

PROJECT HISTORY

Planning commission has recognized the need for harnessing small hydro 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) who 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 has 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 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 25 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.



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|------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| 1. NAME OF THE PROJECT | Pre-Feasibility study of Hydel Power Project Sbarnarekha-4 at Sbarnarekha river |
| 2. Location | |
| i) State | Jharkhand |
| ii) District | East Singhbhum |
| iii) Taluk | Sbarnarekha-4 |
| 3. Category of Project | Hydel Power Scheme with a total installed capacity of 1.02 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 Sbarnarekha 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 | |
| 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 chapter.
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, as 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 Equipment, and control and Protection equipment.	As per manufacturer's design/specification
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, Development 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.

Economically viable.

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

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1. Location i) State ii) District iii) Taluka / mandal iv) Village v) Access – - Road - Rail vi) Geographical coordinates - Latitude - Longitude		Jharkhand East Singhbhum Sbarnarekha Ichagarah, Senduri, Baratakur pahar. Approach up to river bank S.H. N.A. Sbarnarekha 23.°15'0.25"N 86°45'3.8"E
2. River Fall i) Project ii) River		Sbarnarekha -4 Hydal Project Sbarnarekha River
3. Hydrology i) Design discharge ii) Water availability		20.07 cumt/sce. 75% dependable discharge
4. Low Head / Channel Scheme a) Head Regulator i) Total waterway ii) Minimum upstream water level for maximum discharge iii) Height of Roadway above Deepest Foundation		25-30 6 m 8-10 m

b) Pen Stock 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 25-30 m 10 m 30 m, 30 m
5. Power House 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		Mini Hydro 6 m 40m 30m 6.0 m above Ground level 1.02 MW Horizontal full Kaplan 1 1.02 MW Horizontal synchronous E.O.T. 20 T

6. Tail Race 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 13 m 3 m 4 Number
7. Power i) Installed capacity ii) Seasonal maximum power iii) Annual energy Load factor		1.02 Mw 1.02 Mw 4467600 kwhrs 0.5
8. Switch Yard / Sub-station i) Voltage level ii) Length of transmission		11kV / 33 kV N.A.
9. Estimate of costs i) Total cost ii) Cost per Mw installed iii) Cost of generation per kWh		5.1 Crore(approx) 5 Crore(approx) Reduces to Rs. 2.00 after loan repayment

PROPOSED MINI HYDEL PROJECT AT SUBERNAREKHA-4

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 an important activity 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 keep clean its surroundings.

India is one of the youngest and yet largest democratic republic in the world. There are about six lakes 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 a rational manner began only after independence. Planned power development in systematic manner began in 1951 with the launching of first five- year plan.



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 increased. Power supply to industry causes the number of unelectrified homes has considerably increased. This is because of the number of households are increasing at the rate of about 2.9 million a year where as the number of electrified houses are increasing at the rate of 2.1 millions per year .The most 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 labours and can be achieved in least strain on the nation economy. The cost of hydroelectric project (capital and running) is comparatively less than thermal as well as nuclear project based on natural uranium reactor technology as the foreign components required are comparatively less. The economic advantage from the point of view of system operation clearly indicates the need for greater tempo of hydroelectric development in the country less smaller 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 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 providing 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 investigations of large number 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 and has directed to prepare the feasibility of installing mini/micro hydro projects.



2. PROPOSED SITE

The proposed project is at a distance of about 235 kms. from the state capital Ranchi and is 25 kms. away from chandil railway station. Its longitude and latitude are $86^{\circ}45'3.8''\text{E}$ and $23^{\circ}15'0.25''\text{N}$ respectively.

The surrounding area of the falls has a beautiful forest with undulating terrain. There are populated villages namely Ichagarah, Senduri, Baratakurphara, about 5 to 10 kms. from the falls and the other village at a distance of about 5 kms. Their populations are Nine thousand five hunderade. Their livelihood depends on agriculture and dairy, farming with no infrastructural development like well connected all-weather roads and electricity supply, the standard of living is very poor .However this area has picturesque surroundings and has the potential to be developed into a tourist spot. Hence there is a need to develop this area by providing infrastructure like electricity.

Once this area gets electricity, industries will grow fast and living standard of people around this will improve. Hydro plant can be installed here, as it has got railway station named only 10 kms. from the proposed site. State highway from Ichagarah to chandil is only 20km 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.

The source of water from stream (nala) Sbarnarekha river converge into a stream. These tributaries carry water into a stream flowing and falls through about 4to 5 mts. The powerhouse is planned at about 16 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 inquiry, 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 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 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 faults, 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 of major consideration in selecting the site hydraulic power plant.

Water sample after processing 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. 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 (21ST YEARS) is 144.12 cm.

Monsoon rainfall from June to September is 221.86 % of the average rainfall during 21st year whereas from Jan to May it amounts to 38.46 % and from Oct to Dec it amounts to 40.00 % 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 144.12 cm.

Assuming 20 % losses, the estimated rainfall per year comes out to be $(144.12) \times (1 - 0.2) = 115.29$ cm

So from probability theory chances of average rainfall 144.12 cm Is about 33 %. (Column 6 of table).

For 115.29 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 Sarnarekha river = 300.00 sq. kms.

Discharge calculation:

(a) Ryve's Formulae

$$\begin{aligned} Q &= C A^{2/3} & C &= 10.1 \text{ (For hilly area)} \\ &= 10.1 \times 300^{2/3} \\ &= 461.30 \text{ cumt} \end{aligned}$$

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

Total water available for power generation

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

$$= (300 \times 10^6 \times 1 \times 0.8) / (365 \times 24 \times 3600) = 20.07 \text{ cu mt/sec}$$

$$H = 15 \text{ m}$$

$$P = 1.02 \text{ Mw}$$

RAINFALL DATA (TABLE1)

Monthly Rain fall Data from year 1995-2002

Year	Jan.	Feb.	Mar	April	May	June	July	Aug	Sept.	Oct.	Nov.	Dec
1983	27.50	0.00	23.20	61.21	131.25	180.85	289.50	330.25	251.00	115.51	25.50	20.50
1984	19.65	16.85	25.60	72.50	130.00	171.29	301.00	335.25	245.20	123.60	21.00	10.65
1985	15.00	13.60	22.50	65.25	129.50	160.55	315.51	345.00	231.50	124.00	15.65	7.29
1986	25.25	12.00	19.60	63.20	120.65	155.23	321.50	331.23	255.65	111.52	13.25	0.00
1987	21.62	0.00	18.52	59.50	131.30	145.50	270.23	311.52	251.25	115.00	12.00	15.52
1988	10.55	7.59	10.59	60.00	121.20	159.59	291.52	299.80	265.35	120.52	13.00	25.25
1989	13.75	19.60	27.60	0.00	115.20	190.62	325.32	270.52	263.60	121.00	17.50	30.20
1990	20.50	21.50	29.65	70.59	111.23	171.52	330.50	319.59	264.55	113.29	0.00	17.50
1991	17.65	10.59	17.85	65.35	119.59	173.60	311.25	325.80	270.25	100.25	7.59	11.23
1992	28.52	15.60	13.59	64.50	135.60	162.52	325.60	339.75	261.30	99.55	21.52	13.50
1993	29.50	13.20	24.20	63.58	123.20	180.00	331.25	340.55	230.52	120.20	22.65	19.20
1994	23.60	17.62	21.52	55.50	134.71	189.59	299.00	365.62	245.90	121.52	29.25	21.00
1995	0.00	10.00	22.40	45.59	133.52	165.55	270.20	370.75	253.80	123.60	32.20	15.52
1996	13.50	11.55	22.00	69.25	137.65	167.00	380.50	380.50	260.52	129.35	31.50	12.50
1997	14.25	13.60	0.00	67.25	127.25	170.52	350.23	331.25	259.60	140.55	27.50	11.25
1998	12.50	20.50	9.52	58.85	129.23	152.23	265.26	321.50	243.50	121.20	29.25	13.30
1999	18.65	0.00	20.60	53.65	131.52	154.59	273.39	315.25	233.60	112.52	31.50	10.50
2000	27.80	7.59	29.59	49.50	139.00	159.50	291.52	320.30	233.00	115.00	28.59	13.00
2001	30.50	13.60	30.50	51.00	137.00	162.62	299.85	319.00	200.55	110.25	21.00	15.52
2002	32.50	15.50	10.00	71.20	123.30	167.85	305.25	335.55	199.50	109.25	0.00	8.20
2003	21.65	19.65	15.50	54.30	127.80	181.55	315.00	338.00	230.50	105.52	16.50	9.65

TABLE 2

Rainfall Data From 1983 TO 2003 Month wise in mm

January	487.74
February	260.14
March	414.53
April	1221.77
May	2690.00
June	4522.27
July	6473.38
August	7268.20
September	5150.64
October	2453.20
November	416.95
December	301.28
Total	31660.1

Average (21 years record) = 1441.21 mm.

During monsoon period (June to September) amounts to 221.86 % of average discharge.

Whereas from January to May amounts to 38.46 % of average discharge and October to December amounts to 40.00 % 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	1465.27	1616.82	1	2.3
1984	1472.59	1524.83	2	7.14
1985	1445.35	1513.25	3	11.90
1986	1429.08	1498.05	4	16.67
1987	1351.96	1481.55	5	21.43
1988	1384.96	1472.59	6	26.19
1989	1395.21	1470.42	7	30.95
1990	1470.42	1465.27	8	35.71
1991	1431.00	1445.35	9	40.47
1992	1481.55	1435.62	10	45.24
1993	1498.05	1433.13	11	50.00
1994	1524.83	1431.00	12	54.76
1995	1433.13	1429.08	13	59.52
1996	1616.82	1414.39	14	64.28
1997	1513.25	1395.21	15	69.04
1998	1376.84	1391.39	16	73.81
1999	1355.77	1384.96	17	78.57
2000	1414.39	1378.10	18	83.33
2001	1391.39	1376.84	19	88.09
2002	1378.10	1355.77	20	92.85
2003	1435.62	1351.96	21	100.00

For average rainfall of 1445.35, causes 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 machineries 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 m³/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 hum 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.