

## PROJECT HISTORY

The Planning commission of India has recognized the need for harnessing small hydro plants for meeting the rural areas energy need in extremely environmentally benign manner. The Govt. of India have entrusted Ministry of Non-conventional Energy Sources (MNES) with the task of overseeing the development of small hydro electric power generation up to installed capacity of 3MW which signified the thrust attached to the activity by the Govt. Recently commission for Additional Source of Energy(CASE) which governs the policy of MNES, has approved the policy of supporting the small hydro power development on a large scale with different investment support in terms of capital, subsidy on capital which will depend on capital which will depend upon the site (whether grid connected or non grid connected). Thou the plan target for small hydro power have been 200 MW but recently MNES has revised its plan largest to 600 MW in the remaining 3 years of plan (Minister of State for MNES – June 1993). IX five year plan.

- \* Under MNES subsidy schemes – 200MW
- \* Under IR&DA loan (World Bank) – 200 MW
- \* Under Fiscal Incentives through promotion policies - 200MW

Further capital subsidies as announced vide MNES Circular No. 6/1/36/92-SHP dated 22.06.1993 for all SHP project up to 3 MW capacities are as follows:

- a) For Grid connected project, MNES may provide subsidies up to 25% of the acceptable capital cost of civil works and E & M equipment including generator and transformers.
- b) For Non-Grid connected projects and projects in hilly regions (whether grid connected or non grid connected) MNES may provide subsidize up to 50% of acceptable

Capital cost for the civil works and E & M equipment including generators and transformers.

The projects are taken to be non-grid if the grid transformer is more than 9 kms away from the project site. Further, power from the SHP projects not connected to the grid or in hilly regions is to be supplied at reduced rates reckoned on a cost of generation calculated after netting out subsidy element from the capital cost.

The above element form the capital cost.

The above subsidies may be provided for projects whether in private, Government or Co-operative sectors etc. However, the loss making private and public sector entrepreneurs will not be eligible for grant of subsidy.



## **CHECK LIST**

1. NAME OF THE PROJECT	Pre-Feasibility study of Hydel Power Project Kharkai river at Kharkai -2
2. Location	
i) State	Jharkhand
ii) District	East singhbhum.
iii) Taluk	Kharkai
3.Category of Project	Hydel Power Scheme with a total installed capacity of 1.61 MW.
4.Planning: Has the overall development of the stream / canal been prepared and stages of development discussed briefly ?	The total drop available in the existing river Kharkai shall be utilized for power generation.
5.Have the site surveys been Carried out for the following Items and drawing prepared as Per prescribed scales?	
i) Stream/Canal surveys	Yes, necessary site surveys of river, navigation canal and sites of project components have been carried out and are given in (page no-26) drawings forming part of the project report.
ii) head work surveys	
iii) Plant and camp site	
iv) Water conductor system	
v) Power House, Switchyard, Tail Race	
vi) Communications	

6. Have the surveys for construction Materials been carried out?

Yes, materials of e good quality are available from in the vicinity of project site.

7. Hydrological & Meteorological Investigations  
Have the hydrological and meteorological investigations been carried out and data discussed in report

Yes, C/S And Velocity of flow has been evaluated and analyzed in the Hydrology r.

i) Rainfall

**Rainfall data of the area is included.**

ii) Gauge-discharge data Hydrology

8. Have hydrological studies been carried out to establish the availability of water for the benefits envisaged and what is the Dependability of the potential.

Yes, The power benefits have been based on **75% availability** of water.

9. Land Acquisition Resettlement

Have the provisions for land Acquisition and resettlement been Considered?

No, There is **no resettlement involved.**

10. Have the socio-economic problems

Involved in resettlement been Investigated and discussed?

Not applicable

11. Design

Has the layout of the project area Viz. Location of diversion structure, Workshop sheds offices, camp etc. Been finalized?

Yes

12. Have the preliminary design Prepared for the following Components?

i) Diversion structure

No

ii) Water conductor system

Yes

iii) Power House & Sub-station

Yes

iv) Power House Equipment, LT/HT

As per manufacturer's design/specification.

Equipment, and control and Protection equipment.

**13. Power Benefits**

Have the following points Discussed?

i) Total energy production & Installed capacity of the grid system.

Yes

ii) How does the scheme fit into

overall development of power of The region.	Irrigation, Developments of villages.
iii) Energy generation from the Project.	Yes
iv) Proposals for transmission or Connecting to the existing system.	N.A.
v) Cost of generation per kW installed, per kwh generated, as compared to the various and various services in the region to justify economic viability.	<b>Economically viable.</b>

#### 14.Estimate

Is the Preliminary estimate Prepared?	
Has the analysis of rates for various major items of works furnished with the basis of analysis and the price Index?	Yes. Preliminary Estimates prepared on 1999-2000 schedule of Jharkhand Government.

#### 15.Ecological & Environmental Aspects

Is the area likely to have any Environmental and ecological Problems due to the altered surface Water pattern. Preventive measures Discussed ?	No environmental or ecological problems will arise.
--	---

#### 16 Camps and Buildings Has the planning of camps/ Buildings been done? Soil Conservation

Yes

#### 17.Is the need for soil conservation Measures in the project discussed?

No

**Section – II**

**SALIENT FEATURES**

## SALIENT FEATURES

<b>1. Location</b> i) State ii) District iii) Taluka / mandal iv) Village v) Access – - Road - Rail vi) Geographical coordinates - Latitude - Longitude		Jharkhand East singhbhum Kharkai-2 Kharkai Approach up to river bank NH & SH Kharkai -2 22°8'8.12"N 85°5'15.5"E
<b>2. River Fall</b> i) Project ii) River		Kharkai-2K Hydel Project Kharkai river
<b>3. Hydrology</b> i) Design discharge ii) Water availability		16.50 cu mt/sce 75% dependable discharge
<b>4. Low Head / Channel Scheme</b> a) Head Regulator i) Total waterway ii) Minimum upstream water level for maximum discharge iii) Height of Roadway above Deepest Foundation		65 m 8 m 15 m

<b>b) Pen Stock</b>  i) Length ii) Dia = 600 mm  iii) Bed width  iv) bed slope  v) Fully supply depth  vi) Height of fall		300m Trapezoidal with irregular slopes  45 m  10 m  10 m,  45 m
<b>5. Power House</b> i) Type ii) Head-Gross - Design iii) Size of power house a) length b) Width c) Height iv) Installed capacity  v) Turbines - Type - Number - Capacity  vi) Type of Generator  vii) Power house crane capacity		Small Hydro  4 m  40m 20m 3.0 m above Ground level 1.61 MW  Horizontal full Kaplan 1 1.61 MW  Horizontal synchronous  E.O.T. 20 T



<b>6. Tail Race</b>  i) Shape  ii) Size  iii) Length  iv) Water level - Maximum  - Minimum  v) Number and size of D/T gates		Trapezoidal  Same as power channel  500 m  7 m  3 m  4 Number
<b>7. Power</b>  i) Installed capacity  ii) Seasonal maximum power  iii) Annual energy  Load factor		1.61 Mw  1.61 Mw  7051800 kwhrs.  0.5
<b>8. Switch Yard / Sub-station</b>  i) Voltage level  ii) Length of transmission		11kV / 33 kV  N.A.
<b>9. Estimate of costs</b>  i) Total cost  ii) Cost per Mw installed  iii) Cost of generation per kWh		8.1 Crore(approx)  5 Crore(approx)  Reduces to Rs. 2.00 after loan repayment

## **PROPOSED MINI HYDEL PROJECT AT KHARKAI-2**

### **Pre-feasibility report:-**

#### **1.1 Introduction:-**

The availability of electrical energy and its per capita consumption is regarded as an index of national standard of living in the present day civilization. Energy has become synonymous with progress. The lack of it and inadequate measures can throttle the entire economy and well being of the country. Thus the energy is considered as the basic input for any country for keeping the wheels of economy rolling.

Next to food, fuel and power are the most important activities on which national standard of living depends. After the requirement of food is fulfilled, every stride has been made to increase the power potential of the nation. It is also imperative that when power position increases, the production of food also increases.

The energy in the form of electricity is most desired as it is easy to transport, easy to control and clean its surrounding.

India is one of the youngest and yet largest democratic republic in the world. There are about six lakhs villages in India and cover a population of about 70% of the total population. There are no basic amenities and their standard of living is very low. It is imperative on the part of society to provide electricity to all villages in the shortest time.

Efforts for organizing the power supply in industry in the rational manner began only after independence. Planned power development in systematic manner began in 1951 with the launching of first five- year plans.



The per capita consumption in 1947 was only 12 kWh and it has increased to many folds in the current plan. But due to increase in population the shortage has also increase. Power supply to industry the number of unelectrified homes has considerably increased. This is because of the number of household is increasing at the rate of about 2.9 million a year where as the number of electrified house are increasing at the rate of 2.1 millions per year. The most a effected persons are from rural areas



## 1.1 HYDRO POWER DEVELOPMENT

The role of water in the taste of nation building needs no emphasis. The power developed by the water source in the world plays a very important role in the development of the world and nation.

Hydropower is the commercial source of energy with supplies 22% of the total electricity of the world in 1986. It has been estimated that currently a merely 17% of the world hydel potential is tapped. Even with the doubling of the hydro capacity by the year 2000, we would be tapping merely one-third of the world's hydro potential.

Although the hydro potential of the developing countries is far greater than that of developed countries, probably resource constraints have inhibited the growth of the capital-intensive hydro projects.

According to recent estimates, the world's total potential waterpower is probably equivalent to 1500 millions kW at mean flow. This means that the energy generation at a load factor of 50% would be 6.5 million kWh, a quantity equivalent 3750 million tons of coal if generated in coal fired steam station at 20% efficiency.

As from being perennial and inexhaustible source of energy, it represents the cheapest source of energy in our country. Its development is based on the use of indigenous technological skills, material and labour and can be achieved in least strain on the nation economy. The cost of hydroelectric project (capital and running) is comparatively smaller than thermal as well as nuclear project based on natural uranium reactor technology as the foreign component required are comparatively less. The economic advantage from the point of view if system operation clearly indicates the need for greater tempo of hydroelectric development in the country.

As foreign exchange in hydroelectric power generation is comparatively less than thermal or nuclear generation, therefore, it is necessary to harvest energy drop of water and utilize every meter of head to develop maximum amount of hydropower. The cost of hydropower should not be based on the cost per kilowatt installed but on the cost of energy that can be produced. At present stage, the primary role of hydro station in most areas of the country is to provide peaking capacity operating in coordination with base load thermal or nuclear stations.

India with vast geographical expansion, varying climate, and topographic feature faces a challenging in the field of water resource development. The major difficulty in the development of the hydro electric project is that it takes relative longer time for its hydrological, topographical, geological and economical investigation as well as time required for its construction is also large. Among the topographical geological and seismological limitation, lack of suitable surface storage is a major problem. The hydro development in the country is caught the web of short planning horizon, rising cost, constraints of financial resources organizational deficiencies, long construction period and lack of sophisticated construction equipments. Constraints associated with obtaining environmental and forest clearance for hydro and transmissions have further added to the existing problems. The total national share of hydropower has been declining over the year become of these factors.

Due to above mention reasons, government has taken a decision at the issue of accelerated hydro-development related issues of developing mini/ micro hydro projects. It has gained importance in the context of our national policy to extent the facility of electricity even to the remotest area where the cost of taking electricity to thin population density area (particularly hilly terrain of Chotanagpur plateau) is high due to long transmission and network involved. To overcome this problem, greater emphasis is given for development of mini/micro projects, which can meet the power requirements of the local people in such remote area and to improve the standard of living. The industry will grow faster and the employment for the local people will be

generated. The country has about 5000MW mini/micro potentials. Detailed investigation of large no. of schemes are also under process . The future plans should take this renewable source of energy generation into consideration and earmarked funds provide for development of mini/micro hydro projects.

To provide electricity to the remotest village and to improve their living standard by installing small-scale industries, developing tourist spots, it is high time to plan for mini/micro hydro projects especially in the hilly terrain of Jharkhand plateau. Hence Government of Jharkhand has taken a right step in this direction. Hence Government has directed to prepare the feasibility of installing mini/micro hydro projects.





## 2. PROPOSED SITE

The proposed project is at a distance of about 245 kms from the state capital Ranchi and is 48 kms away from Manoharpur railway station . Its longitude and latitude are 85°5'15.5"E and 22°8'8.12"N respectively.

The area surrounding the falls has a beautiful forest with undulating terrain. There are two populated village namely Guha and Barkel Village about 2 to 8 kms. from the falls and the other villages at a distance of about 10 kms. Their population are five thousands and eight thousands respectively. Their standard of living is poor as there is no infrastructure. Their living hood of living is agriculture and dairy only. This region is not well connected with all weather roads. It will become a great tourist spot in future. Hence there is a need to develop this area by providing infrastructure like power generation etc.

Once this area gets electricity, industries will grow fast and living standard of people around this area will improve. Hydro plant can be installed here, as it has got railway station named Manoharpur only 48 kms away from the proposed site. State highway from Chaibasa to Manoharpur.. from the site which can be linked easily up to the falls where the plant is to be installed. Hence the site is suitable for installing a mini hydro generating plant as it has got sufficient energy to generate electric powers. The topography of the area has got some peculiarity. The river with high bank flows and falls through a flatter slope. These are shown in fig-1 and fig-2.

The source of water from stream (nala) Kharkai river, converge into a stream. These tributaries carry water into a stream flowing and falls through about 3 to 4.0 mts. And then flows through Kharkai river shown in fig.. water flows in three steps having falls of 6m., 10m.. approximately and then meet River Kharkai The powerhouse is planned to install at about 14 m. from the top .

A suitable dam of height 12m. and about 25 m. long is suggested to store the water needed to generate electricity. From local enquiry, the highest water level during storm is 10 m. and lowest water level is about 1m.



## **PRELIMINARY INVESTIGATION**

The purposes of preliminary investigation are to provide sufficient information to find out the practicability of the proposed scheme and to choose between alternative schemes. The preliminary design and estimations can be proposed and recommendations are made with reasonable confidence

**1) HYDROLOGICAL INVESTIGATION:** The hydrological investigation includes the investigation of water availability, storage capacity, head of water available, and load center from the plant and approach to the site by the rail or road.

**1.1) WATER AVAILABILITY:** Run of data at the proposed site has collected from 1983 to 2003 from irrigation department.

The rainfall data collected is tabulated in table no 1 analysis of runoff (rainfall data)

**1.2) GROUND WATER DATA:** underground movement of water has important effect on the stability of ground slope and also on the stability of ground slope and also on the amount and type of grounding required to prevent leakage.



## **GEOLOGICAL INVESTIGATION**

Almost in all major civil engineering projects, Geological advice is most essential. Geological investigation cost varies a little in comparison to the total cost of the project. This relatively small amount represents a valuable insurance against expensive difficulties.

The geological investigations are required to give detailed information about the following terms

1. Water tightness of reservoir basin
2. Suitability of the foundation for the dam
3. Geological and structural features, such as floods, fault, fissures etc. of rock basin.
4. Type and depth of overburden.
5. Location of permeable rock of any strata.
6. Ground water conditions.
7. Location of quarry site for the material required.

The nature of the subsurface geology should be explored by trial bores or various means of explorations.

### **TYPE OF ROCKS:-**

The area is having a rocky terrain from visual inspections; the rock is of granite type. Granite rocks have good strength and it is suitable for foundation of dams and powerhouses. Geological and structural features such as fault zone, fissures etc. can be ascertained by taking bore hole drilling and analyzing the rock cores. Quarry sites are available close to the site for construction work.



## **CONSIDERATION OF WATER POLLUTION AND ITS EFFECT**

The effect of polluted water on the power plant is one of major consideration in selecting the site hydraulic power plant. Water sample after taste indicates that pH value; turbidity etc. is well within the prescribed limit.

### **Sedimentation effects.**

The sedimentation of the reservoir is important from two points of views. The sedimentation rocks, the capacity of the reservoir and it further causes rapid erosion of the turbine blades. In the proposed site the causes of these effects is negligible as terrain is hilly with rocks near the ground.

### **Environmental aspects of site selection:-**

The site selection should fulfill all the following requirements.

- A. To assure safe, healthier, productive and culturally pleasing surroundings
- B. To avoid the health hazards.
- C. To preserve important historic, cultural and natural aspects of the site.

All the above condition satisfies the proposed site for mini hydroelectric project.



## **Environmental impact Assessment**

1. Mini hydel scheme envisages the power generation from existing discharge canal and this development is without any additional poundage. Mini hydel development projects, while sharing all the benefits of hydro electric generation, harnesses a renewable source of energy in extremely environmentally benign manner. Social cost therefore is almost nil to even an environmental conscious state. Being small it does not involve any additional submergence or violation of the sanctity of forests.



## ANALYSIS OF RAINFALL DATA

The rainfall data from 1983 to 2003 has been shown in table no. 1

The following observation are made:

(A) Refer table no 2: the average rainfall from Jan to Dec for the above mentioned period (21<sup>ST</sup> YEARS) is 119.91 cm.

Monsoon rainfall from June to September is 244.93 % of the average rainfall during 21<sup>st</sup> year whereas from Jan to May it amounts to 20.97 % and from Oct to Dec it amounts to 38.45 % of average discharge. Hence, it is necessary to store the water for continuous generation of power, as there is a wide variation in rainfall during the year. The storage capacity can be so calculated with the help of mass curve.

Table 3 shows the yearly average rainfall (21 years data).

The average rainfall is 119.91 cm.

Assuming 20 % losses, the estimated rainfall per year comes out to be  $(119.91) \times (1-0.2) = 95.93 \text{ m}^3/\text{sec}$ .

So from probability theory chances of average rainfall 119.91 cm. Is about 33 %. (Column 6 of table).

For 95.93 cm rainfall, it is about 60 % (Column 6).

Even for the worst case rainfall of 90 cm the probability is 75 %.

Hence, it is suggested that 100 cm rainfall, the hydro – electric project can be analyzed.

Catchment area of the Subarnrekha river = 307 sq. kms.

### Discharge calculation:

(a) Ryve's Formulae

$$\begin{aligned} Q &= C A^{2/3} & C &= 10.1 \text{ (For hilly area)} \\ &= 10.1 \times 307^{2/3} \\ &= 468.49 \text{ cu mt} \end{aligned}$$

(b) From catchment area and corresponding annual rainfall of 100 cm.

Total water available for power generation

$$= A \times 10^6 \times 1 \times 0.8 \text{ cubic meter per year}$$

$$= (307 \times 10^6 \times 1 \times 0.8) / (365 \times 24 \times 3600) = 16.50 \text{ cu mt}$$

$$P = 1.61 \text{ Mw.}$$

$$H = 30 \text{ m.}$$

## RAINFALL DATA (TABLE1)

Monthly Rain fall Data from year 1983-2003

Year	Jan.	Feb.	Mar	April	May	June	July	Aug	Sept.	Oct.	Nov.	Dec
1983	23.00	10.80	21.50	19.50	61.00	120.50	310.50	305.75	203.50	83.20	15.70	0.00
1984	20.15	0.00	29.50	20.20	57.00	140.30	315.62	298.85	209.60	90.35	0.00	7.50
1985	10.70	7.91	23.00	10.50	67.23	160.70	302.65	290.52	180.72	75.40	19.60	8.90
1986	12.59	15.50	18.70	8.70	57.50	150.85	298.76	309.85	130.52	71.58	20.00	9.00
1987	15.82	11.72	22.35	0.00	60.35	161.72	280.50	325.65	280.53	90.50	30.50	7.82
1988	7.52	5.98	21.52	7.52	59.52	154.50	301.52	320.25	290.62	91.32	11.25	12.72
1989	19.60	6.60	16.25	15.80	60.75	153.73	309.00	340.20	215.62	95.52	13.65	20.80
1990	18.52	10.52	18.52	19.72	45.70	140.75	315.75	360.52	270.82	96.73	31.00	11.62
1991	15.00	8.59	10.00	13.50	35.50	165.00	325.82	298.30	260.75	99.50	17.59	15.30
1992	16.35	20.52	0.00	20.20	47.80	135.23	300.55	285.10	250.25	81.61	19.60	17.80
1993	13.80	15.72	7.52	7.00	49.50	90.50	292.80	270.40	230.70	70.50	13.50	19.00
1994	14.59	27.53	9.10	18.50	38.50	85.72	270.72	333.00	199.55	65.20	17.80	25.20
1995	11.00	21.52	7.95	15.75	35.20	100.23	325.65	289.99	170.72	63.72	9.00	13.70
1996	9.50	9.50	12.75	27.52	31.55	125.70	310.20	310.57	198.82	90.52	13.70	15.00
1997	25.70	10.72	19.80	19.25	33.72	165.51	311.52	315.85	215.70	75.00	21.50	18.59
1998	21.23	25.00	20.50	10.55	10.52	143.25	330.52	320.75	250.50	85.35	29.30	19.00
1999	20.50	27.00	23.62	17.00	15.70	139.52	270.95	399.85	280.00	86.72	30.70	10.50
2000	17.23	15.72	28.00	13.55	29.72	136.25	299.85	309.00	281.82	70.62	23.20	18.00
2001	18.70	18.00	23.50	15.72	40.50	135.30	310.65	340.51	198.00	85.80	28.50	7.85
2002	0.00	19.70	19.00	12.55	43.82	138.40	320.55	360.00	190.52	86.00	25.00	15.80
2003	7.20	20.50	15.50	9.00	44.55	150.50	330.00	320.50	210.52	80.00	27.50	17.00

TABLE 2

Rainfall Data From 1983 TO 2003 Month wise in mm

January	318.70
February	309.05
March	368.58
April	302.03
May	923.63
June	2894.16
July	6434.12
August	6705.41
September	4719.78
October	1734.14
November	418.59
December	291.10
Total	25419.24

Average (21 years record) = 1199.15 mm.

During monsoon period ( June to September) amounts to 244.93 % of average discharge.

Whereas from January to May amounts to 20.97 % of average discharge and October to December amounts to 38.45 % of average discharge.

**Geological investigation TABLE no-3**  
**Rainfall Data From 1983 to 2003 in mm**

Year	Rainfall (cm)	Values Arranged Analyzed in order of Magnitude	Order	Frequency
1983	1174.95	1340.17	1	2.3
1984	1189.07	1322.07	2	7.14
1985	1155.85	1289.24	3	11.90
1986	1103.55	1287.46	4	16.67
1987	1287.46	1267.52	5	21.43
1988	1289.24	1264.85	6	26.19
1989	1267.52	1242.96	7	30.95
1990	1340.17	1232.86	8	35.71
1991	1264.85	1232.77	9	40.47
1992	1197.01	1223.34	10	45.24
1993	1080.94	1223.03	11	50.00
1994	1103.41	1197.01	12	54.76
1995	1064.43	1189.07	13	59.52
1996	1155.33	1174.95	14	64.28
1997	1232.86	1155.85	15	69.04
1998	1036.47	1155.33	16	73.81
1999	1322.07	1103.55	17	78.57
2000	1242.96	1103.41	18	83.33
2001	1223.03	1080.94	19	88.09
2002	1223.34	1064.43	20	92.85
2003	1232.77	1036.47	21	100.00

For average rainfall of 119.91 cm from the table is 42 %.

For 100 cm rainfall causes is 62 %.

For 90 cm rainfall causes is 75 %.

## **Electro Mechanical Works**

**General :** The major impediment observed for the slow progress of such low head schemes were the high cost per kilowatt of Electromechanical equipment and conventional civil works design. Regrettably Indian manufacturers of such equipment till recent past were not competitive on low head installations. However indigenous manufacturers/suppliers are now able to offer a variety of low cost efficient designs suitable for a wide range of flow and heads. These machinery offer economic solutions comparable to global standards. Improved designs, better equipment have reduced electromechanical and subsequent civil cost substantially.

Based on the techno economic studies and choice of scheme, the selection of electromechanical has been worked out. Efforts have been made to adopt standardized equipment available.

**Fortune:** Keeping in view the head and discharge conditions which are varying from 5 to 15 m and 43-63 m<sup>3</sup>/s respectively different type of turbines and installations from different manufacturers depending upon their standard equipment design were considered. Following types of turbines are found suitable for this range of head and discharge conditions and their variations. The average weighted head works out to be 10.0 m and accordingly turbines is to work at a rated head 10 m with maximum and minimum head about 15 to 5.0 m. However the operation at maximum and minimum head will depend the operating range of actual tendered equipment which differs from manufacturer to manufacturer. For the estimation purpose for the Semi Kaplan type flow the operating rated net head works out to be 8.0 m and operating range will be from 10.0 to 5.6 m.

1. Horizontal Tubular Turbine
2. Vertical Tubular Turbine
3. Vertical flume Francis Turbine

The type of turbine and layout, the most suitable to the site shall entirely depend upon the actual tendering of the equipment. Because at the stage of preparing detailed project report it is not desirable to specify the single type of turbine and layout. Based on the actual cost of turbine, consequent cost of power house building and operation and maintenance cost the selection for the turbine is recommended.

For the purpose of project report and to know the cost involvement, a reasonable estimation is being made. Horizontal S-Tubular turbine which at present appears to be logical choice due to its widest application range is included in the detailed cost analysis. However the technical specification should include the other options and techno economic evaluation should be carried out.

**S-Tubular Turbine:** It is proposed to install horizontal shaft tubular turbine with fixed guide vanes and adjustable blades to generate 1500 kW output at generator terminals under rated head and nominal speed. The nominal diameter of runner is and shall have 4 cast (13% Cr 4% Ni) stainless steel blades, Carbon steel hub and associated internals. The turbine shall be coupled to gear box to gear up speed. The turbine shall be coupled to gear box to gear up speed. The turbine runner diameter may be of 1900 mm will rotate at about 250 rpm.

This turbine would give simple arrangements with appreciable cost reduction and least maintenance. Even with major fluctuations in the water supply this gives relatively high efficiency i.e. high energy yields. It shall involve small dimensions of power house. The shallow bend in the water passes reduces the depth of excavations.

**Speed Increaser (Gear Box) :** Speed of such types of turbines are on lower side. The size of standard low speed generator is larger. Therefore generator required to match with such turbine will be costly. In order to achieve cost reduction in size and cost of the generator, the speed increaser shall be used. The gear box ratio will depend upon the speed of turbine and generator which is designed for 250 rpm to 750 rpm.

**Generator:** Small hydel scheme is located in the area where a stable network of electric grid owned by NTPC is available. Accordingly two numbers of standard induction (asynchronous) generators having rating of 1500 kW each are proposed to be installed with a terminal voltage of 3.3 kV, 3 Phase, 50 Hz and 750 rpm.



The generators shall be natural air cooled, self ventilated and shall be designed to withstand the runaway speed of the turbine up to 20 minutes without any detrimental effect. The generators will operate in parallel with grid. This generator should have magnetizing reactance. The rotor of induction generators will be of squirrel cage type with low leakage reactance and resistance rotor bars so as to have a good efficiency and power of factor. The generator does require any external excitation system. These take excitation from the grid itself. However, a capacitor bank of the order of 600 kVAR maybe connected in parallel to each generator to compensate the lagging kVAR drawn by generator which in turn will maintain the power factor of the system.

The generator shall be star connected three line terminals and neutral leads shall be brought out to the terminal box. The generator neutral shall be directly connected to earth through an isolating switch. Proper interlocks shall be provided so that at any time one neutral isolation switch is closed to earth.

While using Induction generator, newly developed electro-hydraulic governing system is envisaged to be used. It will not have features for speed regulation but will be actuated by the upstream water level. Runner blades will be adjustable based on water level. In the event of the system failure the turbine is shut down or generated with a partial opening at no load. Thus maximum utilization of water discharge is achieved. These types of systems are available in standard packages from different manufacturers.