GOVERNMENT OF NAGALAND
DEPARTMENT OF NEW & RENEWABLE ENERGY

DETAIL PROJECT REPORT OF
CHICHUNG YONGKI HYDRO ELECTRIC PROJECT
CUM
IRRIGATION PROJECT
2X500KW

APRIL 2010

DETAILED SURVEY & INVESTIGATION (DSI) PREPARATION

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Chapter – 1

1.0. Surveys & Investigation

1. SURVEYS & INVESTIGATIONS:

1.0. Salient Features:

1. Name of the proposed project		: Tsutsung Yongki / Chichung. 2x500KW Mini-Hydel Power Project
2. Project Location		: 94^0-20'-18" E, 25^0-50'-37" N
3. District, State		: Mokokchung, Nagaland.
4. Main Beneficiary		: Longsa, Sapotimi, Tichipami.
5. Average rainfall		: 200 – 400 cm/year
6. Name of the river		: Tsutsung Yongki.
7. Nature of flow		: Perennial
8. Type of the project		: Run off the river.
9. Length of power channel		: 2.50 km
10. Gross Head		: 46m
12. Hydrology	(a) Discharge	: 0.49 cumecs (leanest – 12th April 2004)
	(b) Design discharge	: 3 cumec
	(b) Installed capacity	: 2x500Kw
	(c) Catchment area	: 54 Sq.km
	(d) Slope	: Strongly (15%) to very steep (11%)

13. Site Accessibility: The project is at the main State Highway connecting Tuensang from Mokokchung, another district headquarter at a distance of 20kM and 104kM from Mariani from where the construction materials like cement, sand and steel will be brought. The power generated from this project will be utilized for the Tea factory located at a distance of 500m and the adjoining villages like Longsa, Sapoti, etc.

1.1. Topographical Surveys

The work of reconnaissance, survey and investigation of the various components of the project was taken up over a period of 2 1/2 years. The entire works were carried out by the department of Power, Nagaland with the financial support from the Ministry of New & renewable Energy, Delhi. The preliminary survey was carried out from January 2004. The gauging was started from July 2004 and followed by the detail investigation from Dec. 2004 and was completed in Feb.2006.

Survey of India Toposheet in the scale of 1:50,000 scale was used to fixed preliminary locations and Dumpy Level survey was undertaken.

Various alternatives for weir and power house were surveyed before finalising on present layout and locations

1.2. Reference Bench-mark.

A 30m length Bailey bridge is constructed over the Tsutsung Yongki/Chichung River and about 400m from the forebay location. Temporary bench mark was fixed near the bridge as there is no permanent Benchmark is available.

The temporary benchmark was fixed over a stone near the bridge at the following co-ordinates.

X (Easting)	Y (Northing)	Altitude (m)
94^0-20'-18"	25^0-50'-37"	500

All the surveys has been carried out w.r.t. this Bench-mark. The elevation at 500m has been arrived at on the basis of temporary benchmark.

1.3. Water Power Channel.

A Dumpy Level and a spirit leveling line were run from the Reference Bench-mark mentioned in Para 3.2 to the proposed weir site to establish the horizontal and vertical control. As strip survey on the scale 1:1000 with contours at 2m vertical was carried out. A Bench-mark was established near the bridge site and was marked by a pillar. The power channel will practically follow the course of the river from the weir till the forebay.

1.4. River Course.

The survey of the course of Tsutsung Yongki river from the proposed weir has been done up to 2.5km upstream. It is approx. 1800m from the bridge.

1.5 Forebay.

The area where the forebay has been proposed to be located along with the penstock intake has been covered by systematic contour mapping along with the survey and mapping for penstock and power house area. The forebay will be located just by the right side of the road (towards Tuensang and from the weir direction). It is proposed to have 2 minutes detention time.

1.6 Penstock.

The alignment of penstock has been fixed just about 100m from the benchmark stone near the bridge. The penstock would be about 136 m in length from the forebay to the power house. A single penstock will channel the water from the forebay, which will be bifurcated into two, one for each unit, just near the power house. The penstock will be supported on support piers and anchor blocks.

1.7 Diversion Weir.

For location of weir, the survey includes sufficient area. The cross section is approx. 25 m. The weir is located about 2.5km upstream from the bridge at a height of 548 m.

1.8 Power House

The power house is located on the right bank of the river, below the road. And about 2.5m above the high flood level of the river and sufficiently bounded by the big stones. The battery house along with the small duty room attached with toilet is proposed. The actual final size of the Power house will be determined after the suppliers of electro-mechanical units are supplied. Provision pf crane is not made for the sake of economy. The power house area is naturally bounded and would be free from any other disturbances. The staff colony will also be constructed at the same area preferably above the road.

1.9 Tail Race.

The tail race level is approx 25m. The turbine to be used being reaction turbine, the tail race level and the draft tube will be appropriately constructed to have maximum draft tube efficiency to convert the kinetic energy of the water exiting from the turbine.

1.10 Switch Yard

The requirement of space for the 11KV switch yard is approx. 10mx6m. This can be accommodated within the same area of the demarcated 10,000 sq.m along with the power house. Locating the switch just near the power house will have operating convenience.

1.11 Staff Colony & Office Complex.

It is proposed that the colony will also be located within the same demarcated area of 10,000 sq.m where the power house and the switchyard is to be located. There is sufficient space to accommodate all three components of the projects.

There will not be much requirement for office complex. No separate office complex building is proposed. Adequate office space and rooms will be attached within the power house building only.

1.12 Communications.

The project site is along the existing state highway between Mokokchung and Tuensang maintained by the Border Roads and hence there will not be any problem through out the year. The proposed project is 104 Km from Mariani, Assam the nearest railway station and will be convenient while transporting the construction materials. As far as the telecommunication is concerned it is through with modern gadgets like mobile and other wireless phones.

Chapter – 2

2.0. Hydrology & Meteorology

2.0. HYDROLOGY & METEOROLOGY

2.1. Introduction:

Tsutsung Yongki / Chichung Mini Hydel Power project was investigated by department of Power, Nagaland during 2004 to 2006. The project is located at Mokokchung District, Nagaland. The water resources of the Tsutsung Yongki River is proposed to be utilized for power generation by setting up a mini hydel power project. The main head structure works consists of a trench type diversion weir across the river Tsutsung Yongki, a power channel and the power house. The project is a run-off-the-river scheme.

The catchment area at the proposed weir location is about 54 sq.km. The Tsutsung yongki originates from Zunheboto District which flows into Dikhu River and is a tributary of mighty Brahmaputra. Then crosses the international boundary and flows into Bangladesh then to the Indian Ocean.

The topography of the project area is hilly and mountainous, though there are small strips of land by the river banks, which are fairly flat and where terrace cultivation exists. But the sizes of these lands are negligible and would not be more than a few acres in total.

2.2. Hydrological Studies Required:

The nature of the hydrological studies depend upon the type of river valley structures on one hand and on the data availability on the other hand. Since there had been no previous studies or investigations, there are no site specific historical hydrological or meteorological data available. The proposed structure is a trench type diversion weir without any significant storage/pondage element in it. The objective is power generation. According to the above requirement, certain criteria and methods were followed as briefly detailed below:

2.2.1. *Existing uses:*

Near the proposed diversion weir, there is practically existing uses of the water from the Tsutsung yongki river. Further downstream, below the proposed power house, there are good command area of terraced cultivation, for which the water from Tsutsung yongki is used. However, the project will have no impact on this as the water diversion for these are after the tail race only. i.e the full quantity of the water will have been discharged back to the river at this point. Even otherwise, there is sufficient water for both activities.

2.2.2. *Water Resources for Planning:*

The criteria generally adopted for the planning of power projects is to estimate the firm power on the basis of 90% dependability, which is statistically, the random variable value, realised at a probability of exceedance level of 0.9, and to assess the average power generation at 50% dependability criteria, considering the Hydrological year as one unit.

The Tsutsung yongki project being run-off-the river scheme, there is no utility in analysing the yearly quantum of flows, and the time resolution level should be at least 10 daily blocks with the 10-daily mean discharges as the variable. Accordingly, the hydrological year has been divided into 90 blocks of 10-daily discharges and the dependable discharges have been estimated for each of these blocks.

Hydrology readings is Appendix – 2.1.

2.2.3. *Floods:*

It is considered that there is no need to estimate a construction of diversion flood peak, as the construction of the weir could be well completed within one dry season.

2.3. Rainfall data and Meteorological Observations:

In addition to the rainfall data near the weir site for a few years, the data of 7 other stations set up by the Department of Soil and Water Conservation, Govt of Nagaland, are available with daily readings and observations. The monthly average dates are reproduced for the following stations;

i.	Kohima station	: 1998, 1997, 1995, 1992, 1991
ii.	Kipheri station	: Jan-Apr 2000, 1999, 1998
iii.	Meluri station	: Jan-Apr 2000, 1998
iv.	Mon station	: Jan-Mar 2000, 1999, 1998, 1992
v.	Phek station	: Jan-Apr 2000, 1999, 1998
vi.	Wokha station	: Jan-Apr 2000, 1999, 1998, 1992, 1991
vii.	Tuensang station	: 1992, 1991, 1990

The meteorological observations are given at Appendix 2.3.

TSUTSUNG YONGKI CHICHUNG HYDROLOGY/WATER READING TABLE

Date	10day-average	2004	2005	2006
Jan.	1-10	-	3.91	2.30
	11-20	-	3.90	2.06
	21-31	-	3.55	2.90
Feb.	1-10	-	3.30	2.22
	11-20	-	2.90	2.16
	21-28	-	2.50	2.03
March.	1-10	-	3.34	1.90
	11-20	-	3.40	3.14
	21-31	-	2.91	3.44
April.	1-10	-	2.20	2.50
	11-20	-	2.54	2.11
	21-30	-	3.40	2.84
May	1-10	-	3.30	2.88
	11-20	-	9.80	2.05
	21-31	-	11.30	2.90
June	1-10	-	41.00	5.60
	11-20	-	78.10	4.80
	21-31	-	76.70	5.52
July	1-10	82.64	65.90	9.12
	11-20	59.3	73.20	15.90
	21-31	77.8	68.10	45.50
August	1-10	127.3	17.60	37.60
	11-20	180.7	64.30	47.20
	21-31	86.1	86.10	47.60
Sept	1-10	27.3	48.90	40.65
	11-20	88.04	77.50	37.32
	21-30	42.2	62.00	50.55
Oct	1-10	23.3	27.20	52.40
	11-20	26.65	22.70	40.60
	21-31	15.12	22.60	40.43
Nov	1-10	10.3	27.90	34.20
	11-20	7.90	3.10	13.00
	21-30	7.20	5.70	9.80
Dec	1-10	6.36	2.80	6.70
	11-20	5.55	2.14	5.60
	21-31	5.20	2.70	03.20

Correction factor for water velocity is taken as C= 0.65

Percentage Dependability

% Dependability	1994	1995	1996	Averageof 1995 &96.
50	26.65	9.80	5.60	7.70
60	23.30	3.50	3.20	3.35
75	7.90	3.10	2.88	2.99
90	5.55	2.20	2.11	2.165
100	5.20	2.14	1.90	2.02

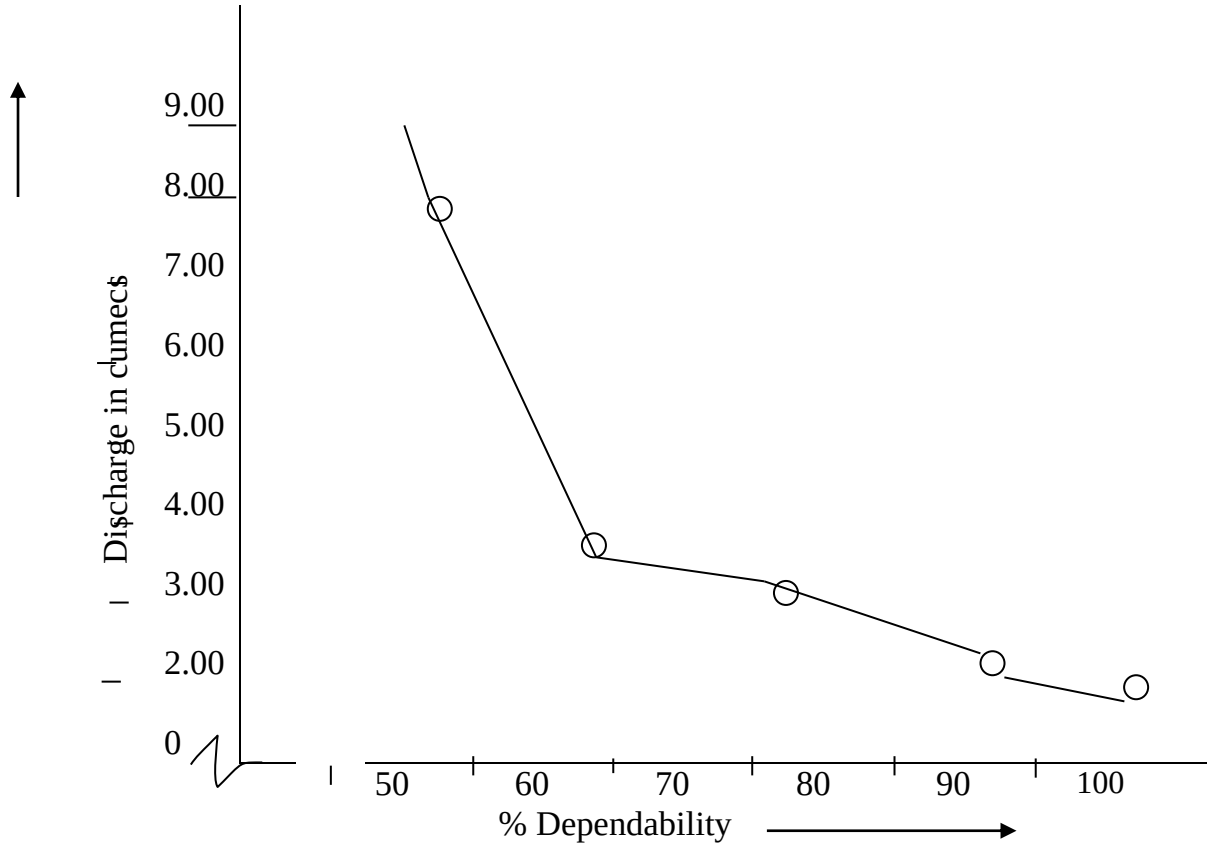


Chart: Dependability (%) – Discharge (Cumecs).

Chapter – 3

3.0. Geology

Particulars: Page:

3.0. GEOLOGY

3.1. General:

The area around the project site consists primarily of shales and barail sandstones with comparatively a lower content of clay. Intense folding, faulting and jointing besides fracturing is a very common phenomena in these rocks, in view of the tectonic movements and thrusting that the area had undergone since tertiary times. The region falls under the sub-Himalayan region and the soil is relatively young, with lots of sedimentary rock formations. The soil is generally unstable and landslides, particularly during the monsoon are very common. The geological history of this area has been quite complicated and there is not yet sufficient data of any serious research. The region is also covered by heavy soil cover as well as thick forests and steep slopes. Consequently, geological evaluation is made more difficult.

3.2. Project Geology:

The different civil engineering features that are planned in the project are the trench type intake weir, desilting chamber, power channel, the penstock and the power house. General geological observations point out that the geological features would support the above structures, except the power channel where some difficulties are expected in two or three short portions, for which special provisions are being made.

3.2.1. Diversion Weir:

The Tsutsung Yongki Chichung river at this portion is about 25m in wide and the gradient is relatively calm. The stream bed is covered with rocks and pebbles. Further downstream of about 70m, on the right side of the bank, there is gentle terrace with a width varying from 40m to 60m. This area is stable and easy to work at. This flat terrace on the right bank is ideal for desilting chamber. The stream at this portion of the right bank will be protected with guide bunds for protection against possible erosion from the river.

3.2.2. Power Channel:

It is felt that while constructing the power channel we may not face much difficulties as the slopes as well as the rocks appears to be of soft in nature. Blasting may not be required. However whenever required will be provided with cut and cover provision. Hence there will be no difficulties for the channel even if the there are small landslides.

3.2.3. Penstock:

The penstock area at the right bank of the river is entirely soil covered with clay and shale. The slope ranges from nearly 65 degree at the top to about 20 degree at the bottom near the power housed. Anchor Blocks will be provided at the penstock, at the break of slopes and change of angles.

3.2.4. Power House:

The power house will be constructed on the right bank of the river with about 20m safety margin from the bank and about 2.5m above the high flood level. The slope is ideal and gentle. In fact, this is the only possible place for a power house along this stretch of the river side. The slope will be excavated and dressed properly to construct the power house. The wide of the river at the power house portion is also about 30m and gentle filled with rocks. Protective bunding will also be provided along this portion of the river bank.

3.2.5. Seismicity:

The area lies in the active seismic belt of the sub-Himalayan region, where tremors are experienced regularly. The Richter magnitude of the shocks range from mild to very strong (3 to 6) which generally last for only a few seconds.

Chapter – 4

4.0. Project Purposes

4.0. PROJECT PURPOSE

4.1 Present Development:

4.1.1 Existing Power Facilities.

At present the Longsa and the villages around it are connected with 11KV transmission lines. However, due to long lines through forests and difficult terrain from the grid sub-stations located at administrative headquarters from which it is fed, there are frequent line disruptions caused by natural causes such as bamboo, trees, conductor snapping, load shedding etc. Consequently, the villagers are often deprived of power for continuous long periods of time, even though they are connected to grid. Even when power is available, the voltage quality is also quite poor.

4.1.2. Generating Capacity.

In spite of having installed capacity of almost 28MW due to operational problems the State of Nagaland is almost dependent upon Central power Sector such as from NEEPCO and NHPC. Department of Power Nagaland has some few DG sets set up during the 1960s and 70s. These also amount to only about 1MW of installed capacity and are now being decommissioned.

There are also no power projects installed or proposed to be set up near the Tsutsung Yongki Chichung MHP project.

State MHPs	Comm. Year	Cap. (KW)
1. Duilimroi I&II MEP	1999	740
2. Tsutha MHP	1999	700
3. Dzüza I MHP	1979	1500
4. Kithuri MHP	1991	200
5. Ghekhu ghakhubu MHP.	1993	120
6. Telangsao MHP.	2002	600
7. Likimro HEP.	2002	24000
Total		**27860**

Table 4.1. Hydro Electric Projects in Nagaland.

Source: Department of Power, Nagaland.

Consequently, the State is power deficit state. The peak demand is about 50MW (December 1999-Jan 2000). Most of the load shedding imposed is usually borne by the rural consumers, much to their displeasure.

4.1.3. Transmission Systems:

The State UNDER THE Department of power as a whole is now relatively well connected with 66KV and 132 KV transmission line network. The nearest 132KV sub-station from the project site is at Mokokchung. The 132KV T/L from Kohima to Kiphire then 66KV lines from Tuensang to Mokokchung passes through the project. But it is of no consequence to the project. The State Power Map is appended at Appendix – 4.3

4.1.4. **System Loads.**

System loads in Nagaland is extremely variable. It has got very high evening peak demands particularly during winter and low demand during the day. This is because the load in the state is mainly domestic, with very little industrial demand. The summer-winter is slightly balanced by the fact that demand reduces in the warmer areas of the foothills during winter, while it shoots up in the colder hill towns. The reverse follows during the summer.

The daily load curve at Kohima 132KV sub-station during Dec 1998, Mar'99 and June'99 are appended at Appendix – 4.1 & 4.2. This is representative of the System loads in the state.

It is expected that the demand load on the Tsutsung Yongki Chichung MHP will also follow the same pattern.

4.1.5. Load Factors:

Since there are no major power stations in the state, station specific load factors are not available. However, due to the nature of the above system loads, load factor in the region would be quite low.

4.2. Proposed Development

The scope of proposed development is mainly confined to the area near the project, as the project is a small one and would have only very little impact on the State grid supply-demand as a whole. The objective is to set up similar projects in sufficiently large numbers, so that its aggregate contribution can make a substantial impact.

4.2.1 **Existing markets.**

Due to the lack of generating capacity in the state as well difficulty in maintaining long 11KV or 33KV transmission lines through thick forests and inhospitable terrain in order to reach the villages, all the villages are potential target market for mini/micro hydel power projects.

The existing category of consumers in the above mentioned existing market for the power from Tsutsung Yongki Chichung MHP are;

i. Domestic light & Power
ii. Public lighting.
iii. Commercial consumers.
iv. Small scale industries.
v. Farm house lighting.
vi. Power house auxiliary.
vii. Tea factory is located at about 500m from the proposed hydro power project which will take almost all the power generated.

4.2.2. **Growth trends & Load Forecast:**

Even though Mokokchung district is under the developed district, and the project falls under the same district the power supply in this area is not sufficient as the

entire state is facing the power shortage. At the same time the situation is changing and it is expected that there will be an accelerated economic growth in the near future. People are beginning to become more aware of the need for entrepreneurial activities and are taking up economic activities. The State Govt has taken a number of steps for the exploitation of mineral resources.. All these are expected to give a boost to industrial and other economic activities, and hence, greater demand for electricity.

Electricity demand in the State has been growing steadily, even in the face of heavy load shedding and restricted supply. This is illustrated below;

Peak demand during 1980s	= 30MW
Peak demand during 1990s	= 42MW (restricted to 36MW)
Peak demand during Dec'99-Jan'00	= 50MW
Peak demand during Dec 2003	= 70 MW
Peak demand during Dec 2008	= 90 MW

The above big jump in peak demand during Dec'99 had been due to commissioning of several 132 and 66kv sub-stations in the State (Kipheri 132kv , Tuensang 66kv, Tuli 66kv etc). Some more 132kv and 66kv sub-stations are expected to be commissioned within 2000 (Wokha 132KV, Naginimora 66KV etc.).

Major system improvement schemes to upgrade and strengthen the distribution system in Dimapur. Both Dimapur and Kohima has upgraded from 25MW capacity to 50MW capacity. Once the above schemes are completed, there will be a quantum increase in power demand growth in the State. When generation or supply to the State becomes inadequate, it will be rural consumer who will bear the brunt of load shedding.

4.2.3. Installed capacity:

Based on the Hydrological readings given at Appendix 2.1 & 2.2, the installed capacity of the Tsutsung Yongki Chichung MHP can have the following alternatives between 60% to 90% dependability;

i. Energy potential tapped with different installed capacities ranging from 500kw to 1000kw.
ii. Energy generation per KW for different installed capacities.
iii. Cost per KW for installed capacities.
iv. Cost of generation and cost of incremental energy for different installed capacities and
v. Annual revenue versus annual cost for different installed capacities.

Based on the above studies, the most technically and economically feasible capacity can be determined during Detailed Project Report (DPR) preparation.

4.3. Transmission System:

Power will be generated at 440v and stepped up to 11kv. This shall be transmitted through the existing 33KV lines to Longsa village from Mokokchung. The 11kv S/C T/L shall be 2 km in length shall be constructed on SP-35 steel tubular poles, and will have earth wire, lighting arrestors and other protective measures.

It is proposed that the 11kv T/L will be included in the detail estimate while preparing DPR. Which will be executed departmentally.

4.4. Rural Electrification:

Government of India has given high priority for the development of rural electrification, recognizing it as a pre-requisite for socio-economic development of the rural masses of poor. With this objective, Govt of India set up the Rural Electrification Corporation (REC).

More than 80% of the population in Nagaland is rural based. Nagaland took up the task of rural electrification very seriously during the 1980s and became the first state in the NE region to achieve 100% rural electrification in 1989.

But it is seen that though the electric poles and transmission lines had reached the villages, in many cases, these remained without power, as there were just not enough power to be transmitted, or even if power in the Grid was available, due to main sub-stations overload etc. power could not be distributed. This is likely to be the scenario for quite some years to come.

APPENDIX – I

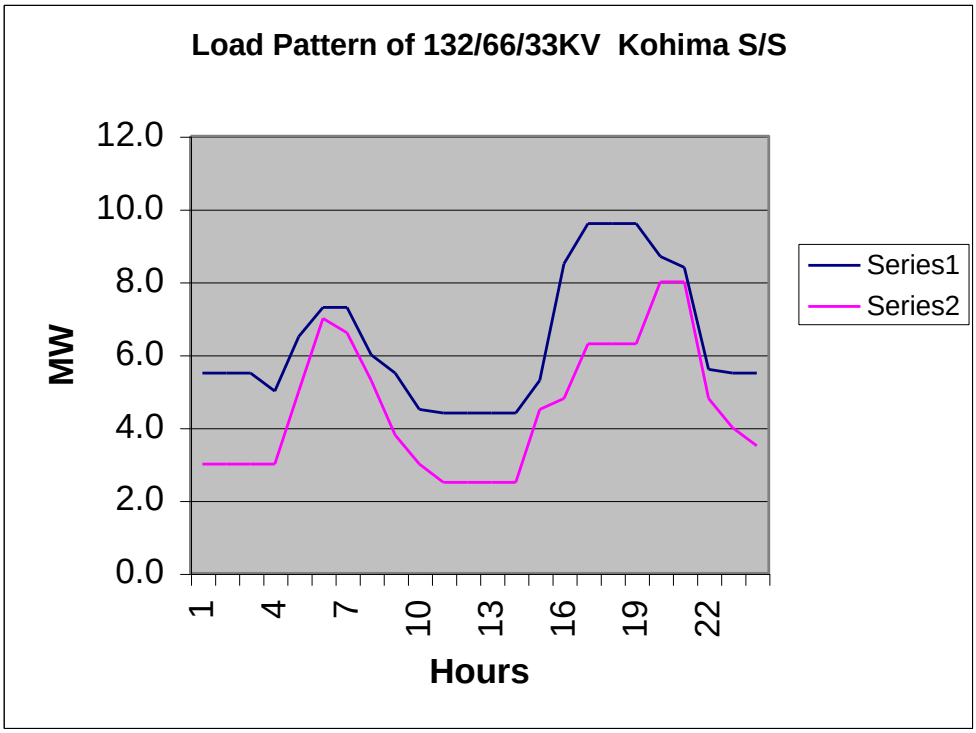
Kohima 132/66/33KV Sub-Station Load Pattern during Dec 1998 and Mar 1999.

Daily Load Curve (average)

Hour	Dec'98 (MW)	Mar'99 (MW)
0100	5.5	3.0
0200	5.5	3.0
0300	5.5	3.0
0400	5.0	3.0
0500	6.5	5.0
0600	7.3	7.0
0700	7.3	6.6
0800	6.0	5.3
0900	5.5	3.8
1000	4.5	3.0
1100	4.4	2.5
1200	4.4	2.5
1300	4.4	2.5
1400	4.4	2.5
1500	5.3	4.5
1600	8.5	4.8
1700	9.6	6.3
1800	9.6	6.3
1900	9.6	6.3
2000	8.7	8.0
2100	8.4	8.0
2200	5.6	4.8
2300	5.5	4.0
2400	5.5	3.5

APPENDIX – II

Kohima 132/66/33KV Sub-Station Load Pattern during Dec 1998 and Mar 1999.



Series 1 : Daily Load curve during Dec1998
(representative of winter demand).
Series 2 : Daily Load curve during Mar 1999
(representative of summer demand).

Note: Winter demand in the hills are much higher than summer demand on account of heating purposes.

DESIGN

Name of project: Tsutsung Yongki Hydro Electric Project

5.0 MAXIMUM FLOOD ESTIMATE

The maximum flood does not have much bearing to install capacity of project However, to check the safety for the intake structure, some approximate value of maximum possible flood predicted by various empirical formulas.

(i) Inglis Formula for fan shaped catchments

$$Q = \frac{7000A}{(A+4)^{0.5}}$$

Where A = catchment area in sq. miles

Our catchment area is 54 Sq.km

i.e. A = 20.90 sq miles

Now using the values

$$Q = \frac{7000 \times 20.90}{(20.90 + 4)^{0.5}}$$

= 29318.69 cusecs

= 830.20 cumecs

OR

(ii) Dicken's formula

$$Q = CA^{2.4} \text{ cusec}$$

Where A = Catchment area in sq miles

C = run-off coefficient and its value varies between 825 to 1600 higher value of C in hill section.

Assuming

C = 1300 as catchment is steep

$Q = 1300 \times (20.90)^{3/4}$ = 12707.30 cusecs

= 360 cumecs

(iii) Nawab Jung Formula

$$Q = CA^{(0.92 - 1/14 \log A)} \text{ cusec.}$$

Where C = 1600 – 2000

Assuming C = 1700 for steep hill slope

$Q = 1700 \times (72.65)^{(0.92 - 1/14 \log 72.65)}$

$= 1700 \times (20.90)^{0.787}$

= 18595.33 cusecs

= 526.533 cumecs.

The maximum flood predicted by Inglis formula which is 830.20 cumecs may be for checking the intake structure.

River bed slope	= 1: 25
Width of weir	= 25 m
Height of apron above bed level	= 3 m
Free board provided	= 0.5 m
C.S. Area	= 2.5.x.25 = 62.5 sq. m
Wetted perimeter	= 2.5.x 2 + 25 = 30 m
Hydraulic radius (R)	= A/P = 2.083 m

By Robert Meaning's formula $V = 1/n\ R^{2/3} S^{1/2}$

Where, n = 0.011 for cement concrete surface.

$$V = \frac{1}{0.011} (2.083)^{0.67}\ 0.04)^{1/2}$$

$$= 29.73 \text{ m/sec}$$

Capacity of diversion weir = 29.73 x 62.5

= 1858 cumecs.

Hence the weir section provided is safe.

5.1. DIVERSION WEIR

Top width	= 1.50 m
Bottom Width	= 1.00 m
Design discharge	= 3.00 cumec
Increase in design discharge 25%	= 0.75 cumec
Total design discharge	= 3.75 cumec
Weir slope provided	= 1/25
Thrash slope	= 1/10

Provided trapezoidal weir depth 1.20M

By Robert Meaning's Formula $V = 1/n\ R^{2/3} S^{1/2}$

Where, n= 0.011 for cement plaster

Cross section Area, A= (1+1.50)/2 x 1.20 = 1.50 sq. m.

Wetted perimeter P= 1+2x√2 x 1.2

= 4.39 m

Hydraulic Radius, R =1.50/4.39

=0.341 m.

Using the value in equation (1),

$$V = \frac{1}{0.011} (0.341)^{0.67} (1/25)^{0.5}$$

= 8.84 m/sec

Q = 13.26 cumecs

The design discharge is 3.00 cumecs. Hence, the section is sufficient to hold the design discharge. Provided wall of thickness inclined side 30 cm and bottom width of 1m. This will cover pebbles, sand and silt deposits thereby allowing sufficient for manual cleaning from time to time. Side apron is made up with C.C. (1:3:6) as shown in the diagram. Weir will be made with R.C.C. ($1:1^{1/2}$:3) reinforced with 15cm c/c in both direction near both the faces. Thrash rack will be provided with Slope 1:10 made up of 25mm ø M.S. rods @ 5cm c/c as shown in the diagram.

5.2 RECTANGULAR POWER CHANNEL

For a rectangular section, the most efficient section is when depth of channel 'd' is half of width 'b' of channel (d=1/2b)

From Robert Manning's formula

$$b = (1.3969\ Q)^{0.375}$$

$$= (1.3969 \times 105.84)^{0.375}$$

$$= 6.51 \text{ fts.}$$

Provide b = 2.00 m

Since, d = b/2 = 1.00 m

Hence provide channel section as 2 x 1.30 m.

Check $V = 1/n\ R^{2/3}S^{1/2}$

n = 0.011 for cement plaster
S = 1/1000
A = 2x1 = 2 sq.m.

Wetted parameter P = 2+1x2 = 4 m.

Hydraulic radius R = 2/4 = 0.05

Now, $V = 1/0.011(0.5)^{2/3}x(1/1000)^{1/2}$
$= 1.8$ m/sec

Since, $Q = AV = 2x1.8$
$= 3.62$ cumecs (safe).

Design of Wall Thickness

Assuming full flow of channel at a section maximum BM on the wall of channel due to water pressure is given by the relation.

$$M = \frac{WH^3}{6}$$
$$= \frac{1000x(1.3)^3}{6}$$
$$= 366.16 \text{ Kg-m.}$$

Using 1:2:4 efficient thickness of wall

$$d = (M/Qb)^{0.5}$$
$$= \frac{(366.16)^{0.5}}{3 \times 100}$$
$$= 0.063\text{m}$$
$$= 6.30\text{cm}$$

Provide over all thickness of 10cm using 12mm bars

Effective Depth $d_e = 10 - 2.5 - 0.6$
$= 6.9$ cm

Steel required Ast $= \frac{366.16}{1250x0.86x6.9}$
$= 4.93$sq.cm.

Area of 12 mm bar = 1.13sq.cm

Spacing = 1.03x100 = 22.93 cum c/c

Provide 12mm @ 20 cm c/c both ways.

Design on Slab

The top of power channel for about 150m will be designed to cover the power channel of that length.

Width, b = 2.00m

Thickness of wall = 0.10m

Effective length = 2.10m

Live load (L.L) = 100Kg/m

Dead load (D.L) = $\frac{0.1x2400}{}$

340 kg/m

$$BM = \frac{Wl^2}{8}$$

$$= \frac{340(2.10)^2}{8}$$

$$=187.42 \text{Kg-m}$$

Using M = 150 R.C.C.

$$d = \frac{(1874.2)^{0.05}}{9.03x100}$$

$$=10.30 \text{ cm.}$$

Provide over all thickness as 15cm.

Effective thickness = 15-2.5-0.5

= 12cm

Steel required = Ast = $\frac{1874.2}{1250 \times 0.86x12}$

= 1.453sq.cm

Using 10mm =1.453sq.cm.

Spacing = $\frac{0.79x100}{1.453}$

= 68.97

Provide 25cm c/c

Design Of Side Weir Or Overall

Provide an overall to dispel the excess discharge other than the design discharge that may flow due to failure of regulating the gate at the diversion weir. The full capacity of power channel is 13.26 -3.75 cumec = 9.51 cumec.

By Engel's formula.

$$Q = 3.32L^{0.83}xh^{1.67} \text{ cusec}$$

Now Q = 9.51 cumec = 355.50 cusec

Adopt h = 0.30m = 0.984 ft.

Or

355.50 = 3.32Lx0.97

L = 281 ft.

= 86m

Provide overall size 30 x 0.5 m.

5.3 HYDRAULIC DESIGN OF DESILTING BASIN :

Discharge for power generation = 3.00 cumecs.

Discharge for silt flushing = 20 % = 0.60 cumecs.

Design discharge for desilting basin = 3.60 cumecs.

As per Mosoyoni Hydro electric hand book, critical flow- through velocity

$= a \sqrt{d}$

Where,

a = Constant

= 44 for 1.0 mm > d > 0.1 mm.

d = dia of silt particles to be removed = 0.2 mm.

$\therefore$ critical flow through velocity = $V = 44 \sqrt{0.20}$

= 19.7 cm /sec.

However to avoid short circuiting of flow a minimum flow-through velocity of 30 cm/sec shall be provided. For silt particles of 0.20 mm, settling velocity is calculated as follows :

Settling velocity w = 3.0 cm/sec.

Area of cross section = Q / V = 3.60 / 0.30

= 12 sq.m

provide a depth of flow = 2.50 m

$\therefore$ Width = 12 / 2.5 = 4.80

say 5.0 meters.

Length of tank has been calculated using A. Velikonov formula.

$$L = \frac{\lambda \; v^2 \; (\sqrt{H - 0.2})^2}{7.51 \; w^2}$$

Where, L = Length of Basin in meters.

= a factor depending upon % removal factor.

= 0.9 for 90 % removal of particles.

H = depth of Tank.

= 2.50 m.

w = Settling velocity.

= 3.0 cm / sec.

V = flow through velocity.

= 30 cm / sec.

$$\therefore L = \frac{(0.9)^2 \times (0.3)^2 \times (\sqrt{2.5 - 0.2})^2}{7.51 \times (0.030)^2}$$

= 20.75 m.

Parameters of De-silting Basin :
Provide a desilting tank chamber with the following dimensions,
Length of basin = 23 m.
Width of tank = 5 m.
Clear water depth = 2.5 m.

A free board of 60 cm has been provided above FSL.

For collection of silt settled at bottom into the cunette, the bottom slab of the tank has been provided with a cross slope of 1 in 2.2 at the beginning to 1 in 1.46 at the end.

Similarly the depth of the cunette at the beginning is 500mm and at the end it increases to 750 mm and overall bed slope of 1 in 33.3 has been provided to flush out deposited silt.

5.40 CROSS DRAINAGE

4.Nos. Major aqueducts and 4nos. Minor cross drainage works will be required. We will design for the major aqueducts.

Aqueduct width = 2.55m
Inside depth of the aqueduct = 1.3m
Providing Free board of 50cm the total Depth becomes 1.80m.

Assuming that the supporting beams (side walls) are 20cm thick the effective span of the bottom slab = 2.75m
Maximum sagging moment will be determined considering the aqueduct is full.
Sagging moment due to weight of water = $\frac{1000x1.8x(2.75)^2}{8}$
= 1701.56 kgm.
Sagging moment due to self weight of base slab considering 15m thick bottom slab
= $\frac{2100x0.15x(2.75)^2}{8}$ - 340.31 kg-m.
Water pressure on side walls will create a hogging moment = $\frac{1000x(1.8)^2 \times (1.8x0.15)}{2 \quad 3 \quad 2}$
=1093.5kg-m.
Net BM centre of bottom slab
M_c = 1701.56+ 340.31 – 1093.5
= 948.37 Kg-m
Corresponding pull = 1000 x $(1.8)^2$
= 1620 kg.

Let the cover to steel reinforcement be 2.5 cm.
Sufficient effective depth = 15-2.5 – 0.6
= 11.9 cm
Since, resultant B.M. = 948.37 – 1620 x (0.119-0.075)
= 877.09 Kg.-m.
Steel for B.M. = $\frac{87709}{1350x0.86x11.9}$
= 6.86 cm^2.
Steel for pull = $\frac{1620}{1250}$ = 1.296 cm^2
Total steel required = 6.86 + 1.296
= 8.156 cm^2

Since spacing of 12mm ø bars = $\frac{1.134 \times 100}{8.156}$ = 13.85 cm

Provide 12mm ø M.S. bars @ 12mm c/c.

End Section

Maximum hogging moment = $\frac{1000x(1.8)(1.8+0.075)}{2 \quad 3}$

= 1093.5 Kg-m

Pull = 1620 Kg

Since resultant moment = 1093.5-1620(0.119-0.075)

= 1022.22 Kg-m

This moment produce tension near the water face

Steel for B.M. = $\frac{1022.22x100}{1250x0.86x11.9}$

= 7.99 cm^2

Steel for pull = 1620/1250 = 1.296 cm^2

Total steel required = 7.99+1.296 = 9.286 cm^2

Spacing of 12mm ø M.S. bars = $\frac{1.13x100}{9.286}$ = 12.17 cm

For both the faces near and away from water provide 12mm ø bars @12 cm c/c.

Distributing steel = $\frac{0.3x15x100}{100}$

= 4.5 cm^2

Say = 17cm c/c

If this be provided near both the faces the spacing of the distribution bars will be at 34 cm c/c near each face.

Design of Beams (Side Walls)

Load per meter run of the beam

Weight of water = $1000x1.8x\frac{2.55}{2}$

= 2295 Kg/m

Dead load of the slab = $2.55 \times 0.15 \times \frac{2400}{2}$

= 459 Kg/m

Dead load of the beam = 0.2 x 1.8 x 2400 = 864 kg-m.

Total weight = 3618kg/m.

Effective span = Clear span + bearing

= 3.5 + 0.5 = 4 m.

Maximum BM = $3618 \times \frac{(4)^2}{8}$ Kg

= 7236 Kg-m

Providing a cover of 2.5 cm

Effective depth = 195-2.5-1 = 191.5 cm.

At = $\frac{723600}{1250x0.86x191.5}$

= 3.5 cm^2

Provide 3 Nos. of 20mm ø MS bars (10.5 cm^2)
Maximum shearing force = S = 3618x4/2
= 7236 kg.

Nominal shear stress $\tau_n = \frac{S}{bd}$

$= \frac{7236}{20x191.5}$
$= 1.89\ kg/cm^2$
Percentage of steel $= \frac{10.5x100}{20x191.5}$
$= 0.274\%$
As per code for 0.25% of steel $q_s = 2.2\ kg/cm^2$
$q_c = 3\ kg/cm^2$
$q_v = 2.276\ kg/cm^2$

q_v, q_c
Hence provide two legged 10mm stirrups @ 30cm c/c.

5.5 FOREBAY

Detention time 3 minutes
Design discharge = 3 cumec
Capacity = 3x3x60 cumec
= 540 cumec
Provide section 6x35x3 = 630 cum

Provide rectangular shape of 6mx35mx3m RCC (1:2:4) structure.

5.6 PENSTOCK

Total length = 136 m
Gross Head = 46 m
Assume dia. of penstock = 100 cm

Assume wall thickness = (6mm)

D = 100cm
$A = \pi R^2$
$= 0.78m^2$
V = Q/A = 3/0.78 = 3.82 m/sec

Head loss, $HL = \frac{flv^2}{2qd}$
$= \frac{0.00062x136x(3.82)^2}{2x9.8x1}$
= 0.062 m

5.7 DESIGN OF STEEL PENSTOCK :

1. HYDRAULIC DESIGN :

A. ECONOMICAL DIAMETER.

The economical diameter of the penstock has been calculated using the well known empirical formulae with the following basic data.

Discharge = 3.00 cumecs

Head = 46 m

Installed capacity = 1000 KW

1. Sarkaria Formulae :

$$D = \frac{0.62\ P^{0.43}}{H^{0.65}} \quad \text{in MKS system.}$$

Where P = rated horse power of Turbines = 1360.54 HP

$$D = \frac{0.62 \times 1360.54^{0.43}}{46^{0.65}}$$

D = 1.145 m
Say 115 cm

2. Doland's Formulae :

$$D = 0.176(P / H)^{0.466}$$

$$D = 0.176\ (1360.54 / 46)^{0.466}$$

D = 0.85 m

D = 85cm.

The optimum diameter can also be calculated by the following formula given in the book of Hydro Electric Station by ILYINKH as

$$D_{opt} = 7\sqrt[3]{5.2\ Q / H}$$

$$D_{opt.} = \left[\frac{(5.2 \times 3^{3})}{46}\right]^{1/7}$$

$$= 1.00 \text{ m}$$

$$= 100 \text{ cm.}$$

From the above calculation it is seen that the optimum diameter of the penstock lies between 85 cm to 115 cm. However as discussed in the hydraulic design of penstock, to facilitate telescopic transportation of fabricated ferrules from workshop to project site the whole length has been provided with 100cm. This gives the average diameter of penstock as 100cm.

B. HYDRAULIC LOSSES.

Maximum design discharge = 3.00 cumecs.

Dia of penstock = 100

Average dia = 100

Max. velocity = 3.82 m / sec.

Length of the penstock = 136 m.

1. Friction Losses :

As per CWC penstock manual and as per USBR engineering monograph No.3 on welded steel penstock, the head loss in steel penstocks is most commonly estimated using Scobeys formula.

$$\frac{H_F}{} = \frac{0.34 \times V^{1.9}}{D^{1.1}}$$

Where H_F = head loss per 1000 ft (300m)length of penstock.

V = Velocity in ft/sec = 12.53 ft/sec.

D = Diameter of pipe in ft. = 3.28 ft.

$$\therefore \frac{H}{F} = 0.34 \times \frac{(12.53)^{1.9}}{(3.28)^{1.1}} \text{ per 1000 ft.}$$

$$= 11.22\text{ft} / 1000\text{ ft.}$$

$\therefore$ Friction loss in 136m length of penstock = 5 meters.

Gross head loss = 0.06+5 = 5.06

Net Head = 46- (0.06+5) = 40.94 m

Power at 85% efficiency = 8.5xQHKW = 8.5X3X40.94 KW
= 1043.97KW

Provide 2x500 KW turbine generator sets.

ENERGY OUTPUT PER YEAR:

i) Two unit will run for 6months =2x6x30.4x24x500 = 4377600 KWH

ii) One unit will run for 6 months = 1x6x30.4x24x500 = 2188800 KWH

Total 65,66,400 KWH

COST OF GENERATION:

Sl. No	Items	Amount (Rs. In lacs)
1	Total project cost	1283.42
2	Recovery @ 1%	12.83
	Net expenditure	1296.25
3	Interest on capital @ 8%	103.70
4	Depreciation @ 2%	2.07
5	Maintenance @1%	12.83
	Total	**1414.85**

Cost per unit for 75% load factor $\frac{158545000.00}{6566400} = 2.15$

Table 10.1 – PRELIMINARY.

Sl. No.	Item of Works.	Qty.	Rate. (Rs)	Unit.	Amount (Rs. in Lacs)
1	Expenditure incurred on previous investigation and preparation of DPR.				00
2	Detailed surveys for final location.	L.S			2.00
3	Vehicle for inspecting officers.	L.S			00
4	Camp equipment.	L.S			1.00
5	Construction material for Survey.	L.S			00
6	Consultation Fee.	L.S			00
7	Training of Engineers.				00
8	Construction of access roads to facilitate investigation.	L.S			2.00
9				**Total**	**5.00**

Table 10.2 – LAND.

Sl. No.	Item of Works.	Qty.	Rate. (Rs)	Unit.	Amount (Rs. in Lacs)
1	Cost of Land.				
	(i) Water conductor system.	4	3000.00	Acre.	1.00
	(ii)Power house and switchyard.	2	3000.00	Acre.	0.50
	(iii) Colonies and Offices	2	3000.00	Acre.	1.00
	(iv) Access roads.	2	3000.00	Acre.	0.50
	(v) Other Structures.	1	3000.00	Acre.	0.50
	(vi) Diversion weir.	2	3000.00	Acre.	0.50
2	Compensation for trees and Other standing crops.	LS			00
3	Survey of Land etc. to be acquired	LS			0.50
4	Legal charges	LS			0.50
				Total	**5.00**

Table 10.3 – BUILDING.

Sl. No.	Item of Works.	Qty.	Rate. (Rs)	Unit.	Amount (Rs. in Lacs)
1	Permanent Residential building.	1514.60	1254.47	Sq.ft	19.00
2	Temporary labour shed.		LS		1.00
3	Colony Roads @ 10%				2.00
4	Fencing		LS		5.00
				Total	**27.00**

Table 10.4 – PLANTATION.

Sl. No.	Item of Works.	Qty.	Rate. (Rs)	Unit.	Amount (Rs. in Lacs)
1	Procurement of 3000 plants of different species, jungle clearance, excavation of pits and plantation of plants including the care for 2 years, all complete.	LS			0.10
				Total	**0.10**

Table 10.5 SPECIAL T & P.

Sl. No.	Item of Works.	Qty.	Rate. (Rs)	Unit.	Amount (Rs. in Lacs)
1	10 Tonner Truck	1	16,00000.00	No	14.00
2	Bolero	3	9,00000.00	No	27.00
3	Jeep 4WD	1	500000.00	No	5.00
3	Ordinary T & P	LS			5.00
				Total	**51.00**

A. DETAIL ESTIMATES(CIVIL):

1. Name of the project : Tsutsung Yongki Hydro Electric Project.
Name of Work : Construction of Diversion Weir.

Sl. No.	Description of items.	Quantity	Unit	Rate in Rupees.	Amount in Lakh.
1	Jungle clearance.	250		30.60	0.077
2	Earthwork in excavation in river bed in soil mixed with boulders soft and disintegrated rocks not requiring blasting including de-watering and removing slush including lead and lifts and disposing the surplus soil as per directive of the Engineers in charge.	400	Sq.m	297.00	1.20
3	Earthwork excavation in river bed in hard rock requiring blasting including dewatering with lead and lifts.	30	Cum.	1400.00	0.42
4	Cement concrete M-100 laid and compacted including curing as specified in technical specification	62	Cum.	5178.72	3.21
5	Reinforced Cement concrete M-200 laid and compacted including curing as specified in technical specification.	350	Cum.	6350.00	22.22
6	Supplying, bending, binding and placing in position of steel reinforcement including cost of binding wire as per technical specifications.	14000	Kg.	71.00	9.94
7	Providing and fixing and removing of form work for plain and reinforced cement concrete.	400	Sq.m	183.30	0.73
8	Providing and fixing of boulders and stones of minimum size 300x300x200mm encased and packed in sausage wire mesh.	170	Cum.	671.00	1.14
9	Supplying, fabricating and installing vertical lift iron gate 2x1.70m including all mechanism and painting.	1	No	355000.00	3.55
10	Supplying, fabricating and fixing at site steel thrash rack size for entire area of diversion weir opening.	8700	Kg	85.00	7.40
				Total	49.887

2. Name of the project : Tsutsung Yongki Hydro Electric Project.
Name of Work : Construction of De-silting tank.

Sl. No.	Description of items.	Quantity	Unit	Rate in Rupees.	Amount in Lakh.
1	Jungle clearance.	100	Sq.m	30.60	0.03
2	Earthwork in excavation in ordinary soil all including lead and lifts.	100	Cum.	233.00	0.233
3	Earthwork excavation in soft and disintegrated rocks and soil mixed with boulders including all lead and lifts	50	Cum.	297.00	0.15
4	Cement concrete M-100 laid and compacted including curing as specified in technical specification.	3	Cum.	5178.72	0.155
5	Reinforced Cement concrete M-200 laid and compacted including curing as specified in technical specification.	75	Cum	6350.00	4.76
6	Supplying, bending, binding and placing in position of steel reinforcement including cost of binding wire as per technical specifications.	6800	Kg	71.00	4.83
7	Providing and fixing and removing of form work for plain and reinforced cement concrete.	120	Sq.m	183.30	0.22
8	Supplying and fixing C.I. Sluice valve having 300mm diameter, complete with nuts and bolts and end pipes.	1	No	100000.00	1.00
				Total	11.37

3. Name of the project : Tsutsung Yongki Hydro Electric Project.
Name of Work : Construction of Power channel, drainage and protections (2500m).

Sl. No.	Description of items.	Quantity	Unit	Rate in Rupees.	Amount in Lakh.
1	Jungle clearance.	62500	Sq.m	30.60	19.12
2	Excavation of Earth in Power channel Formation cutting including lift and lead	5250	Cum	226.00	11.86
3	Earthwork in excavation in soft soil mixed with boulders and clay including lifts and lead and disposing of soil as per instructions of engineer in charge.	18750	Cum	233.00	43.69
4	Earthwork in excavation in hard rock requiring blasting including lifts and lead and disposing as per instructions of engineer in charge.	1000	Cum	1400.00	14.00
5	Cement concrete M-100 laid and compacted including curing as specified in technical specification.	595	Cum.	5178.72	30.81
6	Reinforced Cement concrete M-200 laid and compacted including curing as specified in technical specification on power channel and 300m top slab.	1400	Cum.	6350.00	88.90
7	Supplying, bending, binding and placing in position of steel reinforcement including cost of binding wire as per technical specifications.	215744	Kg	71.00	153.18
8	Providing and fixing and removing of form work for plain and reinforced cement concrete.	13500	Sq.m	87.00	11.75
9	Coarse Rubble Stone masonry in cement sand mortar(1:6).	3000	Cum	1661.00	49.83
10	Supplying and pitching with boulders minimum size 300x300x200mm and packed with poles.	1500	Cum.	130.00	1.95
				Total	425.09

4. Name of the project : Tsutsung Yongki Hydro Electric Project.
Name of Work : Construction of Forebay & Spillover channel (160m)

Sl. No.	Description of items.	Quantity	Unit	Rate in Rupees.	Amount in Lakh.
1	Jungle clearance.	100	Sq.m	30.60	0.30
2	Earthwork in excavation in soft soil mixed with boulders and clay including lifts and lead and disposing of soil as per instructions of engineer in charge.	3249	Cum.	297.00	9.65
3	Excavation in hard rock requiring blasting including all lift and lead.	144	Cum.	1400.00	2.01
4	Cement concrete M-100 laid and compacted including curing as specified in technical specification.	285.17	Cum.	5178.72	14.77
5	Reinforced Cement concrete M-200 laid and compacted including curing as specified in technical specification.	252.512	Cum.	6350.00	16.03
6	Supplying, bending, binding and placing in position of steel reinforcement including cost of binding wire as per technical specifications.	45700	Kg.	71.00	32.44
7	Providing and fixing and removing of form work for plain and reinforced cement concrete.	3899.52	Sq.m	87.00	3.40
8	Coarse Rubble Stone masonry in cement sand mortar(1:6).	500	Cum.	1661.00	8.30
9	Filling back selected earth in layers including watering, consolidation with all lifts and lead, complete.	27	Cum.	99.00	0.027
10	Cement plaster (1:4)	900	Sq.m	127.00	1.14
11	Providing and fixing 300mm sluice valve with end pipes on both side, all complete.	1	NO.	100000.00	1.00
12	Providing thrash rack.		LS.	100000.00	1.00
13	Stone soling.	21.6	Cum.	130.00	0.028
				Total	90.095
				Say	90.00

5. Name of the project : Tsutsung Yongki Hydro Electric Project.
Name of Work : Construction of approach road to Forebay.

Sl. No.	Description of items.	Quantity	Unit	Rate in Rupees.	Amount in Lakh.
1	Jungle clearance.		Sq.m		
2	Earthwork in excavation in hard shale medium rock (E-class) soil including removal of spoil and lift up to 1.50m and lead up to 30m, all complete, NPWD schedule of rate on actual basis.				
	a) RD 0m –105m.	1648.50	Cum.	LS	
	b) RD 105m – 185m.	1423	Cum.		
	c) RD 185m – 238m.	915.60	Cum.		
	d) RD 238m – 292m.	736	Cum.		
	e) RD 292m – 315m.	282	Cum.		
	f) RD 315m – 348m.	404	Cum.		
	g) RD 348m – 386m.	452	Cum.		
	h) RD 386m – 424m.	452	Cum.		
	i) RD 424m – 540m.	1485	Cum.		
		7798.1			2.00
				Total	2.00

7. Name of the project : Tsutsung Yongki Hydro Electric Project.
Name of Work : Erection of Steel penstock, Construction of anchor and Saddle blocks.

Sl. No	Description of Items.	Quantity.	Unit.	Rate(Rs.)	Amount in Lacs.
1	Supplying, fabricating and installing at site the steel penstock, all complete as specification from pipe of IS-2002 grade 2A plates thickness 6 mm,875(Av) mm ID, test pressure of 15kg/cm.				
	a) Straight piece including bends.	25.30	MT	130000.00	32.89
	b) Expansion joints including nuts and bolts with packing glands etc.	2	MT	160000.00	3.20
	c) Bell mouth for 1000mm dia steel penstock.	0.25	MT	120000.00	0.30
	d) Bifurcation -1000mm x 750mm x750mm	0.50	MT	120000.00	0.60
2	Supplying and fixing iron saddle plates conforming IS 220 i/c bending all complete.	2	MT	130000.00	2.60
3.	Supplying and fixing 1000mm,C.I. sluice valve with end pipe, all complete,.	1	No.	400000.00	4.00
4.	Supplying and fixing 750mm C.I. sluice valve, all complete.	2	No.	150000.00	3.00
5.	Jungle clearance.	1870	Sq.m	30.60	0.57
6.	Earth work in ordinary soil mixed with boulders and clay.	922.23	Cum.	297.00	2.74
7.	Earth work in hard rock requiring blasting, all complete.	285.38	Cum.	1400.00	4.00
8.	Cement concrete M-100, all complete,.	65.491	Cum.	3319.00	2.17
9.	Reinforced cement concrete M-150,all complete.	103.12	Cum.	3945.00	4.07
10.	Supplying, bending, binding and placing steel reinforcement all complete.	14518.39	Kg.	75.00	10.89
11.	Providing and fixing form works, all complete.	1132.83	Sq.m	87.00	1.00
12.	Course rubble stone masonry work(1:6),all complete.	150	Cum.	1661.00	2.49
13.	Backfilling with excavated earth and boulders.	500	Cum.	99.00	0.49
14.	Excise against item no. 1 & 2.			@15%	3.52
15.	CST against item no. 1 & 2			@ 4%	0.94
				Total :	79.47
				say	79.50

8. Name of the project : Tsutsung Yongki Hydro Electric Project.
Name of Work : Construction of machine Foundation, Tail race and Protection wall.

Sl. No	Description of items.	Quantity	Unit	Rate in Rupees.	Amount in lacs
1.	Earthwork in excavation in soft soil mixed with boulders and clay including lifts and lead and disposing of soil as per instructions of engineer in charge.	579	Cum.	297.00	1.72
2.	Excavation in hard rock requiring blasting including all lift and lead.	55.48	Cum.	1400.00	0.78
3.	Cement concrete M-100 laid and compacted including curing as specified in technical specification.	29.12	Cum.	5178.72	1.51
4.	Reinforced Cement concrete M-200 laid and compacted including curing as specified in technical specification.	62.35	Cum.	6350.00	3.96
5.	Grouting of generators, Turbine & governors footing, all complete with M200 mixtures.	5	Cum.	6350.00	0.32
6.	Supplying, bending, binding and placing in position of steel reinforcement including cost of binding wire as per technical specifications.	5367.24	Kg.	33.52	1.80
7.	Providing and fixing and removing of form work for plain and reinforced cement concrete.	514.75	Sq.m	87.00	0.45
8.	Coarse Rubble Stone masonry in cement sand mortar(1:6).	94.50	Cum.	1661.00	1.57
9.	Earth mat, laying all complete.	1272	metre	179.00	2.28
10.	Fabricating and fixing of 8mm chequered plate, all complete.	2	MT.	62000.00	1.24
11.	Fabrication of frames & fixing MS channels, angles and flats of different size, all complete.	1.65	MT.	55000.00	0.91
12.	Spray paintings with approved quality and color, two or more coats on item No.11, all complete	1	Job	22500.00	0.225
13.	Earth pit for earthing i/c the cost of copper plate, salt etc. all complete.	6	No.	18500.00	1.11
14.	Welding of broken parts of economizer with CI rod and repairing of accessories etc. all complete.	1	Job	75000.00	0.75
				Total :	18.62

9. Name of the project : Tsutsung Yongki Hydro Electric Project.
Name of Work : Construction of Power House.

Sl. No	Description of items.	Quantity	Unit	Rate in Rupees.	Amount in Rupees.
1.	Earthwork in excavation in soft soil mixed with boulders and clay including lifts and lead and disposing of soil as per instructions of engineer in charge.	70.75	Cum.	233.00	0.165
2.	Cement concrete M-100 laid and compacted including curing as specified in technical specification.	3.939	Cum.	5178.72	0.021
3.	Reinforced Cement concrete M-150 in lintel, beam and cantilever, all complete.	33.23	Cum.	5889.73	1.96
4.	Supplying, bending, binding and placing in position of steel reinforcement including cost of binding wire as per technical specifications.	4323.12	Kg.	71.00	3.70
5.	Providing centering and shuttering in foundation and plinth, all complete as per specification.	46.64	Sq.m	87.0	0.04
6.	Providing centering and shuttering in lintel and beam all complete as per specification.	176.64	Sq.m	87.00	0.15
7.	Providing centering and shuttering in column and pillars all complete as per specification.	283.56	Sq.m	87.00	0.25
8.	Providing local woodwork A-II, dressed i/c fitting and fixing.	3.09	Cum.	15876.00	0.49
9.	1st class brickwork in foundation and plinth.	4.38	Cum.	3330.00	0.15
10	1st class half brick masonry(1:4) in super structure.	199.03	Sq.m	572.00	1.14
11	Supplying tubular truss i/c purlins etc. all complete.	417.25	Sq.m	200.00	0.84
12	Providing CGI sheet roofing with J hook etc. all as per specification.	430.05	Sq.m	90.00	0.39
13	Providing ridges, hips and valleys, all complete.	32	RM	500.00	0.16
14	Providing 63mm thick CGI sheet for walling, all complete as per specification.	171.80	Sq.m	500.00	0.86
15	Providing and fixing 38mm thick glazed steel windows, all complete.	27.99	Sq.m	2500.00	0.70
16	Providing and fixing 38mm thick fully paneled shutters for doors, all complete.	7.927	Sq.m	2500.00	0.20
17	Providing 40mmx30mm flat iron hold fast, 40cm long i/c fixing to frame, all complete.	24	No.	500.00	0.12
18	Providing MS round nuts and bolts of various size.	200	Kg.	75.00	0.15
19	Providing and fixing in position collapsible shutter i/c locking arrangement.	15	Sq.m	2500.00	0.37
20	Providing and fixing 25mm thick facia board, with 1st class local wood, all complete.	16.41	Sq.m	2000.00	0.33
21	Providing and fixing 100x50x1.9mm, MS	72	No.	45.00	0.032

	handle, all complete.				
22	Providing and fixing MS round or square bars all complete.	250	Kg.	45.00	0.11
23	Providing and fixing MS sliding bolts 300x16mm, all complete.	4	No.	250.00	0.01
24	Providing and fixing MS hooks and eye, 150mm size all complete.	34	No.	25.00	0.0086
25	Providing and fixing MS tower bolts of 750x10mm size all complete.	40	No.	300.00	0.12
26	Providing and fixing MS handle with screws, 150mm round, all complete.	34	No.	72.00	0.025
27	Providing 12mm thick cement plaster (1:3).	688.883	Sq.m	153.00	1.05
28	Providing 100mm thick boulder soling with approved quality of stone.	319.62	Sq.m	200.00	0.64
29	Providing floor finish, 62mm thick (1:3:6), all complete.	319.62	Sq.m	300.00	0.96
30	Providing cement concrete topping(1:1:2), all complete.	319.62	Sq.m	200.00	0.64
31	Providing and fixing 5mm thick plywood ceiling, all complete.	17	Sq.m	480.00	0.082
32	Applying priming coat with ready made mixed primer, all complete.	503.23	Sq.m	20.00	0.16
	Painting two or more coat with ready mixed paints, all complete.	85.98	Sq.m	32.00	0.027
33	Applying priming coat with ready mixed primer of approved brand.	15.852	Sq.m	25.00	0.04
34	Painting two or more coats with ready mixed paints, all complete.	15.852	Sq.m	32.00	0.005
35	White washing with lime on new works.	688.883	Sq.m	16.00	0.11
36	Providing apron furnishing 62mm thick with 1:3:6 cc works, all complete.	84	Sq.m	300.00	0.25
37	Construction of 225mm wide open surface drain, all complete.	88	m	350.00	0.30
38	Labour cost for erection of truss etc. all complete.	417.25	Sq.m	200.00	0.84
				Total :	16.9256
				Say	17.00

B. DETAIL ESTIMATES (ELECTRICAL).

1. Name of the project : Tsutsung Yongki Hydro Electric Project.
Name of Work : Construction of 11KV lines.

Sl. No.	Description of items.	Quantity	Unit	Rate in Rupees.	Amount in Lakh.
1	S.T. Pole SP - 35	10	No.	5078.00	0.578
2	Painting of Pole.	10	No.	220.00	0.022
3	Concreting collar of pole.	10	No.	375.00	0.037
4	Disc insulators 11KV.	40	No.	375.00	0.15
5	H.W. fitting with dead end clamp.	40	sets.	312.00	0.13
6	G.I. stay set 3/4"x6' long complete with stay wire.	10	sets.	456.00	0.0456
7	11KV pin insulator with GI Pin.	60	No.	79.00	0.0474
8	A.C.S.R Weasel.	10	KM	16927.00	1.693
9	G.I. wire 10 SWG.	300	KG.	29.00	0.087
10	Anti climbing device.	10	No.	38.00	0.0038
11	Cross arm made of M.S. 75x40x6mm 6' long.	20	No.	782.00	0.375
12	11KV gang switch complete.	1	Set.	7132.00	0.072
13	Misc. such as nuts & bolts HS blade, rope etc.			L.S.	0.025
				Sub-total:	3.2658
	Add 3% Contingency				0.10
	5% Transportation				0.163
	5% Storage				0.163
		Total			3.69
	Add contractors profit @ 10%				0.37
			Grand total		4.06

2. Name of the project : Tsutsung Yongki Hydro Electric Project.
Name of Work : Construction of 11/0.4KV/63KVA Pole mounting Sub-Station.

Sl. No.	Description of items.	Quantity	Unit	Rate in Rupees.	Amount in Lakh.
1	Transformer 11/0.43/63KVA.	1	No.	300000.00	3.00
2	S.T. Pole SP - 35	2	No.	5078.00	0.10
3	Painting of Pole.	2	No.	220.00	0.0044
4	Concreting collar for pole.	2	No.	375.00	0.0075
5	Disc insulator 11KV.	6	No.	280.00	0.017
6	Hardware fitting with dead end clamp.	6	No.	312.00	0.019
7	G.I. Stay set 3/4"x6' complete with stay wire.	2	set.	456.00	0.009
8	Stay clamp for SP - 35.	12	pair.	38.00	0.005
9	M.S. channel 100x50x6 mm.	185	Kg.	24.00	0.045
10	11KV pin insulator with GI pin.	3	No.	79.00	0.002
11	11KV gang switch complete.	1	set.	7132.00	0.073
12	11KV D O fuse complete.	1	set.	2587.00	0.025
13	Lightning arrester 11KV 9/10 KA.	3	No.	6277.00	0.19
14	M.S. nuts and bolts 2.5"x5/8".	10	Kg.	34.00	0.003
15	PVC cable 50mm 3.5 core.	25	metre.	231.00	0.056
16	Kit Kat fuse 200A .	6	No.	250.00	0.015
17	M.S. washer 5/8".	2	Kg.	26.00	0.0005
18	Street light fitting 1x40W complete with tube.	1	No.	1200.00	0.012
19	KWH meter 3-phase 4 wire50 A.	1	No.	595.00	0.006
20	Earthing complete with pipe and GI wire.	2	No.	780.00	0.016
21	Anti climbing device.	2	No.	38.00	0.0008
22	Misc. such as rope etc.			L.S.	0.005
23				**Sub-total :**	**3.6112**
	Note: contingency @3%				0.108
	Transportation @5%				0.18
	Storage @5%				0.18
	Labour charge @15%				0.54
				Total	4.6192
	Add contractors profit @ 10%				0.46
			Grand total		**5.08**

3. Name of the project : Tsutsung Yongki Hydro Electric Project.
Name of Work : Construction of 3 Phase, 5-Wire line with street lights.

Sl. No.	Description of Items.	Quantity.	Unit.	Rate.	Amount, Rupees in lacs.
1	S.T. Pole SP - 11.	17	No.	3358.00	0.57
2	Concreting of pole.	17	No.	375.00	0.064
3	Painting of pole.	17	No.	220.00	0.038
4	G.I. Stay set complete5/8"x6' long.	15	set.	276.00	0.042
5	Stay wire 7/12 SWG.	92	Kg.	45.00	0.042
6	G.I. D clamp 3"x3.5".	109	No.	19.50	0.02
7	Shackle insulator 3"x3.5".	92	No.	17.90	0.0165
8	A.A.C. Irish.	5.2	Km.	15346.00	0.8
9	G.I. Wire 8 SWG.	85	Kg.	29.00	0.024
10	M.S. nuts and bolts 2.5"x1/2".	45	Kg.	35.00	0.016
11	M.S. washer 1/2".	8	Kg.	24.00	0.002
12	Stay clamp for SP - 11.	109	Pair.	34.00	0.037
13	Street light fitting 1x40W complete with GI bracket.	6	No.	1500.00	0.09
14	Misc. such as rope etc.			L.S.	0.01
				Total :	1.7715
	Note: contingency @3%				0.531
	Transportation @5%				0.0885
	Storage @5%				0.0885
				Sub-total	2.48
	Labour charge @15%				0.372
				Total	2.85
	Add contractors profit @ 10%				0.28
			Grand total		3.13

4. Name of the project : Tsutsung Yongki Hydro Electric Project.
Name of Work : Construction of Step up Sub-station.

Sl. No.	Description of Items.	Quantity.	Unit.	Rate.	Amount, Rupees in lacs.
1	0.4/11KV, 1.2 MVA step up transformer .	1	No.	2500000.00	25.00
2	11KVA circuit breaker, three incoming and two out going.	1	Set.	500000.00	5.00
3	Steel pole SP-35.	6	No.	5076.00	0.30
4	MS channel 75x40x6mm	1000	Kg.	24.00	0.24
5	Concreting of pole.	6	No.	375.00	0.022
6	Painting of pole.	6	No.	220.00	0.013
7	11KV gang switch.	3	Set.	7132.00	0.213
8	11KV DC fuse.	2	Set.	2587.00	0.051
9	11KV lightning arrester.	1	Set.	18831.00	0.19
10	Earthing complete.	4	Set.	500.00	0.02
11	Stay set ¾"x6' complete with wire.	7	Set.	680.00	0.048
12	Stay clamp 3 ½".	7	Pair.	32.00	0.002
13	Single clamp for SP-35.	10	No.	20.00	0.002
14	11KV disc insulator with hard ware fittings.	20	Set.	592.00	0.012
15	Cable 150mm square, 3Core	200	Metre.	550.00	1.10
16	Cable socket 150mm square.	12	No.	57.00	0.068
17	11KV panel consisting of V.C.B.C.T 300/1Amp. P.T.OC/EF rely and metering etc.	1	No.	350000.00	3.50
18	24V, Nickel battery with charger.	1	No.	841500.00	8.415
19	11Kv cable, 3Core, 55mm sq.	100	Metre.	1134.00	1.33
20	Cable and cable box, for 50mm sq.	4	Set.	4500.00	0.018
21	Cable trench.			LS.	0.50
22	Transformer foundation.			LS.	0.20
23	Miscellaneous.			LS.	0.05
			Sub-total A:		46.294
	Add 13% for Contingency, storage & transportation on above.				6.02
			Sub-total B:		52.32
	Add 15% for labour charge.				7.84
			Total :		60.17
	Add contractors profit @ 10%				6.00
		Grand total			66.17

FINAL ABSTRACT OF COST: TSUTSUNG YONGKI HEP (2X500KW)

	CIVIL WORKS:	
Sl.no.	**Item of Works.**	**Amount in Lacs**
1	**Preliminary investigation.**	5.00
2	**Diversion weir and intake.**	50.00
3	**De-silting tank.**	11.37
4	**Power channel, cross drainage and protection wall.**	425.09
5	**Construction of Fore bay and Spill over channel.**	90.00
6	**Construction of anchor and saddle blocks and erection of Steel penstock pipes.**	79.50
7	**Construction of Power house building.**	17.00
8	**Construction of Machine foundation, tail race and protection wall.**	18.62
9	**Approach road to Fore bay.**	2.00
10	**Permanent Housing & Temporary housing.**	27.00
11	**Special & Ordinary T&P**	51.00
12	**Plantation.**	0.10
13.	**Land compensation.**	5.00
	Total :	**781.68**
	Add 2% for W/c estt.	15.63
	Add 13% for Departmental charges. (state share only)	45.00
	Sub-total on civil works:	**842.31**
II	**ELECTRICAL WORKS:**	
1	**Turbine, generators, control panels with neutral cubicle (generator line and neutral terminal cubicle), oil pressure unit for economizer and spares.**	300.00
2.	**Construction of 0.4/11KV, 1x1.20 MVA, sub-station.**	66.17
3.	**Construction of 3 Phase 5- wire L.T. line.**	3.13
4.	**Construction of 11/0.4KV/63KVA pole mounting sub-station.**	5.08
5.	**Construction of 11KV line.**	4.06
6.	**Erection of Turbines, Governors, Paneled boards and commissioning etc.**	30.00
	Total :	**408.44**
	Add 2% for W/c estt.	8.17
	Add 6% for Departmental charges.	24.50
	Sub-total on electrical works :	**441.11**
	GRAND TOTAL I + II :	**1283.42**