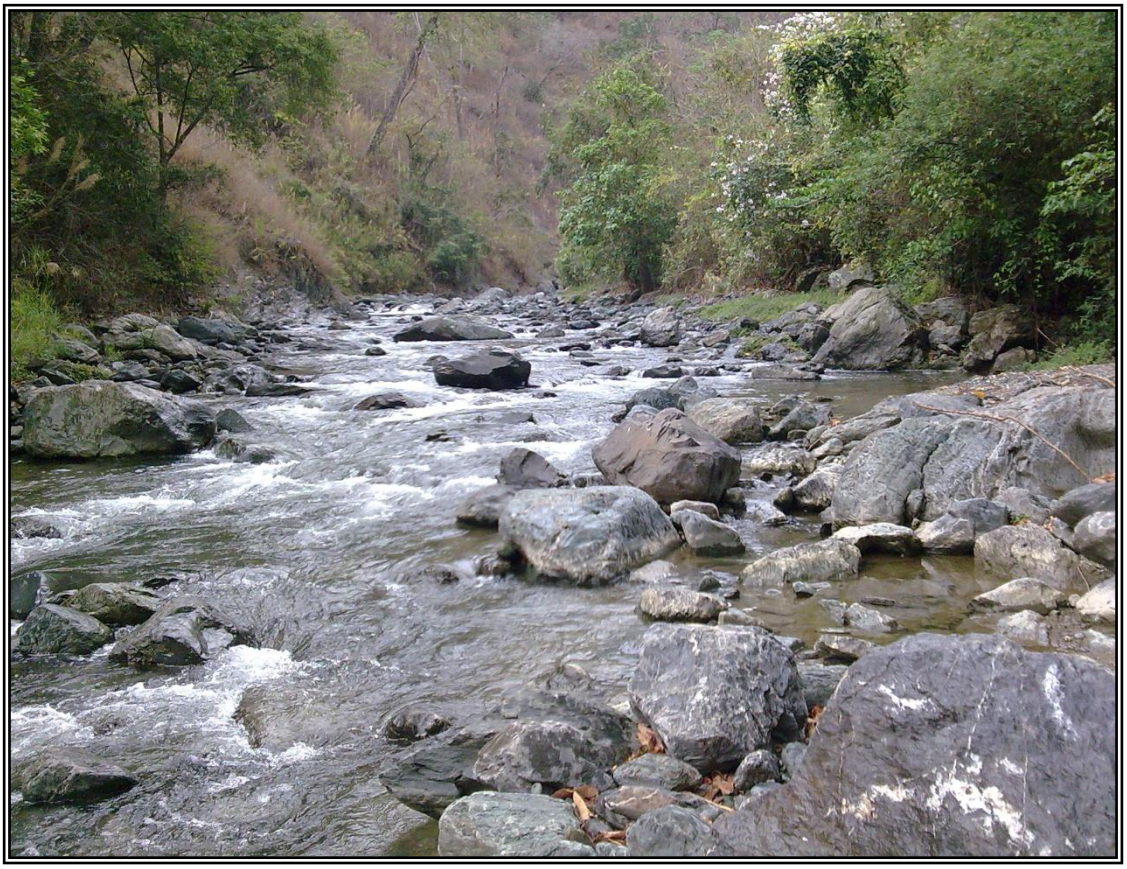
DETAILED PROJECT REPORT

LOWER LIKIMRO HEP

3 x 2.70 MW



VOLUME - I Project Details

NEC Likimro Power Private Limited
Wainok/ Mitkar Apartments, Upper Chandmari
Kohima-797001, Nagaland

Telephone : +91 370 224 2484/85
Facsimile : +91 370 2242486 / 224 4633
Email : necenergy@gmail.com

July 2024

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Executive Summary

EXECUTIVE SUMMARY

INTRODUCTION

This **Detailed Project Report** (DPR) conform and fulfill to all the requirements of *Renewable Energy Tariff Regulations, 2024, dated June 12, 2024* of **Central Electricity Regulatory Commission** (CERC). The Financial Principles *including* Project Cost (Capital Cost), Debt Equity Ration (@ 70:30), Capacity Utilisation Factor / PLF, Auxiliary Consumption, Operation & Maintenance (O&M) expenses, etc.

The proposed **Lower Likimro Hydroelectric Power Project** is a run-of–the river (RoR) type **Small Hydro Project** (SHP) project located in **Village :** Moya; **Sub-division :** Pungro; **District :** Kiphire in the State of Nagaland.

The Project will have an installed capacity of 3 x 2.70 MWe and will be able to generate about 31.93 Million Units (MUs) energy annually. Energy available for sale at bar (the Interconnection Point / Metering Point) shall be 31.61 MU's annually, after considering annual loss of generation due to possible outages, losses in transformation and transmission / auxiliary consumption.

The analysis has been carried out to establish the financial, technical and environmental viability of the proposed Project. The capitalized cost of the project is Rs. 9632.12 Lacs, and it is expected to be completed in 24 to 36 months from the start of construction without any interruption in work.

OUTLINE OF THE PROJECT

The **Lower Likimro Hydroelectric Power Project** (LHPP) is a run-of-river (RoR) scheme on Likimro river (a tributary of Tizu river), in Kiphire district of Nagaland. The Project location is at the downstream of the existing **3 x 8 MW Likimro Hydroelectric Power Project**. The weir

crest of the existing Project is at EL 555.50 m., and the surface Power house is located on the left bank of Likimro river at EL 472.50 m, and switch yard located at EL 476.25 m.

The **Lower Likimro Hydroelectric Power Project** will divert a design flow of 12.82 cumecs through a water conductor system, which will comprise of intake structure including Power Intake (200 m long), Desilting Basin (120m), Water Conductor System (1850 m long), Surge Shaft (8.5 m dia), and Penstock (120 m long main penstock & 23 m long bifurcation). The total length of the water conductor system up-to Surge Shaft is 2170 m. The Head loss in this water conductor system has been computed as 2.24 m at a flow of 12.82 Cumecs. At 12.82 cumecs of water flow, the full reservoir Level (FRL) at Surge Shaft will be maintained at EL 550.15 m, with gives gross head of 77.72 m acting on machine. The steel penstock starts at the end of the Surge Shaft with Central Line elevation of EL 550.15 m. The penstock length up to bifurcation piece is 143 m (120 + 23). The length of penstock from bifurcation to Main Inlet valve (MIV) is 23 m. The Head losses in the entire Penstock (main & bifurcation) work out to be 2.27 m. After deducting all Head losses from intake to Turbine inlet, the Net Head available for Power Generation is 75 m.

The controlling Levels & Head loss data is as follows:

Normal Water Level at Intake	m	555.50
Head Loss from Intake to Surge shaft	m	2.28
Full Supply level at Surge Shaft	m	550.15
Powerhouse level	m	472.50
Normal Tail Water Level	m	470.25
Gross Head	m	77.65
Head Loss in penstock	m	2.27
Net Head	m	75.45
Design net-head adopted	m	**75.0**

An in-depth study has been carried for various installed capacities and unit size selection, out of which 3 x 2.70 MWe solutions emerged as the best selection utilizing available head and discharges in most optimum manner at the proposed plant location site. The plant will have an installed capacity of 3 x 2.70 MWe with three (3) sets of Horizontal Francis Turbines and coupled to its Synchronous Generators, each unit operating at Net Design Head of 75 m at 4.27 cumecs discharge and at 750 rpm.

Power will be generated at 11 kV, bussed & Synchronized at 11 KV, and stepped up to 66 kV at Lower Likimro HEP Switchyard. The power will be transmitted at 66 kV and hooked to existing 66 kV line between main Likimro PH and Kiphire receiving station (132 kV / 66 kV). A T-point type termination will be formed at interconnection point of 66 kV transmission line from Lower Likimro HEP and existing 66 Likimro Kiphire Line. Protection systems are designed accordingly, and such schemes are already in operation at various critical networks in India and Abroad.

ECONOMIC ANALYSIS

The Project-cost till commissioning, which is tentatively before September 2027, including IDC (Interest During Construction), pre-construction activities like clearances, land acquisition, detailed engineering, tendering process, financial closure etc. is estimated at Rs. 9632.12 Lacs. The envisaged start date of construction / ground-breaking is by October 2024 (and the completion date is based on no interruptions at site) subject to the condition works to be carried out without any interruption.

An economic analysis of the Project has been carried out been based on assumptions that funds and financing are available and the Construction costs has been taken as per prevailing rate in the project area. The energy purchase rate by the Government is based on the Central Electricity Regulatory Commission (CERC) *vis-à-vis* the Nagaland Electricity Regulatory Commission (NERC), Renewable Energy Tariff Regulation 2024, as per the NoC issued by the Department of Power, Government of Nagaland *vide* Letter No. CEL/TB/CIVIL/NEC/35/827-29, dated May 6, 2024. Copy of the letter is attached here-below for ready reference.

Writer : S. Bhattacharyya – Director
Direct Line : +91 98110 43072
Direct Fax : +91 124 235 0130 / +91 98117 89993
Email : sapu@necenergy.in

ISO 9001 : 2015

CIN : U74899HR1989PTC082344

Our Reference : NEPL/Saudi-Proposal/2023-24

Company Profile

Commercial – In – Confidence

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Any person reviewing this Proposal does so at its own and holds NEPL, all of their respective Directors, Officers, Investors, Partners and Affiliates harmless from any costs or expenses incurred in connection with such review.

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Brief information of **NEC Energy Private Limited**

We are pleased to inform you that we are a Group Company of the **NEC Groupof Companies** with diversified interest in the field of Energy, Hotels & Resorts, Trading, Food Processing and etc.

NEC Energy Pvt. Ltd.(NEPL) is incorporated under the Companies Act, 1956 (No.1 of 1956) of India and a *registered* **MSME** in the power-sector and is currently, successfully operating and maintaining the **24 MW Likimro Hydroelectric Power Project** of the **Government of Nagaland** on Public Private Partnership (PPP)basis since the year of 2006 and have also submitted the detailed Project Report for the **8.2 MW Lower Likimro Hydroelectric Power Project**, for which clearances from the Power & Finance Department have been received and the Power Purchase Agreement is pending for signing.

NEPL retrofitted and operated the Likimro HEP by way of a strategic Technical Partnership with **K-Water**, Korea Water Resources Corporation, *a State-owned corporation of the* **Government of Korea**.**K-Water**is a world ranking water-utility company having total revenue of USD 1,590,951,000 with an operating income of USD 297,545,000 and asset base of over USD 11,120,617,000. **K-Water** is involved and offers comprehensive services throughout the project stages to meet various requirements.

Further, **Rongnichu Hydro Project Private Limited (SPV),***a subsidiary of* **NEC Energy Private Limited** have entered into a Power Purchase Agreement with the **Government of Sikkim** for **8 MW Upper Rongnichu Hydro Power Project**, which was de-commissioned by the Government of Sikkim and is contemplating to generate *wef* April 2021.

NEC Energy Private Limited recently, on April 4, 2018 have also entered into a Partnership Agreement with *M/*s **Water Resources Engineering Corporation (WARECO)**, Republic of Korea for mutual growth in operation and maintenance of water supply and power generation facilities, amongst various other Agreements with various companies in the field of power-sector.

NEC Energy Private Limited, have signed an Agreement with *M/s* **INCELL Co., Ltd.**, Republic of Korea to carryon business as strategic Partners and for setting-up of Lithium-Ion Battery Assembly line in the Indian sub-continent for joint development of business in Energy Storage Systems in December 2019.

NEC Energy Private Limited, have also signed an Agreement with *M/s* **WOOJIN Industrial Systems Co., Ltd.**, Republic of Korea on December 17, 2019 for Smart Energy Systems and its development including its Engineering, Procurement, Construction and Operation & Management.

NEC Energy Private Limited, have also entered in to a strategic MoU for Distribution of Energy with *M/s* **Feedback Energy Distribution Company Limited (FEDCO).** FEDCO (**Feedback Energy Distribution Company Limited**) is one of very few national players who are having multi-state presence as franchisee operator. FEDCO has been operating in 3 states as "Input based Distribution Franchisee - IBDF" and also operating in different utilities in different capacities of Madhya Pradesh, Chhattisgarh, West Bengal, Uttar Pradesh, Haryana, Meghalaya, Tripura etc. FEDCO is also the technical service partner of 2 Nigerian Discoms *i.e.* Port Harcourt and Enugu.

NEC Energy Private Limited have also executed an Memorandum of Understanding with **Adarsh Stainless Private Limited** (ASPL) for **power-trading / banking.** The main objective of this is for *open grid-access* categorically for the proposed Projects for which no-objection have been received from the Government of Nagaland, to be set-up on Build Own & Operate (BOO) basis.

List of Directors and Shareholding pattern of NEC Energy Private Limited
as on **March 31, 2024.**

Sl. No.	Name of the Directors	Address of the Directors
1	Subrata Bhattacharyya DoB : June 23, 1963 Nationality : Indian	30 Ashoka Crescent DLF City-I Gurgaon-122 002, Haryana, India
2	Anandy Ezung DoB : June 4, 1976 Nationality : Indian	H/No-141, Sewak Road, Midland Colony Ward -14, Dimapur Sadar Dimapur, Nagaland-797112

Sl. No.	Name of the Directors	Date of Birth	Nationality	No. of Shares held by each Shareholders	%age of Shares Held
1	Subrata Bhattacharyya	23 / 06 / 1963	Indian	9,999	99.99%
2	Anandy Ezung	04 / 06 / 1976	Indian	1	00.01%

Certified True Copy

S. BHATTACHARYYA
Director
DIN: 00363550

ANANDY EZUNG
Director
DIN: 07675089

NEC Energy Private Limited
CIN : U74899HR1989PTC082344
INDIA

Confidential

No-objection

GOVERNMENT OF NAGALAND
DEPARTMENT OF POWER :: OFFICE OF THE ENGINEER-IN-CHIEF
NAGALAND, KOHIMA.

No. CEL/TB/CIVIL/NEC/35/ 1827-29 Dt: Kohima, 06 May'2024

To

The Director
NEC Energy Pvt Ltd.
212 DLF Qutab Plaza, DLF City-I
Gurugram-122002,India

Sub: **No Objection Certificate (NOC) for Detailed Survey & Investigation (DSI) and preparation of DPR of SHPs.**

Ref: 1.No.PWR/W-28/2010/61 Dt: 3rd May ,2024.
2.No. CEL/TB/CIVIL/NEC/35/1749-52 Dt: 12th April 2024.

Sir

Inviting reference to the subject above, please find enclosed the No Objection Certificate (NOC) for the detailed Survey & Investigation (DSI) and Preparation of DPR of SHPs issued by the department of Power , Government of Nagaland vide above referred letter No. CEL/TB/CIVIL/NEC/35/1749-52 Dt: 12th April 2024 for your further necessary action.

Encl: As stated.

Yours faithfully,

(**Er. Moa Aier**)
Engineer-in-Chief
Department of Power
Nagaland, Kohima.

No. CEL/TB/CIVIL/NEC/35/ Dt: Kohima, May' 2024
Copy to:

1. The Chief Engineer (T&G), Department of Power, Govt. of Nagaland, Kohima.
2. The Superintending Engineer, Civil Circle, Department of Power, Kohima, Nagaland.

Engineer-in-Chief
Department of Power
Nagaland, Kohima.

GOVERNMENT OF NAGALAND
POWER DEPARTMENT
NAGALAND:KOHIMA

NO. PWR/W-28/2010 /61 **Dated Kohima, the 2nd May, 2024.**

To
The Engineer-in-Chief
Department of Power
Nagaland:Kohima

Sub:- **No Objection Certificate (NOC) for Detailed Survey & Investigation (DSI) and Preparation of DPR of SHPs.**

Sir,

In inviting a reference to your letter No.CEL/TB/CIVIL/NEC/35/1749-52 Dated 12th April, 2024 on the subject cited above, I am directed to convey herewith **No Objection Certificate/Permission** for Detailed Survey & Investigation (DSI) and preparation of Detail Project Report (DPR) of Small Hydroelectric Projects (SHPs) for the below mentioned sites (Category A), under the following terms and conditions:

Sl. No.	Name	District	Approx (MW)
A:Sites for NOC (Greenfield Projects)			
1	Teipuiki SHP	Peren	-
2	Lanye SHP	Phek	6.0
3	Arachu-I SHP		3.0
4	Arachu-II SHP		4.5
5	Arachu-III SHP		4.5
6	Shilloi SHP		6.0
7	Yai Horangki SHP	Shamator	10.0
8	Dzü-u SHP	Kohima	3.0

However, with regard to the projects under categories B and C as mentioned below, the matter will be taken up as and when the draft MoUs are submitted:-

B: Sites for MoU (Greenfield Projects)			
1	Lower Likimro SHP	Kiphire	8.1
2	Tsüngi-Tzütang MHP	Mokokchung	0.45
3	Menüng SHP	Mokokchung	3.0
C: Sites for MoU (Brown field) R&M			
1	Tuphaleri MHP	Phek	0.20

Terms & Conditions:

1. DSI & DPR may be prepared by the Firm i.e M/s NEC Energy Pvt Ltd. at their cost, without any financial implications or project obligations to the State Government.
2. The DSI & DPR so prepared shall be submitted to the Power Department for vetting and acceptance.

3. After DSI & DPR submission to the DoPN, the project(s) may be allowed to be developed by the Firm and DoPN under a Special Purpose Vehicle (SPV) under the following terms;
    a. The project(s) shall be developed on basis of BOO (Build Operate Own) under a SPV
    b. The MoU shall be executed between the Firm and DoPN.
    c. PPA shall be executed as per the Tariff determination by NERC.
4. The NOC is valid for a period of 18 (eighteen) months from the date of issue, during which the DSI & DPR should be completed.
5. During the period, a Provisional MoU and PPA may be entered upon, including formation of a SPV, where the DoPN/GoN shall have appropriate stake.

Yours faithfully,

3/5/24

(NIKESONO KEVICHUSA),NCS
Deputy Secretary to the Govt. of Nagaland

NO. PWR/W-28/2010 **Dated Kohima, the May, 2024.**

Copy to
1) The Chief Engineer (T&G), Power Department, Nagaland, Kohima for information
2) Office copy.

(NIKESONO KEVICHUSA),NCS
Deputy Secretary to the Govt. of Nagaland

CE(T&G)
Pl. process for issue
6/5/24

Addl CE (C)
for CE
6/5/24.

INDEX

Form FIN-1

Form FIN 1: Financial Situation

Financial Data for Previous 5 Years *(in Rupees)*					
	Year 1 : 2019-20	**Year 2** : 2020-21	**Year 3** : 2021-22	**Year 4** : 2022-23	**Year 5** : 2023-24
Information from Balance Sheet					
Total Assets	38,19,47,042	45,49,36,312	50,84,47,649	48,69,62,143	54,37,77,733
Total Liabilities	38,19,47,042	45,49,36,312	50,84,47,649	48,69,62,143	54,37,77,733
Net Worth	28,45,36,966	30,30,45,307	31,91,96,906	35,20,44,509	41,77,60,688
Current Assets	30,03,93,263	32,94,86,116	38,76,52,928	37,15,23,548	43,30,41,845
Current Liabilities	9,53,58,864	15,13,04,811	17,61,01,364	9,41,99,592	8,99,85,422
Information from Income Statement					
Profits before Taxes	2,43,61,504	2,63,41,889	2,17,92,541	4,76,24,573	4,39,63,674
Profit After Taxes	1,79,45,965	1,85,95,491	1,61,51,599	3,28,66,354	3,25,33,118

Form Fin-2

Form FIN-2 : Financial Resources

Financial Resources		
No.	**Source of Financing**	**Amount** (*in Rupees*)
1	**Internal Reserve & Surplus / Net Worth as on 31.03.2024**	41,77,60,688
2	**Liquid Funds :** FD and Bank	4,80,00,000
3	**Bank OD Limit**	6,60,00,000
4	**Income Receivables** *by March 31, 2024*	10,47,98,567

Personal Net-worth of Promoter

Manish Aggarwal & Co.
Chartered Accountants

TO WHOMSOEVER IT MAY CONCERN

(Net-worth Certificate)

This is to certify that the net worth of **Mr. Subrata Bhattacharyya,** S/o Late Shri B. Bhattacharyya director and promoter of **M/s NEC Energy Private Limited (NEC GROUP), PAN AABCN7988G** having registered office at **212 DLF Qutab Plaza DLF City-1 Gurgaon HR-122001** as on August 10, 2022 is Rupees 110,09,64,430/- (*Rupees one-hundred ten crores nine-lakhs sixty-four thousand four-hundred and thirty*) only.

It is further certified that the computation of Net worth is based on market value of assets and liabilities, scrutiny of the books of accounts, records and documents, which is true and correct to the best my knowledge and as per the information provided to my satisfaction.

MANISH AGGARWAL & CO. New Delhi Chartered Accountants

Nitin Mittal
(*Partner*)
M No.: 540076
for **Manish Aggarwal & Co**
(*Chartered Accountants*)
FRN: 031007N

Place: New Delhi
Date: 10/08/2022

Regd. Office : 8A/37G, W.E.A., Karol Bagh, (Near Karol Bagh Metro Station), New Delhi - 110 005
Tel : 011-45635123 |**E-mail :** mmaca2016@gmail.com |**Web :** www.manishaggarwalca.com

Certificate of Experience from *Department of Power* Government of Nagaland

GOVERNMENT OF NAGALAND
DEPARTMENT OF POWER
OFFICE OF THE CHIEF ENGINEER, TRANSMISSION AND GENERATION
NAGALAND: KOHIMA

NO.CEL/T&G/LHEP/15-16/ 132 Dated Kohima, the 19th Jan. 2017.

TO WHOME IT MAY CONCERN

This is to certify that M/s. NEC Energy Private Limited has been successfully operating and maintaining 3x8 MW Likimro Hydroelectric Power Project since June 2006.

We recognize their sincere effort in running the plant as per the terms and conditions of the agreement and has been outstanding in the effort towards the Corporate Social Responsibility.

They have been carrying out the maintenance work of the following :
Main-inlet, Power Channel, Balancing Reservoir, Penstock, Control Systems, Power House including all electrical, mechanical and civil installations and its ancillaries/utilities.

We wish them a bright future and success.

(Er. K. MACHIEO)
Chief Engineer

NEC ENERGY PVT LTD

TO WHOM IT MAY CONCERNED

This is to certify that M/S NEC Energy Private Limited has been successfully operating and maintaining the Electrical and Electro-Mechanical Installations of the 3X8 MW Likimro Hydro Electric Project of the Government of Nagaland, Department of Power, since June 2006.

We recognize their sincere effort to perform as per the lease agreement made with the Department.

We wish them success in their future endeavor.

(Er.Penrithung Yanthan)
Executive Engineer,
Generation Division,
Kohima, Nagaland.

Office of the Executive Engineer ★ Generation Division, Kohima ★
Date 12/04/17

CLEAN ENERGY GREEN ENERGY

ISO Certificate

QRO
QUALITY RESEARCH ORGANIZATION

Certificate of Registration

This is to certify that

NEC ENERGY PVT. LTD.

212 DLF QUTAB PLAZA DLF CITY-1 GURUGRAM GURGAON HARYANA 122002 INDIA

has been independently assessed by QRO
and is compliant with the requirement of:

ISO 9001:2015

Quality Management System

For the following scope of activities:

GENERATION OF ELECTRICITY AND ERECTION, PROCUREMENT, COMMISSIONING & DEVELOPMENT OF PROJECTS ON TURNKEY BASIS

Date of Certification: 27th October 2023
1st Surveillance Audit Due: 26th October 2024
2nd Surveillance Audit Due: 26th October 2025
Certificate Expiry: 26th October 2026

Certificate Number: 1070820083S

UKAF
UKAF-CB-004

Head of Certification

Validity of this certificate is subject to annual surveillance audits to be done successfully on or before 365 days from date of the audit.
(In case if surveillance audit is not allowed to be conducted; this certificate shall be suspended / withdrawn).
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Winnington House 2 Woodberry Grove Finchley London N12 0DR

QRO Certification Limited
27 Old Gloucester Street, London, WC1N 3AX Company Number : 14230776
Website : www.qrocert.com, E-mail : info@qrocert.com

CLEAN ENERGY GREEN ENERGY

MSME Registration

भारत सरकार
Govt. of India
सूक्ष्म,लघु और मध्यम उद्यम मंत्रालय
MINISTRY OF MICRO, SMALL & MEDIUM ENTERPRISES

सूक्ष्म,लघु और मध्यम उद्यम
MICRO, SMALL & MEDIUM ENTERPRISES

उद्योग आधार Udyog Aadhaar

C

Type of Enterprise	Micro	Small	Medium
Manufacturing	A	B	C
Services	D	E	F
UAM No.	DL08C0016260		

Udyog Aadhaar Registration Certificate

Udyog Aadhaar Number: DL08C0016260

Name of Enterprise: NEC ENERGY PRIVATE LIMITED

Location of Plant Details

SN	Flat/Door/Block No.	Name of Premises/Building Village	Road/Street/ Lane	Area/Locality	City	Pin	State	District
1	NA	Likimro Hydro Electric Power Project	NA	Kipheri	Nagaland	798611	NAGALAND	KIPHRIE

Official Address of Enterprise: D-36 (LOWER GROUNG FLOOR), N.D.S.E-II, NEW DELHI

District: SOUTH State: DELHI PIN: 110049
Mobile No: 9811043072 Email: sapu@necenergy.in

Date of commencement: 19/07/1989

Major Activity: MANUFACTURING

Enterprise Type: Medium

Previous Registration details-if any: ::

National Industry Classification Code

SN	NIC 2 Digit	NIC 4 Digit	NIC 5 Digit Code	Activity Type
1	33 - Repair and installation of machinery and equipment	3312 - Repair of machinery	33121 - Repair and maintenance of engines and turbines excluding aircraft, vehicle and cycle engines	Manufacturing
2	33 - Repair and installation of machinery and equipment	3312 - Repair of machinery	33122 - Repair and maintenance of pumps and related equipment, fluid power equipment, valves	Manufacturing
3	33 - Repair and installation of machinery and equipment	3312 - Repair of machinery	33123 - Repair and maintenance of metal cutting and metal forming machine tools and accessories, power-driven hand-tools and other machine tools	Manufacturing
4	33 - Repair and installation of machinery and equipment	3312 - Repair of machinery	33125 - Repair and maintenance of mining, construction, and oil and gas field machinery; metallurgy machinery	Manufacturing
5	33 - Repair and installation of machinery and equipment	3320 - Installation of industrial machinery and equipment	33200 - Installation of industrial machinery and equipment	Manufacturing
6	35 - Electricity, gas, steam and air conditioning supply	3510 - Electric power generation, transmission and distribution	35101 - Electric power generation by hydroelectric power plants	Manufacturing
7	42 - Civil Engineering	4220 - Construction of utility projects	42201 - Construction and maintenance of power plants	Manufacturing
8	66 - Other financial activities	6630 - Fund management activities	66309 - Management of other investment funds	Services
9	81 - Services to buildings and landscape activities	8129 - Other building and industrial cleaning activities	81292 - Cleaning of industrial machinery	Services

Acknowledgement Date of Filing 01/07/2019 Date of Printing 01/07/2019

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PRINT

Letter from K-Water

K water

6 May 2013

To Whom It May Concern

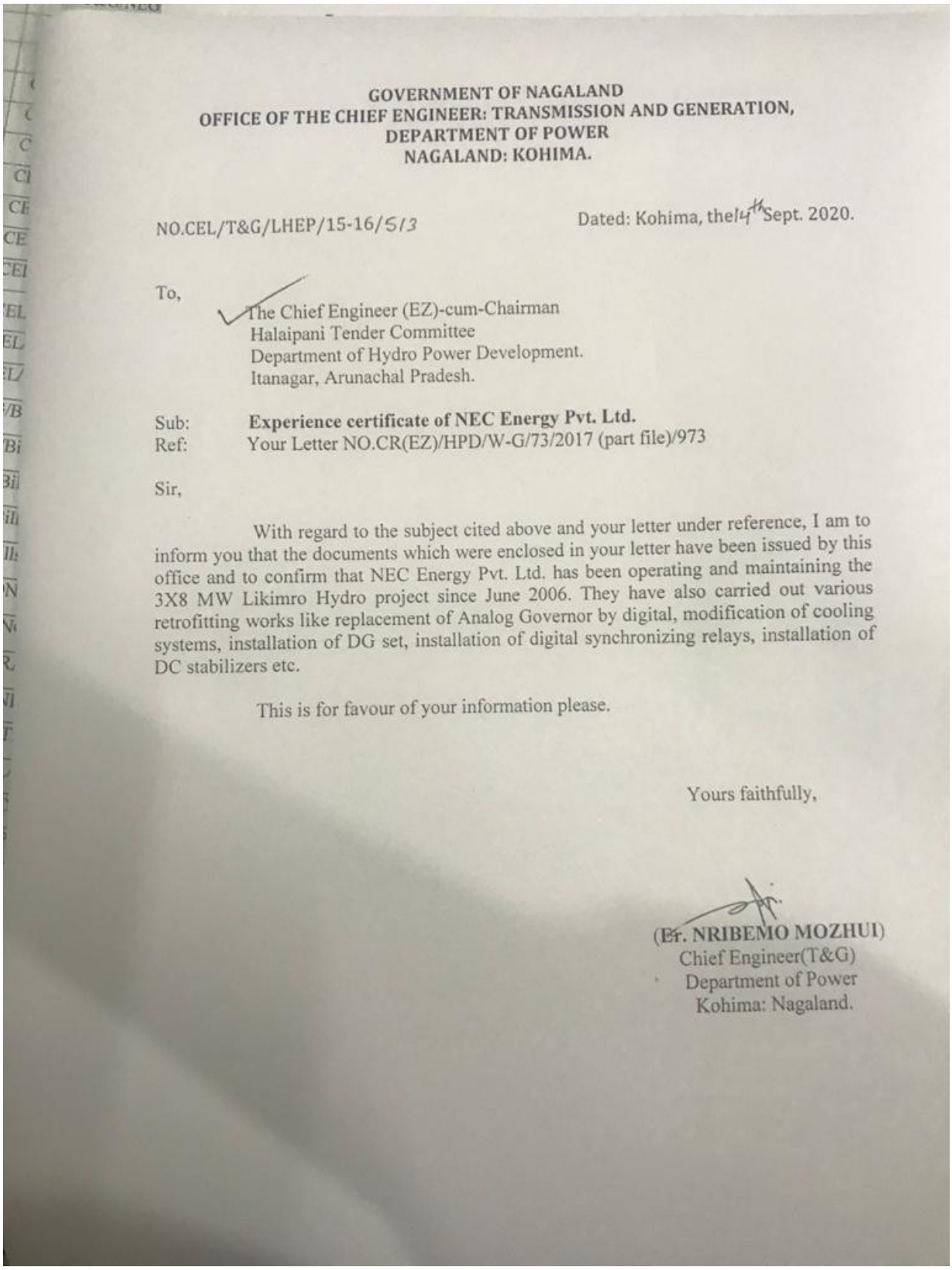
This is to certify that **K-water** (Korea Water Resources Corporation) is providing Technical Assistance and support services to **NEC Energy Pvt. Ltd.**, India for the Operation & Maintenance of the **Likimro Hydroelectric Power Project** in Nagaland since 2006.

KOREA WATER RESOURCES CORPORATION K water

Ko, Doo Suk
General Manager
Overseas Business Department
K-water (Korea Water Resources Corporation)

Address : 11 Gyoyookwon-ro, Gwacheon-si, Gyeonggi-do, 427-100, Republic of Korea;
Tel: +82 -2-2150-0776, e-mail: shjdrums@kwater.or.kr, Homepage : http://english.kwater.or.kr

Certificates of
Successful Projects Implementation



GOVERNMENT OF NAGALAND
OFFICE OF THE CHIEF ENGINEER: TRANSMISSION AND GENERATION,
DEPARTMENT OF POWER
NAGALAND: KOHIMA.

NO.CEL/T&G/LHEP/15-16/513 Dated: Kohima, the 14th Sept. 2020.

To,

The Chief Engineer (EZ)-cum-Chairman
Halaipani Tender Committee
Department of Hydro Power Development.
Itanagar, Arunachal Pradesh.

Sub: **Experience certificate of NEC Energy Pvt. Ltd.**
Ref: Your Letter NO.CR(EZ)/HPD/W-G/73/2017 (part file)/973

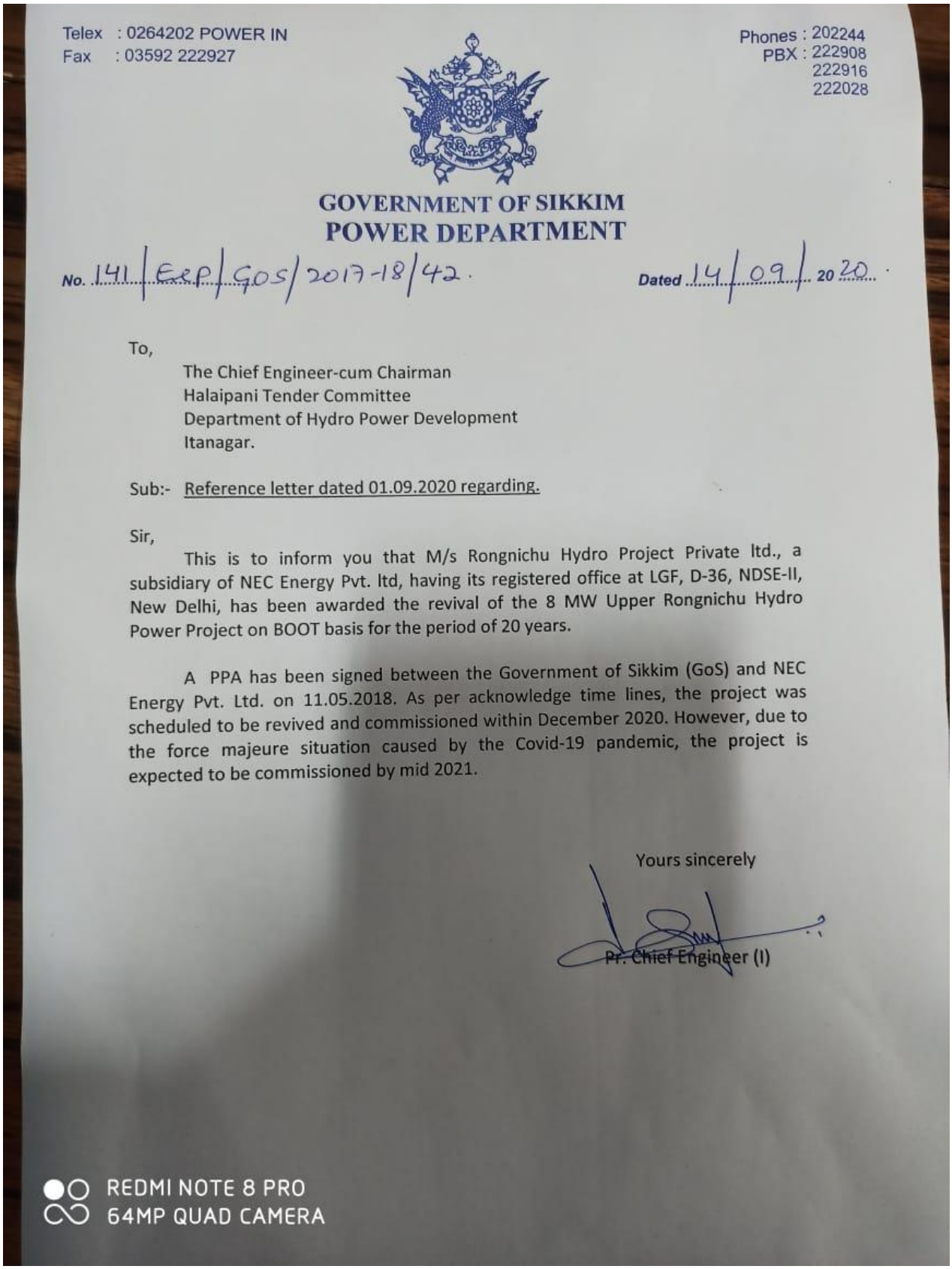
Sir,

With regard to the subject cited above and your letter under reference, I am to inform you that the documents which were enclosed in your letter have been issued by this office and to confirm that NEC Energy Pvt. Ltd. has been operating and maintaining the 3X8 MW Likimro Hydro project since June 2006. They have also carried out various retrofitting works like replacement of Analog Governor by digital, modification of cooling systems, installation of DG set, installation of digital synchronizing relays, installation of DC stabilizers etc.

This is for favour of your information please.

Yours faithfully,

(Er. NRIBEMO MOZHUI)
Chief Engineer(T&G)
Department of Power
Kohima: Nagaland.



Telex : 0264202 POWER IN
Fax : 03592 222927

Phones : 202244
PBX : 222908
222916
222028

GOVERNMENT OF SIKKIM
POWER DEPARTMENT

No. 141/Exp/GoS/2017-18/42. Dated 14/09/2020.

To,

The Chief Engineer-cum Chairman
Halaipani Tender Committee
Department of Hydro Power Development
Itanagar.

Sub:- Reference letter dated 01.09.2020 regarding.

Sir,

This is to inform you that M/s Rongnichu Hydro Project Private ltd., a subsidiary of NEC Energy Pvt. ltd, having its registered office at LGF, D-36, NDSE-II, New Delhi, has been awarded the revival of the 8 MW Upper Rongnichu Hydro Power Project on BOOT basis for the period of 20 years.

A PPA has been signed between the Government of Sikkim (GoS) and NEC Energy Pvt. Ltd. on 11.05.2018. As per acknowledge time lines, the project was scheduled to be revived and commissioned within December 2020. However, due to the force majeure situation caused by the Covid-19 pandemic, the project is expected to be commissioned by mid 2021.

Yours sincerely

Pr. Chief Engineer (I)

REDMI NOTE 8 PRO
64MP QUAD CAMERA

NEC ENERGY PVT LTD

Telex : 0264202 POWER IN
Fax : 03592 222927

Phones : 202244
PBX : 222908
222916
222028

GOVERNMENT OF SIKKIM
POWER DEPARTMENT

No. 141/EEP/GOS/2013-18/43 Dated 14/09/2020.

TO WHOM IT MAY CONCERN

This is to certify the M/s Rongnichu Hydro Project Pvt. ltd, a subsidiary of NEC Energy Pvt. ltd, having its registered office at LGF, D-36, NDCE-II, New Delhi, has been awarded the revival and recommissioning of the 8 MW Rongnichu Hydro Electric Project in East Sikkim, on BOOT basis for a period of 20 Years. A Power Purchase Agreement (PPA) between the Power Department and M/s Rongnichu HPP ltd has also been executed on 11th May 2018.

The Progress of works at site is found to be satisfactory.

Chief Engineer (East)
Government of Sikkim
Power Department.

Energy & Power Department ★ Govt. of Sikkim ★

GREEN ENERGY

Confidential

Fax: 03592 202927

Phones: 202706
PBX: 222908
222916

GOVERNMENT OF SIKKIM
POWER DEPARTMENT

No.23/ASP(P)/SLDC/2021-22 Dated 06/12/2021

TO WHOM IT MAY CONCERN

This is to certify that *M/s* **Rongnichu Hydro Project Private Limited** have successfully commissioned the 4 x 2 MW Upper Rongnichu Hydroelectric Power Project and have started its commercial operation by delivering Active Power and Reactive Power on regular basis after having successfully met the requirements of the Commissioning Tests.

The details are as here below :

Commercial Operation Date(COD) : 1ST December, 2021; **Time:** 19:00 hrs.

Project Name : 4*2MW Upper Rongnichu Hydroelectric Power Project

Project Location : *Village* : Nimtar
District : East Sikkim, Sikkim – 737135

Chief Engineer SLDC.
Power Department, Sikkim
Government of Sikkim

Chief Engineer
Power Department
Government of Sikkim
Gangtok

Certificates of
Class -I (A) Government Contractors

GOVT.OF ASSAM
OFFICE OF THE ADDL. CHIEF ENGINEER, PWD(R&B), HILLS, ASSAM, DIPHU.

No. ACEH/ADT/01/2022-23/2. **Dated Diphu the 4th JUNE/2022.**

The following named existing registered Contractor is hereby **Renewed as Class-I(A)** category under PWD (Hills) and registration number is allotted as shown against his name for the year **2022-2023**.

The registration is provisional and liable for cancellation at any time in case of unsatisfactory works and in the event of adverse Police Report.

The registration number will remain valid up to **31/03/2023** and therein after fresh renewal number will have to be obtained by submitting application.

Sl. No.	Name of the contractor/Firm/Company with Address	New Registration number
1.	**NEC ENERGY PVT. LTD.** **PROP:- SAPU BHATTACHARJEE,** **ALPCO COMPOUND,** **SIX MILE,** **Juripar, Khanapara,** **Guwahati-22**	**APWD(H)/(R&B)/I(A)/GNL/2022-23/0169.**

(Er. Parag Kr. Barman)
Addl. Chief Engineer,
PWD(R&B), Hills, Assam, Diphu.

Memo No. ACEH/ADT/01/2022-23/ 2 -A, **Dated Diphu, the 4th June/2022.**

Copy to:-

1. The Superintending Engineer, PWD (R&B) Diphu Circle/Hamren Circle for information.
2. All Executive Engineers, PWD, (R&B) Divisions under the jurisdiction of this office for information.
3. Person concerned **NEC ENERGY PVT. LTD.** for information.
4. The Registration Asstt. Of this office for information.

(Er. Parag Kr. Barman)
Addl. Chief Engineer,
PWD(R&B), Hills, Assam, Diphu.

04/04/22

GOVERNMENT OF NAGALAND
OFFICE OF THE CHIEF ENGINEER, P.W.D (R&B)
NAGALAND ::: KOHIMA.

N O T I F I C A T I O N

NO.CE/RC/15/PT/2014 **Dated Kohima,the 04 th March./2014.**

As approved vide Government letter No.WH/R-11/2010/5071 Dt. 07/02/2014 the under mentioned contractor is hereby registered as Class-I Contractor as required under Rule 4 (b) of Nagaland PWD Registration of contractor Rule 1966 as shown below :-

Sl.No.	Name of contractor	Category	Registration No.
1.	**NEC ENERGY PVT. LTD. WAINOK APARTMENT, UPPER CHANGMARI KOHIMA 797001.**	**Class-I**	**NPW/Class-I/1003**

(Er. D.MERO)
Chief Engineer, PWD (R&B)
Nagaland, Kohima.

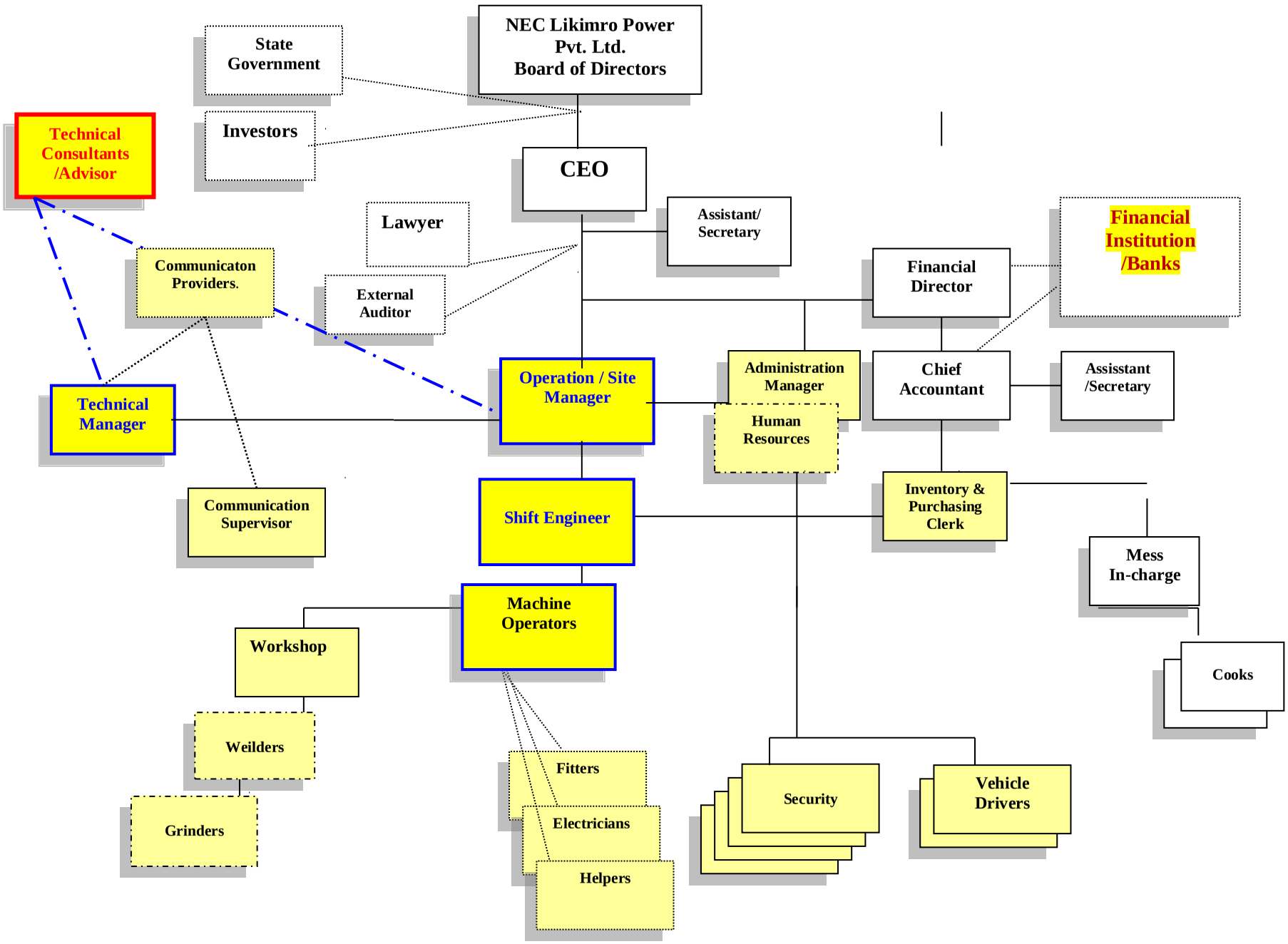
NO.CE/RC/15/PT/2014 :: **Dated Kohima,the 04th March./2014.**

Copy to :-

1. The Commissioner & Secretary to the Govt. of Nagaland (W&H) Department, Kohima with reference to Govt. letter No. quoted above.
2. NEC ENERGY PVT. LTD.The receipt No. 8421591 dt. 21/02/2014 of ICICI BANK SOUTH EXTENSION NEW DELHI for **Rs.75,000/-** only is hereby acknowledged.
3. The Engineer-In-Chief, NPWD, Kohima for your information.
4. The Chief Engineer,PWD (Housing) Kohima/ Addl. Chief Engineer,PWD (R&B) Mokokchung/ Tuensang.
5. All Superintending Engineers' / Executive Engineers' under Nagaland PWD (R&B).
6. Tender Branch/ Tech. branch of C.E's Office, PWD (R&B) Kohima.
7. The President,Nagaland Contractor & Suppliers Union for information.
8. Office order Book.

(Er. D.MERO)
Chief Engineer, PWD (R&B)
Nagaland, Kohima

Likimro Power Private Limited




Thank You!

GOVERNMENT OF NAGALAND
DEPARTMENT OF POWER :: OFFICE OF THE ENGINEER-IN-CHIEF
NAGALAND, KOHIMA.

No. CEL/TB/CIVIL/NEC/35/ 1827-29 Dt: Kohima, 06th May'2024

To

The Director
NEC Energy Pvt Ltd.
212 DLF Qutab Plaza, DLF City-I
Gurugram-122002,India

Sub: **No Objection Certificate (NOC) for Detailed Survey & Investigation (DSI) and preparation of DPR of SHPs.**

Ref: 1.No.PWR/W-28/2010/61 Dt: 3rd May ,2024.
2.No. CEL/TB/CIVIL/NEC/35/1749-52 Dt: 12th April 2024.

Sir

Inviting reference to the subject above, please find enclosed the No Objection Certificate (NOC) for the detailed Survey & Investigation (DSI) and Preparation of DPR of SHPs issued by the department of Power , Government of Nagaland vide above referred letter No. CEL/TB/CIVIL/NEC/35/1749-52 Dt: 12th April 2024 for your further necessary action.

Encl: As stated.

Yours faithfully,

(**Er. Moa Aier**)
Engineer-in-Chief
Department of Power
Nagaland, Kohima.

No. CEL/TB/CIVIL/NEC/35/ Dt: Kohima, May' 2024

Copy to:

1. The Chief Engineer (T&G), Department of Power, Govt. of Nagaland, Kohima.
2. The Superintending Engineer, Civil Circle, Department of Power, Kohima, Nagaland.

Engineer-in-Chief
Department of Power
Nagaland, Kohima.

GOVERNMENT OF NAGALAND
POWER DEPARTMENT
NAGALAND:KOHIMA

NO. PWR/W-28/2010 / 61 Dated Kohima, the 7th May, 2024.

To
The Engineer-in-Chief
Department of Power
Nagaland:Kohima

Sub:- **No Objection Certificate (NOC) for Detailed Survey & Investigation (DSI) and Preparation of DPR of SHPs.**

Sir,

In inviting a reference to your letter No.CEL/TB/CIVIL/NEC/35/1749-52 Dated 12th April, 2024 on the subject cited above, I am directed to convey herewith **No Objection Certificate/Permission** for Detailed Survey & Investigation (DSI) and preparation of Detail Project Report (DPR) of Small Hydroelectric Projects (SHPs) for the below mentioned sites (Category A), under the following terms and conditions:

Sl. No.	Name	District	Approx (MW)
A:Sites for NOC (Greenfield Projects)			
1	Teipuiki SHP	Peren	-
2	Lanye SHP	Phek	6.0
3	Arachu-I SHP		3.0
4	Arachu-II SHP		4.5
5	Arachu-III SHP		4.5
6	Shilloi SHP		6.0
7	Yai Horangki SHP	Shamator	10.0
8	Dzü-u SHP	Kohima	3.0

However, with regard to the projects under categories B and C as mentioned below, the matter will be taken up as and when the draft MoUs are submitted:-

B: Sites for MoU (Greenfield Projects)			
1	Lower Likimro SHP	Kiphire	8.1
2	Tsüngi-Tzütang MHP	Mokokchung	0.45
3	Menüng SHP	Mokokchung	3.0
C: Sites for MoU (Brown field) R&M			
1	Tuphaleri MHP	Phek	0.20

Terms & Conditions:

1. DSI & DPR may be prepared by the Firm i.e M/s NEC Energy Pvt Ltd. at their cost, without any financial implications or project obligations to the State Government.
2. The DSI & DPR so prepared shall be submitted to the Power Department for vetting and acceptance.

3. After DSI & DPR submission to the DoPN, the project(s) may be allowed to be developed by the Firm and DoPN under a Special Purpose Vehicle (SPV) under the following terms;
   a. The project(s) shall be developed on basis of BOO (Build Operate Own) under a SPV
   b. The MoU shall be executed between the Firm and DoPN.
   c. PPA shall be executed as per the Tariff determination by NERC.
4. The NOC is valid for a period of 18 (eighteen) months from the date of issue, during which the DSI & DPR should be completed.
5. During the period, a Provisional MoU and PPA may be entered upon, including formation of a SPV, where the DoPN/GoN shall have appropriate stake.

Yours faithfully,

Nkevichusa 2/5/24

(NIKESONO KEVICHUSA),NCS
Deputy Secretary to the Govt. of Nagaland

NO. PWR/W-28/2010 **Dated Kohima, the May, 2024.**

Copy to
1) The Chief Engineer (T&G), Power Department, Nagaland, Kohima for information
2) Office copy.

(NIKESONO KEVICHUSA),NCS
Deputy Secretary to the Govt. of Nagaland

A summary of financial indicators are given below.

Total Capitalized Cost	Rs.9632.12 Lacs
IRR- Project	17 %
Average DSCR	1.58
Minimum	1.26
Maximum	2.07

Abstract of Project Cost Estimation

Sl. No.	Particulars	Amount (*in lakhs*)
A	**Civil works**	**4,766.70**
	Trench Weir	434.85
	Power Channel	187.32
	Desilting Basin	468.30
	Water Conductor System	2,342.20
	Surge Shaft	301.05
	Power House and Tail Race	883.08
	Land Acquisition	149.90
B.	**Cost of EM works**	**2,943.60**
	Power Plant + Erection (E&M)	2,500.00
	Transmission line / Distribution	443.60
C.	**Cost of HM works**	**334.50**
	Penstock	334.50
D.	**Contigencies**	**156.90**
	Preliminary & Environmental Exp	156.90
E.	**Project Managements & Other Services**	**420.08**
I	**Total (A + B + C + D + E)**	**8,621.78**
II	Financing Charges	69.59
III	Interest During Construction (IDC)	940.75
	Project Cost (I + II + III)	**9,632.12**
	MEANS OF FINANCE	
1	Equity (30% of Project Cost, including Finance charges)	2,656.12
2	Debt without IDC (70% of Project Cost)	6,035.25
3	IDC	940.75
	Total Capitalised Cost	**9,632.12**

Salient Features

SALIENT FEATURES

Salient Features of the project with components are given below :

Sl. No.	Item		Description
A	**LOCATION**		
1	State	:	Nagaland
2	District	:	Kiphire
3	Sub-Division	:	Pungro
4	Village	:	Moya
5	Access Road Rail Head	:	 Kiphire Dimapur
6	Geographical Coordinates (Diversion Site) Latitude Longitude	:	Altitude 990 m N 25° 47' 16.16" E 94° 57' 21.66"
B	**RIVER CATCHMENT**		
1	Catchment	:	Likimro
2	River	:	Likimro
3	Tributary	:	Ramwongto & Wurki
4	Sub-tributary	:	-
C	**DIVERSION STRUCTURE**		
1	Type of structure	:	Trench type weir with trash rack
2	Length	:	Appx. 50 m
D	**INTAKE STRUCTURE**		
1	Shape and size	:	Rect. 10 m x 6 m x 6 m
2	Size of gates Inlet to Desilting Structure	:	4.0 m x 3.0 m
E	**DESILTING BASIN**		
1	Type	:	Hopper Type
2	Material of construction	:	RCC
3	Size	:	Approx 120m (L) X 12m (W)

4	Particle size to be removed	:	0.2 mm
5	Size of silt flushing pipe	:	400 mm dia (06 Nos)
F	**WATER CONDUCTOR SYSTEM**		
1	Length (approx.)	:	1850 M
2	Shape	:	Circular
3	Size	:	Dia 3000 mm
4	Material	:	Steel Pipe
G	**SURGE SHAFT**		
1	Size	:	Dia 8.5m, Height 23.8 m
H	**PENSTOCK**		
1	Main penstock Diameter and Thickness	:	2000 mm ID & 12 - 18 mm
2	Number	:	One
3	Length	:	Approx 120 M
4	Design discharge	:	12.82 cumecs
I	**BRANCH MAIN PENSTOCK (after bifurcation)**		
1	Number	:	Three
2	Diameter and Thickness	:	1300 mm ID & 14 -16 mm
3	Length	:	18, 23, 29 M (Unit 1,2,3)
4	Design discharge	:	4.27 cumecs for each branch
J	**POWER HOUSE**		
1	Type	:	Surface
2	**Head**	:	
2.1	- Gross	:	77.65 m
2.2	- Net Design	:	75.00 m
3	Design Discharge	:	12.82 cumec
4	Size of power house (LxWxH)	:	42.0mx (8.75+6.5) mx11.2 m
5	Installed capacity	:	3 X 2700 kWe

K	**TURBINES**		
1	Type	:	Horizontal Francis
2	Number	:	Three
3	Capacity	:	2700 kWe at Generator terminal
4	Type of generator	:	Horizontal Synchronous with Brushless excitation system, 11kV, 0.9pf.
5	Regulation system	:	Digital Governor for Turbine & AVR for Generator
6	Power house crane	:	EOT / 8.7 m span
7	Lifting tackle capacity	:	30 MT/ 5 MT
L	**TAIL RACE**		
1	Shape	:	Rectangular
2	No.	:	One
3	Length.	:	Approx. 20 m
4	Size W x H (m) W x H x L (m) W x H (m)	:	DT Exit: 3 x 4. 3 Tail Race Pool: 23 x 15.5 x 9.5 Tail race pool exit: 10 x 5
M	**POWER / ENERGY**		
1	Installed capacity	:	8100 kW (3 units of 2.7 MW each)
2	Total energy		36.68 MUs per year
N	**66 kV SWITCHYARD & OVERHEAD LINE TERMINATION**		
1	Size of yard	:	13 m x 23 m
2	Transformer capacity at PH end		10 MVA, ONAN, 11kV/66kV
3	Length of 66 kV overhead line upto hooking T-point of existing Likimro-Kiphire 66 line		Single circuit 66 kV max at existing Likimro Project Out Door Switchyard

Chapter - 01

Introduction

CHAPTER – 1

INTRODUCTION

1.1 GENERAL

The role of Small Hydropower Project (SHP) in the context of overall power shortage in the country is significant. Further from the viewpoint of developing rural economy, its role is very important. Their small gestation period, low investment requirement, absence of major socio-economic issues are attractive features. Besides these being located in close proximity of rural areas development of such schemes will lead to small scale agro-based industrialization, chances for the growth of the Tourism facilities etc. and avoid transmission and distribution losses associated with carrying power from distant sources particularly in hills. Small Hydro-power Projects (SHP's), is therefore not only investment friendly, but can also promote rural development in the most economically viable way. Considerable enthusiasm has been created by these inherent features of SHP's in the Government of Nagaland.

Small Hydro Power (SHP) projects are environmentally friendly because they do not encounter the problems of large-scale land acquisition/deforestation and displacement of human settlements. Being located in remote locations and at the tail end of the transmission network, they help in improving voltage levels and can also feed into the local grid in case of a major grid failure, thereby avoiding complete black out. They improve the socio-economic condition of the adjoining areas as well as a large chunk of the investment made in the project's feeds into the local economy. Further, they lead to creation of permanent jobs for operation and maintenance for at least forty (40) years.

1.2 PROJECT BACKGROUND

The proposed Lower Likimro small Hydro Electric Project is a run-of–the river (RoR) type hydropower project located in Village : Moya, Sub-division : Pungro, District : Kiphire of Nagaland. The project will have an installed capacity of 3 x 2.70 MWe and will be able to generate about 36.68 MUs energy annually. Energy available for sale at bar shall be 31.93 Million Units (MU's) annually, after considering annual loss of generation of 4.75 MU's due to possible outages considered as losses, transformation and transmission sent out to the grid including 1% auxiliaries consumption.

The analysis has been carried out to establish the financial, technical and environmental viability of the project. The capitalized cost of the project is Rs 9632.12 Lacs., and it is expected to be completed within 24 - 36 months from the start of construction without any interruption in work.

The survey and investigation for the scheme has been carried out by M/s Nirman C.E. (Govt. approved Surveyor), H.O. Biswanath Chariali, Sonitpur (Assam). The objective of this study is to undertake preparation of 'bankable "Detailed Project Report" - a study that can be used as a basis to secure funding for the project.

1.3 PROJECT DESCRIPTION

1.3.1 Project Location & Approach

Lower Likimro Hydroelectric Power Project has been contemplated as run-of-river (RoR) scheme on Likimro river (a tributary of Tizu river), in Kiphire district of Nagaland.

Lower Likimro Hydro Electric Project is accessed through Kiphire road. The approach to site is via Kiphire, (Kohima) located at a distance of 122 km from Tuensang on the State highway. Kiphire is connected with Pungro town via a fair-weather road and is approx 35 km away. The weir is approx 17.5 km from the bridge over the Likimro river on the Pungro – Moya village road. Nearest air head & rail head is Dimapur.

The road connectivity of Lower Likimro P.H is Dimapur – Kohima – Chakabama – Kikruma – Pfutsero – Jessamni – Meluri – Akhego – Longmatra – 6 kms before Kiphire turn – Pungro – Moya. The distance from Dimapur to Pungro is about 386 km.

1.3.2 Land and Infrastructure

Based on survey details, the project components have been located in a manner that no major orchards or disputed lands are coming in the proposed alignment of water conductor system or at proposed location of powerhouse. The total land requirement for realizing the construction of components of Lower Likimro Hydroelectric Power Project is about thirty (30) Hectares. The major part of land measuring falls in the area owned by people of Mayo Village Council.

The preliminary talks with local landowners through the Village Council nominees indicate that they are very much receptive to make available their lands at reasonable terms & condition and no difficulties are envisaged in acquiring the required land for construction of proposed Project.

1.3.3 Geology of the project area

- Surface geological survey have been carried out to investigate the project and to collect required geological inputs for design of main civil structures.
- In the trench weir area, depth of river fill material is expected to be about 5 m.
- The 143 m length of penstock from surge shaft to power house will be laid on natural soil. The foundation of anchor blocks of penstock shall be laid on rock.
- The Powerhouse is located on exposed quartz mica schist. The foundation of Powerhouse will be laid on bedrock. Back hill slope of Powerhouse shall require proper stabilization measures.
- Our investigations, site visits and tests lead to the conclusion that Lower Likimro Hydroelectric Power Project is suitable geologically and geo-technically. Hence, the

Project is recommended to move into the construction stage. No geological surprises are foreseen through a brief investigation that has been carried out. The terrain is positive for the construction of this 3 x 2.70 MWe Lower Likimro Hydroelectric Power Project.

1.3.4 Hydrology

This hydrological data was taken from the Technical Assistance Report prepared by Korea Water Resources Corporation (K-Water). The main rivers that flow through Nagaland are the Dhansiri, Doyang, Dikhu, Jhanji and Tizu. The terrain is mountainous, thickly wooded, and cut by deep river valleys. The river system draining the hills of Nagaland consists of the Doyang, Dikhu & Jhanji of Brahamputra catchment and the Tizu river from the Irrawady catchment. The Doyang river is a tributary of the Dhansiri river. The Likimro river is a major tributary of the Tizu river.

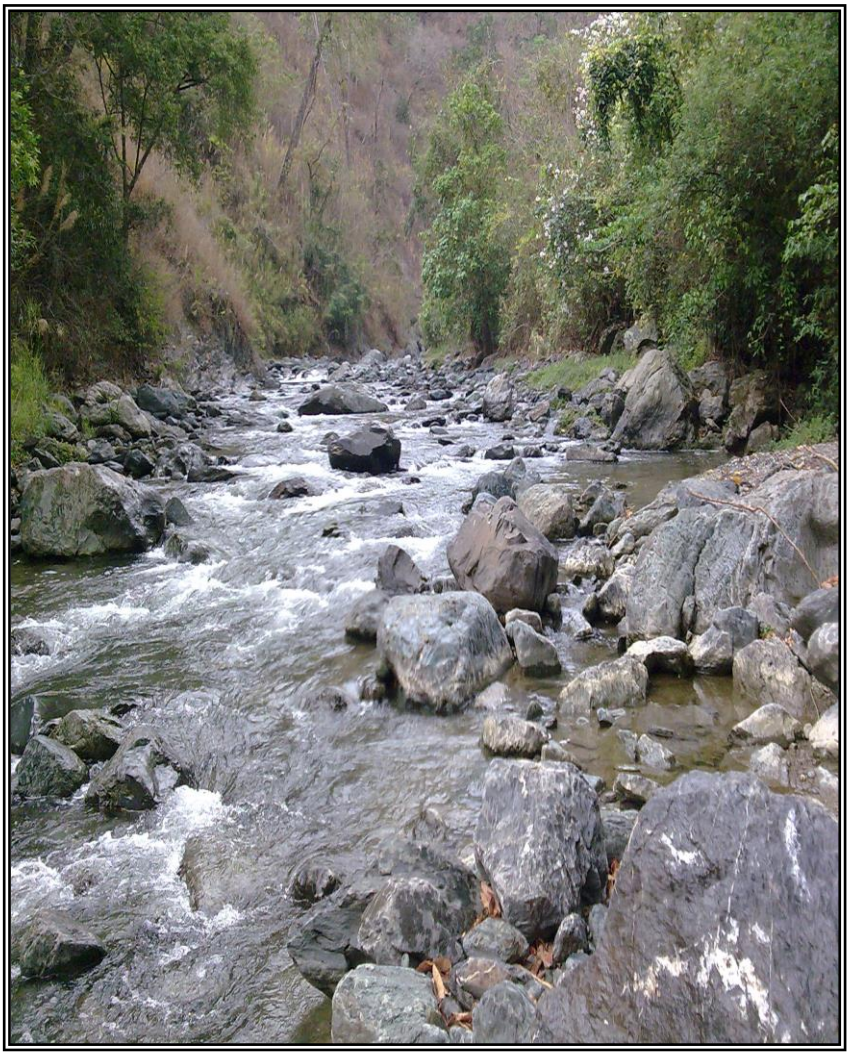
The Likimro river rises to an elevation of about 3100 m above MSL on the western slopes of the Saramati Range. It flows due northwest for about 5Km and then turns westward. After traversing for about 11 Km, the river moves in a southwest direction. The Ramwongto and Wurki are its main tributaries. A number of springs, on the right bank as well as on the left bank, aid to the river flow. The total length of the river, up to its confluence with the Tizu river is 37 Km.

The catchment within the State of Nagaland can be broadly divided into the Brahamputra catchment and the Irrawady catchment. The state's area within the Irrawady catchment is approximately 7000 Km2.

The Likimro catchment lies between latitude 25°6'N & 27°4'N and Longitude 93°20'E & 95°13'E.

Hydrological investigations and analysis of data for Lower Likimro H. E. Project have been carried out in order to assess the following :

- Availability of water for power generation by establishing a long-term flow series applicable to the project site



1.4 OUTLINE OF THE PROJECT

Lower Likimro Hydroelectric Power Project has been contemplated as run-of-river (RoR) scheme on Likimro river (a tributary of Tizu river), in Kiphire district of Nagaland.

The weir crest is at EL 555.50 m. The surface Power house is located on the left bank of Likimro river at EL 472.50 m and switch yard located at EL 476.25 m.

The Project will divert a design flow of 12.82 cumecs through a water conductor system, which will comprise of intake structure including Power Intake (200 m long), Desilting Basin (120m), Water Conductor System (1850 m long), Surge Shaft (8.5 m dia), and Penstock (120 m long main penstock & 23 m long bifurcation). The total length of the water conductor system up-to Surge Shaft is 2170 m. The Head loss in this water conductor system has been computed as 2.24 m at a flow of 12.82 Cumecs. At 12.82 cumecs of water flow, the full reservoir Level (FRL) at Surge Shaft will be maintained at EL 550.15m, with gives gross head of 77.65 m acting on machine. The steel penstock starts at the end of the Surge Shaft with Central Line elevation of EL 550.15 m. The penstock length up to bifurcation piece is 143 m (120 + 23). The length of penstock from bifurcation to Main Inlet valve (MIV) is 23 m. The Head losses in the entire Penstock (main & bifurcation) work out to be 2.27 m. After deducting all Head losses from intake to Turbine inlet, the Net Head available for Power Generation is 75 m.

The controlling Levels & Head loss data is as follows :

Normal Water Level at Intake	m	555.50
Head Loss from Intake to Surge shaft	m	2.28
Full Supply level at Surge Shaft	m	550.15
Powerhouse Level	m	472.50

Normal Tail Water Level	m	470.25
Gross Head	m	77.65
Head Loss in penstock	m	2.27
Net Head	m	75.45
Design net head adopted	m	**75.0**

An in-depth study has been carried for various installed capacities and unit size selection, out of which 3 x 2.70 MWe solutions emerged as the best selection utilizing available head and discharges in most optimum manner at the proposed plant location site. The plant will have an installed capacity of 3 x 2.70 MWe with 3 sets of Horizontal Francis Turbines and coupled to its Synchronous generators, each unit operating at Net Head of 75 m at 4.27 cumecs discharge, 750 rpm.

Power will be generated at 11 kV, bussed & Synchronized at 11 KV, and stepped up to 66 kV at Lower Likimro HEP Switchyard. The power will be transmitted at 66 kV and hooked to existing 66 kV line between main Likimro PH and Kiphire receiving station (132 kV / 66 kV). A T-point type termination will be formed at interconnection point of 66 kV transmission line from Lower Likimro HEP and existing 66 Likimro Kiphire Line. Protection systems are designed accordingly, and such schemes are already in operation at various critical networks in India and Abroad.

The estimated base construction cost of the project is Rs.9632.12 Lacs, which will be spent for the construction and pre-construction activities like clearances, land acquisition, detailed engineering, tendering process, financial closure etc., including Interest During Construction (IDC) & upfront fees.

Summary of Financial Analysis results are as follows:

Total Capitalized Cost	9632.12 Lacs
IRR -Project	17 %
DSCR Average Minimum Maximum	 1.58 1.26 2.07

1.5 MNRE INCENTIVES

With an objective to improve the economic viability of SHP projects, **Ministry of New and Renewable Energy** (MNRE) at times declare incentive schemes for the commercial SHP Projects upto 25 MW station capacity.

The subsidy is intended for making pre-payment of the term loan provided to the developer of an SHP project by the financial institution. The subsidy is generally released, after successful commissioning and commencement of commercial generation from the project, to financial institution providing loan to set up the SHP project.

The quantum of subsidy will be independent of the quantum of term loan and currently there is no incentive schemes from the MNRE.

1.6 CDM BENEFITS

The company, **NEC Likimro Power Private Limited** (NLPPL) may apply at its own costs with any competent authorities for any viable gap funding through green asset management as well as sustainable development program pertaining to the project for which NLPPL shall be fully responsible financially and may receive such benefits without any liabilities of the Government of Nagaland, since entire investments is done by NLPPL. All the green attributes of the power generated shall also is of NLPPL.

1.7 RENEWABLE ENERGY CERTIFICATES (REC)

In the case of non-preferential /negotiated Tariff the company may avail a benefit by way of selling such RECs, where the current rate is @ Rs.150/- (*Rupees one-hundred and fifty*) only, per MWh. In the case of Preferential Tariff, the REC benefit is not available. The REC rate is variable is now at a downward trend, which is traded in **Central Electricity Regulatory Commission** (CERC) approved electricity traders and power exchanges *viz.* **Indian Energy Exchange** (IEX), **Power Exchange India Limited** (PXIL), **Hindustan Power Exchange Limited** (HPXIndia)

Indian Energy Exchange is India's premier energy marketplace, providing a nationwide automated trading platform for the physical delivery of electricity, renewables, and certificates. More recently, IEX has pioneered cross border electricity trade expanding its power market beyond India in an endeavour to create an integrated South Asian Power Market. IEX is powered by state-of-the-art, intuitive and customer centric technology, enabling efficient price discovery and facilitating the ease of power procurement.

IEX has a robust ecosystem of 7,600+ participants located across 28 States and 8 Union Territories comprising of 60+ distribution utilities, 700+ conventional generators and 1,900+ RE generators and obligated entities. It also has a strong base of 4800+ commercial and industrial consumers representing industries such as metal, food processing, textile, cement, ceramic, chemicals, automobiles, information technology industries, institutional, housing, and real estate, and commercial entities.

IEX is approved and regulated by the Central Electricity Regulatory Commission and has been operating since 27 June 2008 and is a publicly listed company with NSE and BSE since October 2017.

The Exchange has ISO Certifications for quality management, Information security management and environmental management since August 2016.

Hindustan Power Exchange (HPX) (formerly known as Pranurja Solutions Limited) is the new age power exchange in Indian Electricity Market. It provides a comprehensive market platform for different electricity products providing a transparent, seamless and robust exchange platform for the market participants. HPX provides opportunity to market participants to transact in most equitable and transparent manner giving its customers unmatched user experience through advanced technology and customized value-added services. Through continuous innovation and creativity in the services as well as its technology, HPX brings in fresh perspective in the power market.

HPX is promoted by three leading institutions of their respective fields

- PTC India Limited
- BSE Investments Limited
- ICICI Bank Limited

The three conglomerates joining hands represents a unique blend of expertise and skillset. PTC is a pioneer of power trading and played a vital role in development of power market in India and South-East Asia. Similarly, BSE has an expertise in setting up and running exchanges / trading platforms. It is the oldest and the fastest stock exchange in the world. Parallelly, on the Clearing and Settlement front, ICICI bring in the financial expertise being the largest and most preferred private bank in India.

Apart from the three promoters, several esteemed power sector entities including Government utilities, Independent Power Producers (IPPs), Power Traders, Distribution Utilities, sector consultants and others have reposed faith in the company through their investments in HPX.

HPX possesses a diversified and dedicated team of power sector professionals well versed with technicalities of power transactions, the regulatory & policy environment at the Central & State level and has an in-depth expertise in understanding and resolving challenges associated with running a successful power exchange.

Power Exchange India Limited (PXIL), India's first institutionally promoted power exchange, has been providing innovative and credible solutions since 2008, and has revolutionized the way Indian power markets operate. PXIL's unique combination of local insights and global perspectives has helped its members make better informed business and investment decisions, and has improved the overall efficiency of power markets in India by accurately and seamlessly connecting buyers and sellers.

1.8 INVESTMENT SUBSIDIES

As per the **Uttar Poorva Transformative Industrialization Scheme** (UNNATI), **2024** the company, NLPPL may apply for such Industrial benefits, as approved by the Union Cabinet, as applicable. The Gazette Notification, dated March 9, 2024 of the **Ministry of Commerce and Industry** (Department for Promotion of Industry and Internal Trade) is attached herewith for reference.

This subsidy is generally released, after successful commissioning and commencement of commercial generation from the project.

1.9 CLEARANCES

The following clearances will be obtained prior to execution of the projects and adequate action has been initiated from the same.

S.No	Description	Remarks
1.	Techno economic clearance from State Government	To be obtained
2.	Forest clearance from forest department	Not Applicable
3.	Clearance from pollution control board/ Department of science and Technology	Not Applicable
4.	Clearance from State irrigation Department for water use for irrigation and water supply.	Not Applicable
5.	Clearance from state fisheries Department	Not Applicable
6.	Clearance from local Village Council	Obtained / attached here-below
7.	Clearance from wild life Department	Not Applicable

OFFICE OF THE JOINT VILLAGE COUNCIL
MOYA,AMIKIORO AND KIURO
Pungro Sub-Division, District Kiphire-798611,Nagaland

Date 8/06/2024

Ref No.....

NO OBJECTION CERTIFICATE

As per the letter No.**CEL/TP/CIVIL/NEC/351/829-29** dated **May 6, 2024** issued by the **Department of Power,Government of Nagaland** We are pleased to inform that the joint Village Council of **Moya,Amikioro and Kiuro** hereby agrees to give the land for the **Development of Lower Likimro Hydroelectric Power Project by M/s NEC Energy Pvt.Ltd.** Who has been operating and maintain the **24 MW Likimro Hydroelectric Power Project since 2006.**

Chairman
Kiuro Village Council

K Asang VCC
Moya Village

Chairman
VILLAGE COUNCIL MOYA

Likhomong VCC
Kiuro Village

Head G.B.
Kiuro Village

Kiumusu Hd/GB
Moya Village

Tsasukiu Hd/GB
Kiuro Village

Kurakmong VCC
Amikioro Village

Chairman
Village Council
Amikioro

Chuba Hd/GB
Amikioro Village

T. Chuba
Head G.B.
Amikioro Village

Chapter - 02

Survey And Investigations

CHAPTER-2

SURVEY AND GEOLOGICAL INVESTIGATIONS

2.1 GENERAL

This chapter deals with topographical survey, hydrological survey, geological investigations, power evacuation survey and market survey. Detailed topographical survey has been carried out after detailed investigations of the area and finalization of reach of the stream for the development of hydropower project. Various components of the scheme have been plotted on the topographic sheets with respect to the arbitrary bench mark. Hydrological & Meteorological survey deals with the collection of data & related information and gauging the stream.

2.2 TOPOGRAPHICAL SURVEYS

2.2.1 General Layout

The survey has been carried out as per standard norms for survey The survey covers 10 m on hillside and 10 m on valley side from the centre line of proposed water conductor route.

All the components like Diversion weir, Power intake, Desilting tank, Water Conductor System, Surge Shaft, Penstock & Power House are marked on the survey sheets.

A team of customer comprising Senior Engineers, Geologists and Surveyors carried out the reconnaissance of the site and identified the possible options of location of the principal components of the project. Comparative studies have been made to finalize the best suitable locations of the scheme components. Thereafter topographical surveys were carried out to decide upon the general layout of the project and to identify the exact location of the various components of the scheme.

2.2.2 Reconnaissance

The following exercise has been done in this survey:

- Desk Study to find out probable locations.
- Site Visit and collection of related data by the team of customer comprising Senior Engineers, Surveyors and Geologists.
- L-Section of the suitable stretch of river has been drawn.

2.2.3 Methodology

The highly experienced surveyors have done detailed survey. Total Station has been used for topographical survey. Sufficient control stations have been set-up at ground with proper identification mark at all components and along the water conductor. All main features like huts, bridle path, landslide zone, and cultivation have been covered in the survey and marked on the sheet at site.

2.3 HYDROLOGICAL SURVEYS

This hydrological data was taken from the Technical Assistance Report prepared by Korea Water Resources Corporation. Hydrological data, especially stream flow, is basic and essential data in order to operate power plants properly and efficiently. Thus, it is necessary to know not only the average stream flow, but also the variations of the stream flow over time. For run of river plants, the preparation of daily flow duration curves shows not only the time variations, but also the calculation of available energy.

Since a hydropower plant normally has a lifetime exceeding 50 years, a correspondingly large variability in future flow conditions must generally be expected. To obtain the best possible estimate for average power production and its variability from year to year, as long a flow series as possible is desirable. A few months flow values for a river or even a few years of measurements have very little value unless they can be correlated with nearby, longer data series.

Traditionally, hydrologists have been mostly involved during the planning stage of new hydropower schemes, collecting data and performing analysis of available water resources and design floods. These are still important tasks, but in addition the new trend is towards an increased use of hydrology for improving the operation of hydropower systems. This has led to an increasing need for real imp data acquisition systems and flow forecasting methods, and the integration of such methods used in combination with hydropower simulations and optimization models.

2.4 GEOLOGICAL INVESTIGATIONS

Experienced geologists have carried out the geological investigations and mapping of the project area Investigations, site visits and tests lead to the conclusion that Lower Likimro Hydroelectric Power Project is suitable geologically and geo-technically. Hence, the Project is recommended to move into the construction stage. No geological surprises are foreseen through a thorough investigation. The terrain is positive for the construction of this 8.1 MW power plant.

2.5 POWER EVACUATION SURVEY

Power will be generated at 11 kV and transmitted at 66 kV upto main Likimro HEP switchyard via a unity ratio at 10 MVA 11/66 kV transformers. A 10 MVA, 11 kV / 66kV step-up transformer is located at main Likimro switchyard and stepped-up power is connected to 66 kV Busbar of up-stream 24 MW Likimro Hydroelectric Power Project's switchyard.

2.6 CHOICE OF SCHEME – OPTIMISATION STUDIES

A number of options for the layout of the scheme were considered during the study. As following considerations have been taken to optimise the best scheme layout.

- The scheme should not conflict with downstream project.
- All components should be geologically safe locations.
- All components should be techno-economically viable.
- A safe elevation of Powerhouse from flash floods and cloud bursting
- Shortest and easiest way of power evacuation

2.7 LAND DETAILS

Based on survey details, the project components have been located in a manner that no major orchards or disputed lands are coming in the proposed alignment of water conductor system or at proposed location of powerhouse. The total land requirement for realizing the construction of components of Lower Likimro HEP is about 30 Hectares. The major part of land measuring falls in the area owned by people of Moya Village Council.

The preliminary talks with local landowners & Village Council nominees indicate that they are very much receptive to development of the Project in their lands and no difficulties are envisaged in acquiring the required land for construction of proposed Project.

Chapter - 03

Hydrology

CHAPTER-3

HYDROLOGY

3.1 GENERAL

The hydrological studies of Lower Likimro Hydroelectric Power Project have been carried out in order to determine the optimum techno-economic potential of the site, to work out the design flood discharge and other related issues in respect of the Lower Likimro Hydroelectric Power Project. This basic hydrological data was taken from the Technical Assistance Report prepared by K-Water (Korea Water Resources Corporation), which was carried out for upstream 24 MW Likimro Hydroelectric Power Project.

Hydrological investigations and analysis of data for Lower Likimro Hydroelecrtic Power Project have been carried out on the basis of water available at upstream 24 MW Likimro tailrace & Likimro river confluence point and addition due to right bank Perennial nallah at this confluence point assess the following:

- Availability of water for power generation by establishing a long-term flow series applicable to the project site
- For calculating the dependable discharges in Likimro river
- For establishing the stage – discharge relationship and for preparing the site-specific rating curve.

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3.2 HISTORY

Hydrological data, especially stream flow, is basic and essential data in order to operate power plants properly and efficiently. Thus, it is necessary to know not only the average stream flow, but also the variations of the stream flow over time. For run of river plants,

the preparation of daily flow duration curves shows not only the time variations, but also the calculation of available energy.

Since a hydropower plant normally has a lifetime exceeding 40 years, a correspondingly large variability in future flow conditions must generally be expected. To obtain the best possible estimate for average power production and its variability from year-to-year, as long a flow series as possible is desirable. A few months flow values for a river or even a few years of measurements have very little value unless they can be correlated with nearby, longer data series.

Traditionally, hydrologists have been mostly involved during the planning stage of new hydropower schemes, collecting data and performing analysis of available water resources and design floods. These are still important tasks, but in addition the new trend is towards an increased use of hydrology for improving the operation of hydropower systems. This has led to an increasing need for real imp data acquisition systems and flow forecasting methods, and the integration of such methods used in combination with hydropower simulations and optimization models.

3.3 RAINFALL

Rainfall is the principal source of water resources. Thus, it is considered basic and essential to determine the areal and temporal distribution of precipitation in water resources management. According to the Detailed Project Report (1988), there are seven reporting rain gauge stations at Mokokchung, Tuensang, Kohima, Dimapur, Wokha, Wakching, Pherima and one self-recording rain gauge station at Kohima in Nagaland. For the purpose of hydrological investigation related to power projects, the State Power Department established rain gauge stations at Salumi, Doyang dam site, Longmatra, Laluri, Phek and Tamlu.

However, there are currently no rain gauge stations in the Likimro catchment area. Rainfall data at Salumi where a rain gauge station had been located is available for the

period June 1983 to February 1988. A rain gauge station was established at Salumi village in June 1983. Daily, 10-daily and monthly rainfall data for the period June 1983 to April 1988 were recorded and it is given in below mentioned Table:-3-1

Table:-3-1

Monthly Rainfall Data at Salumi

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1983						179.8	379.5	280.2	120.5	146	48.3	30	1184.2
1984	24.5	26.3	14	50	195.3	431.1	470.1	344.4	188.2	70.6	27.3	50.4	1892.2
1985	6.1	90.6	56.4	107	116.9	253.2	358.1	328.9	280.6	116	75.4	71.2	1860.5
1986	9.4	10.4	17.5	137	54.9	214.9	347.5	353.1	319.5	304	42.2	3.8	1814.1
1987	18.3	31.8	59.9	81	59.2	281.7	254.8	339.6	178.3	24.6	42.7	4.3	1376.2
Average	14.6	39.8	37.0	93.7	106.6	272.1	362.0	329.2	217.4	132.2	47.2	31.9	1625.4

Based on the above-mentioned data, it was found that the majority of precipitation is generally spread over a period of five months (from May to September). The basin experience southeast monsoon and cyclonic rain at this time and about 79% of the total precipitation occurs during these months. From October to April only 21% of the total precipitation occurs. Rain gauge stations adjacent to the Likimro site are listed in Table 3-2 and monthly data are given in Table 3-3 and Table 3-4 respectively for reference:-

Table 3-2 List of Rain Gauge Stations

State	Station	Longitude	Latitude	Height (EL.M)	Data Collection initiated	Available Data
NAGALAND	SALUMI	94'53'48"	25'47'07"	N.A.	1983.06	1983.06-1988.02
NAGALAND	KIPIHIRE	94'47'00"	25'58'00"	1195	N.A.	1998.01-2005.12
NAGALAND	MELURI	94'38'00"	25'41'30"	1350	N.A.	1995.01-2005.12

Table 3-3 Monthly Rainfall Data at Kiphire

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1978		3.2	33.7	48.3	110	255	221.7	166.4	152.8	25.3	15.6		1032.4
1979		6.2	54.4	43.8	39	102.1	226.5	178	184.9	66.3	12.2	19.4	932.8
1980	5.9	11.3	75.1	35.6	203	322.8	221.7	267.3	166.9	174		1.3	1485.5
1981	22.5	23.7	34.3	116	211	181.1	309	152.7	132.8	29.9	6	7	1225.7

1982		37.3	6.8	92.6	61.8	168	388	66	127	26	43	10	1026.5
1998			45.5	111	144	103.8	284	246.8	91.2	71	39.2		1136.6
1999	5	0	10.7	4.6	251	217.7	147.4	254.1	175.4	128	23.1	11.1	1227.5
2000	21.6	5.7	58.7	19.9	154	116.2	231.8	166.6	146	149	1.2		1070.3
2001	3.9	41.4	3.6	25.9	71.9	215.2	147.4	110.8	80	142	39.7		881.6
2002	26	6.5	31.7	82.9	161	143.6	199.8	211.5	87.1	17.6	32.1	3.3	1002.9
2003	16.7	14.2	16.9	105	99.4	142.9	143.2	241.6	92	78.1	5.2	17	971.9
2004	0.7	0	1.2	153	63.9	116.2	102.8	102	122.2	85	7.6	1.6	756.4
2005	3.9	2.1	49.8	25.1	78	76.4	118.8	88.8	66.4	108	0.5	3.8	621.6
Average	**11.8**	**15.2**	**32.5**	**66.4**	**126.8**	**166.2**	**210.9**	**173.3**	**125.0**	**84.6**	**18.8**	**8.3**	**1039.7**

Table 3-4 Monthly Rainfall Data at Meluri

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1995	5.6	54.1	5.2	65.3	130								259.9
1996	0	0	74	22.6	72	94.5	136	116.7	26.1	44.2	3		589.1
1997	0	12.4	21.3	41.5	42.4	85.4	127.5	139	63	4	5	26.5	568
1998	0	8.6	71	112	156	87.7	192.5	140.4	50	30.6	60.8	4.4	913.7
1999	0.6	0	5.5	9.1	226	31.6	150.7	200.2	105.8	57.9	17	0	804.7
2000	27	4.6	75.4	45.4	229	176.8	296.7	140	137.8	102	0	0	1234.2
2001	0	55	15.5	8.6	116	207.9	192.1	96.3	112.9	174	38	0	1015.9
2002	15.6	6.5	35.6	124	144	85	186	221.1	78.6	41.2	47.6	6.7	992
2003	17.9	15.5	5	63	126	111.2	201	298.1	181.2	161	21.1	34.9	1235.4
2004	2.5	0	0.8	210	33.1	168.1	325.4	159.7	277.3	151	24.2		1351.8
2005	7.4	9.5	24	40	122	44.7	153.6	79.6	100.8	166	16.6	10.4	774.8
Average	**10.9**	**20.8**	**30.3**	**67.4**	**127.0**	**109.3**	**196.2**	**159.1**	**113.4**	**93.0**	**25.9**	**7.5**	**960.76**

Based on the results, it can be seen that there are relatively large deviations among the rain gauge stations. The annual average precipitation of the Salumi station is much higher than that of the other stations. Thus, it is necessary to verify the reliability of the Salumi stations rainfall data using a correlation analysis. However, there is no way to analyze the correlation among the stations because rainfall observation was discontinued at the Salumi station and the observation period is inconsistent at the other stations as well.

Therefore, a new rain gauge should be installed in the Likimro catchment area and maintained properly in order to achieve consecutive rainfall data series for assessing reliable water resources availability in the catchment area as soon as possible.

3.4 STREAMFLOW DATA

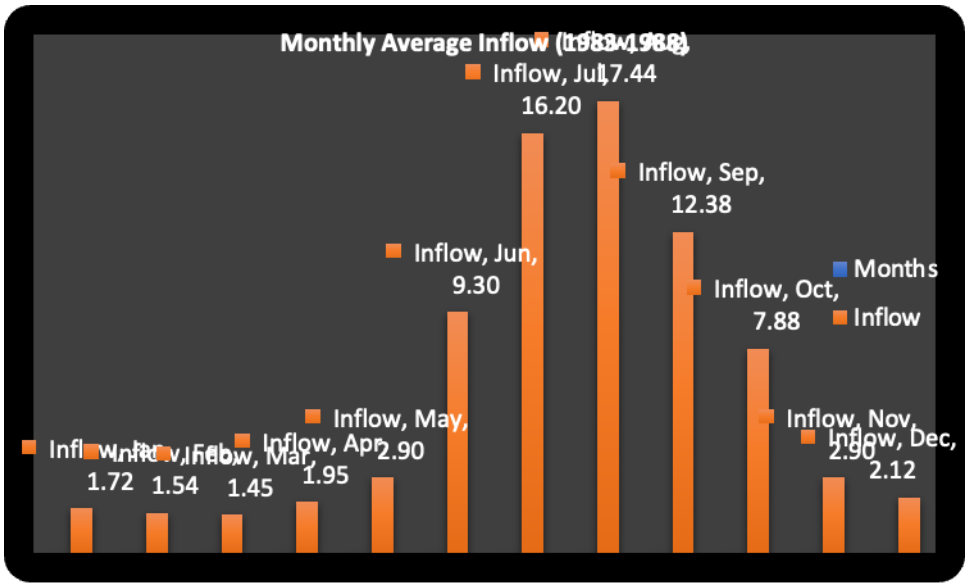
Runoff data can be defined simply as continuous flow data series in the streams (or rivers). It is normally produced by streamflow measurements. Flow data series are basic and essential for hydrological analysis related to hydropower planning and operation.

It is necessary to not only know the average annual streamflow, but also the variation of the streamflow over time. For run of river plants, preparation of a daily flow duration curve shows not only the time variations, but also allows for the calculation of available energy. The most important parameters is the average annual runoff and it can be computed as the long term average for an extended period of observation, if possible for 30 years or more.

No discharge observation was made at any section of the Likimro River prior to June 1983 due to remoteness and difficult approach. Gauge and discharge observation was started at the diversion weir site since 1983. Discharge observations were carried out using the float run method. As the velocity was observed by float run, a 20% deduction from the observed discharge was applied. A minimum discharge of 0.94 cumecs was recorded on the 20th of March 1985. The monthly average stream discharges are summarized in Table 3-5.

Table 3-5: Monthly Stream Discharge Data at Diversion Weir Site of Likimro (3x8MW)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1983						3.6	9.5	7.2	6.6	5.2	3	2.6
1984	2.2	1.8	1.4	1.3	2.3	8.4	15.7	11.3	12.9	3.9	2.4	1.8
1985	1.3	1.3	1.2	1.9	3.5	12.6	24.5	18.2	9.2	3.7	2.5	2.3
1986	1.9	1.8	1.7	3.1	4.2	10.9	19.9	21.3	21.1	21.7	3.5	2.1
1987	1.8	1.6	1.5	1.5	1.6	11	11.4	29.2	12.1	4.9	3.1	1.8
1988	1.4	1.2										
Average	1.72	1.54	1.45	1.95	2.90	9.30	16.20	17.44	12.38	7.88	2.90	2.12



Based on the data, it is evident that the inflow fluctuates highly from month to month, especially during the wet seasons from June to October, mainly due to heavy rainfall caused by monsoon. The average annual runoff was estimated as 6.48 cumecs.

There is a variety of methods for discharge measurement, but the most commonly used is based on velocity measurements with current meters. This method is regarded as more accurate than the float run method. The use of current meters is the most widespread method for discharge measurements. The principle is to measure the flux of water through a river cross section, by determining the velocity of water at a high number of points. The most commonly used current meters are propeller type water velocity meters.

K-water's hydrological investigation team carried out river discharge measurements using propeller type current meters during their investigation into the Likimro river catchment area in March 2006. The results are given in Table 3-6.

Table 3-6 Results of River Discharge Measurements using Current Meter

Date	Location	Mean Velocity	Discharge	Remarks
25-Mar-06	30 m upstream from D/W	0.149	0.522	Diversion Weir
25-Mar-06	Inlet of Balancing Reservoir	0.176	0.388	Power Channel
29-Mar-06	100 m Upstream from permanent H/B	0.22	0.5	Hanging Bridge

From the results, it was found that the average river discharge is about 0.5 cumecs. This is much less than the minimum discharge of 0.94 cumecs recorded in 1985. The deviation may be due to several causes. One cause may be the extreme draught that has lasted since November, 2005. Others may be caused by unreliability of the applied float run methods in the past etc. However, it is difficult to figure out the cause due to insufficient amounts of reliable hydrological data.

Therefore, it is recommended to obtain and accumulate reliable runoff data by stream flow measurements using proper methods, such as current meters, as soon as possible.

3.5 FLOW FORECASTING AND AUTOMATIC DATA ACQUISITION SYSTEMS

The operation of hydropower plants is significantly different from the operation of thermal power plants. One major difference is that future water inflow is never known exactly, the inflow is a stochastic variable, leading to high degree of uncertainty concerning future production capacity.

The optimum operation of a hydropower system can be greatly improved if reliable inflow forecasts can be issued. Such forecasts can be short-term (hours to days) or seasonal for some types of rivers.

Short – term forecasts are mostly bases on the use of computerized hydraulic and hydrological models. Hydrological models (precipitation – runoff models) are used to forecast runoff from the catchment into the river system and hydraulic models are used to route the river flow through the systems of rivers, power channel and reservoir.

The increasingly complex systems for short-term forecasting for hydropower operation also require more input data and frequent model updating. This has created a demand for automatic data acquisition systems, where the flow of data from sensors into the

forecasting models can be made automatically and without human interruption or delays.

Therefore, ultimately, it is necessary to adopt suitable models for runoff forecasting & flow routing, and to build up automatic data acquisition systems for optimum operation of the Likimro Hydro Electric Power Plant in the future.

3.6 ACTUAL FLOW

Actual flow available for Lower Likimro HEP at confluence point of Tailrace of Main 24 MW Likimro HEP. Refer to Table 3.7 below.

Table 3.7: Flow available at Tailrace confluence point of main Likimro for Hydrology purpose of Lower Likimro

Month	Discharge available at gauging station at Diversion weir of Likimro HEP (Table 3.5 figures)	Discharge available through Likimro HEP	Overflow Discharge at Diversion Weir of Likimro HEP	Perinial Additional discharge available due to Catchment area & adl springs between Diversion Weir site of Likimro HEP & Tailrace confleance point of Likimro HEP.	Perinial Discharge available from right bank Nallah at confluence point of Tailrace of Likimro HEP	Total Inflow
				10%	10%	
Jan	1.72	1.72	0	0.17	0.172	2.06
Feb	1.54	1.54	0	0.15	0.154	1.85
Mar	1.45	1.45	0	0.15	0.145	1.74
Apr	1.95	1.95	0	0.20	0.195	2.34
May	2.9	2.9	0	0.29	0.29	3.48
Jun	9.3	3.77	5.53	0.93	0.93	11.16
Jul	16.2	3.77	12.43	1.62	1.62	19.44
Aug	17.44	3.77	13.67	1.74	1.744	20.93
Sep	12.38	3.77	8.61	1.24	1.238	14.86
Oct	7.88	3.77	4.11	0.79	0.788	9.46
Nov	2.9	2.9	0	0.29	0.29	3.48
Dec	2.12	2.12	0	0.21	0.212	2.54

3.7 Flood Calculations

3.7.1 Flood of 50 years Return Period

3.7.1.1 Dicken's *Formula*

This formula is particularly applicable to catchment areas of North India. According to this formula, flood is estimated using the following relationship:

$Q = C A^{3/4}$

Where,

Q = Estimated peak flood in m^3/sec (probability 1 in 50)

C = A constant depending upon the type of catchment. Its value for North India hilly region varies from 11 to 14.

a1 = Catchment area up to main likimro diversion weir = 148.25 km^2

a2 = Catchment area between Main Likimro Diversion site & Lower Likimro River site = 29.65 km^2

a3 = additional catchment area of right bank nallah = 29.65 km^2

A = a1+a2+a3

A = Total Catchment area at lower likimro diversion site = 148.25 + 29.65 + 29.65 = 207.55 km^2

A = 207.55 km^2

Hence,

$Q = 14 \times 207.55^{3/4} = 765.54$ m^3/sec

3.7.1.2 Ryve's Formula

This formula is based upon investigations carried out during a dam project.

According to this formula, flood is estimated using the following relationship.

$Q = CA^{2/3}$

Where Q is the estimated peak flow in m^3/sec

C is a constant whose value is 18.19 for a return period of 25 years and 20.78 for a return period of 50 years

Thus,

$Q = 18.19 \times 1207.55^{2/3} = 637.64\ m^3/sec$ for 25 year return period

and

$Q = 20.78 \times 207.55^{2/3} = 728.44\ m^3/sec$ for 50 year return period

Keeping in view the medium size of catchment and its location being in Himachal Pradesh, flood discharge as computed from Ryve's formula can be safely adopted.

Hence, design flood discharge = 637.64 m^3/sec for 25 year return period

= 728.44 m^3/sec for 50 year return period

Since Ryve's formula shows a value higher then Dicken's formula, the same, viz. 728.44 m^3/sec has been adopted as the 50 year design flood.

3.7.2 Flood of 100 years Return Period

3.7.2.1 Fuller's Formula

In order to obtain a flood of 100 years return period, Fuller's formula has been used. According to this formula

$(Q_f)_{100} = F_{50} \times (1 + 0.8 \log T_{100}) / (1 + 0.8 \log T_{50})$

Where,

$(Q_f)_{100}$ = estimated peak flood in m^3/sec corresponding to a return period of 100 years

T_{100} = 100 years time period

T_{50} = 50 years time period

F_{50} = Flood discharge at 50 years time period

Hence,

$(Q_f)_{100}$ = 728.44 x (1+0.8 log T_{100}) / (1+0.8 log T_{50})

= 802.79 m^3 / sec

Thus, it can be concluded that for Lower Likimro Hydroelectric Power Project,

Peak design flood = 728.44 m^3 / sec for 50 years return period

= 802.79 m^3 / sec for 100 years return period.

Chapter - 04

Power Potential

CHAPTER – 4

POWER POTENTIAL

4.1 GENERAL

Power potential includes the power studies, optimization of installed capacity and generated energy for selected capacity of the Project.

This chapter includes the adopted approaches and assumptions for optimization purpose of the proposed project in order to achieve the most economically effective plant size.

After carrying detailed studies of Topographical survey and optimum location of Project components, the operating Gross head was established. Losses in the water conductor system were computed after carrying the hydraulic designs of project components. Net head was computed after deducting losses from Gross head. Plant capacity was established based on assumed net head and assumed design discharge. Annual Energy calculations are also computed based on selected plant and unit size.

4. 2 POWER STUDIES FOR OPTIMIZATION OF PLANT SIZE

Power studies on the basis of data given in assistance report. The studies have been done from 1 MW to 9 MW with a step of 1.0 MW. The hydrology and net head have been taken as hereunder.

4 .3 HYDROLOGY

Since the hydrological data plays the most important role on the selection of plant size and the calculation of the energy needed for revenue calculations. The level of assurance of having certain hydrology of a river plays an important role not only on capacity selection but it is lifeline of the project.

4. 4 OPERATING HEAD

The operating heads available for power generation have been estimated from the following reservoir levels and proposed center line of the machines.

Normal Water Level at Intake	m	555.50
Head Loss from Intake to Surge shaft	m	2.28
Full Supply level at Surge Shaft	m	550.15
Powerhouse Level	m	472.50
Normal Tail Water Level	m	470.25
Gross Head	m	77.65
Head Loss in penstock	m	2.27
Net Head	m	75.45
Design net head adopted	m	**75.0**

The rated net operating head of 75 meter has been used for calculating the power output, at rated design discharge of 12.82 cumecs.

HEAD LOSS CALCULATIONS			
1	**Water level at Intake well after weir EL**	**m**	**987.50**
POWER CHANNEL FROM WEIR TO DESILTING BASIN			
2	Design Discharge	Cumecs	**12.82**
3	Additional Discharge (25%) for flushing	Cumecs	3.205
4	Discharge	Cumecs	16.025
5	Bed Slope of Channel	1:750	0.0013
6	Length of Channel	m	**200**
7	Friction Factor in Concrete		0.012
8	Width of Channel	m	**4**
9	Effective Depth of the Channel	m	**3**
10	Wetted Area	Sq.m	12
11	Wetted Perimeter	m	10
12	Rugosity Coefficient ®		1.20
13	**Channel Velocity**		
14	V = 1/n *(BD/B+2D)^0.66*S^0.5	m/sec	3.43
15	Discharge	Cumecs	41.18
16	Required Flow Velocity	m/sec	1.335
17	**Frictional Head Loss** hf = $(V^2n^2L)/R^{4/3}$	m	**0.04**
FROM DESILTING TO SURGE SHAFT			
18	Design Discharge	Cumecs	12.82
19	Bed Slope of Channel	1:500	0.0020
20	Length of Channel	m	**1850**
21	Friction Factor in Steel	m	0.014
22	Width of Channel / DIA OF PIPELINE	m	**3**
23	Effective Depth of the Channel	m	
24	Wetted Area	Sq.m	7.065
25	Wetted Perimeter	m	9.42
26	Rugosity Coefficient ®		0.75
27	**Channel Velocity**		
28	V = 1/n *(BD/B+2D)^0.66*S^0.5	m/sec	2.64
29	Discharge	Cumecs	18.67
30	Required Flow Velocity	m/sec	1.815
31	**Frictional Head Loss** hf = $(V^2n^2L)/R^{4/3}$	m	**1.75**
32	**Bend Loss** hf = Kb V2 / 2g	**m**	
33	K_b is taken as per the CBIP manual for tunnel construction		0.11
34	No of Bends		**5**
35	**Total Bend Loss**	**m**	**0.09**
36	**Miscelleneous Losses**		**0.40**
TOTAL LOSSES IN WATER CONDUCTOR SYSTEM (Intake to Surge shaft)		**m**	**2.244**

HEAD LOSS CALCULATIONS (Contd.)			
FROM SURGE SHAFT TO POWER HOUSE			
37	Main Penstock Diameter	mm	**2000**
38	Area of Penstock	m^2	3.14
39	Discharge	cumecs	12.82
40	Velocity	m/s	4.08
41	Kinematic Viscocity of water at 20^0 c	m^2/s	1300000
42	Reynold No.	VD/n	0.0063
43	Roughness of the pipe material	mm	0.045
44	Relative Roughness	K/D	0.000023
45	Friction Factor		0.014
46	Length	m	**120**
47	**Friction Head Loss**	**m**	**0.71**
48	For Bell Mouth Entry	1	0.042
49	For first bend T - Joint	1	0.170
50	For bend (bifurcation)	2	0.509
51	for Contraction at bifurcation	2	0.212
52	for other bends	3	0.280
53	**Total Losses**	**m**	**1.214**
54	Bifurcated Penstock Diameter	mm	**1300**
55	Area of Penstock	m^2	1.33
56	Discharge	cumecs	4.27
57	Velocity	m/s	3.22
58	Kinematic Viscocity of water at 20^0 c	m^2/s	1300000
59	Reynold No.	VD/n	0.0032
60	Roughness of the pipe material	mm	0.045
61	Relative Roughness	K/D	0.000035
62	Friction Factor		0.014
63	Length	m	**23**
64	**Friction Head Loss**	**m**	**0.13**
65	No. of Branches		2
66	**Total Frictional Loss**		**0.26**
67	Valve Losses	1	0.212
68	**TOTAL LOSSES FROM SURGE SHAFT TO POWER HOUSE**	**m**	**2.27**

HEAD LOSS CALCULATIONS (Contd.)			
69	Full Supply level at Surge Shaft	m	985.22
70	Normal Tail Water Level	m	**470.25**
71	Gross Head	m	75.65
72	Net Head	m	75.45

73	**Design net head adopted**	m	**75**

4. 5 EFFICIENCIES

The power and energy generated by three units of Francis Turbine and Generator are computed using their efficiencies corresponding to the load on unit. For this purpose, the load efficiency curves for similar size of turbine and generator are used. The typical average efficiencies at 100% load for turbine and generator are 89.8% and 95.73% respectively.

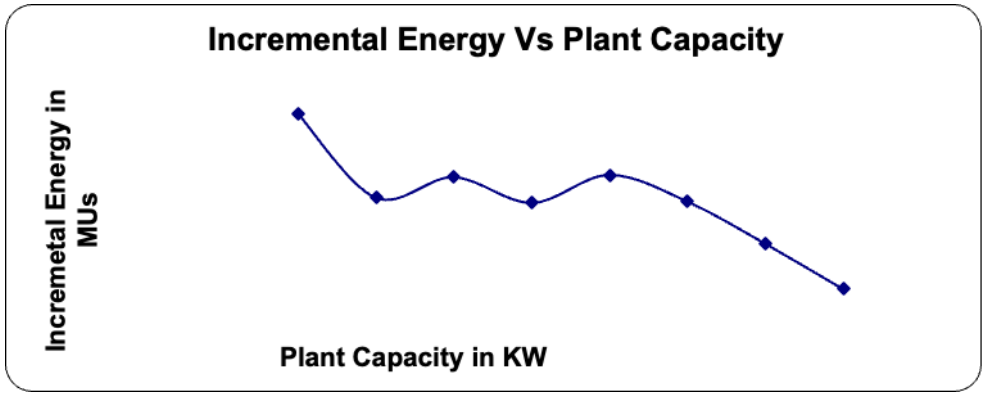
For carrying out optimization studies the efficiency values at full load operation of Turbine and Generator have been considered.

4.6 INCREMENTAL POWER STUDIES

Incremental power studies are presented in the following table. A chart in incremental energy vs installed capacity is drawn as fig.

INCREMENTAL POWER STUDY

Sl. No.	Capacity of Plant in KW	Discharge for three units in Cumecs	Design Net Head in m	Energy Generation in MU	Incremental Energy in Mus
1	1000	1.59	75	8.93	
2	2000	3.15	75	15.26	6.330
3	3000	4.74	75	18.67	3.410
4	4000	6.33	75	22.80	4.130
5	5000	7.92	75	26.04	3.240
6	6000	9.48	75	30.24	4.200
7	7000	11.07	75	33.51	3.270
8	8000	12.66	75	35.31	1.800
9	9000	14.22	75	35.54	0.230



4.8 OPTIMISATION OF PLANT CAPACITY

Optimization Process

The objective of the optimization of the plant capacity is to find out the project configuration, which can generate maximum annual energy at the lowest possible cost. Optimization curve is based on the Plant capacity vs Incremental Energy.

From above curve it is observed that the optimum plant capacity can be in the range of 8 MW. The optimization curve shows that beyond 8 MW the incremental energy is very low.

Hence, plant capacity of Lower Likimro Hydroelectric Power Project is optimized at 8.1 MW .

4.8 ENERGY CALCULATION AT FINAL INSTALLED CAPACITY

Total Annual Energy Generation is presented in below Tables.

The Energy generation for 2 x 4 MW works out to be 31.07 MUs (shown in table 4.3)

The energy generation for 3 x 2.7 MW works out to be 36.68 MUs (shown in table 4.3)

Table 4.3 indicates that the Energy generation for 2 x 4 MW is less than energy generated from 3 x 2.7 MW installed capacity, because of the reason that Francis machines has inherent limitation of operation less than 40%-unit capacity.

Therefore, instead of providing 2 units of 4 MW, it is better to provide 3 x 2.7 MW.

For Financial Analysis 3 x 2.7 MW units producing 36.68 MUs (at 5% Overload capacity) has been considered.

Table 4.1 :- Energy Generation without overload

Plant Capacity	3 x 2.7 MW	= 8.1 MW
Unit capacity	2700	kW
Unit Discharge	4.27	cumecs
Net Head	75.00	m

Month	Discharge available at gauging station at Diversion weir of Likimro HEP (Table 3.5 figures)	Discharge available through Likimro HEP	Overflow Discharge at Diversion Weir of Likimro HEP	Perinial Additional discharge available due to Catchment area & adl springs between Diversion Weir site of Likimro HEP & Tailrace confleance point of Likimro HEP.	Perinial Discharge available from right bank Nallah at confluence point of Tailrace of Likimro HEP	Total Inflow	Discharge for Unit I	Power Generated from unit I	Discharge for Unit II	Net Head (m)	Power Generated from unit II	Discharge for Unit III	Power Generated from unit III	Energy Generated - Unit I + Unit II + Unit III (in MUs)
				10%	10%									
Jan	1.72	1.72	0	0.17	0.172	2.06	2.06	1305.11	0.00	75.00	0	0.00	0	0.97
Feb	1.54	1.54	0	0.15	0.154	1.85	1.85	1168.52	0.00	75.00	0	0.00	0	0.87
Mar	1.45	1.45	0	0.15	0.145	1.74	1.74	1100.23	0.00	75.00	0	0.00	0	0.82
Apr	1.95	1.95	0	0.20	0.195	2.34	2.34	1479.63	0.00	75.00	0	0.00	0	1.10
May	2.9	2.9	0	0.29	0.29	3.48	3.48	2200.47	0.00	75.00	0	0.00	0	1.64
Jun	9.3	3.77	5.53	0.93	0.93	11.16	4.27	2700.00	4.27	75.00	2700	2.62	1657	5.25
Jul	16.2	3.77	12.43	1.62	1.62	19.44	4.27	2700.00	4.27	75.00	2700	4.27	2700	6.03
Aug	17.44	3.77	13.67	1.74	1.744	20.93	4.27	2700.00	4.27	75.00	2700	4.27	2700	6.03
Sep	12.38	3.77	8.61	1.24	1.238	14.86	4.27	2700.00	4.27	75.00	2700	4.27	2700	6.03
Oct	7.88	3.77	4.11	0.79	0.788	9.46	4.27	2700.00	4.27	75.00	2700	0.00	0	4.02
Nov	2.9	2.9	0	0.29	0.29	3.48	3.48	2200.47	0.00	75.00	0	0.00	0	1.64
Dec	2.12	2.12	0	0.21	0.212	2.54	2.54	1608.62	0.00	75.00	0	0.00	0	1.20
Total Energy in MUs														**35.58**

Table 4.2 Energy Generation with 5% Overload

Plant Capacity	3 x 2.7 MW = 8.1 MW	
Unit capacity	2700	kW
Unit Capacity including 5% overload	2835	
Unit Discharge including 5% overload	4.48	cumecs
Net Head	75.00	m

Month	Discharge available at gauging station at Diversion weir of Likimro HEP (Table 3.5 figures)	Discharge available through Likimro HEP	Overflow Discharge at Diversion Weir of Likimro HEP	Perinial Additional discharge available due to Catchment area & adl springs between Diversion Weir site of Likimro HEP & Tailrace confleance point of Likimro HEP.	Perinial Discharge available from right bank Nallah at confluence point of Tailrace of Likimro HEP	Total Inflow	Discharge for Unit I	Power Generated from unit I	Discharge for Unit II	Net Head (m)	Power Generated from unit II	Discharge for Unit III	Power Generated from unit III	Energy Generated - Unit I + Unit II + Unit III (in MUs)
				10%	10%									
Jan	1.72	1.72	0	0.17	0.172	2.06	2.06	1305.11	0.00	75.00	0	0.00	0	0.97
Feb	1.54	1.54	0	0.15	0.154	1.85	1.85	1168.52	0.00	75.00	0	0.00	0	0.87
Mar	1.45	1.45	0	0.15	0.145	1.74	1.74	1100.23	0.00	75.00	0	0.00	0	0.82
Apr	1.95	1.95	0	0.20	0.195	2.34	2.34	1479.63	0.00	75.00	0	0.00	0	1.10
May	2.9	2.9	0	0.29	0.29	3.48	3.48	2200.47	0.00	75.00	0	0.00	0	1.64
Jun	9.3	3.77	5.53	0.93	0.93	11.16	4.48	2835.00	4.48	75.00	2835	2.19	1387	5.25
Jul	16.2	3.77	12.43	1.62	1.62	19.44	4.48	2835.00	4.48	75.00	2835	4.48	2835	6.33
Aug	17.44	3.77	13.67	1.74	1.744	20.93	4.48	2835.00	4.48	75.00	2835	4.48	2835	6.33
Sep	12.38	3.77	8.61	1.24	1.238	14.86	4.48	2835.00	4.48	75.00	2835	4.48	2835	6.33
Oct	7.88	3.77	4.11	0.79	0.788	9.46	4.48	2835.00	4.48	75.00	2835	0.00	0	4.22
Nov	2.9	2.9	0	0.29	0.29	3.48	3.48	2200.47	0.00	75.00	0	0.00	0	1.64
Dec	2.12	2.12	0	0.21	0.212	2.54	2.54	1608.62	0.00	75.00	0	0.00	0	1.20
												Total Energy in MUs		**36.68**

Table 4.3 Energy Generation for 2 x 4 MW

Plant Capacity	2 x 4 MW = 8 MW	
Unit Capacity	4000	
Unit Discharge	6.41	cumecs
Net Head	75.00	m

Month	Discharge available at gauging station at Diversion weir of Likimro HEP (Table 3.5 figures)	Discharge available through Likimro HEP	Overflow Discharge at Diversion Weir of Likimro HEP	Perinial Additional discharge available due to Catchment area & adl springs between Diversion Weir site of Likimro HEP & Tailrace confleance point of Likimro HEP.	Perinial Discharge available from right bank Nallah at confluence point of Tailrace of Likimro HEP	Total Inflow	Discharge for Unit I	Power Generated from unit I	Discharge for Unit II	Net Head (m)	Power Generated from unit II	Energy Generated - Unit I + Unit II (in MUs)
				10%	10%							
Jan	1.72	1.72	0	0.17	0.172	2.06	0.00	0.00	0.00	75.00	0	0.00
Feb	1.54	1.54	0	0.15	0.154	1.85	0.00	0.00	0.00	75.00	0	0.00
Mar	1.45	1.45	0	0.15	0.145	1.74	0.00	0.00	0.00	75.00	0	0.00
Apr	1.95	1.95	0	0.20	0.195	2.34	0.00	0.00	0.00	75.00	0	0.00
May	2.9	2.9	0	0.29	0.29	3.48	3.48	2200.47	0.00	75.00	0	1.64
Jun	9.3	3.77	5.53	0.93	0.93	11.16	6.41	4053.32	4.75	75.00	3003	5.25
Jul	16.2	3.77	12.43	1.62	1.62	19.44	6.41	4053.32	6.41	75.00	4053	6.03
Aug	17.44	3.77	13.67	1.74	1.744	20.93	6.41	4053.32	6.41	75.00	4053	6.03
Sep	12.38	3.77	8.61	1.24	1.238	14.86	6.41	4053.32	6.41	75.00	4053	6.03
Oct	7.88	3.77	4.11	0.79	0.788	9.46	6.41	4053.32	3.05	75.00	1926	4.45
Nov	2.9	2.9	0	0.29	0.29	3.48	3.48	2200.47	0.00	75.00	0	1.64
Dec	2.12	2.12	0	0.21	0.212	2.54	0.00	0.00	0.00	75.00	0	0.00
Total Energy in MUs												**31.07**

Chapter - 05

Civil Engineering Structures

CHAPTER – 5

CIVIL ENGINEERING STRUCTURES

5.1 GENERAL

The 8.1 MW Lower Likimro Hydroelectric Power Project has been contemplated as run-of-river (RoR) scheme on Likimro river (a tributary of Tizu river), in Kiphire district of Nagaland. Lower Likimro is located on the downstream of existing 3 x 8 MW Likimro HEP and the project has been O&M leased to *M/s*. **NEC Energy Private Limited** by **the Government of Nagaland,** which was in-operational for many years and all the three Units could not be synchronized until the time NEC Energy Private Limited along with the Technical Assistance with **K-Water** took over the O&M of the said Project in June 2006. The Project since has been generating till date successfully.

5.2 PROJECT LAYOUT PLANNING

Location of the project has been decided after careful study of the following factors:

a. Suitability of location of different components of hydel scheme
b. Environmentally & ecologically suitable location
c. Minimum civil work cost

All components of the Project viz., the diversion weir site, power intake, desilting tank, water conductor system, surge shaft, penstock, switchyard, powerhouse and tail race have been located on left bank of Likimro river on the basis of topographical, geological and geotechnical study. Layout has been finalized so as to maximize the exploitation of available discharge and head.

Diversion weir site has been proposed at a suitable location on the topographic survey sheet. Any location upstream of this point would no doubt yield higher head. However, a stable and relatively flat bed slope of the river, an almost straight reach of the river and presence of rock outcrops on the riverbanks suggest that the chosen location for diversion weir would

be ideal. Moreover, due to the presence of the outfall of tailrace of the upstream project just upstream of the proposed diversion weir, its location cannot be shifted to the upstream side.

Location of surge shaft and the alignment of water conductor system (power intake, de-silting tank, steel water conductor and penstock) have been decided on the basis of geological set-up, topography of the area and the most optimum hydraulic computation for water conductor system. Presence of a good, nearly flat terrace located between the left banks of Likimro River which controls the sitting of powerhouse and tailrace channel. The alignments of approach roads to the powerhouse, surge shaft and diversion weir sites have been finalized based upon Topographic survey.

5.3 COMPONENTS OF THE SCHEME

Following are the principal components of the scheme:

Sl.No.	Description	Sizes in m
a.	Diversion weir (Trench type weir)	Approx. 50 m
b.	Power Intake structure	10 m x 6 m x 6 m
c.	Desilting tank	Approx 120m (L) X 12m (W)
d.	Water Conductor System	3.0 m dia & 1850 m
e.	Surge Shaft	Dia 8.5m, Height 23.8 m
f.	Penstock	120 m (Main Penstock) , Branch 18 , 23, 29 M (Unit 1,2,3) bifurcated penstock
g.	Power house	42.0mx(8.75+6.5)mx11.2 m
h.	Tailrace channel	Approx. 20 m
i.	Switchyard	13 m x 23 m
j.	Approach roads	

Details of the each components are as discussed in below :

5.3.1 Project Component

a) Diversion Weir :

In run of the river schemes, a diversion structure across the stream is required to divert the stream water to the water conductor system and ultimately to the powerhouse for power generation. In most of these schemes, this structure is a weir.

In hilly regions, it has been experienced that the conventional types of weir obstructing the stream flow are not ideally suited since hilly streams carry boulders and bed loads. If a conventional over ground weir is constructed across the stream, the structure is vulnerable to damages by the rolling boulders in the stream. Further, the conventional storage type diversion structure is not feasible across such stream firstly because the storage space gets filled up fast by the bed load that get trapped and secondly because there are recurring problems of intake choking. Further, the over ground structure has to be founded on good rock foundation which is not available at reasonable depths. The removal of deep bouldery overburden proves uneconomical. In view of the above, “trench type” or ‘drop type’ weir is the most feasible solution. This simple and ingenious type of structure does not interfere with the natural regime of the bouldery stream.

A trench weir is a trapezoidal trench (trough) built across the stream below the streambed level. The trench is given a bed slope of not less than 1 in 25 towards the intake so that sufficient velocity is generated to carry away the silt / shingle that fall into it. The bed slope also gradually increases the cross sectional area of the trench to cater to more and more water entering into it from the stream through the trash rack. The top of the weir is covered with trash rack to ensure that boulders and bigger stones do not fall into the trench and clog it. The rack itself is designed rigid, fixed, within concrete to withstand the load of the rolling boulders. The rack may also be made removable so that it can be removed after rains to clear the trench of any deposits if required. The crest level of the diversion weir is kept slightly below the streambed to facilitate maximum withdrawal of stream flow during lean periods and to take care of variations in bed level.

The upstream and downstream riverbeds are joined with the crest in a slope matching the slope of the riverbed, so that even at the diversion site the regime of stream is not disturbed. It also prevents the stones / pebbles from resting over the trash rack and makes them roll down. The stream water flowing over it passes through the trash rack and falls into the trench. This water is then conveyed to the R.C.C. intake well located at one end of trench.

The R.C.C. trench is extended to the side abutments so that the stream flow during the heavy floods will pass over the weir without damaging the structure. At the intake structure, flushing arrangement is proposed to clear away the shingle passing through the trash rack. For this purpose, the trench weir is designed to carry 125% extra discharge.

b) Power Intake Channel :

An Power intake Channel of Rect. 6 m x 6 m of 10 m length shall be provided for tapping the water from Diversion weir.

c) Desilting Basin :

A Gravel Trap cum Desilting tank is proposed to remove the gravel & silt. Generally the water in hilly stream is silt free except during monsoons when it carries lot of silt. The particles smaller than the trash rack opening size enter the trench weir. Of these, heavier particles settle in the intake well and are flushed out through the shingle excluder at the intake. The silt particles, however, flow through the power conduit and hence a desilting tank is provided at the end of Intake channel to trap the silt load of particle size more than the desirable particle size from turbine point of view. Just before the desilting tank a surplusing weir is provided to spill back to the river the flow in excess of 125% of design discharge. The open power channel carriers relatively silt free water as the desilting chamber is designed to settle all silt particles bigger than permissible particle size.

The desilting tank is located at a relatively flatter ground keeping in view the structural safety, economy in design and operation, easy accessibility and availability of natural drainage for escape of flushing discharge and for location of surplussing weir. The sediment particles of size more than 0.20 mm are removed by the desilting tank by gravitational settling.

Hydraulic Design for Desilting Basin

Design Discharge	=	12.82 cumecs
Add 25% for flushing	=	3.205 cumecs
Total discharge consider	=	16.025 cumecs
Inner Width of basin (Assume)	=	12 m

Design

a) Flow velocity in the tank should not entrain material that has settled out to the bottom of the tank

Thus $\sqrt{\quad}$

Where U – Velocity through tank in m/s

d – particle sediment size – 0.2 mm

a – 0.36 for d>1.0 mm

0.44 for 1.0 mm>d>0.10mm

0.51 for d<0.10 mm

$$U = a\sqrt{d}$$

$$U = 0.44\sqrt{0.2}$$

U = 0.197 m/s

b) Select fall velocity (W0) for d from fig. 2.2.3.2 of CWC manual appropriate water temp.

W0 = 2.85 cm/s, i.e. 0.0285 m/s

c) Assume width of basin (B) and calculate depth (D) from the equation of continuity,

$$D = \frac{Q}{BU} = \frac{16.025}{12.0x0.197}$$

$$D = 6.77m$$

Depth provided 7.08 m.

d) Effect of turbulence

$$W = W0 \square \quad W'$$

$$W' = \alpha U$$

$$\alpha = \frac{0.132}{\sqrt{D}} = \frac{0.132}{\sqrt{7.08}} = 0.049$$

$$W' = 0.049x0.197 = 0.0097\,m/s$$

W = W0 – W' = 0.0285 – 0.0097 = 0.0188 m/s

e) Transit Time t = $t = \frac{D}{W0 \square \alpha U}$

$$t = \frac{7.08}{0.0188} = 376.59\,\text{sec}$$

f) Length of Tank $L = Vt$

$L = 0.197x376.59 = 74.18m$,

length SAY 120 m

We have provided 120 m long, 12 m wide & 7.08 m high Desilting Basin

d) Water Conductor System :

Water will be diverted from Desilting Basin to Surge Shaft via closed water conductor system. In view of economy and maintenance problems, it is proposed to carry the water from desilting tank to Surge Shaft in water conductor system made of steel pipe. The discharging capacity of water conductor system is so fixed that it draws water equal to the required design discharge for power generation through its travel length. Approximate length of Power Channel is 1088 m.

e) Surge Shaft :

In order to control the effect of surges due to load rejection / acceptance, it is necessary to provide a water body as close to the turbine as possible; if the length of water conductor system is greater than 5 times the head (Masonyi, 1956).

Looking to the site conditions and availability of building materials, a reinforced cement concrete surge shaft is proposed. The layout does not involve significant excavation as the storage required is not much.

Hydraulic Design for Surge Shaft

Design Discharge	Cumecs	12.82
Dia. Of Tunnel / pipe	m	3
Length of Tunnel / pipe	m	1850
Velocity of Flow in Tunnel / pipe	m	2.64
Net Head on Turbine	m	75.45
Losses in Tunnel / pipe	m	2.24
Area of Tunnel / pipe	m/sec	7.065
Design Calculation		
Friction Coefficient		0.321551405
Area of Surge Shaft	Sqm	27.4600005
To include the factor of Safety, provide an area of Surge Shaft	Sqm	41.19000074

Diameter of Surge shaft	m	7.243710274
Adopted Dia of Surge Shaft	m	8.5
Check		**SAFE**

f) Penstock :

The water under pressure is conveyed from surge shaft to the turbines through a steel pipe termed as penstock. 1No. Penstock, 3 branches have been provided to feed 3 Francis turbines kept in the powerhouse.

It is proposed to provide steel penstock in view of high strength and flexibility required in the pipe conveying the discharge to the machines. Since the head encountered is high, pressure vessel grade Steel namely ASTM 285 Grade C or its equivalent has been provided. Computational method as given in CWC's Penstock Manual has been adopted for selection of diameter, wall thickness and test pressure.

The penstock installation can be surface, embedded or buried. Looking to the site, climate, topographical and geological conditions, it is proposed to largely provide a surface penstock where steel conduit is laid on the ground surface and anchored. The alignment of the penstock is so adjusted as to have minimum excavation and least numbers of anchor blocks.

The bends are proposed to have successive segments of curved portion with optimum deflection angles to avoid sharp change in direction of flow.

Over / Under ground penstock of 2000 mm dia with 1300 mm dia branch penstock.

1. Pressure Rise

Design of penstock is also dependent upon water hammer. Water hammer is phenomenon of sudden pressure rise in the penstock. When a hydro power plant is operated, gradual changes in flow cannot be guaranteed. Sudden changes in flow can occur when the plant operator or governing apparatus rapidly opens or closes the inlet gate or valve of the turbine. With this sudden change in flow velocity, the corresponding change in Kinetic energy of the water gives rise to pressure surges in the penstock, commonly referred to as "water hammer". The size of these momentary pressure surges can be significant.

They can exceed the static pressure and can cause the pipe to burst or they can reduce pressures to below ambient pressures and cause the pipe to collapse.

A parameter used to indicate under what circumstances water hammer pressures should be considered is called the critical time and is defined as :

$$T = \frac{2L}{a}$$

Where, L = penstock length (m)
a = wave velocity (m/s) ..... (Eq. a)

The wave velocity used in this equation can be expressed as :

$$a = \frac{1420}{\left(1+\frac{1000\,kD}{E\,X\,t}\right)^{.0.5}}$$

..... (Eq. b)

Where, a = wave velocity (m/s)
k = fluid bulk modulus = 2.1 x 10^6 kPa or 2.1 x 10^4 kgf/cm^2 for water
D = internal pipe diameter (m)
E = modulus of elasticity of pipe
t = wall thickness (mm)

The magnitude of the surge pressure, which will be encountered during the operation of a plant depends on how quickly flow velocity changes in the penstock. If this change occurs in less than critical time, maximum surge pressures will be experienced. If the valve is closed instantaneously, the entire length of penstock will experience this pressure peak. Joukovsky's equation expresses the value of this peak pressure as :

$$P_s = \frac{a \Delta v}{g}$$

Where, Ps = maximum surge pressure (in m of water)

a = wave velocity (m/s)

Δ v = change in flow velocity in pipe (m/s)

g = acceleration due to gravity = 9.81 m/s^2

Allowable pressure rise in penstock is 30%.

2. Economic Diameter of Penstock

Since 3 machines are proposed to be provided, one main penstock shall take-off from the Surge Shaft and the same would be bifurcated into two branches to feed the two turbines kept in the powerhouse.

Economic diameter of the main penstock, catering to 3 machines, i.e., 8.1 MW has been computed using following two empirical formulae, which has been derived based upon parametric study of existing power projects in India :

* $D = (P / H)^{0.466}$ in feet units

Where D = Penstock dia. in feet

P = Rated H.P.

H = Rated Head in feet

$D = [\{8100/ 0.746\} \div (75 \times 3.2808)]^{0.466}$

= 5.84 feet

= 1916 mm

= 2000 mm

Let us provide one main penstock of 2000 mm internal diameter.

3. Penstock bifurcation

Since two turbines have been proposed, the single main penstock of 2000 mm diameter

shall be bifurcated by providing a bifurcation near the upstream end of the powerhouse. Diameter of each pipe after bifurcation feeding one machine has been computed based upon equal velocity criteria for least hydraulic disturbance and the same works out to 1300 mm.

4. Hydraulic Pressure Test

As per CWC's Penstock Manual, each pipe shall be hydraulically tested at the manufacturer's works before the pipe is dispatched to the site.

Penstock thickness has been computed using the following expression:

$$t = \frac{PD}{2S_e}$$

Where, P = Maximum pressure, which is likely to develop in the penstock The maximum head for penstock pipe = EL 985.22-908.02 = 77.2 m

S_e = Stress in kg/cm^2 which shall be taken as 50% of the yield point strength or 33 1/3 % of the ultimate strength - whichever is lower. For ASTM 285 Gr. "C" pipe,

S_e = 1050 kg/cm^2

t = specified thickness of penstock pipe in mm,

D = inside diameter of the penstock in cm = 180 cm

$$\therefore\ t = \frac{(77.2) \times 1000 \times 200}{2 \times 1050 \times 100^2} = 0.73 \text{ cm} = 7.3 \text{ mm}$$

Add 1.5 mm for corrosion allowance,

Thickness required = 7.3 + 1.5 = 8.8 mm Thickness required from handling consideration is governed by the expression

$$\frac{D+50}{400} = \frac{2000 + 50}{400} = 5.125 \text{ mm}$$

From the above expressions, it emerges that the maximum required thickness of the main penstock pipe of 2000 m dia is 12-18 mm as a safety.

5. Anchor Blocks & Saddle Piers

Anchors, Saddle Piers (Support Piers) and thrust blocks all serve the same basic function to provide the necessary forces on a rigid pipe to check undesired movement.

Anchor Blocks

The anchor blocks are obligatory at every change in the direction and at intermediate point and also if distance between any two exceeds 150 m. As per IS : 5330 - 1984 the Anchor Blocks are required to hold pipe at intervals along its length in order to :

a) Prevent the pipe line sliding down the hill
b) Control the direction of expansion
c) Resist the unbalanced hydrostatic forces at a change of direction of the pipe line and
d) Prevent movement of the pipe line on account of vibrations or water hammer pressure within permissible limits

The main forces, which can act on anchor blocks are as follows:

i) Hydro static pressure on exposed end of pipe
ii) Hydro dynamic force acting along axis of pipe on each side of the bend
iii) Force due to dead weight of pipe and water uphill or down hill

The foundation of anchor blocks shall be designed so that the maximum pressure on the foundation shall not exceed the allowable bearing pressure of the soil determined as specified in IS 1904 - 1978. The permissible bearing capacity shall be increased in accordance with IS : 1893 - 1975 for seismic condition.

Saddle Piers

The weight of the portion of pipe and enclosed water which is supported by the pier creates a force which can be divided into two components : one parallel to the pipe and the other perpendicular to it. A support pier is not designed to resist significant longitudinal forces

and is therefore unaffected by the component of this weight parallel to the pipe. IS : 11639 Part - I 1986 shall be followed for design of saddle supports.

g) Power House and Tailrace:-

Surface power house will be constructed approximately of size 42.0mx(8.75+6.5)mx11.2 m and Tail Race approx. 20 m long.

The powerhouse is divided into two units (a) super-structure and (b) sub-structure. These are discussed below :

Super Structure

The major components of the super-structure are :

i. Roof
ii. Roof Supports
iii. Gantry Girder
iv. Gantry Columns
v. Cross Beams or Braces
vi. Panel Walls
vii. Floor

The super-structure is designed to take care of the following loads :

a) Dead Loads : Considering the self load of the structure and the permanent super imposed loads.
b) Live Loads : For roofs and floors and taken in accordance with IS : 4247.
c) Wind Loads : Taken in accordance with IS: 875
d) Crane Loads : Consisting of the weight of fully loaded crane and longitudinal & lateral impact forces
e) Earthquake forces in accordance with IS : 1893
f) Water pressure and earth pressure wherever applicable

Permissible Stresses

The permissible stresses for design of super-structure are taken as per IS: 456 for RCC and IS : 800 for structural steel. The same are increased for various combination of loads in accordance with IS : 4247.

Roof Supports

Considering the site location, construction equipment facility, and construction time needed, the roof is supported by purlins resting on steel trusses; the spacing of trusses is governed by the spacing of columns, which are decided as per layout of the powerhouse. The truss is analyzed for the applicable loads and permissible stresses.

Gantry Girders

The gantry girders can be of reinforced of steel.

The gantry girders are supported on columns provided with brackets to accommodate the girders. Suitable base plates are also provided for the rails to be fixed.
The gantry girders are designed for moments, shear forces and thrust transmitted to it by the longitudinal frame when crane is positioned to give the worst effect.

Columns

The columns can also be of steel. Keeping in view the transportation difficulties, construction equipment facility, steel columns are most ideally suited. The columns are subjected to moments in transverse and longitudinal directions and direct thrusts. Therefore, these are designed as members subjected to biaxial bending and direct thrust. The design procedure shall be based on IS : 4247 - Part - II.

The columns are supported on concrete raft floor to limit the pressure below the base to safe bearing capacity of sub-grade.

Cross Member or Braces

The cross member in the form of ring beams are provided to stiffen the column in longitudinal direction. These beams shall also be made of reinforced cement concrete and shall support the panel walls. Thus, ring beam shall be provided below the gantry girder level. The ring beam is treated as a part of longitudinal frame and is designed for the moment and thrusts obtained from frame analysis, as well as for loads of walls coming over it.

Flooring

Different kinds of floors are provided at different locations in the powerhouse.

For service bay, ironite flooring is provided
For control room, PVC tiles flooring is provided
For battery room, acid proof tile flooring is provided
For machine hall floor and stair cases, terrazzo flooring is provided

Sub-structure

The sub-structure can be classified as that portion of the Power house which is below the machine hall floor.

The sub-structure of powerhouse is a massive gravity structure and is assumed to be rigid. The stability analysis is, therefore, done considering:

a. Over-turning and bearing pressures
b. Shear friction factor
c. Floatation

The analysis is done in two directions - longitudinal and transverse. The loads considered for its design are :

a. Dead load of structure including embedded parts.
b. Main equipment loads such as turbines, generators, transformers etc.
c. Crane loads including horizontal thrust
d. Live loads
e. Wind loads as per IS : 875
f. Penstock thrust including water hammer
g. Weight of water acting on the substructure i.e. in scroll case, draft tube etc.
h. Back-fill pressure

i. Water pressure due to TWL
j. Uplift pressure
k. Pull of conductor if fixed on building
l. Seismic forces in accordance with IS : 1893

Structurally, the foundations for columns are analyzed for their behavior as continuous beam. The recommendations of IS : 456 for minimum reinforcements, spacing, size etc. are kept in view while providing the reinforcement.

Chapter - 06

Power Plant & Transmission Line

CHAPTER –6

POWER PLANT & TRANSMISSION LINE

6.1 GENERAL

The Lower Likimro Hydroelectric Power Project has been optimized with three (3) generating units of capacity of 2.70 MW each at generator terminals. The selection of type of hydro turbine and generator is based upon the plant hydrological data. In order to optimize the size of Powerhouse a compact type Horizontal Turbine Generator combination is selected. In this case the turbine runner is mounted on the generator shaft extension. This arrangement is cost effective without affecting the output and efficiency of unit yet providing ease of maintenance. The Plant also has various unit auxiliary systems, control, metering, protection and other balance of Plant-systems.

The Generation voltage is 11 kV., the generators are bussed at 11 kV Switch gear. The 11 kV Switch gear has three incoming and one outgoing feeders. The outgoing feeder is connected to one common 11 kV / 11 kV unity ratio transformer and then it is evacuated to 66 kV grid via a dedicated single circuit 1.2 km long 11 kV overhead transmission line to be constructed between Lower Likimro 11kV switchyard and 66 kV Switchyard of existing 24 MW Likimro HEP via step up 11kV/66 kV power transformer. Power generated at Lower Likimro Power Project will get pumped into 66 kV bus at the existing 24 MW Likimro Hydroelectric Power Project Switchyard and then to Nagaland grid via existing 66 kV transmission system of upstream 24 MW Likimro Hydroelectric Power Project.

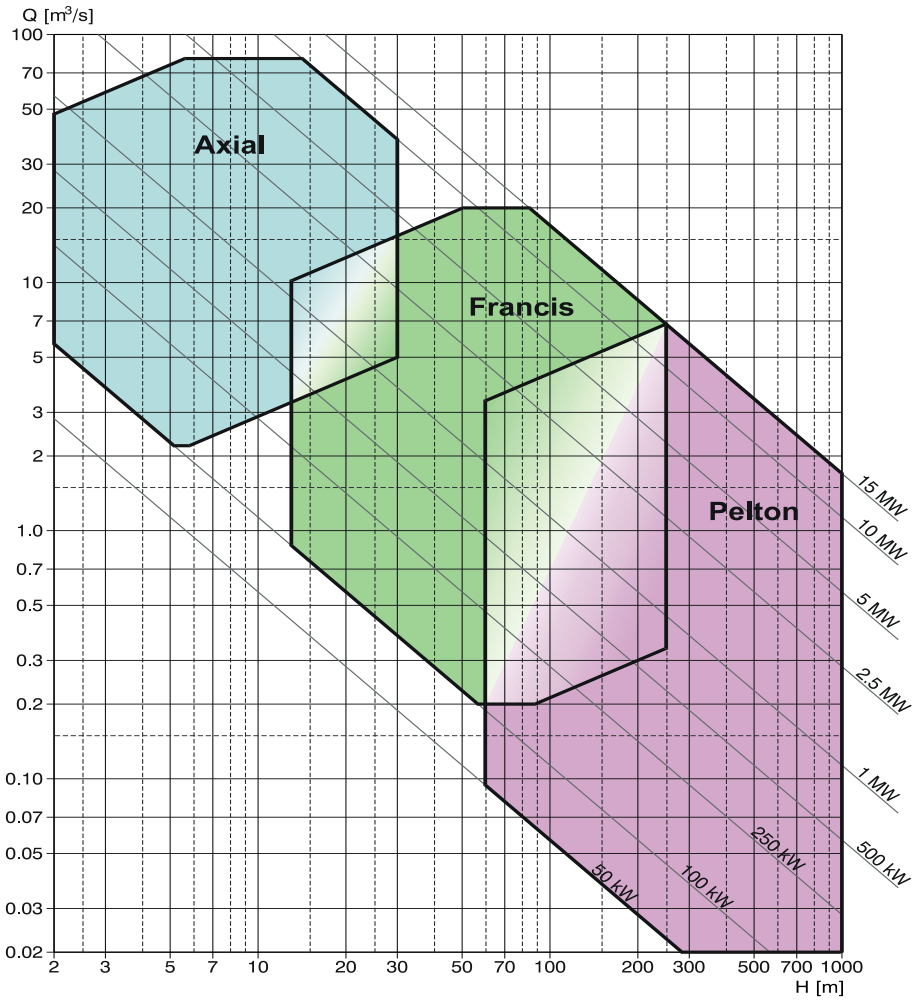
6.2 GENERATING EQUIPMENTS

6.2.1 Hydro Turbines

Selection of the turbine (Size and Numbers) is based upon the plant hydrological data and standard ratings available with various reputed manufacturers. The turbine is

designed to give high performance over a long period for rated head and the variation of discharge throughout the season.

Selection of Turbine :



The main plant hydrological data is as follows.

- Net Rated Head H = 75 m
- Design discharge for plant Q = 12.82 Cumecs
  (4.27 Cumecs per unit)
- Installed Unit Capacity (Gen. Terminals) P_G = 2700 kW
- Rotational speed N = 750 RPM

The above specific speed suggests selection of the Horizontal Francis Turbines running at 750 RPM as the most suitable option for Lower Likimro Hydroelectric Power Project.

The Francis-runner shall be made of steel alloy casting of 13/4 Cr/Ni composition. Similarly, the casing shall be made of fabricated steel sheets of welded construction. The turbine and generator shall be assembled on a common base frame at manufacturers shop, so as to minimize the erection time and minimize the risk of misalignment during erection. The unit be doweled and match-marked in shop and then shipped in dismantled condition due to transport limitations, etc.

Technical Data

The main characteristics of the turbine are summarized as follows :

Type of turbine	:	Horizontal Francis
Mounting type	:	Foot Mounted
No. of units	:	3
Design head	:	75 Meters (Net)
Rated Flow	:	4.27 Cumecs per Unit
Rated Turbine output:		2700 kW at generator terminal
Turbine speed	:	750 rpm
Type of Governor	:	Digital Electro Hydraulic type

The turbine and its auxiliaries shall be provided with necessary measuring instruments and protection elements as required by system design.

In general, the hydro turbine and its auxiliaries shall be manufactured with following applicable standards

IEC 41 - Field acceptance test to determine the hydraulic performance of hydraulic turbines, storage pumps and pump turbine.

IEC 308 - International code for testing speed governing systems for hydraulic turbines.

IEC 193 - International code for model acceptance tests of hydraulic turbines.

IEC 995 - Determination of prototype performance from model acceptance test of hydraulic machines with consideration of scale effects.

IEC 994 - Guide for field measurement of vibrations and pulsations of hydraulic machines.

IEC 545 - Guide for commissioning, operation and maintenance of hydraulic turbines.

AGMA American Gear Manufacturer's Association

6.2.2 Governor and Oil Pressure Unit

The turbine governing system consists of a combination of different individual units, which operate together to control the speed, power of machine and /or the water level at the Forebay through turbine or discharge regulator. Each turbine shall be fitted with a fully independent and dedicated digital governor and high-pressure oil system. The high-pressure oil system supplies pressurized oil for the normal governing functions and also for controlled operation of the Turbine Inlet valve.

The Governor for turbine-control will be of the digital electronic-hydraulic. The Governor will be complete with all necessary parts and devices for Governor and Turbine control including speed detection, starting control, normal shutdown, emergency shutdown, speed control, load control, load limiter, and Main Turbine Inlet-valve closing/opening time control etc.

The rotational speed for turbine will be detected by the speed signal generator-inductive pick-up sensor, which is connected to microprocessor based high speed and high accuracy counter. The speed switches for over speed, brake close and for excitation ON permissive shall be provided as governor signal outputs or by using dedicated speed monitor.

6.2.3 Generator, Excitation and Protection

The Generator will be of the synchronous type, horizontal shaft, open air ventilated, provided with two self or force lubricated guide bearings on Non-Driving End (NDE) and Driving End (DE) respectively. The Generator-bearings will be designed to take Axial & Radial and shock loads emanating from Turbine-Runner. The Generator-bearings shall be provided with forced oil lubrication system, if necessary, as decided during manufacturer's detailed engineering.

The Generator-shaft shall be designed to accommodate Francis wheel turbine runner on its shaft extension and the entire turbine generator assembly shall be mounted on common base frame to simplify the erection of TG set.

The Generator stator, rotor, Exciter stator and rotor winding shall be of copper and shall be built using Class F insulation with temperature rise limited to Class B during operation its operation at normal conditions. The temperature detectors in stator winding and bearings shall be provided for monitoring and protection.

The Generator is provided with brushless electronic excitation system with built in monitoring and protections. The terminal equipment such as Lightening & Voltage Transformer (LAVT) panel and Neutral Grounding Transformer (NGT) panel housing current and voltage transformers for protection and metering of generators shall be provided near the generator in machine hall.

The generator general characteristics are:

Type	:	Horizontal Synchronous, 3 Phase
Rated output	:	2700 kW
Number of units	:	3
Type of cooling	:	Air cooled open ventilated (IC01/IP23 enclosure)
Rated voltage	:	11kV±10%
Frequency	:	50 Hz±3%
Power factor	:	0.9 lag
Rated speed	:	To suit turbine
Generator Excitation	:	Brushless excitation type

The generator shall be manufactured and tested at works with following standards and codes

IS:2253	Designation for type of construction and mounting arrangements of rotating electrical machines.
IS:4691	Degree of protection provided by enclosures of rotating electrical machinery.
IS:4728	Terminal marking of rotating electrical machines.
IS:4729	Vibration measurements and evaluation of rotating electrical machines.
IS:4889	Methods of determination of efficiency of rotating electrical machines.
IS:6362	Designation of methods of cooling for rotating electrical machinery.
IS:7132	Guide for testing synchronous machines.
IEC:34	Rotating electrical machines.
IS:1271	Insulating materials for electric machinery and apparatus in relation to their thermal stability in service, classification of.
IS:4722	Specification for rotating electrical machines.
IS:7816	Guide for testing of insulation resistance of rotating machines

6.2.4 Main Inlet valve

Main Inlet Valve of butterfly type shall be installed at each branch of Penstock just upstream of the turbine, to automatically isolate the turbine during maintenance or in case of fault in the turbine generator system.

The valve is designed in such a way that the head loss in the valve are minimum. The maximum pressure rating of the valve body will be 150% of the static head on the valve. The valve shall also withstand the maximum possible penstock pressure developed during transient conditions such as full load rejection.

The valve will be provided the seal to withstand with full penstock pressure on the upstream side and atmospheric pressure on the downstream side. The electrical or

hydraulically operated bypass valve is provided to equalize the pressure across main valve before opening the main inlet valve. The valve is capable of closing against the maximum flow at the design head. The Main Inlet Valve will be opened by oil pressure and closed by counter weight, so that it is capable of being closed under all emergencies. All associated equipment such as servomotors, oil pressure units, counter weights etc., shall be provided. The valve will be complete with Inlet pipe, outlet pipe with dismantling joint etc.

In addition to the Codes and Standards norms stated above, the bidder will submit his offer in line with following Codes and Standards, as stated below:

Equipment	Standard
Turbine and Generator (Rotating Electrical Machine)	IEC 34 – 1 : 1983 IEC 61366 – 1 : 1998 IEC 61116 – 1 : 1992 IS : 4722 – 2001 IS 12800 (part 3) 1991
Governing system for hydraulic turbine	IEC 60308
Transformers	IS 3156 – 1992 IS 2705 – 1992 IS 2026 - 1983
Inlet valves for hydro power stations & systems	IS 7326 - 1902

6.2.5 Control & Instrumentation

The operating conditions and the status of generator, turbine, transformers, and switchgear are monitored using appropriate type of protective relays, instrumentation and safety devices. The status and operating data of plant equipment shall be made available in control room for operator information.

All the equipment in plant shall be provided with adequate electrical or mechanical, thermal protection such that in the event of any abnormally in operating condition of equipment the protective devices shall generate alert alarm for operator or in case the fault is of serious in nature the faulty equipment shall be isolated immediately.

6.3 ELECTIRCAL PROTECTION RELAY & METERING SYSTEM

The main equipment in power plant such as turbine, generator, main transformer and overhead transmission line are provided with protection, monitoring, control and metering as follows:

Generator Metering & Protections are:

- Over current
- Short circuit
- Reverse power
- Over and under voltage
- Loss of excitation
- Stator earth fault
- Winding temperature high
- Bearing temperature high

The electrical meters and monitoring equipment such as Ammeter, voltmeters, Kwh, KVA, KW, Pf, temperatures, annunciations shall be provided

Transformer & Outgoing Line Mains protection

- Over current
- Short circuit
- Over & under voltage
- Vector surge
- Transformer diff. protection
- Restricted Earth fault
- Buchholz gas relay
- Winding & oil temp. high
- Oil level low

The electrical meters and monitoring equipment such as Ammeter, voltmeters, Kwh, KVA, KW, Pf, temperatures, annunciations shall be provided

6.4 MV & LV SWITCHGEAR

The power is generated at 11 kV level and transmitted to 66kV state grid via. Combination of 10 MVA unity ratio transformer, 66 kV transmission line and 10 MVA, 11 kV, 66 kV step up transformer. As such when grid supply is available, the 11kV switchgear bus shall be charged from grid via. Unity ratio transformer and generating units then will be synchronized at 11 kV bus one after another.

The 415V power supply for power house auxiliaries shall be derived from 11 kV / 433 V,100 kVA, ONAN, Off circuit tap changer, Aux. Transformer whose LV side shall be connected to 11 kV bus through fused load break switch in 11 kV switchboard. The LV side aux. Transformer shall be connected to 415 V AC LT distribution board through MCCB and contactor. The power supply to LTAC Distribution Board shall be backed by Emergency diesel generator set of 40kVA also connected to bus through MCCB and contactor. Auto mains failure circuit between Aux. Transformer incomer and DG incomer shall be provided such that in the event of failure of grid supply, the DG will start automatically and resume the power supply to LT bus. When grid supply returns back, the supply to LT panel will changeover from DG to Aux. Transformer and DG will stop automatically.

The motive feeders such as OPU pumps for each unit shall be fed from LTAC panel and shall be provided with thermal overload protection, local indication, local operation etc.

The lighting distribution boards also shall be fed from LTAC panels.

The connection between the generator, LAVT & NGT panels, 11 kV switchgear and LV side of transformer shall be using 11 kV power, XLPE insulated, aluminum conductor,

armoured cables and all other control and LV power cables shall be using PVC insulated aluminum conductor cables.

The main single line diagram is shown in drawing B 2 0056 C 005 01.1 respectively.

6.5 STATION DC SUPPLIES

It is proposed to install 110 V D.C system comprising of 150 AH capacity, Sealed, Maintenance Free (SMF) set of batteries and 1No. Float cum boost charger along with 100 A DC distribution board. The system will cater the requirement of DC control supply for turbine, governor, generator control protection, excitation and monitoring systems of the Plant.

6.6 POWERHOUSE & OUTDOOR SWITCHYARD EARTHING

In order to control the step and touch potential during occurrence of earth fault conditions in 11kV network, the safety Earthmat made of MS Flats shall be laid in the powerhouse and switchyard area. All the outdoor and indoor electrical equipment shall be grounded to this Earthmat using GI flats of appropriate size. All small equipment such as motors, junction boxes etc shall be provided with safety earth using copper wires of appropriate sizes. The earthing system shall be designed as per IS-3043 and the effective earth resistance shall be limited to max. 1 Ohm. The equipment safety earthing shall be carried out using 40 x 5mm GI flats risers connected to Earthmat.

6.7 POWER, CONTROL & INSTRUMENTATION CABLES

The interconnection between various panels is carried out using cables. The power cables shall be Al. conductor and control & instrumentation cables shall be of copper conductors. The HV (11kV) power cable shall have XLPE insulation and LT power and

control cable shall be of PVC insulation. All power and control cables shall be manufactured as per relevant Indian Standard IS- 7078 and IS-1554 respectively.

6.8 MISCELLANEOUS ITEMS

The Plant shall also be provided with equipment for safe operation and for carrying out effective maintenance.

6.9 HAND OPERATED OVERHEAD TRAVELLING CRANE

The Hand Operated 30/5 Ton overhead traveling crane moving on Concrete steel Beam, and rail etc. shall be provided in machine hall. This crane shall be used during erection of plant initially and then for regular maintenance as required.

6.10 VENTILATION

The powerhouse building shall be provided with proper ventilation to evacuate the hot air generated by various operating equipment. The exhaust fan of appropriate sizes shall be installed in powerhouse. The toilet and battery room also shall be provided with exhaust fans of approved type.

6.11 FIRE EXTINGUISHERS

Portable fire extinguishers of various types shall be provided in powerhouse and switchyard depending upon the type of equipment to be protected.

6.12 ILLUMINATION & SMALL POWER

The powerhouse building shall be provided with proper illumination. The lighting fittings and luminaries shall be selected depending upon the light intensity required in various areas of powerhouse. These areas illuminated shall include machine hall, control room, office, outdoor yard, approach roads etc. Emergency lights at strategic location in powerhouse shall be provided using 110V DC source. The wiring for illumination shall be drawn in exposed conduit from lighting distribution board to the various fittings

through control switches for circuits. The 230V, 3pin power sockets of 5A,15A and 63A of 3-phase, 4-wire for utility maintenance purposes shall be provided at selected locations.

6.13 AIR CONDITIONING

The office and powerhouse control room shall be provided with 2 x 2T split air conditioner each.

6.14 COMMUNICATION

VHF radio communication system is planed during construction. The same shall be used for communication among the operation staff from and to area such as powerhouse, surge shaft, weir site, upstream 24 MW Likimro HEP etc.

6.15 EMERGENCY DG SET

40 kVA, 415V, 0.8 pf, Diesel Generator shall be provided as back up station aux. supply. The DG shall be connected to station 415 V LTAC panel through MCCB and contactor. Auto mains failure features shall be built into the LTAC panel in DG incomer compartment such that in the vent of failure of grid supply, DG will start automatically and feed the LTAC bus and will switch off automatically when grid supply resumes.

6.16 DRAINAGE AND DEWATERING

Drainage and Dewatering Pump stations are envisaged, even though all floor levels are above the Tail water Levels. The civil drainage across the powerhouse shall feed water to outside drain, which will discharge water to Main River.

Chapter - 07

Communication & Construction Facilities

CHAPTER-7

COMMUNICATION AND CONSTRUCTION FACILITIES

7.1 LOCATION OF PROJECT

Lower Likimro Hydro Electric Project has been contemplated as run-of-river (RoR) scheme on Likimro river (a tributary of Tizu river), in the Kiphire district of Nagaland.

Lower Likimro Hydro Electric Project is accessed through Kiphire road. The approach to site is via Kiphire located at a distance of 122 km from Tuensang on the State highway and approximately 306 kms from Kohima. Kiphire is connected with Pungro town via a fair weather road and is approx 35 km away. The weir is approx 17.5 km from the bridge over the Likimro river on the Pungro – Moya village road. Nearest air head & rail head is Dimapur, which is 400 kms. appx.

The road connectivity of Lower Likimro P.H is Dimapur - Kohima - Chakabama - Kikruma - Pfutsero - Chizami - Jessamni - Meluri - Akhego - Longmatra - Kiphire – Chomi - Pungro - Moya. The distance from Dimapur to Pungro is 386 km.

7.2 PROJECT ROADS

Following project roads /footpath shall be provided:

(i) Access to the diversion /intake from existing road shall be provided.

(ii) Motor able road to the Power House from the road shall be provided.

(iii) Bridal path along the power channel shall be provided.

7.3 AVAILABILITY OF LABOUR

Unskilled labour is available locally in the nearby and adjoining villages. However semi-skilled and technicians will have to be bought from outside. Engineers and other skilled personnel shall be brought from places within the State or mostly from out-side the State.

7.4 AVAILABILITY OF ACCOMMODATION

Availability of residential accommodation for the various categories of staff/supervisory personnel is good in the project area. The project executing agency will make their own arrangements for camping and tin-shed accommodation for their staff to be engaged for construction, operation and maintenance of various works. For routine inspection and erection of equipment, permanent accommodation consisting of 4 suites shall be constructed in the beginning. These suits shall be used for supervision of operation and maintenance of the plant in the O&M phase of the project. After the construction of the scheme, the accommodation required for the O&M staff shall be constructed near the powerhouse location.

7.5 TELE-COMMUNICATION FACILITIES

P&T Telephone facilities are not available at site however mobile WLL / GSM network is available.

7.6 OTHER SERVICES AND FACILITIES

Post office, secondary school, rented accommodation, medical facilities, college, shopping, hotels, taxi stand, etc are available at the Moya town's and some facilities are available at Pungro village. The project site is well connected with public transport.

Chapter – 8

Construction Materials

CHAPTER -8

CONSTRUCTION MATERIALS

8.1 AVAILABILITY

The construction material survey has been done to assess the quality of the civil construction materials such as steel, cement, stone, coarse & fine aggregates, explosives, etc and their availability in required quantities. Practically nothing is available in nearby Project Area. Details of principal construction materials are as follows:

8.2.1 Coarse Aggregate

Good quality stones and boulders are available from near by Mimi area. River stones from Likimro river itself may also be used for aggregate after quality test, which are available in the required quantities from the river shoals. Due to abrasion, softer portion of the river borne material gets washed away and aggregates available are of good quality. Proper tests shall be carried out at the time of construction before procurement.

8.2.2 Fine Aggregate (Coarse Sand)

Good quality coarse sand (Deopani Sand) for concrete work has to be brought from Dimapur area. There is no availability from near by area from the powerhouse site.

8.2.3 Stone for Masonry

Good quality stone suitable for masonry work is available in the near by Mimi village of the project area.

8.2.4 Cement

Cement will be transported from ACC cement factory from nearby Bokajan, Kabianglong District, Assam or from various wholesale stockists at Dimapur.

8.2.5 Steel

Steel, steel sheets, penstock pipes will be brought from Dimapur. Procurement could be direct from factory or nearest stockyard depending upon the availability of a particular item and shall be transported to the project site. Penstock shall be fabricated in welding shop at the project site or shall be procured from nearby Steel Plant (if available.)

8.2.6 Other materials

Explosives, CGI Sheets, Industrial gas, valve and other materials required by the project will be transported to the site from the factory stockyards. Petrol, diesel and other general materials required for the construction shall be transported from adjacent villages near power house.

8.2.7 REQUIREMENT OF QUANTITIES OF ITEM OF CIVIL WORKS

The estimated quantities of various items of civil works of Diversion, Power Intake, Desilting Basin, Water Conductor System, Surge Shaft, Penstock, Power house building, Tail race channel.

Chapter - 9

Construction Methodology

CHAPTER –9

CONSTRUCTION METHODOLOGY

9.1 GENERAL

Lower Likimro Hydro Electric Project is proposed to be set up in 24 working months from start of construction. Pre-construction activities like arrangement of finance, land acquisition, tendering etc. are currently in progress.

9.2 PRE-CONSTRUCTION ACTIVITIES

Following activities have been undertaken proceeding to main construction activities:

- Survey, investigations and preparation of Detailed Project Report.
- Techno-economic clearance of DPR.
- Implementation Agreements

Following activities are currently in progress:

- Land acquisition
- Financial closure
- Tender and award of contract
- Detailed Engineering
- Establishment at site
- PPA Evaluation

The enclosed bar chart shows the schedule of pre-construction activities. The most critical activity in pre-construction phase is land acquisition. The practical time considered for this activity is about 2 months.

9.3 CONSTRUCTION SCHEDULE

The bar-chart for implementation is prepared with due precautions to avoid time overrun of the project. The most critical activity is laying of penstock activities.

Other activities are well defined in the bar chart, which are scheduled to make the project economical as well as have sufficient margins for any time delay.

The project is scheduled to be ready for testing and commissioning in 2012.
The Bar chart/Construction Schedule chart is enclosed in B.1 of Appendix - B.

9.4 MATERIAL PLANNING

Planning shall be done for continuous procurement of various construction materials well before requirements of the materials. Mainly cement, reinforced steel, structural steel, sand, aggregate, stone, explosives, CGI sheets, petrol, diesel, gas for welding shall be required during construction of the project.

9.5 PLANT AND EQUIPMENT PLANNING

The material stockyard shall be so selected that it is well above and away from the estimated and observed high flood level of the river. The site shall also be safe from damages from natural drains & scouring due to heavy river flows. Adequate buffer stocks of cement and steel will be maintained at site stores to ensure the regular supply against blockage of roads due to slips and rains.

The award of supply and erection of Electro-mechanical works shall be time bound. It shall be ensured that all these equipment are available at powerhouse site within due date of contract. By obtaining suitable bank guarantees from the supplier(s)/ contractor(s), for ensuring the committed delivery periods, the order will be placed so that the equipments are received within time frame. Monitoring shall be done during manufacturing of the equipments.

9.6 MAN POWER PLANNING

The work shall be done by the contractor(s) with supervision by the company's consultants. However the company shall employ the technical team having Civil, Mechanical and Electrical engineers to monitor the work.

The technical staffs, skilled, semi skilled and unskilled labour are available. They shall be used as per requirements of the work.

The site organization chart is enclosed in B.1 of Appendix - B.

9.7 WORKSHOP AND TRANSPORT ARRANGEMENT

A small workshop is planned to be set up at the site. Workshop will mainly constitute drilling machine, grinder, gas cutting equipment, welding equipment, diesel generator, gantry, pulling and lifting machinery, dewatering pumps, concrete mixers, concrete vibrators, excavators, compressors, hand tools and accessories, measuring instruments, etc. Jeep and station wagon will be stationed at project site for quick movement of manpower and supervisory staff.

9.8 MODE OF CONSTRUCTION

It is possible to follow two modes of construction:

A) One EPC Contract on one Agency, who has pre-requisite experience and having qualified Technical and experienced people, who will ensure deliverables on time (One point responsibility)

B) Splitting the contract in various heads.

In this event –

The construction of major civil works shall be carried out through one or more established construction agencies/having long experience in the construction of similar projects and having good track record of project completion within specific time schedule.

The fabrication of penstock and its erection shall be carried out through one or more established construction agencies/ having long experience in the similar field and having good track record of project completion within specific time schedule.

The supply of power generating equipment shall be given to the one or more manufacturer's/ contractor's on turnkey basis for their portion of the expertise.

The erection contract for power generating equipment shall be given to the Licensed Contractor on turnkey contract.

The supply and erection of Transmission line works including Sub-station works shall be given to the Licensed Contractor on turnkey contract.

Nevertheless, best option suiting the project schedule and cost economics will be adopted during implementation of project.

Chapter -10

Environment & Ecology

CHAPTER -10

ENVIROMENT AND ECOLOGY

10.1 SITE SELECTION

Site selection of the scheme has been done keeping in view the ecological setting of the area. As the Lower Likimro HEP is a run-of-river hydropower scheme, having no storage, there will be no submergence of forest and cultivated lands due to construction of any components of the scheme. Moreover the project does not involve the highly sensitive issues of displacement of people due to construction of the project. The infrastructure facilities for the scheme and its construction and maintenance staff will not cause any adverse effect on the environment. The project components are planned to be founded on geologically sound formations. Slopes shall be stabilised with adequate slope stabilisation measures thereby ensuring that there is no danger of any erosion, slips and rock movement's etc.

10.2 CATCHMENT AREA AND SLOPE STABILITY

The catchment area up to powerhouse location comprises of moderately stable rocks, riverbed material and slope wash. The proposed Lower Likimro HEP will not have any effect on the catchment area. Apart from afforestation in this area, other protection measures such as contour drainage and nallah training etc would be carried out. Detailed study shall be taken up during construction of the project.

10.3 ENVIRONMENT IMPACT OF THE PROJECT

The environmental impact of the project, both during construction and operation will be negligible. The main impact of the project will be in the following areas.

- Loss of a very small amount of farmland for the penstock construction: This farmland has low commercial value. No persons will be displaced because of the project.

- Felling of trees, which obstruct the water conductor route: As the main water conductor system, which is of 3.0 m dia, a very less number may need to be cut where not possible to avoid to cut them.

- Felling of trees, which obstruct the penstock route: As the penstock system, which is of 2.0 m dia, a very less number may need to be cut where not possible to avoid to cut them.

- Extraction of stones from the river bed for construction: This is not expected to have any significant effect on the environment since the amounts required are very small compared to what is available. Sand and aggregates shall be transported either from nearby quarry or crushing plant.

- Fish migration: As there are falls in the stream downstream of the intake which are higher than any weir that will be built, no adverse impact on fish migration is expected.

- Flora and fauna: Since there will be no inundation no adverse impact is expected. The amount of land used by the project is too small to cause any significant impact.

10.4 PREVENTIVE MEASURES

Following main measures shall be considered during implementation of the project:

- Provision of kerosene to labour.

- Provision of drinking water supply and sanitation facility.
- Restoration of temporary land acquired for project work to the original shape.
- Plantation of trees nearby powerhouse area.
- The construction labour and project staff will be educated in terms of environmental concerns and anti-poaching laws

10.5 ENVIROMENTAL IMPACT ASSESSMENT

The environmental impact assessment is carried out on the prescribed format of Department of Environment for River Valley Projects, which is given in section 10.6.

As per the notification of Ministry of Environment & Forest published in the Gazette of India, Extraordinary, Part II and section 3, Sub-section (ii), dated September 14, 206, no prior approval is necessary for Project below 25 MW.

10.6 ECOLOGICAL ASPECTS OF RIVER VALLEY HYDRO – ELECTRIC PROJECTS

S.no.	Particulars	Comments
1	Detailed basic information affecting the environment	
1.01	Predominant existing land-use pattern (agricultural land, reserve and other forest etc.) in project area and upto 10 kms upstream.	The major part of land measuring falls in the area owned by people of Mayo Village Council
1.02	Breakup of submerged area	No submergence Project does not have any reservoir
	Total submerged area	NIL

	Forest land % (ha)	NIL
	Cultivated land % (ha)	NIL
	Shrubs and fallow rocky outcrop %	NIL
	Wet land	NIL
	Open Water	NIL
	Other uses	NIL
1.03	(a) Forest type in catchment and submerged area (indicate the type of trees whether sparse or thickly wooded and other details)	NIL
	(b) Extent and nature of forest to be cut for the construction of roads, colony and other appurtenant works	NIL
1.04	Duration of project's construction stage	21 Months
1.05	Estimated peak labour	About 400 skilled, 200 unskilled. A part of labour force proposed to be recruited from nearby villages
1.06	Population density in the area per hectare	Less than 1
1.07	Number of villages and population to be displaced	NIL
	Size of affected village	NIL
	Affected families in each village	NIL
	Occupation of the affected people	NIL
	Agriculture	NIL
	Industrial Labour	NIL
	Artisans	NIL

	Forest based	NIL
	Others	NIL
	Owner cultivator by size of land holdings	
	Marginal (0.0-1.0 ha)	NA
	Small (1.0-2.5 ha)	NA
	Medium (2.5-5.0)	NA
	Big (over 5.0 ha)	NA
1.08	Resettlement	Not involved
	Is a rehabilitation committee being constituted	Not applicable
	Existing guidelines, if any for compensation	Not applicable
	Level of compensation in cash and kind	Not applicable
	Number of ousted families likely to be settled in new settlements	Nil
	Size of proposed new settlements layout plans/ master plans for new settlements	NIL
	Distance of new settlements from the present habitats	Not applicable
1.09	Number and type of facilities (e.g. school, post office, bank, panchayat and well water supply etc.) proposed to be provided	Necessary action will taken at the time of execution of project
1.10	Is the affected area covered by development programs like IRD, SFD, drought prone area, tribal development etc?	No
	Any proposal to provide/create employment for oustees?	Not applicable
	Nature and quantum of employment to be provided	Not applicable

	Vocational training programme envisaged, if any	Not applicable
1.11	What is the expected rate of siltation? Details of how the siltation problem is proposed to be handled	No storage is envisaged. Trench weir and settling basin arrangement provided, hence no siltation will take place
1.12	Is downstream area subject to flooding	No
1.13	Wind rose at dam site:	Not applicable
	(Diagram giving statistical information concerning the direction and speed of the wind at the site)	
1.14	Hurricane, tornadoes, cyclones frequency of and velocity	No record available
	Wind velocity	
	Average	-
	Maximum	-
1.15	Plan of areas on the reservoir periphery, subject to erosion, slides and slips	Not applicable
1.16	The depth of groundwater tables	NA
	Maximum	
	Minimum	
	Quantity of ground water	
1.17	Present ground water use pattern in the command area under irrigation	
	Surface	NIL
	Ground water	NIL

1.18	Based on the experience of similar projects in the area, specify the interaction between the altered surface water patterns and under ground aquifers and their recharge.	Not applicable
2	Environmental Status	
2.01	(a) Indicate the pollution sources in the region (industries like chemicals, textiles and other thermal power units mining operation etc.)	NIL
	(b) Indicate the industrial and other development project likely to be taken up in the area during the next five to ten years	NIL
2.02	(a) Does the area support economically viable aquatic life fish, crocodiles? Please give details	No
	(b) Are there any fish/ crocodile breeding grounds in the river/ tributaries in the submergence area?	No
2.03	Does the site contain a wildlife (including birds) habit, breeding area/ feeding area, migration route? Indicate the number of wildlife available in the area	No
2.04	Is the site a potential wildlife sanctuary?	No
2.05	Specify any rare of endangered species of flora and fauna found in the affected area along with their approximate number and measures to salvage/ rehabilitate them	None
2.06	Is the area a tourist resort:	No

2.07	Are any monuments/ sites of cultural historical, religious, archaeological or recreational importance including wildlife sanctuaries and national parks etc. likely to be affected by the project? If so details thereof	No
2.08	Does the proposed area suffer from endemic health problems due to water/ soil borne diseases?	No
2.09	If yes, specify the problem(s) and give details	Not applicable
3	Environmental Impacts	
3.01	What measures are planned to develop the site to enhance its aesthetic aspects (i.e. recreation and water sport facilities and picnic sites etc.?)	Plantation
3.02	Will be project help in flood control reduction or even eradication of flood havoc down stream?	Not applicable
3.03	Are any changes in water salinity expected ? If yes, give details of the proposed measures counter this	NIL
3.04	Is problem of water logging envisaged in the command area? If so, give details of proposed measures to counteract this	Not applicable
3.05	Will reservoir be used for fisheries development (fish culture as well as fish breeding, crocodile farming etc.?)	Not applicable
3.06	Will fish ladders/ lift and like arrangement be provided to allow movement of important migratory fish population?	Not applicable

3.07	Measures proposed to prevent grazing and cultivation on reservoir slopes to avoid erosion and premature silting up of the impoundment	Not applicable
3.08	Will any important natural resources (minerals, commercial timber etc.) be lost or their use precluded because of the presence or operation of the project? If yes, specify the resources and magnitude of the estimated loss	No
3.09	What is the potential loss in aquatic production on site, up and down stream? (Fish and other useful aquatic animals and plants)	Nil
3.10	Will the formation and use of water body result in the introduction or enhancement of water borne diseases?	Not applicable as no water bodies are being formed
3.11	Will the impounded reservoir lead to	
	(i) Noxious aquatic weeds like salvinia, water hyacinth etc.?	Not applicable
	(ii) Intermittent host (vectors) like snails, mosquitoes etc.	Not applicable
3.12	How will aquatic weeds be controlled in submerged areas so as to provide an improved habitat for fishery exploitation?	Not applicable
3.13	Will the project include adverse climatic change (regarding temperature, humidity, wind and precipitation including modifications to micro and macro climate	No

3.14	What impact is expected on geological factors (e.g. seismic impact of reservoir loading)?	No Impact
3.15	Indicate the magnitude of impact due to population pressure on :	NIL
	(i) Felling of trees for fire wood	Nil
	(ii) Forest fires	Nil
	(iii) Over-grazing leading to depletion of postures, and	Nil
	(iv) Visual pollution and damage to scenic values	Nil
3.16	What arrangement are being made :	
	(i) To meet fuel requirements of the labour force during project construction	Adequate provision for Kerosene and fuel oil has been kept in the Project
	(ii) To enforce anti-poaching laws	Not applicable
	(iii) For restoration of land in construction area (filling grading and reforesting etc. to prevent erosion and to erases cars)?	Not applicable
	(iv) For soil conservation in the catchment?	Not applicable

4	Cost of environmental studies, project management and monitoring	Not applicable
4.01	Provision for environmental studies/ surveys needed for this project	Not required
4.02	Cost of the proposed remedial and mitigating measures, if any to protect the environment?	NIL

4.03	Has the cost of environmental studies/ protection measures been considered in the cost benefit analysis of the project	Yes

Chapter - 11

Analysis of Rates

CHAPTER – 11

ANALYSIS OF RATES

11.1 GENERAL

Unit prices have been derived in detail for all scope of works. Those details include works for all earthworks, structural works, protection works, building works, electromechanical works, mobilisation and demobilisation, infrastructure works, transmission lines etc.

11.2 PRICE LEVEL

The unit rates have been made at the price level of 2023-2024, the time of preparation of estimates.

11.3 RATE ANALYSIS

The unit rates have been formulated based on market survey and prevailing rates of similar project, which are of similar size and have similar scope of works. The rates reflect quantity of material to be used for each unit item and the labour cost required for each unit of work. The rate of equipment and machinery has been included in the unit cost rate. Profit and office overhead has also been included in the unit rates.

Detailed rate analysis is presented in **Appendix - C** .

Chapter - 12

Cost Estimates

CHAPTER – 12

COST ESTIMATE

12.1 BASIS OF ESTIMATE

The costing of the project has been carried out on the basis of a detailed project report carried out by consultants experienced in this field. Wherever possible current costs of equipment and material have been taken from manufacturers.

12.2 PRICE LEVEL

The cost estimate has been made at the price level of 2023-2024. All costs have been first estimated on a per unit basis for each of the components. These have been added to obtain the entire project cost. Lump sum costs have been allocated for components where a detailed breakdown of costs is not available or worthwhile.

12.3 DETAILED COST ESTIMATE

A detailed cost estimate has been prepared and appended from

TABLE D.1 to TABLE D.2 of Appendix D.

TABLE D.1 Summary : Civil and Hydro – Mechanical Works

TABLE D.2 Summary : Electro – Mechanical Equipment Works

Chapter - 13

Financial Analysis

CHAPTER – 13

FINANCIAL ANALYSIS

13.1 INTRODUCTION TO FINANCIAL ANALYSIS

The financial analysis for the Lower Likimro HEP has been carried out to ascertain the financial viability of the scheme. The financial evaluation is aimed at giving potential investors in the project an overview of the risks and benefits associated with financing the project.

Wherever possible, the financial analysis has been carried out on the basis of known information. These assumptions are, on the whole, conservative estimates and figures considered to be realistic and standard for analysis of this nature. The financial analysis consists of a cash flow during the project life, a financial evaluation which suggests the Net Present Value (NPV), internal rate of return (IRR) of the project, and debt cover ratio, payback period Debt. Service Coverage Ratio (DSCR)

13.2 MAJOR ASSUMPTIONS

Assumptions and inputs for financial analysis are presented in TABLE E.1, E.2 & E.3. Major assumptions made for the financial evaluation are as follows:

Project Cost :

Base Cost

Cost of the project is taken after detailed estimates as discussed in Chapter -12 (Cost Estimates). The cost is estimated in the base year of 2023-24. Base Cost of the project is Rs. **9632.12** Lacs.

IDC

Interest during construction is worked out based on the disbursement of cash flow. The interest rate is taken as 9.25 % p.a.

Phasing

Capital cost for the project will be disbursed during the project construction period as follows:

Sr. No.	Period	Phasing of Expenditure	Cost	Escalation	Cost including escalation
1	Oct-2024 to Sept -2025	40.00%	3852.848	included	NA
2	Oct-2025 to June – 2026	60.00%	5779.272	included	NA
TOTAL		**100.00%**	**9632.12.50**		

Financing & Loan Repayment and Sensitivity Analysis

The rate of interest taken into consideration 10.5% p.a. on 70% of capital cost, which is considered for debt.

Debt Equity ratio = 70. : 30

Project Cost : 9632.12 lakhs

Debt. : 6976.00 lakhs

Equity. : 2656.12 lakhs

Scenario A (Preferential Tariff)

If we consider the loan repayment in 15 years, as per the *Renewable Energy Tariff Regulations, 2024, dated June 12, 2024* of **Central Electricity Regulatory Commission** (CERC), then the tariff comes to Rs.5.45 per KwH.

Av. Debt Service Coverage Ratio	**1.58**
Minimum DSCR	**1.26**
Maximum DSCR	**2.07**
IRR	**17%**

Energy Benefits

The financial analysis is based on the energy output on flows as per the Government norms for small hydropower projects. Total annual energy generation with 5% overload will be 36.86 Mus, however, we are considering design-generation of 31.93 MU and net sealable energy will be 31.61 MUs after accounting for 1% auxiliary consumption.

13.3 MAJOR FINANCIAL RESULTS

The complete financial analysis is presented in **Appendix - E** as per following:

TABLE E.1 Project Cost Breakup

TABLE E.2 Capitalized Cost and Energy losses

TABLE E.3 Input Data and Assumptions for Financial Analysis

TABLE E.4 Debt Service Schedule and Interest Calculations

TABLE E.5 Working Capital Requirements

TABLE E.6 Depreciation Calculations

TABLE E.7 Tax Liabilities

TABLE E.8 Profitability Statement

TABLE E.9 Fund Flow Statement

TABLE E.10 Balance Sheet

TABLE E.11 DSCR

TABLE E.12 Cost of Generation

13.4 ENERGY BENEFITS

The financial analysis is based on as follows :

- the energy output is 31.93 MUs.
- Net Saleable energy is 31.61 MUs
- 1 % auxiliary consumption including transformation losses
- **Economic life of the project is 40 years,**

13.5 SUMMARY FINANCIAL ANALYSIS RESULTS

Summary of Financial Analysis results are as follows:

Total Capitalized Cost (*in* INR)	9632.12 Lacs
IRR -Project	17%
DSCR	Average : 1.58 Minimum. : 1.26 Maximum : 2.07

Chapter-14
Techno-Economic Clearance

DEPARTMENT OF POWER

Techno-Economic Clearance

The Government of Nagaland (GoN) is pleased to accord **Techno-Economic Clearance** (TEC) to the **3 x 2.7 MW Lower Likimro Hydroelectric Power Project** [*the* 'Project'] on river Likimro, [*downstream of existing 3 x 8 MW Likimro Hydroelectric Power Project of Government of Nagaland*] in District Kiphire, Nagaland, allotted to ***M/s* NEC Likimro Power Private Limited [NLPPL]** having its Registered Office at 212 Qutab Plaza, DLF City-I, Gurugram-122002 at an estimated cost of Rs. 9632.12 lakhs [*Rupees Ninety-six crores thirty-two lakhs one hundred and twenty*] only, including interest during construction, escalation & financial charges as per the Detailed Project Report, subject to the following conditions:-

1 i) The completion cost shall not exceed the above cost except on account of the following :

(a) Interest during construction (IDC) and financial charges (FC) shall be as per actual, but not exceeding the amount as indicated in **Annexure-I**, unless revised by GoN while according concurrence under clause 8 of Part III (page 9) of Indian Electricity Act, 2003 after review of the financial package.

(b) Change in rates of Indian taxes & duties such as excise duty, sales tax, custom duty and levy of any other taxes/duties subsequent to issue of Techno-Economic Clearance.

(c) Change in Indian Law affecting the cost.

ii) The abstract of the approved estimated cost is enclosed in **Annexure-I**.

2 i) Estimated Cost/ Techno-Economic Clearance shall not be re-opened due to the following:

(a) Non-acquisition of land.

(b) Non-finalisation of Power Purchase Agreement (PPA).

(c) Delay in financial closure.

ii) Tariff for sale of power to Government of Nagaland (GoN) shall be fixed in accordance with the agreement between the Independent Power Producer *viz.* **NEC Likimro Power Private Limited]** and GoN, as per the CERC Renewable Energy Tariff Regulation 2024.

iii) The final financial arrangement shall not be inferior to the financing arrangement projected in the DPR for TEC.

iv) The public issue expenses, if any, shall be reconsidered at the time of approval of completion cost based on documentary proof and in accordance with SEBI guidelines regarding regulation of public issue expenses.

v) Any increase in the estimated cost due to design modifications and geological surprises would be absorbed by the IPP.

vi)

a) The interconnection point with GoN grid and interconnection facilities at this interconnection point shall be at the cost of IPP and as per the proposal being accepted /finalized by GoN.

b) GoN shall at its cost set-up the transmission system for evacuation of power generated from the Project beyond inter-connection facilities.

c) The generating equipment shall be compatible for parallel operation with GoN Grid after inter-linking. Otherwise, Deemed Generation shall not be committed at PPA stage.

d) No deemed energy charges shall be payable for transmission system below 33kV.

e) GoN guarantees off-take of entire power generated from the Project, as per PPA.

vii) Any statutory clearances, as required, shall be provided by GoN before execution/ implementation of the Project.

viii) This TEC is based on the reports and data furnished in the DPR and it is presumed that information furnished is accurate and has been collected reliably after carrying out detailed field investigations and surveys under the supervision of competent personnel. The scrutiny of GoN does not cover the examination of the detailed designs & working drawings of work components in regard to their structural, hydraulic and mechanical performance & safety, which shall be ensured by the IPP/ project authority [NLPPL]. The observations & replies thereof shall form an integral part of the DPR.

3. The project shall be completed within 36 months after /financial closure.

4. The completion cost of the scheme shall be submitted to GoN for approval within 3 months from the commercial operation date (COD) of the Project.

5. The concurrence of GoN to the scheme under clause 8 of Part III of the Electricity Act, 2003 is hereby considered.

BY ORDER

July 27, 2024

Asangla Imti - IAS
Secretary
Department of Power
Government of Nagaland
Nagaland Civil Secretariat
Kohima-797004

No. GoN/Lower Likimro/2024 Dated:- 27-07-2024

Copy for information and necessary action to the :

1. Secretary, Ministry of Renewable Energy (MNRE), Block No. 14, CGO Complex, Lodhi Road, New Delhi-110003.
2. Commissioner & Secretary, Department of Finance, Government of Nagaland, Nagaland Secretariat, Kohima-797004.
3. Engineer-in-Chief, Department of Power, Government of Nagaland, 'Electricity House', Lower Lerie, Kohima-797004.
4. *M/s* NEC Energy Pvt. Ltd., 212 Qutab Plaza, DLF City-I, Gurugram-122002.

Asangla Imti - IAS
Secretary
Department of Power
Government of Nagaland
Nagaland Civil Secretariat
Kohima-797004

ANNEXURE- I

3x2.7 MW Lower Likimro Hydroelectric Project in Distt. Kiphire, Nagaland of
***M/s* NEC Likimro Power Private Limited**
212 Qutab Plaza, DLF City-I
Gurugram-122002, India

ABSTRACT OF COST ESTIMATE

Sl. No.	Particulars	Amount (*in lakhs*)
A	**Civil works**	**4,766.70**
	Trench Weir	434.85
	Power Channel	187.32
	Desilting Basin	468.30
	Water Conductor System	2,342.20
	Surge Shaft	301.05
	Power House and Tail Race	883.08
	Land Acquisition	149.90
B.	**Cost of EM works**	**2,943.60**
	Power Plant + Erection (E&M)	2,500.00
	Transmission line / Distribution	443.60
C.	**Cost of HM works**	**334.50**
	Penstock	334.50
D.	**Contingencies**	**156.90**
	Preliminary & Environmental Exp	156.90
E.	**Project Managements & Other Services**	**420.08**
I	**Total (A + B + C + D + E)**	**8,621.78**
II	Financing Charges	69.59
III	Interest During Construction (IDC)	940.75
	Project Cost (I + II + III)	**9,632.12**
	MEANS OF FINANCE	
1	Equity (30% of Project Cost, including Finance charges)	2,656.12
2	Debt without IDC (70% of Project Cost)	6,035.25
3	IDC	940.75
	Total Capitalised Cost	**9,632.12**
Rupees ninety-six crores thirty-two lakhs one hundred and twenty only.		

Asangla Imti - IAS
Secretary
Department of Power
Government of Nagaland
Nagaland Civil Secretariat
Kohima-797004