.49%)
	Transformation losses (MU)		-	0.571 (1.22%)	2.63 (3.17%)	1.956 (2.5%)
45.	SUPA DAM POWER	2X50				

	HOUSE (KPCL)					
	Energy Generation (MU)			386.4	368.2	289.2
	Auxiliary consumption (MU)			0.38 (0.09%)	1.313 (1.08%)	0.242 (0.083%)
	Transformation losses (MU)		-	7.87 (2.03%)	4.87 (1.32%)	5 (1.73%)
46.	GHATAPRABHA DAM POWER HOUSE (GDPH)	2X16				
	Energy Generation (MU)		-	119.6	90.16	91./39
	Auxiliary consumption (MU)			0.338 (0.28%)	0.314 (0.348%)	0.398 (0.435%)
	Transformation losses (MU)		-	1.52 (1.27%)	0.814 (0.9%)	1.078 (1.17%
47.	KADRA DAM POWER HOUSE (KPCL)	3X50				
	Energy Generation (MU)		-		292.17	277.14
	Auxiliary consumption (MU)				0.41 (0.14%)	0.129 (.046%)
	Transformation losses (MU)		-		4.04 (1.38%)	4.26 (1.54%)
48.	KODASALLI DAM POWER HOUSE (KPCL)	3X40				
	Energy Generation (MU)		-		118.27	193.12
	Auxiliary consumption (MU)				0.307 (0.26%)	0.308 (0.16%)
	Transformation losses (MU)		-		1.46 (1.23%)	1.487 (0.77%)

ANNEXURE - 4

AUXILIARY CONSUMPTION AND TRANSFORMATION LOSSES IN SOME HYDRO ELECTRIC PLANTS (UNDERGROUND POWER HOUSES)

SL. No.	**Name of the HE Plant**	**Installation (MW)**	**1996-97**	**1997-98**	**1998-99**	**1999-2000**
1.	SVP BHABHA POWER HOUSE (HPSEB)	3X40				(UPTO DEC.,99)
	Energy Generation (MU)		553.96	541.6	697.4	530.6
	Auxiliary consumption (MU)		1.69 (0.306%)	0.816 (0.15%)	1.04 (0.149%)	0.75 (0.14%)
	Transformation losses (MU)					
2.	VARAHI P.H. (KPCL)	2X115				
	Energy Generation (MU)		-	1224.37	1146	1038.42
	Auxiliary consumption (MU)		-	5.33 (0.45%)	5.54 (0.48%)	3.913 (0.377%)
	Transformation losses (MU)		-	10.14 (0.83%)	9.9 (0.86%)	9.515 (0.916%)
3.	KOYNA STAGE I&II (MSEB)	4X70+ 4X80				
	Energy Generation (MU)		-	2137.5	2411	1370
	Auxiliary consumption (MU)		-	14.27 (0.66%)	15.25 (0.63%)	11.32 (0.83%)
	Transformation losses (MU)		-			

4.	KOYNA STAGE –III (MSEB)	4X80				
	Energy Generation (MU)		-	537.3	596.6	386.4
	Auxiliary consumption (MU)		-	2.29 (0.426%)	2.36 (0.395%)	2.03 (0.526%)
	Transformation losses (MU)					
5.	CHUKHA	336				
	Energy Generation (MU)		1906.87	1777.2	1780.6	1943.7
	Auxiliary consumption (MU)		6.31 (0.33%)	6.31 (0.35%)	6.26 (0.35%)	6.59 (0.34%)
	Transformation losses (MU)					

ANNEXURE – 5

POWER REQUIREMENT FOR EXCITATION OF GENERATOR

NAGJHARI POWER HOUSE

MW Load	Corresponding Max. MVAR Load (MVAR)	Field Current (A)	Field voltage (V)	Excitation Power (KW)	% of Generation
135	65	1200	200	282	0.21
100 (75%)	85	1227	205	296	0.29
67.5 (50%)	88	1241	207	302	0.45

VARAHI UNDER GROUND POWER HOUSE

MW Load	Corresponding Max. MVAR Load (MVAR)	Field Current (A)	Field voltage (V)	Excitation Power (KW)	% of Generation
115	55	1120	240	316	0.27
85	70	1135	243	324	0.35
60	80	1154	247	335	0.56

KADRA DAM POWER HOUSE

MW Load	Corresponding Max. MVAR Load (MVAR)	Field Current (A)	Field voltage (V)	Excitation Power (KW)	% of Generation
50	24	937	175	193	0.39
37.50	31	946	177	197	0.52
25	35	955	178.5	200	0.80

ANNEXURE - 6

TRANSFORMATION LOSSES

1. NAGJHARI POWER HOUSE

MVA (150)	IRON LOSS (KW)	Copper loss (KW)	Total Loss (KW)	% of Energy Generation
100% rated	140	430	570	0.42
75% rated	140	245	385	0.38
50% rated	140	108	248	0.37
25% rated	140	27	167	0.49

2. VARAHI UNDER GROUND POWER HOUSE

MVA (130)	IRON LOSS (KW)	Copper loss (KW)	Total Loss (KW)	% of Energy Generation
100% rated	105	445	550	0.478
75% rated	105	250	355	0.41
50% rated	105	111	216	0.375
25% rated	105	28	133	0.46

3. SHARAVATHI GENERATING STATION

MVA (115)	IRON LOSS (KW)	Copper loss (KW)	Total Loss (KW)	% of Energy Generation
100% rated	100	435	535	0.52
75% rated	100	245	345	0.44
50% rated	100	109	209	0.40
25% rated	100	27	127	0.49

ANNEXURE – 7

AUXILIARY CONSUMPTION AND TRANSFORMATION LOSSES IN SOME HYDRO ELECTRIC PLANTS IN UP

Sl.No.	Name of the HE Plant	Installation (MW)	Energy Generation (MU)	Aux. Consumption (MU)
1.	Chibro	240	1063.545	4.25 (0.399%)
2.	Khodri	240	1063.545	7.563 (1.55%)
3.	Chilla	144	823.046	0.458 (0.056%)
4.	Dhakrani	33.75	159.385	0.508 (0.318%)
5.	Dhalipur	51	305.032	0.721 (0.236%)
6.	Kulhal	30	185.13	0.357 (0.193%)
7.	Ram ganga	198	348.321	0.495 (0.142%)
8.	Khadra	72	456.197	0.509 (0.112%)
9.	Tiloth	90	470.722	1.428 (0.303%)
10.	Khatima	41.4	170. 72	1.177 (0.69%)

ANNEXURE - 8

DETAILS OF CONNECTED LOAD OF AUXILIARIES OF KHODRI POWER STATION RELATING TO MECHANICAL SECTION

Sl.No.	Apparatus	No. of motors	HP rating	Total Load in H.P.
1.	Governor oil pump sets	8	20	160
2.	By pass valve	4	3	12
3.	Cooling water valves	4	3	12
4.	Drainage pumps	2	7.5	15
5.	Dewatering Pumps	2	25	50
6.	Clean water pumps	3	20	60
7.	Governor air compressors	2	20	40
8.	Turbine pit Exhaust fans	4	1	4
9.	Surge tank Gates	2	35	70
10.	EOT crane main hook motor EOT crane aux. hook motor EOT crane cross travel motor EOT crane long travel motors	1 1 1 2	40 35 10 12	40 35 10 24
11.	Emergency Dewatering pumps	1	75	75
12.	Top cover Dewatering pumps	8	3	24
13.	Heavy duty compressor	1	50	50
14.	Siren P.S.	1	2	2
15.	Siren Surge tank	1	2	2
16.	Draft tube crane main lower/raise left	1	15	15
17.	Draft tube crane long travel	2	3	6
18.	Filteration machine for turbine oil	1	5	5
19.	Welding transformer	1	5	5
20.	Lathe Heavy duty	1	5	5
21.	Grinder	1	1	1
	Total	**55**	**-**	**722 H.P.**

DETAILS OF CONNECTED LOAD PERTAINING TO EMOU

Sl.No.	Apparatus	No. of motors	Rating (HP)	Total Load in (HP)
1.	Switchyard compressors	4	20 HP	80
2.	Emulsifire compressors	1	1	1
3.	Emulsifire Booster pump	1	20	20
4.	Gen. T/F cooling pumps	8	4	32
5.	100 MVA T/F Blowers	3	1	3
6.	Air conditioning plant motors	3	35	105
7.	Air handling unit	2	10	20
8.	Blowers	i) 4 ii) 3	2 5	8 15
9.	Light & fan load			75
10.	Isolator motors	9	0.5	4.5
11.	Oil filter m/c	1	5	5
12.	Amplydyne	4	15	60
13.	Braking/jacking	1	5	5
14.	Lift	1	15	15
15.	Battery & Battery chargers			30
				478.5 HP

ANNEXURE – 9

AUXILIARY CONSUMPTION AND TRANSFORMATION LOSSES IN SOME NHPC PLANTS

Sl.No.	Name of the HE Plant	Installation (MW)	1996-97	1997-98	1998-99	1999-2000
1.	Baira Siul	180 (3x60)				
	Energy Generation (MU)		545.21	779.77	750.26	425. 56
	Aux. Consumption (MU)		3.361 (0.62%)	3.374 (0.43%)	3.916 (0.52%)	2.66 (0.63%)
	Transformation * losses (MU)		3.598 (0.66%)	5.146 (0.66%)	4.952 (0.66%)	2.809 (0.66%)
2.	Loktak	105 (3x35)				
	Energy Generation (MU)		496.53	553.86	532.42	506.75
	Aux. Consumption (MU)		1.88 (0.38%)	2.15 (0.39%)	2.32 (0.44%)	2.11 (0.42%)
	Transformation* losses (MU)		3.177 (0.64%)	3.416 (0.62%)	3.413 (0.64%)	3.243 (0.64%)
3.	Salal	690 (6x115)				
	Energy Generation (MU)		2304.84	2993.46	3222.96	3249.14
	Aux. Consumption (MU)		2.67 (0.12%)	3.26 (0.11%)	4.27 (0.13%)	5.075 (0.16%)
	Transformation* losses (MU)		10.832 (0.47%)	14.069 (0.47%)	15.147 (0.47%)	15.27 (0.47%)
4.	Tanakpur	120 (3x40)				
	Energy Generation (MU)		382.92	426.25	469.33	408. 88
	Aux. Consumption (MU)		2.098 (0.55%)	2.41 (0.57%)	3.289 (0.70%)	2.657 (0.65%)
	Transformation* losses (MU)		1.646 (0.43%)	1.832 (0.43%)	2.018 (0.43%)	1.758 (0.43%)
5.	Chamera	540 (3x180)				
	Energy Generation (MU)		1884.42	1916.56	2367.27	2125.73
	Aux. Consumption		5.647	5.678	10.41	6.312

	(MU) Transformation* losses (MU)		(0.30%) 7.726 (0.41%)	(0.30%) 7.857 (0.41%)	(0.42%) 9.7 (0.41%)	(0.30%) 8.715 (0.41%)
6.	Uri Energy Generation (MU) Aux. Consumption (MU) Transformation* losses (MU)	480 (4x120)	 -- -- ---	 2170.94 13.941 (0.64%) 12.157 (0.56%)	 2575.02 14.21 (0.55%) 14.42 (0.56%)	 1948.93 10.556 (0.54%) 10.91 (0.56%)

Note:

* Rated/estimated as separate energy meters are not provided for measurement of this energy.

ANNEXURE - 10

CALCULATION OF EXCITATION CONSUMPTION OF NHPC PLANTS

Project	Unit Capacity (MW)	Excitation Consumption				
		Excitation Transformer Rating kVA	Full Load Voltage (VDC)	Full Load Current (Amp.)	Loss (kW)	Excitation Loss (%)
BAIRA SIUL	60		Not applicable (Shaft coupled excitation system)			
LOKTAK	35		Not applicable (Shaft coupled excitation system)			
SALAL	115	910	270	1600	453.60	0.39%
TANAKPUR	40	875	228	900	215.46	0.54%
CHAMERA	180	1384	285	1133	339.05	0.19%
URI	120	630	190	1400	279.30	0.23%
RANGIT	20	325	130	1100	150.15	0.75%
TOTAL					1437.56	
AVERAGE						0.30%

ANNEXURE - 11

CALCULATION OF TRANSFORMATION LOSSES FOR NHPC PLANTS

Project	Installed Capacity (MW)	Unit Capacity (MW)	Transformation Loss				
			Transformer Rating (kVA)	No Load Loss (kW)	Load Loss (kW)	Total Load Loss (kW)	Transformation Loss (%)
BAIRA SIUL	180	60	3 x 25000	-	-	3 x 149	0.66%
LOKTAK	105	35	3 x 13300	3 x 15	3 x 62	3 x 77	0.64%
SALAL	690	115	3 x 43330	3 x 27	3 x 155	3 x 182	0.47%
TANAKPUR	120	40	1 x 49500	1 x 30	1 x 160	1 x 190	0.43%
CHAMERA	540	180	3 x 75000	3 x 46	3 x 233	3 x 279	0.41%
URI	480	120	3 x 50000	3 x 27.5	3 x 225	3 x 252.5	0.56%
RANGIT	60	20	1 x 25000	1 x 16	1 x 174	1 x 190	0.84%
AVERAGE			281130			1319.5	0.52%

ANNEXURE – 12

DATA ON HYDRO ELECTRIC PROJECTS IN OPERATION IN ZIMBABWE

1. Name of Project

Kariba South Hydro Power Station

2. Installed Capacity

6 X 111 MW units. The units are being uprated from 111 to 125 MW. To date units 1 and 2 been successfully uprated to 125 MW and units 5 and 6 are currently on outage for the uprating.

3. Date of Commissions

December 1959 to March 1962

4. Completion Cost

$78 million (including associated transmission system)

5. Design

5834 GWh per annum

The amount of energy that can be generated is regulated by the Zambezi River Authority who limit it during times of draught.

6. Types of scheme

7. Type of Power House

Underground

Sl.No.	Item	1996/97	1997/98 *	1999
1.	Annual Energy Generation (GWh)	2128.065	2936.444	2957.17
2.	Annual Energy Consumption by Unit & Station auxiliaries GWh)	4.554 (0.21%)	9.804 (0.33%)	7.853 (0.26%)
3.	Annual availability (%)	86.50	72.66	65.13

*** 18 months**

ANNEXURE - 13

COMPONENTS OF OPERATION AND MAINTENANCE EXPENSES

A. GENERATION EXPENSES

i) Consumption of stores & spares
ii) Repairs & Maintenance

- a) Buildings
- b) Machinery
- c) Others

iii) Other Operational Expenses (Including Royalty)

B. ADMINISTRATION & OTHER EXPENSES

Rent
Rates & Taxes
Insurance
Electricity Charges
Travelling & Conveyance
Expenses on Staff cars/vehicles
Telephone, Telex & Postage
Advertisement & publicity
Entertainment Expenses
Printing & Stationery
Consultancy Charges
Corp. Office Management Expenses
Loss on Sale of Assets
Other Miscellaneous Expenses

C. EMPLOYEES REMUNERATION & BENEFITS

i) Salaries, Wages & Allowances
ii) Gratuity and Contribution to Provident Fund (including Adm. Fee)
iii) Staff Welfare Expenses
iv) Others

D. **OTHER EXPENSES** (Not covered above)

ANNEXURE - 14

O&M EXPENSES IN SOME OF THE HYDRO PLANTS

SL. No.	Name of HE Station	Installed Capacity (MW)	Capital Expenditure applicable to completion in 1997-98 (Crores)	O&M Expenses in 1998-99 (Lacs)	O&M Expenses as % of Capital Expenditure
1.	Mukerian (PSEB)	207	840.42	1178.94	1.4%
2.	Anandpur Sahib (PSEB)	134	544.04	956.90	1.76%
3.	Shanan (PSEB)	110	446.6	524.47	1.17%
4.	Sri Sailam (A.P. Gen. Corp. Ltd.)	770	3126.2	3522.75	1.12%
5.	NagarJuna Sagar (A.P. Gen.Corp. Ltd.)	810.56	3290.87	984.99	0.30%
6.	Upper Sileru (A.P. Gen. Corp. Ltd.)	240	974.4	464.62	0.48%
7.	Lower Sileru (A.P. Gen. Corp. Ltd.)	460	1867.6	835.83	0.45%
8.	Jaldhaka (WBSEB)	35	142.1	590.92	4.16%
9.	Ramam Stage-II (WBSE	51	207.06	370.37	1.78%
10.	Vaitarna (MSEB)	60	243.6	250.38	1.02%
11.	Tillari (MSEB)	60	243.6	128.10	0.52%
12.	Sharavathi (KPCL)	1035	4202.1	2939.19	0.70%
13.	Varahi (KPCL)	230	933.8	1844.10	1.97%
14.	Jawahar Sagar (RSEB)	99	401.94	157.78	0.39%

15.	Mahi Power House-I (RSEB)	50	203	197.69	0.97%
16.	Mahi Power House – II (RSEB)	90	365.4	129.64	0.35%
17.	Dehar Power House, Slapper (BBMB)	990	4019.4	1677.96	0.42%
18.	Bhakra Right & Left Bank P.H. (BBMB)	1225	4973.5	2017.76	0.40%
19.	Bhivpuri (Andhra Valley P.S. Co. Ltd.)	75	304.5	706.83	2.32%
20.	Khopoli (Tata H.E.P.S. Co. Ltd.)	72	292.32	1106.78	3.78%
21.	KHEP (NEEPCO)	250	1015	2088.68	2.05%
22.	SVP Bhaba (HPSEB)	120	487.2	710.59	1.46%
23.	Bassi (HPSEB)	60	243.6	405.35	1.66%
24.	Giri (HPSEB)	60	243.6	510.20	2.09%
25.	Gandhi Sagar (MPEB)	115	466.9	248.30	0.53%
26.	Pench (MPEB)	160	649.6	1556.9	2.39%
27.	Tons (MPEB)	315	1278.9	11071.71	8.66%
28.	Hasdeo Bango (MPEB)	120	487.2	1900	3.90%
29.	Birsinghpur (MPEB)	20	81.2	454.43	5.59%

ANNEXURE - 15

O&M EXPENSES IN SOME HYDRO PLANTS IN UTTAR PRADESH

Sl.No.	Name of HE Station	Installed Capacity (MW)	Capital Expenditure applicable to completion in 1997-98 (Crores)	O&M Expenses in 1998-99 (Lacs)	O&M Expenses as % of Capital Expenditure
1.	Khodri	4x30	487.2	290.53	0.596
2.	Chilla	4x36	584.64	561.74	0.96
3.	Khatima	3x13.8	168.08	253.52	1.51
4.	Dhakrani	3x11.25	137.02	227.77	1.66
5.	Dhalipur	3x17	207.06	186.17	0.899
6.	Kulhal	3x10	121.8	128.79	1.06
7.	Khara	3x24	292.32	180.92	0.62
8.	Ramganga	3x66	803.88	371.36	0.46
9.	Tiloth	3x30	365.4	538	1.47
10.	Galogi	3.00	12.18	19.106	1.57
11.	Mohd.pur	3x3.1	37.76	44.5	1.18
12.	Nirgajni	2x2.5	20.3	21.31	1.05
13.	Chittaura	2x1.5	12.18	24.32	1.996
14.	Salawa	2x1.5	12.18	26.1	2.14
15.	Bhola	4x0.375+ 2x0.6	10.96	41.57	3.79
16.	Chibro	4x60	974.4	856.05	0.88
17.	Pathri	3x6.8	82.82	128.52	1.55

ANNEXURE – 16

O&M EXPENSES IN SOME OF NHPC HYDRO PLANTS

Sl.No.	Name of HE Station	Installed Capacity (MW)	Capital Expenditure applicable to completion in 1997-98 (Crores)	O&M Expenses in 1998-99 (Lacs)	O&M Expenses as % of Capital Expenditure
1.	Baira Siul	180	730.8	3014.97	4.125
2.	Lok tak	105	426.3	2253.421	5.28
3.	Salal	690	2801.4	7228.076	2.58
4.	Tanakpur	120	487.2	1892.42	3.88
5.	Chamera	540	2192.4	6420.818	2.92
6.	Uri	480	1948.8	4343.908	2.22

ANNEXURE –17

ANNUAL EXPENSES OF NHPC PLANTS

SALARY OF O&M STAFF	LOKTAK	BAIRASIUL	SALAL-1	CHAMERA	TANKPUR	URI	RANGIT
1996-97	76577986	74522441	103730135	9971149	43312642		
1997-98	175390850	146153220	458858675	380302409	87206996	68887391	
1998-99	19683846	153582291	480662352	372434818	99499549	117919722	
1999-2000	143720844	113733966	287673063	219334102	71629332	72417852	9333140
VALUE OF SPARES CONSUMED							
1996-97	1276918	16275963	18002979	4576467	7527296		
1997-98	1776473	11041882	39610883	3013778	5282749		
1998-99	869747	100251733	18836729	6932906	6627580		
1999-2000	1410740	20778578	18255662	8709217	8245025	2220872	2809
EXPENSES IN INSURANCE							
1996-97	331039	184248	276165	1255381	141269		
1997-98	204039	268231	502445	103348961	120368	325930	
1998-99	7256320	8211213	46567484	104435728	18874706	165710692	
1999-2000	7875403	9058795	48831010	106005501	18984585	170466916	3024301
OTHER MISC. EXPENSES							
1996-97	58628098	28104177	109124372	289205819	26964839		
1997-98	19022534	28407371	99560340	175436173	51824971	106344242	
1998-99	20377622	39451855	176741115 *	386278377	64240729	150760403	
1999-2000	21053777	71451251	195169431	179421764	46269451	191382221	6596816
DEPRECIATION							
1996-97	43458096	48582384	216321343	698073127	104191064		
1997-98	41920473	47303658	244019040	692571760	104124795	9605848	
1998-99	41051011	47466173	257334168	708957029	103959136	991901724	
1999-2000	41100458	62647887	267337594	704509774	105823302	1014515313	2703304
INTEREST							
1996-97	11675292	6241110	482914934	1720485333	329755469		
1997-98	7179579	3551708	494112130	1603450366	304297969	2058594303	
1998-99	5438937	5440800	466316703	1520514903	271130995	2488740322	
1999-2000	3064530	12465139	180015313	1483317241	234830491	2537442702	46164434
TOTAL							
1996-97	191947429	173910323	930369928	2813307576	511892579	0	0
1997-98	245493948	236726070	1336663513	2958123447	552857848	2243757714	0
1998-99	271832103	354404065	1446458551	3099553761	564332695	3915032863	0
1999-2000	218225752	290135616	997282073	2701297599	485782186	3988445876	67824804

* Includes 228 millions on account of Chamera II's Exp. charged to Chamera – I & should not be taken as O&M Exp.

ANNEXURE - 18

NORMS FOR MANPOWER CALCULATION FOR HYDRO POWER PLANTS

Sr.No.	Area	Unit size	Norms adopted by previous Sub Group Man/MW			Modified norms used by present Sub Group Man/MW		
			Tech.	Non Tech.	Total	Tech.	Non Tech.	Total
1.	O&M		1.94	0.49	2.43	1.7	0.3	2

Note:

Extract from the "Report of the Sub-Group on Man power Planning & Training for the Working Group on Power" - Ninth Plan (1997-2002)